Section 4

Mono Basin Tributaries:
Lee Vining, Rush, Walker, and Parker Creeks

Monitoring Results and Analysis
For Runoff Season 2006-2007

FINAL REPORT

Monitoring Results and Analyses for Runoff Year 2006-07

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April 25, 2007

Mono Basin Tributaries:
Rush, Parker, Walker, and Lee Vining Creeks

Monitoring Results and Analyses for
Runoff Year 2006-07

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1 INTRODUCTION

The monitoring program on Rush and Lee Vining creeks continued in Runoff Year 2006, with less intensive field monitoring activities but continued data collection by instrumentation. Runoff Year (RY) 2006 was the tenth consecutive year of monitoring in the Mono Basin for Dr. Trush (Figure 1), and the eighth official year following the State Water Resources Control Board (SWRCB or Board) Decision 1631 and Order 98-05. The Runoff Year also brought the first Wet water year and highest peak flows since 1998. Primary data collection activities included: (1) continued monitoring of Rush Creek groundwater elevation at Piezometer 8C-8 and stream stage at cross section -9+82; (2) continued temperature monitoring at 11 thermograph locations on Rush, Parker, Walker, and Lee Vining creeks; (3) observations on riparian vegetation germination and recruitment at the 3D, 8, and 4 floodplains of Rush Creek; (4) snowmelt flood inundation mapping at the 8 and 4 floodplains; and (5) mapping of large wood pieces on Rush Creek marked in previous years and transported by 2006 snowmelt flood.

In addition to field data collection, the stream scientists (B. Trush and C. Hunter) appointed by the SWRCB evaluated the Termination Criteria specified in Order No. 98-05 and submitted letters to the SWRCB recommending specific changes to the Termination Criteria be adopted by the Board.

2 HYDROLOGY

2.1 Runoff Year 2006-07 Hydrographs

Rush Creek

The RY 2006 snowmelt peak on Rush Creek was the largest magnitude and longest duration flood event observed since RY 1998 for ‘Rush Creek at Damsite’, ‘below the Return Ditch’, and ‘below the Narrows’ (Table 1). Flows for ‘Rush Creek at Damsite’ and ‘Rush Creek Below Return Ditch’ peaked at 483 cfs and 477 cfs, respectively (Figure 2), roughly the same magnitude because Grant Lake filled and spilled beginning May 23, 2006, and thus propagated the peak downstream of Grant Lake. Recurrence intervals (RI) for those peaks were approximately 10 years for both locations (using the regulated period of record). This peak exceeded the targeted minimum Wet year Stream Restoration Flow (SRF) release of 450 cfs specified in Order No. 98-05 by 33 cfs. All these locations had a peak date of June 7, 2006. The peak flow below the Rush Creek Narrows was 584 cfs (RI = 11 years) on June 8, 2006 (Figure 2). The computed unimpaired Rush Creek Runoff peak magnitude was 630 cfs, with recurrence interval of 3.6 years (Table 2). The daily average peak reported for Rush Creek Runoff is likely smaller than the actual instantaneous peak. The median snowmelt peak date for the computed unimpaired period of record is June 8.

Duration of the Rush Creek snowmelt flood was notable in RY 2006. As a reference, Order No. 98-05 specifies a Wet Year SRF release of 450 cfs for 5 days and 400 cfs for 10 days. The actual peak release (and spill) below the Return Ditch exceeded 450 cfs for 18 days and exceeded 400 cfs for 36 days (Figure 2). Below the Narrows, the snowmelt peak exceeded 450 cfs for 42 days and 500 cfs for 30 days. A flow magnitude of 160 cfs, which was the estimated threshold for flow to access the 4Bii Channel (McBain and Trush 2006), was exceeded 94 days, approximately from May 7 to August 8, 2006, and with changing conditions, the side channel is still flowing.

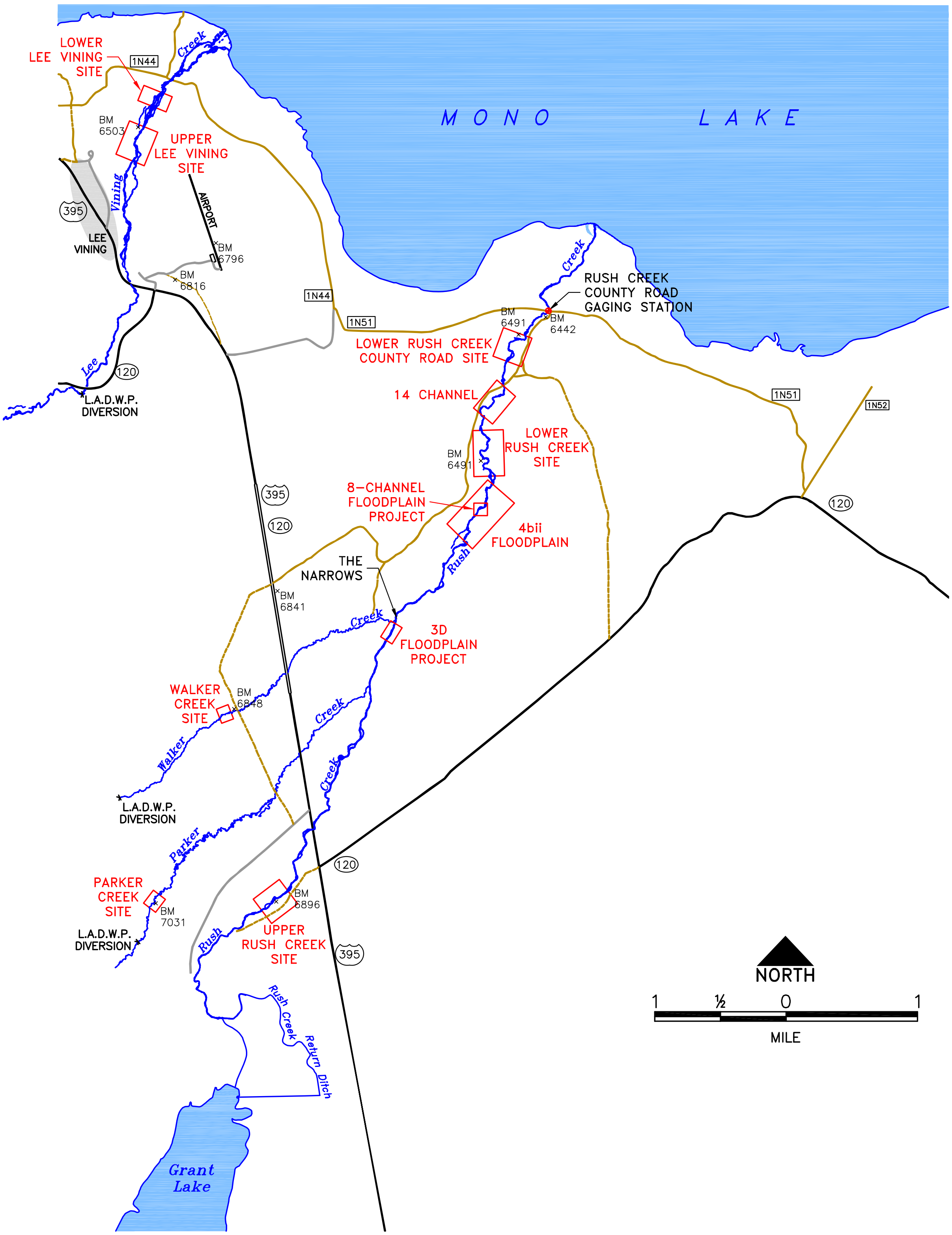

Figure 1. Location of the study sites on each of the four Mono Basin tributaries: Rush, Parker, Walker, and Lee Vining creeks.

Table 1. Summary of peak discharge and dates for the Mono Basin tributaries the past 9 years of monitoring. Values are daily average discharge (in cfs), with some instantaneous values reported in parentheses. Stations left-justified are data reported by LADWP or computed from their data; stations right-justified are an estimated proportion of the LADWP values based on regression analysis of synoptic discharge measurements.

Station	RY 1997 (cfs)	Peak Date	RY 1998 (cfs)	Peak Date	RY 1999 (cfs)	Peak Date	RY 2000 (cfs)	Peak Date	RY 2001 (cfs)	Peak Date	RY 2002 (cfs)	Peak Date	RY 2003 (cfs)	Peak Date	RY 2004 (cfs)	Peak Date	RY 2005 (cfs)	Peak Date	RY 2006 (cfs)	Peak Date
Rush Creek Runoff 1	411	31-May-98	601	22-Jul-98	405	30-Jun-99	502	20-Jun-00	491	26-May-01	243	31-May-02	460	19-Jun-03	228	5-May-04	541	16-Jun-05	630	7-Jun-06
Rush Creek at Damsite (5013)	250	31-May-98	495	22-Jul-98	222	2-Jul-99	372	20-Jun-00	231	26-May-01	102	01-Jun-02	311	19-Jun-03	118	9-Jul-04	441	16-Jun-05	483	7-Jun-06
Rush Creek below Return Ditch	175	18-May-98	538	23-Jul-98	201	10-Jul-99	204	30-Jun-00	162	11-Jun-01	168	8-Jun-02	203	7-Jun-03	343 (384)	11-Jun-04	403	29-Jun-05	477	7-10-June-06
Rush Creek below Narrows (unimpaired) 2	467	1-Jun-98	718	22-Jul-98	463	1-Jul-99	582	20-Jun-00	576	25-May-01	306	01-Jun-02	518	19-Jun-03	239	5-May-04	550	16-Jun-05	640	7-Jun-06
Rush Creek below Narrows (actual) 3	233	20-May-98	635	24-Jul-98	247	11-Jul-99	284	1-Jul-00	202	11-Jun-01	225	8-Jun-02	283	3-Jun-03	354 (413)	11-Jun-04	467	29-Jun-05	584	8-Jun-06
[Lower Rush Creek Main Planmap Reach]	147	20-May-98	396	24-Jul-98	155	11-Jul-99	161	1-Jul-00	128	11-Jun-01	144	8-Jun-02	181	3-Jun-03	241 (281)	11-Jun-04	174546	29-Jun-05	374	8-Jun-06
[Lower Rush Creek 10-Channel]	89	20-May-98	259	24-Jul-98	95	11-Jul-99	99	1-Jul-00	76	11-Jun-01	81	8-Jun-02	102	3-Jun-03	113 (132)	11-Jun-04	98182	29-Jun-05	210	8-Jun-06
Rush Creek at County Road Culvert (5186)											151	8-Jun-02					402	29-Jun-05		
Lee Vining Creek above Intake (5008)	378 (404)	31-May-98	419	9-Jul-98	285	19-Jul-99	264	28-May-00	201	17-May-01	238	30-May-02	332	30-May-03	152	5-May-04	374	28-May-05	444	7-Jun-06
Lee Vining Creek at Intake (5009)	354 (399)	31-May-98	391	9-Jul-98	274	19-Jul-99	258	28-May-00	201	17-May-01	236	31-May-02	317	31-May-03	141	15-Jun-04	372	28-May-05	457	7-Jun-06
[Upper Lee Vining Creek Mainstem]	245	31-May-98	270	9-Jul-98	190	19-Jul-99	179	28-May-00	140	17-May-01	164	31-May-02	231	31-May-03	103	5-May-04	289	28-May-05		
[Upper Lee Vining Creek A-4 Channel]	126	31-May-98	140	9-Jul-98	96	19-Jul-99	90	28-May-00	69	17-May-01	82	31-May-02	105	31-May-03	47	5-May-04	83	28-May-05		
[Upper Lee Vining Creek B-1 Channel]	159	31-May-98	176	9-Jul-98	122	19-Jul-99	115	28-May-00	89	17-May-01	105	31-May-02	139	31-May-03	62	5-May-04	100	28-May-05		
[Lower Lee Vining Creek Main Channel]	195	31-May-98	215	9-Jul-98	152	19-Jul-99	143	28-May-00	112	17-May-01	131	31-May-02	178	31-May-03	79	5-May-04	272	28-May-05		
[Lower Lee Vining Creek B-1 Channel]	159	31-May-98	176	9-Jul-98	122	19-Jul-99	115	28-May-00	89	17-May-01	105	31-May-02	139	31-May-03	62	5-May-04	100	28-May-05		
Parker Creek (5003)	48	20-Jun-98	72	9-Jul-98	52	24-Jun-99	49	25-Jun-00	56	26-May-01	37	1-Jun-02	49	31-May-03	33	7-Jun-04	74	13-Jul-05	64	29-Jun-06
Walker Creek (5002)	34	1-Jun-98	47	21-Jul-98	30	29-May-99	31	28-May-00	42	16-May-01	26	2-Jun-02	43	May 30-03	20	6-Jun-04	51	28-May-05	53	7-Jun-06

1 Computed natural flows, assuming no flow regulation;
2 Computed by adding Rush Creek Runoff+Parker+Walker;
3 Computed by adding RCBRD+Parker+Walker;
4 Only gaged stations provide instantaneous peaks; stations that are calculated provide only the maximum daily average discharge;
5 measured flow

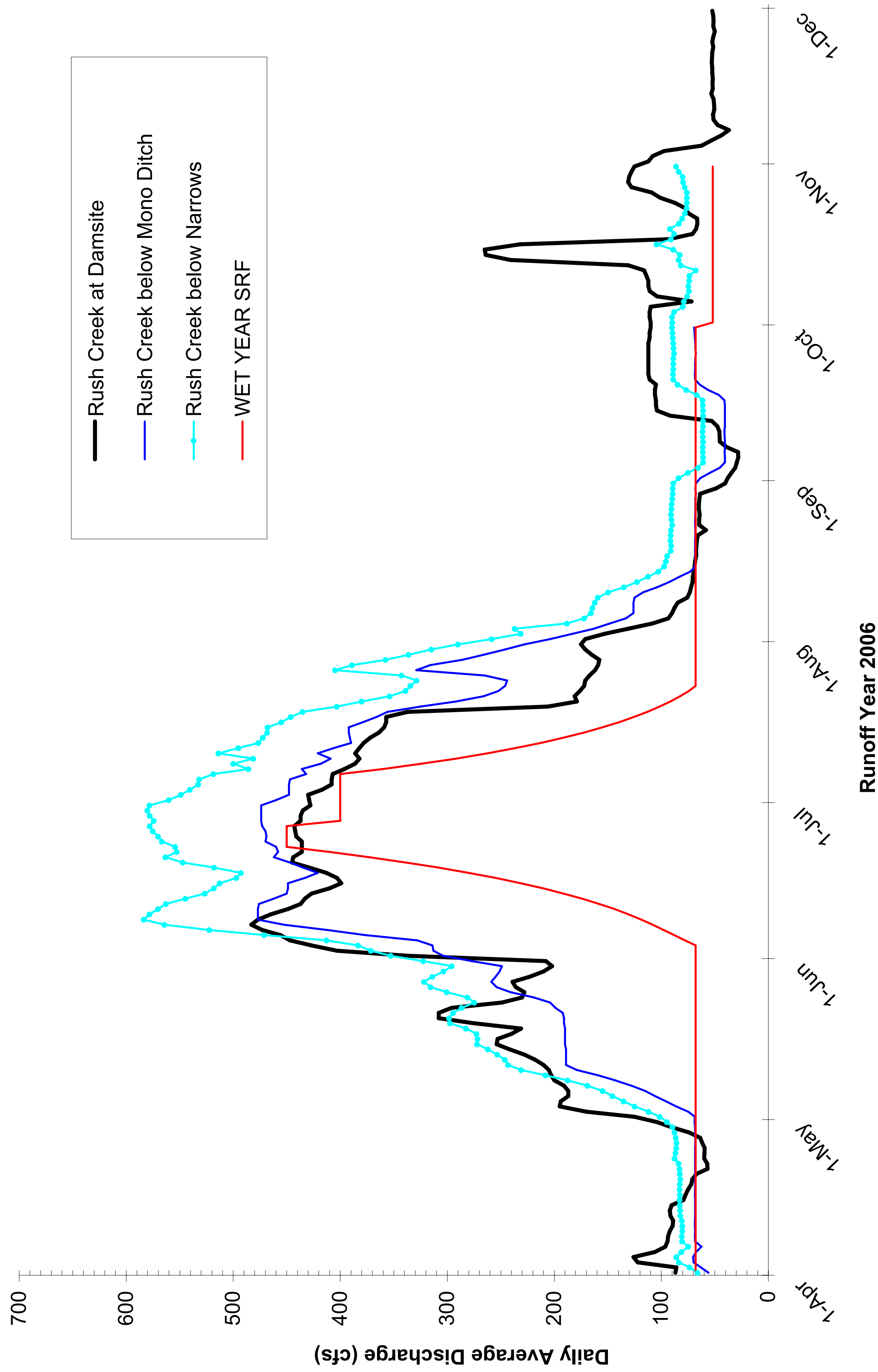

Figure 2. Annual hydrographs for Rush Creek Runoff and Rush Creek at Damsite for Runoff Year 2006-07.

Table 2. Summary of flood magnitudes for several sites along Rush Creek.

	1.5-YR		2.0-YR		2.33-YR		5-YR		10-YR		25-YR		50-YR	
(all data in cfs)	Raw Data	Pearson III Fit	Raw Data	Pearson III Fit	Raw Data	Pearson III Fit	Raw Data	Pearson III Fit	Raw Data	Pearson III Fit	Raw Data	Pearson III Fit	Raw Data	Pearson III Fit
Rush Creek Runoff Unimpaired (1)	411	435	484	502	507	532	683	666	780	776	908	915	1,046	1,019
Rush Creek at Damsite (2)	182	172			250	244	381	363	489	475	655	639	896	777
Rush Creek below Return Ditch (3)	250				380		400		450		500		500	
Rush Creek below Narrows (1937-2003) (4)	346				457		491		523		624		624	
Rush Creek below Narrows (1980-2003) (5)	346				469		522		568		652		772	
Rush Creek below Narrows Unimpaired (6)	497	495			587	605	775	755	882	874	1,011	1,023	1,168	1,133
Rush Creek (Waananen and Crippen-Buckeye) (7)			320				483		602		765		908	
Rush Creek (Waananen and Crippen-Lee Vining) (8)			440				617		730		867		915	
Lee Vining Creek Runoff (9)	287	283	375	339	387	364	492	473	596	561	635	670		
Lee Vining Creek below Intake (10)	221	199	271	250	294	272	363	367	408	446	502	522	512	578

(1) Data Source: LADWP Rush Creek Computed Unimpaired or 'Rush Creek Runoff' (Rush Creek at Damsite + SCE Storage Change)
(2) Data Source: Data for 1937-1979 from USGS archives for 'Rush Creek abv Grant Lake nr June Lake, CA (USGS 10287400)'; Data for 1980-2003 from LADWP 'Rush Creek at Damsite'
(3) Data Source: Uses 'Rush Creek at Damsite' for 1937-2003, assigns water year class based on SWRCB Order 98-05, then assigns Stream Restoration Flow for each water year
(4) Data Source: Uses 'Rush Creek below Return Ditch' for 1937-2003 and adds Parker and Walker average peak flow determined for each water year class
(5) Data Source: Uses 'Rush Creek below Return Ditch' for 1980-2003 and adds Parker and Walker actual peak data for each water year
(6) Data Source: Uses 'Rush Creek Computed Unimpaired' for 1941-2003 and adds Parker and Walker Creek average peak flow for each water year class
(7) Data Source: Applies Waananen and Crippen Regional Flood Regressions, using Buckeye Creek gaged data
(8) Data Source: Applies Waananen and Crippen Regional Flood Regressions, using Lee Vining Creek gaged data
(9) Data Source: LADWP Lee Vining Creek Computed Unimpaired or 'Lee Vining Creek Runoff' (Lee Vining above Intake + SCE Storage Change)
(10) Data Source: Data for 1935 - 1979 from USGS archives for Lee Vining Creek near Lee Vining CA (USGS 10287900); Data for 1980 - 2003 from LADWP 'Lee Vining Creek Spill at Intake'

Lee Vining Creek

Lee Vining Creek also had a large magnitude snowmelt flood in RY 2006 (Figure 3). The peak magnitude of 457 cfs for 'Lee Vining Creek at Intake' gage was the fourth largest event recorded below the intake structure since 1935, and exceeded all flood peaks since the RY 1967 event of 520 cfs (Table 1). This was the largest flood peak observed during the past ten years of monitoring, exceeding the 1995 flood of 436 cfs and the 1997 flood of 422 cfs (Table 1). The 13 cfs difference between the "above Intake" (444 cfs) and "at Intake" (457 cfs) gages was likely a rating curve effect and not a different flood peak magnitude. The Lee Vining Creek snowmelt peak occurred on June 7, 2006, the same day as the peak on Rush Creek. The peak discharge of 457 cfs had a recurrence interval of 18-yr on the regulated 'Lee Vining Creek at Intake' flood frequency curve (1935-2006 period of record) and had a recurrence interval of 4.2-yr on the unimpaired Lee Vining Creek Runoff (1973-2003 period of record) (Table 2). The computed estimate for 'Lee Vining Creek Runoff' had a peak magnitude of 506 cfs, with a 5.7-yr recurrence interval (Figure 3). In addition to the main peak, Lee Vining Creek had two secondary peaks before and after the main peak, with magnitudes of 364 cfs (20 May) and 422 cfs (20 June).

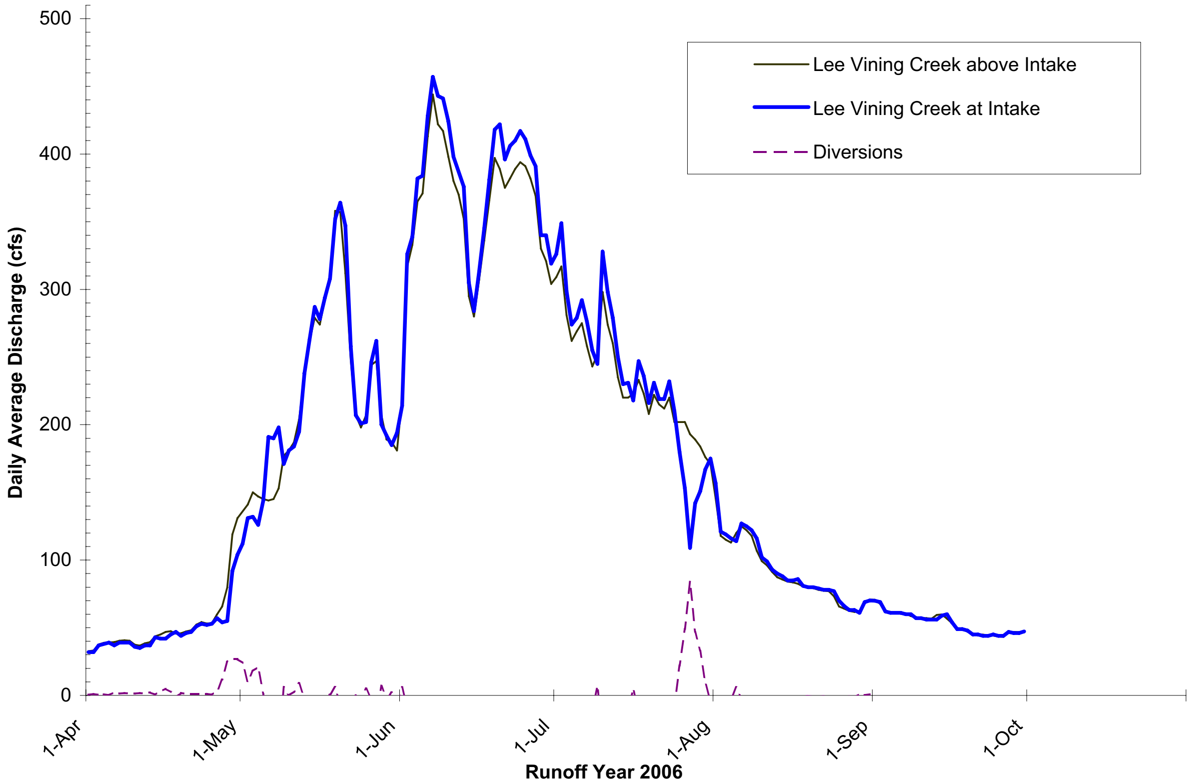

Figure 3. Annual hydrographs for Lee Vining Creek for Runoff Year 2006-07.

The duration of the Lee Vining snowmelt runoff was also large relative to past years. The 'Lee Vining Creek at Intake' gage recorded 35 days with flow exceeding 300 cfs (intermittently from May 15 to July 11) and 11 days of peak runoff exceeding 400 cfs. Flows in this range accessed floodplains and side-channels along the Lee Vining Creek stream corridor and bottomlands.

Portions of the snowmelt hydrograph were diverted from Lee Vining Creek to supplement Rush Creek (Figure 3), beginning during the ascending hydrograph limb in late April. Diversion rates and volumes were small through May, discontinued in June to allow unimpaired peak flooding downstream of the intake, and then resumed in mid-July with the primary diversion in late July (peaking at 84 cfs on July 27).

Parker and Walker creeks

The Parker Creek RY 2006 snowmelt hydrograph had six distinct peaks of comparable magnitude ranging from 56 to 64 cfs from May 22 to August 4 (Figure 4). The primary peak of 64 cfs occurred June 29. A secondary snowmelt peak on June 7 augmented the primary Rush Creek peak below the Narrows. Walker Creek also had several peaks through the snowmelt season, with the main peak of 53 cfs on June 6, 2006, and a secondary peak of 51 cfs on May 20 (Figure 5). Parker and Walker creek streamflows were not diverted in RY 2006

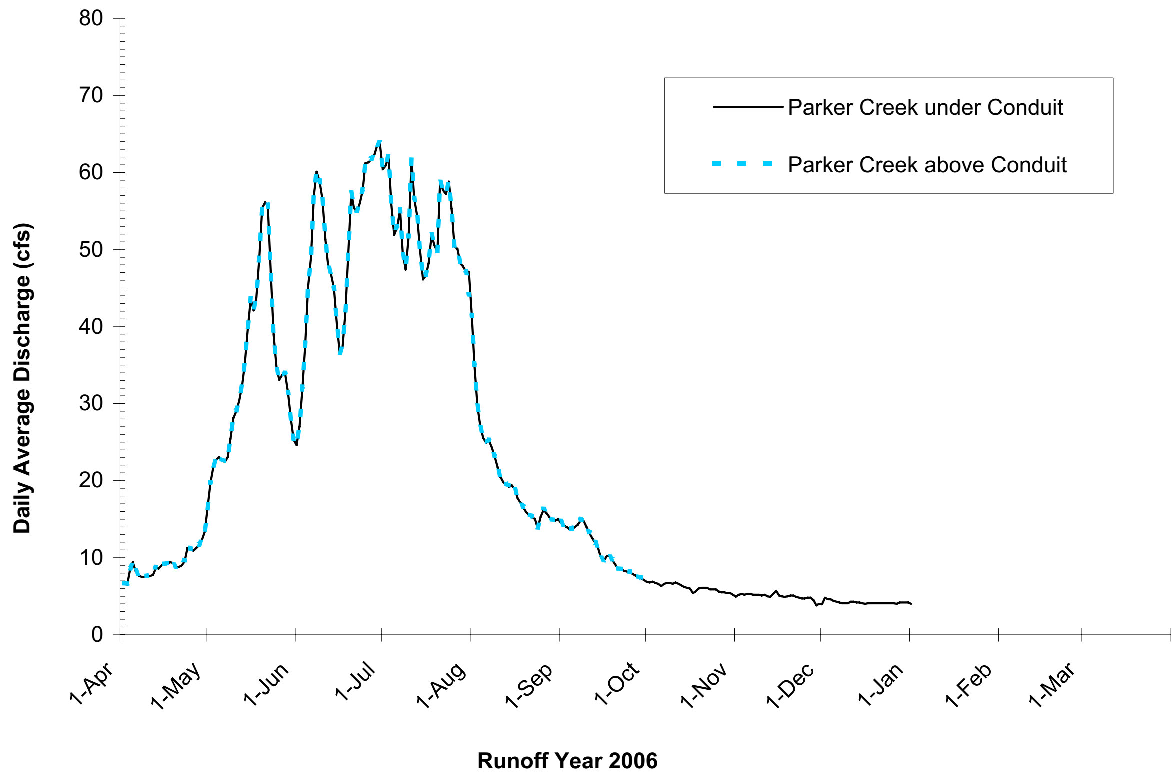

Figure 4. Annual hydrographs for Parker Creek for Runoff Year 2006-07.

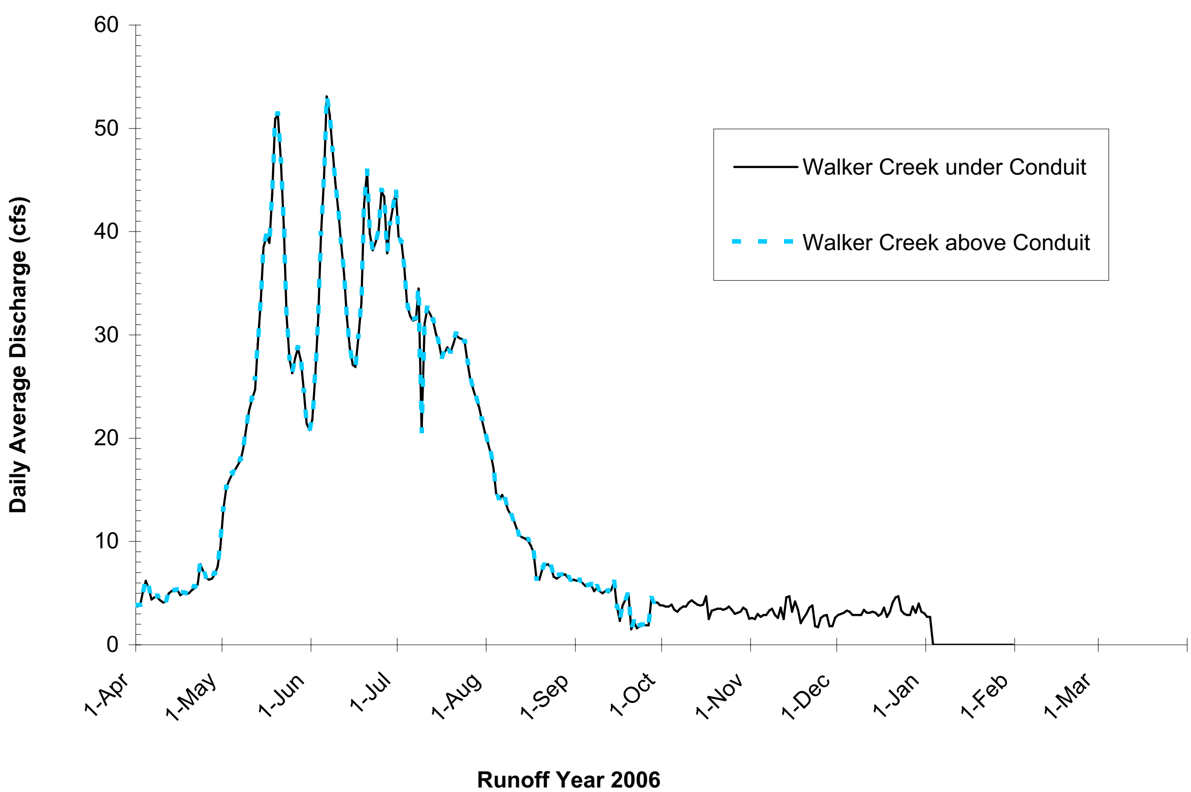

Figure 5. Annual hydrographs for Walker Creek for Runoff Year 2006-07.

2.2 Synoptic Streamflow Gaging

XS -9+82 Gaging Operations

A temporary gaging station was installed and maintained in lower Rush Creek during RYs 2004-06 at XS -9+82. The RY 2005 Annual Report (McBain and Trush 2006) presents a preliminary rating curve and daily average hydrograph. The gage was non-operational during winter 2005-06, and was reinstalled May 31, 2006. However, the RY 2006 snowmelt peak discharge scoured the riffle crest downstream of the gage installation, shifting the rating curve. Therefore, datalogger data were not usable for the RY 2006 snowmelt runoff. We are currently evaluating the need to continue the gage operation.

A single timed-float discharge estimate was made on the Rush Creek 4bii Channel on October 18, 2006 to determine the flow rate in the side-channel with a mainstem Rush Creek discharge of 88 cfs. The measurement was taken at the small pool where the side-channel flow is confined to a single channel. Discharge was 5.1 cfs.

2.3 Temperature Data Collection

During RY 2006 we collected hourly water temperature at 11 monitoring sites throughout the four tributaries (Table 3). Most temperature dataloggers were downloaded June (6/1/06) (some were inaccessible due to high flows), and all dataloggers were downloaded in October (10/18/06). We installed six new Onset® Hobo Water Temp Pro V2 dataloggers to replace older ones with battery life waning, prioritizing locations where six original thermographs were placed in 2000 and where we have the longest data set (Table 3). The RY 2006 summary data were compiled with data presented in past annual reports, and are presented in Table 4A-4D. The datalogger at Lower Rush Creek XS 10+10 was lost, presumably during the snowmelt runoff.

2.4 Groundwater Dynamics

Data review and analyses

Groundwater was monitored in the Lower Rush Creek bottomlands, at Piezometer 8C-8 located nearest the lone Jeffrey Pine at the downstream end of the 8 Floodplain (Figure 6). This piezometer was equipped with a continuously recording datalogger during the 2005 and 2006 runoff seasons, thus providing an opportunity to compare the groundwater response to a higher 2006 SRF peak and a nearly perennially open 8 Channel. The datalogger was installed June 2, 2006 and so did not record groundwater response to the ascending hydrograph limb. Given the almost instantaneous groundwater response to stream stage increases in previous years and other locations, we assumed piezometer 8C-8 responded similarly to the RY 2006 snowmelt ascension.

Flows in lower Rush Creek in RY 2006 were substantially higher than in RY 2005 (Table 1). Peak groundwater elevations at Piezometer 8C-8 were correspondingly higher in RY 2006, peaking at 6504.7 ft, or 0.9 ft higher than the RY 2005 peak stage of 6503.8 (Figure 7). This increase was likely due to channel changes in the vicinity of the piezometers. The ground surface elevation at piezometer 8C-8 is 6506.7; groundwater thus peaked within 2 ft of the floodplain surface over 400 ft from the mainstem and 250 ft down-valley from the 8 Channel. As observed in RY 2005, groundwater tracked fluctuations in mainstem stage height closely in magnitude, and to a lesser degree, in the response time to stage changes. The response time may develop over time.

Table 3. Summary of water temperature thermographs in Rush, Parker, Walker, and Lee Vining creeks.

Thermograph Site Name	Serial Number	Instrument Type	Date of Last Download	Location
RUSH CREEK at RETURN DITCH	1037792	Onset Pro V2	10/18/2006	Located at the downstream end of the return ditch, tied to the metal gates at the entrance to the "A" Ditch.
RUSH CREEK at OLD HWY 395	667646	Onset Stowaway	10/18/2006	Located ~100 ft below the old 395 Hwy Bridge on a right bank rebar pin downstream of a 1.5 ft diamater boulder, adjacent where the floodplain narrows, and the sage terrace extends down to the channel.
RUSH CREEK at 3D SITE	1037788	Onset Pro V2	10/18/2006	Located at the Rush Creek at 3D Staff Plate #5 in the small right bank backwater surrounded by cattails and boulders.
LOWER RUSH CREEK at XS 10+10	280663	Onset Stowaway	10/18/2006	Located on XS 10+10, on right bank in the thalweg up against the dense willow thicket, attached to a rebar pin. This cross section is the upstream-most cross section in the lower Rush electrofishing reach where the painted tracer rocks and scour cores are deployed.
RUSH CREEK at COUNTY RD	1037787	Onset Pro V2	10/18/2006	Located at the County Rd below the culvert, attached to the staff plate in the culvert outfall pool on the right bank.
PARKER CREEK at CONDUIT	667653	Onset Stowaway	10/17/2006	Located ~100 feet downstream of the conduit road crossing, attached to rebar pin on left bank, just before channel enters overgrown, impenetrable willow brush.
LOWER PARKER CREEK at CONFLUENCE	280722	Onset Pro V2	10/18/2006	Located on the right bank ~100 ft upstream of the confluence with Rush Creek, in a braided reach with two channels, attached to a willow along the right bank of the right split channel.
WALKER CREEK at CONFLUENCE	667652	Onset Stowaway	10/17/2006	Located within 100 feet downstream of the conduit road crossing, attached to rebar pin on the right bank in a small backwater between two large willows, under the upstream branches of the downstream willow.
LOWER WALKER CREEK at CONFLUENCE	1037786	Onset Pro V2	10/18/2006	Located approximately 25 ft upstream of the confluence with Rush Creek above the Narrows. Placed on left bank tucked under willows and large boulder.
UPPER LEE VINING CREEK at INTAKE	389435	Onset Stowaway	10/18/2006	Located ~200 ft below the Lee Vining diversion structure, below a 180 meander, on right bank under the exposed roots of a huge Jeffrey Pine (largest in the area) with roots in the channel.
LOWER LEE VINING CREEK at B-CONNECTOR				Previously located at the A4/B1 confluence. Lost in 2005 and not replaced.
LEE VINING CREEK at COUNTY RD	1037784	Onset Pro V2	10/18/2006	Located ~50 below the County Road Crossing on left bank under a large Alder, attached to rebar under alder roots.

Table 4A. Summary of temperature data for Rush Creek collected since October 2000.

	WY2000	WY2001	WY2002	WY2003	WY2004	WY2005	2006
Rush Creek at Return Ditch							
DAILY AVERAGE (°F)	49	49	51	47	43	45	46
ANNUAL MAX (°F)	67	69	71	69	64	65	65
ANNUAL MIN (°F)	34	34	32	32	32	32	32
MAX DAILY FLUX (°F)	9	10	9	6	9	9	11
WINTER MAX (°F)	43	42	43	43	44	40	42
WINTER MIN (°F)	34	34	32	32	32	32	32
WINTER AVERAGE (°F)	37	37	37	37	37	34	37
MAX WINTER FLUX (°F)	5	5	5	5	5	5	7
SUMMER MAX (°F)	67	69	71	69	NA	65	65
SUMMER MIN (°F)	55	53	57	60	NA	53	50
SUMMER AVERAGE (°F)	60	62	64	64	NA	57	55
MAX SUMMER FLUX (°F)	9	10	8	6	NA	9	8
DATE OF ANNUAL MAX	8/27/00 5:00 PM	8/19/01 7:00 PM	7/30/02 3:00 PM	8/20/03 2:30 PM	10/1/03 2:30 PM	9/10/05 3:52 PM	9/12/06 1:20 AM
Start Date	10-Oct-99	1-Oct-00	1-Oct-01	1-Oct-02	1-Oct-03	1-Dec-04	1-Oct-05
End Date	30-Sep-00	30-Sep-01	30-Sep-02	30-Sep-03	6-May-04	30-Sep-05	30-Sep-06
Number of Days Sampled	357	365	365	365	218	303	365
Rush Creek at Old Highway 395							
DAILY AVERAGE (°F)						57	47
ANNUAL MAX (°F)						66	67
ANNUAL MIN (°F)						47	32
MAX DAILY FLUX (°F)						12	11
WINTER MAX (°F)						NA	45
WINTER MIN (°F)						NA	32
WINTER AVERAGE (°F)						NA	34
MAX WINTER FLUX (°F)						NA	11
SUMMER MAX (°F)						66	67
SUMMER MIN (°F)						53	53
SUMMER AVERAGE (°F)						57	57
MAX SUMMER FLUX (°F)						12	11
DATE OF ANNUAL MAX						8/27/05 3:22 PM	9/12/06 1:38 AM
Start Date						1-Jun-05	1-Oct-05
End Date						30-Sep-05	30-Sep-06
Number of Days Sampled						122	365
Rush Creek above the Narrows							
DAILY AVERAGE (°F)	48	48	42	45	48		46
ANNUAL MAX (°F)	71	73	67	67	72		67
ANNUAL MIN (°F)	32	32	32	32	31		32
MAX DAILY FLUX (°F)	20	20	18	21	37		14
WINTER MAX (°F)	52	50	50	51	71		56
WINTER MIN (°F)	32	32	32	32	31		32
WINTER AVERAGE (°F)	37	36	36	37	35		34
MAX WINTER FLUX (°F)	16	15	15	14	37		14
SUMMER MAX (°F)	71	73	67	67	61		67
SUMMER MIN (°F)	50	52	53	52	31		48
SUMMER AVERAGE (°F)	59	61	58	58	40		57
MAX SUMMER FLUX (°F)	17	16	14	14	12		1/14/00 11:02 AM
DATE OF ANNUAL MAX	8/27/00 5:00 PM	8/19/01 6:00 PM	9/21/02 4:00 PM	5/27/03 4:01 PM	7/23/04 5:01 AM		5-Sep-06
Start Date	10-Oct-99	1-Oct-00	1-Oct-01	1-Oct-02	1-Oct-03		21-Nov-05
End Date	30-Sep-00	30-Sep-01	30-Sep-02	30-Sep-03	30-Sep-04		38991
Number of Days Sampled	357	365	365	365	366		313.25
Lower Rush Creek at the Meadows							
DAILY AVERAGE (°F)					not available	52	
ANNUAL MAX (°F)					74	68	
ANNUAL MIN (°F)					not available	32	
MAX DAILY FLUX (°F)					not available	18	
WINTER MAX (°F)					not available	NA	
WINTER MIN (°F)					not available	NA	
WINTER AVERAGE (°F)					not available	NA	
MAX WINTER FLUX (°F)					not available	NA	
SUMMER MAX (°F)					74	67	
SUMMER MIN (°F)					47	52	
SUMMER AVERAGE (°F)					61	58	
MAX SUMMER FLUX (°F)					18	13	
DATE OF ANNUAL MAX					not available	8/28/05 3:27 PM	
Start Date					7-Jun-04	/1/2004 to 11/30/2004	
End Date					30-Sep-04	/17/2005 to 9/30/2005	
Number of Days Sampled					116	226	
Rush Creek at County Road Culvert							
DAILY AVERAGE (°F)	48	48	49	45	49	not available	NA
ANNUAL MAX (°F)	72	71	75	74	75	not available	70
ANNUAL MIN (°F)	32	32	32	32	32	33	NA
MAX DAILY FLUX (°F)	22	18	21	18	24	not available	16
WINTER MAX (°F)	53	47	48	45	56	52	NA
WINTER MIN (°F)	32	32	32	32	32	34	NA
WINTER AVERAGE (°F)	37	36	36	37	36	36	NA
MAX WINTER FLUX (°F)	19	9	12	8	20	17	NA
SUMMER MAX (°F)	72	71	75	not available	75	not available	70
SUMMER MIN (°F)	48	52	51	not available	47	not available	48
SUMMER AVERAGE (°F)	60	61	62	not available	61	not available	61
MAX SUMMER FLUX (°F)	18	17	16	not available	18	not available	11
DATE OF ANNUAL MAX	8/27/00 8:00 PM	7/1/01 8:00 PM	7/25/02 5:00 PM	8/16/03 3:00 PM	7/22/04 3:01 PM	not available	NA
Start Date	10-Oct-99	1-Oct-00	1-Oct-01	10/1/2003 to 3/21/2003	10/1/2003 to 3/21/2003	1-Oct-04	31-May-06
End Date	30-Sep-00	30-Sep-01	30-Sep-02	8/11/2003 to 9/30/2004	8/11/2003 to 9/30/2004	30-Jun-05	30-Sep-06
Number of Days Sampled	357	365	365	221	366	273	122

Table 4B. Summary of temperature data for Lee Vining Creek collected since October 2000.

	WY2000	WY2001	WY2002	WY2003	WY2004	WY2005	WY2006
Lee Vining below Parshall Flume							
DAILY AVERAGE (°F)						44	40
ANNUAL MAX (°F)						53	49
ANNUAL MIN (°F)						33	31
MAX DAILY FLUX (°F)						12	13
WINTER MAX (°F)						not available	47
WINTER MIN (°F)						not available	31
WINTER AVERAGE (°F)						not available	36
MAX WINTER FLUX (°F)						not available	13
SUMMER MAX (°F)						51	49
SUMMER MIN (°F)						43	47
SUMMER AVERAGE (°F)						47	48
MAX SUMMER FLUX (°F)						4	0
DATE OF ANNUAL MAX						not available	9/20/06 1:00 PM
Start Date						17-Apr-05	21-Nov-05
End Date						15-Aug-05	30-Sep-06
Number of Days Sampled						120	313
Lower Lee Vining at B1 Channel							
DAILY AVERAGE (°F)	43	44	44	42	46	45	
ANNUAL MAX (°F)	65	65	65	69	69	64	
ANNUAL MIN (°F)	32	32	30	31	32	32	
MAX DAILY FLUX (°F)	14	15	15	11	18	14	
WINTER MAX (°F)	47	48	46	47	47	not available	
WINTER MIN (°F)	32	32	30	31	32	not available	
WINTER AVERAGE (°F)	35	34	34	35	37	not available	
MAX WINTER FLUX (°F)	12	11	12	11	12	not available	
SUMMER MAX (°F)	65	65	65	not available	69	59	
SUMMER MIN (°F)	43	46	41	not available	43	51	
SUMMER AVERAGE (°F)	54	56	55	not available	54	55	
MAX SUMMER FLUX (°F)	15	15	13	not available	18	8	
DATE OF ANNUAL MAX	7/30/00 3:00 PM	8/7/01 2:00 PM	8/16/02 3:00 PM	8/20/03 2:30 PM	8/10/04 2:00 PM	8/9/05 6:00 PM	
Start Date	10-Oct-99	1-Oct-00	1-Oct-01	/1/2002 to 3/21/20	1-Oct-03	1/2004 to 11/27/2004	
End Date	30-Sep-00	30-Sep-01	30-Sep-02	2/2003 to 9/30/2(	29-Sep-04	8/2005 to 8/16/2005	
Number of Days Sampled	357	365	365	220	366	223	
Lower Lee Vining at County Road							
DAILY AVERAGE (°F)					not available	not available	not available
ANNUAL MAX (°F)					66	not available	60.4
ANNUAL MIN (°F)					not available	0	not available
MAX DAILY FLUX (°F)					not available	not available	not available
WINTER MAX (°F)					not available	47	not available
WINTER MIN (°F)					not available	32	not available
WINTER AVERAGE (°F)					not available	35	not available
MAX WINTER FLUX (°F)					not available	12	not available
SUMMER MAX (°F)					66	not available	60.4
SUMMER MIN (°F)					37	not available	36.5
SUMMER AVERAGE (°F)					53	not available	50.9
MAX SUMMER FLUX (°F)					14	not available	10.9
DATE OF ANNUAL MAX					8/10/04 3:15 PM	not available	7/28/06 16:43
Start Date					6-May-04	1-Oct-04	7/16/06 7:43
End Date					30-Sep-04	17-Apr-05	10/18/06 15:43
Number of Days Sampled					147	198	94

Table 4C. Summary of temperature data for Parker Creek collected since October 2000.

	WY2000	WY2001	WY2002	WY2003	WY2004	WY2005	WY2006
Upper Parker Creek							
DAILY AVERAGE (°F)	43	43	NA	43	NA	41	42
ANNUAL MAX (°F)	62	64	NA	69	NA	57	58
ANNUAL MIN (°F)	26	32	32	32	29	32	32
MAX DAILY FLUX (°F)	18	18	14	13	14	12	13
WINTER MAX (°F)	48	39	43	43	46	40	39
WINTER MIN (°F)	39	32	32	32	31	36	32
WINTER AVERAGE (°F)	41	33	33	33	33	38	32
MAX WINTER FLUX (°F)	18	3	9	8	9	5	5
SUMMER MAX (°F)	59	63	NA	69	NA	57	58
SUMMER MIN (°F)	52	47	NA	45	NA	37	40
SUMMER AVERAGE (°F)	54	55	NA	55	NA	49	51
MAX SUMMER FLUX (°F)	18	10	NA	11	NA	12	9
DATE OF ANNUAL MAX	7/30/00 6:00 PM	6/5/01 6:00 PM	NA	8/14/03 12:01 PM	NA	8/12/05 6:00 PM	7/28/06 1:18 AM
Start Date	7-Nov-99	1-Oct-00	1-Oct-01	1-Oct-02	1-Oct-03	1-Oct-04	1-Oct-05
End Date	30-Sep-00	30-Sep-01	2-May-02	30-Sep-03	6-May-04	16-Aug-05	30-Sep-06
Number of Days Sampled	329	365	214	365	218	320	365
Lower Parker Creek							
DAILY AVERAGE (°F)					NA	NA	43
ANNUAL MAX (°F)					72	NA	62
ANNUAL MIN (°F)					NA	NA	32
MAX DAILY FLUX (°F)					16	NA	16
WINTER MAX (°F)					NA	NA	42
WINTER MIN (°F)					NA	NA	32
WINTER AVERAGE (°F)					NA	NA	33
MAX WINTER FLUX (°F)					NA	NA	10
SUMMER MAX (°F)					72	NA	62
SUMMER MIN (°F)					50	NA	39
SUMMER AVERAGE (°F)					60	NA	53
MAX SUMMER FLUX (°F)					14	NA	13
DATE OF ANNUAL MAX					8/11/04 4:15 PM	NA	9/5/06 1:18 AM
Start Date					6-May-04	NA	10/10/05 14:29
End Date					30-Sep-04	NA	9/30/06 23:18
Number of Days Sampled					148	NA	355

Table 4D. Summary of temperature data for Walker Creek collected since October 2000.

	WY2000	WY2001	WY2002	WY2003	WY2004	WY2005	WY2006
Upper Walker Creek							
DAILY AVERAGE (°F)	46	45	NA	45	45	42	44
ANNUAL MAX (°F)	69	70	NA	77	76	69	69
ANNUAL MIN (°F)	29	32	32	32	29	31	32
MAX DAILY FLUX (°F)	NA	23	16	32	34	16	9
WINTER MAX (°F)	55	38	45	42	47	37	38
WINTER MIN (°F)	41	32	32	32	32	34	32
WINTER AVERAGE (°F)	43	33	33	33	33	35	33
MAX WINTER FLUX (°F)	24	6	12	9	12	4	4
SUMMER MAX (°F)	68	70	NA	71	76	69	69
SUMMER MIN (°F)	58	46	NA	43	35	35	41
SUMMER AVERAGE (°F)	61	59	NA	59	58	56	58
MAX SUMMER FLUX (°F)	32	19	NA	16	34	11	9
DATE OF ANNUAL MAX	7/30/00 3:00 PM	8/16/01 4:00 PM	NA	5/22/03 3:00 PM	9/14/04 3:15 PM	7/19/05 5:00 PM	7/28/06 5:03 PM
Start Date	7-Nov-99	1-Oct-00	1-Oct-01	1-Oct-02	1-Oct-03	1-Oct-04	1-Oct-05
End Date	30-Sep-00	30-Sep-01	4-Apr-02	30-Sep-03	30-Sep-04	16-Aug-05	30-Sep-06
Number of Days Sampled	329	365	186	365	366	320	365
Lower Walker Creek							
DAILY AVERAGE (°F)					NA	43	46
ANNUAL MAX (°F)					76	71	101
ANNUAL MIN (°F)					NA	27	33
MAX DAILY FLUX (°F)					NA	17	60
WINTER MAX (°F)					NA	46	44
WINTER MIN (°F)					NA	34	33
WINTER AVERAGE (°F)					NA	36	35
MAX WINTER FLUX (°F)					NA	13	11
SUMMER MAX (°F)					76	71	101
SUMMER MIN (°F)					35	34	37
SUMMER AVERAGE (°F)					58	57	59
MAX SUMMER FLUX (°F)					34	17	60
DATE OF ANNUAL MAX					9/14/04 3:15 PM	7/17/05 6:00 PM	9/13/06 1:40 AM
Start Date					6-May-04	1-Oct-04	1-Oct-05
End Date					30-Sep-04	15-Aug-05	30-Sep-06
Number of Days Sampled					147	318	365

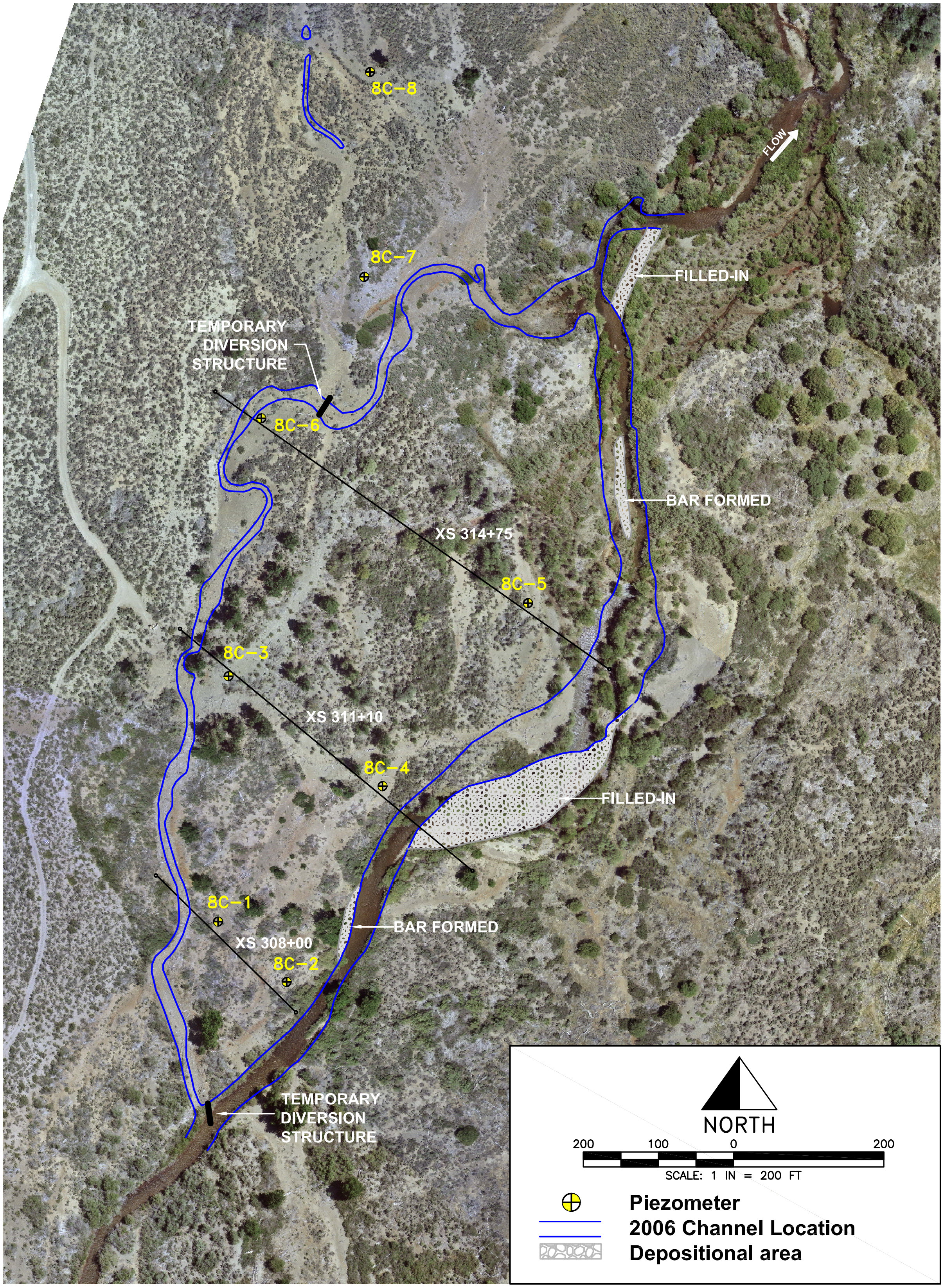

Figure 6. Location of piezometers and staff plates across the 8 Floodplain and field sketch map of channel realignment along the mainstem Rush Creek resulting from the RY 2006-07 snowmelt release.

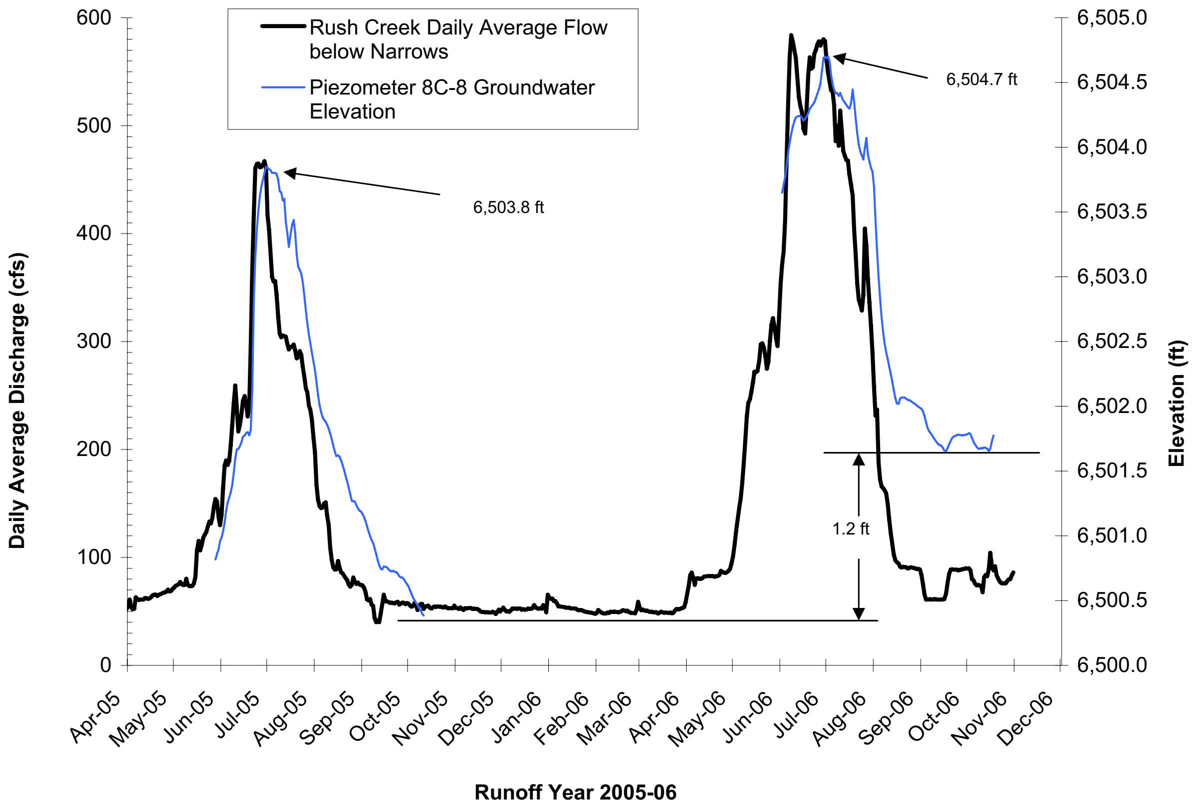

Figure 7. Annual hydrograph of daily average flow for Rush Creek below the Narrows for RY 2005 and 2006, plotted with groundwater elevation from the datalogger installed in Piezometer 8C-8.

During the snowmelt runoff season, flows in the 8 Channel were intermittent due to the changing configuration of the 8 Channel entrance. The changes in inflow into the 8 Channel altered groundwater elevations recorded by the piezometer 8C-8 datalogger (Figure 8). For example, the datalogger recorded a temporary 0.25 ft spike in groundwater elevation on July 14 with increased inflow into the 8 Channel, before groundwater stage continued its downward descent. Then on August 15-16, the groundwater stage observed at piezometer 8C-8 leveled out as mainstem stage continued to descend. A small trickle of flow continued in the 8 Channel as mainstem stage dropped, thus maintaining groundwater stage height approximately 1. 2 ft higher than the last RY 2005 measurement, and sustaining higher groundwater elevations well into October 2006 and potentially much longer.

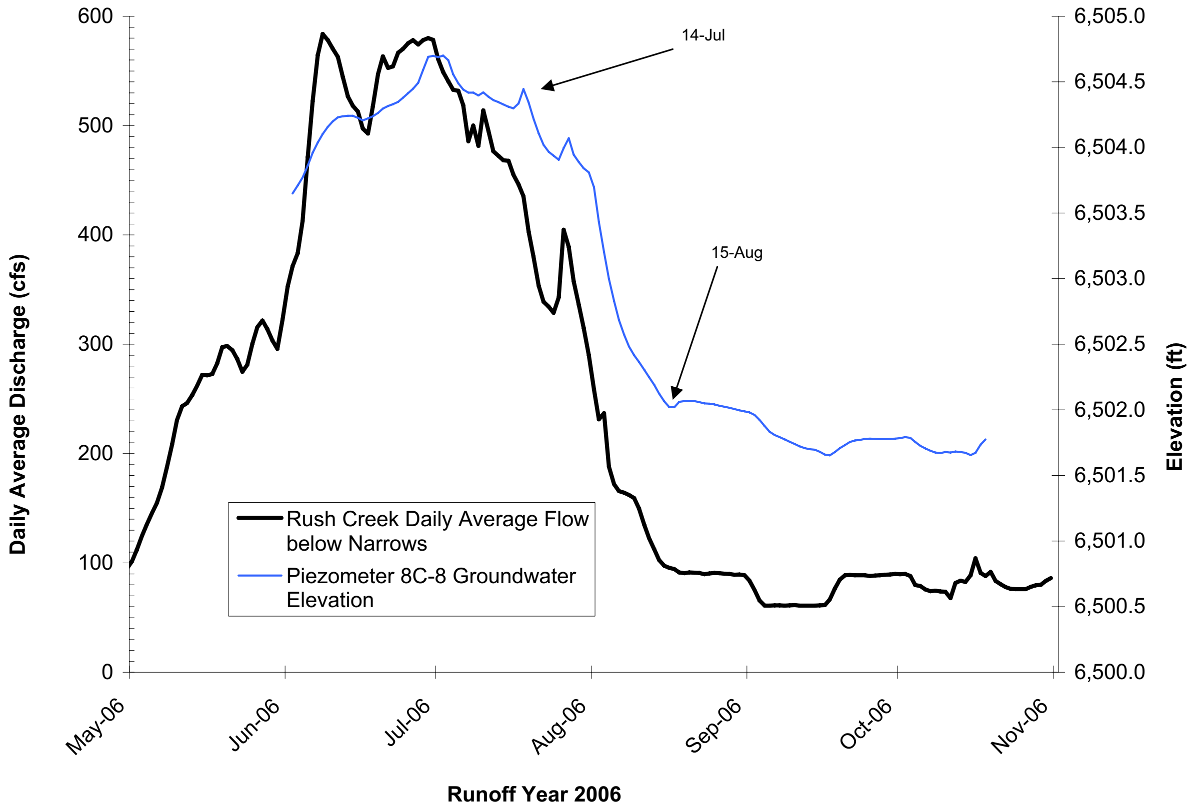

Figure 8. Rush Creek annual hydrograph and piezometer 8C-8 groundwater elevation for RY 2006-07.

3 GEOMORPHOLOGY

3.1 Channel Dynamics

No specific channel monitoring tasks were conducted in 2006. Peak flows on Rush Creek caused channel changes in some sections of channel throughout the bottomlands, although a systematic corridor-wide inventory was not made. In October, D. Mierau walked from the 4bii Channel entrance to the 10 Channel return, and observed the following changes:

At the broad right bank meander bend from which the 4bii Channel diverges, the medial bar controlling flow into the right split channel continued to aggrade, forcing more flow into the left main channel and less flow into the right side-channel. Maintaining perennial flow into the 4bii Channel is tenuous given how dynamic the two split channels have been the past several years.

Downstream of the 4bii Channel entrance, at the next broad meander bend with split channel, the entrance to the right side-channel aggraded and cutoff flow into the right channel (Figure 9). The right side-channel was mostly dry in October 2006, with only ponded water in deep pools.

The channelbed adjacent the 8 Channel entrance did not aggrade or degrade to change the stage-discharge relationship and thus the threshold elevation for flow entering the 8 Channel stayed the same.

Figure 9. Side-channel entrance closed off from the RY 2006-07 snowmelt release.

The 1,200 ft section of channel below the 8 Channel entrance had the most substantial channel changes observed along lower Rush Creek in 2006. Flows scoured into the left bank along 400 ft of channel and moved the bank back approximately 100 ft into the 8 Floodplain. The former channel location along the right floodplain became depositional and was abandoned except for small rivulets of flow through the willows and small channels (Figure 10). A portion of the mainstem baseflow accesses this former channel and return to the main channel by flowing across the "floodplain" and over a small falls formed by the former channel bank. This section of channel remains unstable and will likely continue to adjust in the coming years. At the downstream end of this hand-mapped reach, the right channel of the former split channel also aggraded, directing all baseflows into the left channel.

The section of channel at the 10 Channel and Main Channel split continued to be very dynamic, but local changes did not substantially shift the proportion of baseflow accessing each channel. A small headcut at the top of the short section of braided mainstem could threaten to capture most/all mainstem flow if it continues migrating upstream.

3.2 Large Wood Transport

In RY 2004, 36 pieces of large wood were marked with numbered metal tags and white nylon cord in lower Rush Creek to evaluate the mobilization frequency and transport distances of dominant wood pieces (refer to McBain and Trush 2005, Section 3.1.5 for methodology). Marked pieces were recovered following the 2004 and 2005 snowmelt releases (Figure 11). Results are presented in Annual Reports (McBain and Trush 2005 and 2006). In October 2006, we surveyed the mainstem reach from the 4bii Channel entrance to the 10 Channel confluence, and throughout the 10 Channel to recover marked wood pieces.

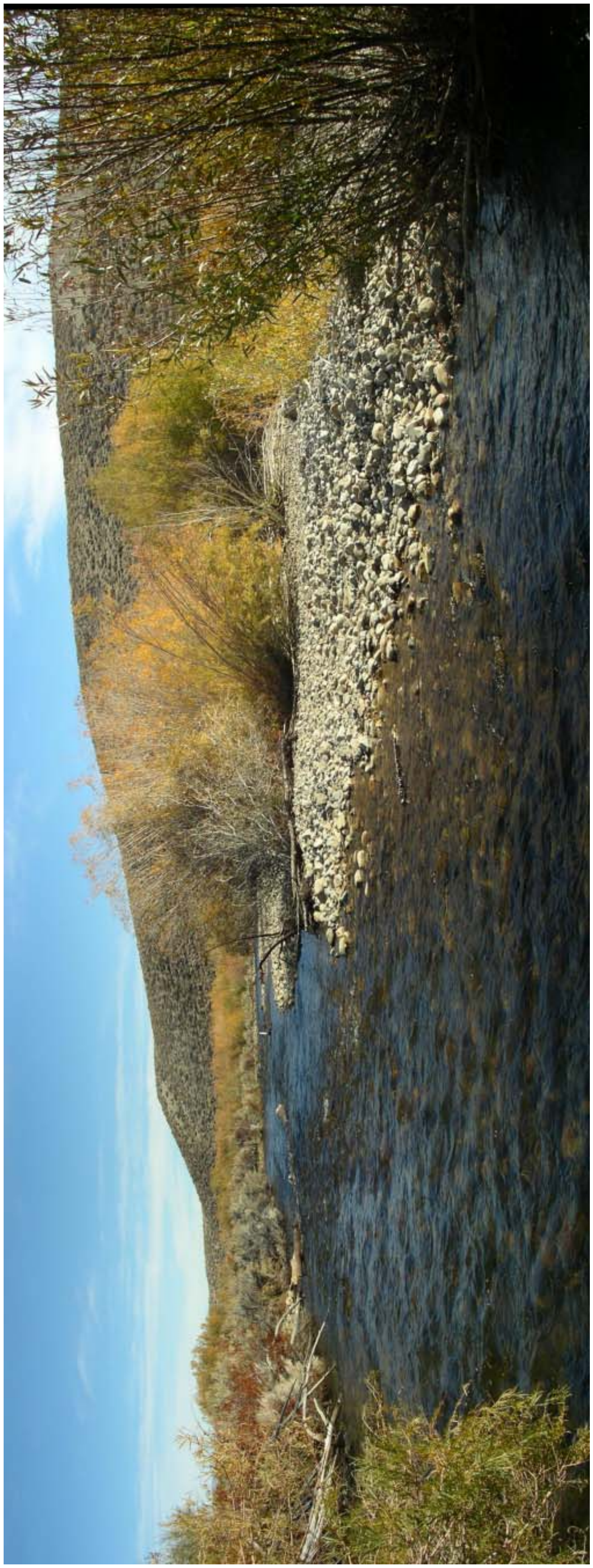

Figure 10. View looking downstream of new channel alignment (left) and former channel location (right) approximately adjacent to the 8C-4 piezometer.

We recovered 13 of the 26 wood pieces that were relocated after the RY 2005 snowmelt release (Figure 12). Of those 13 pieces, 4 were mobilized by high flows and transported to new locations; the other 8 pieces remained in the same locations in which they were recovered in 2005. An additional 11 pieces were not relocated and were presumed absent from their known 2005 recovery location. Combining the 4 moved/recovered pieces and the 11 moved/not recovered pieces gives a total of 15 out of 26 pieces moved in the RY 2006 snowmelt flood.

Three of the four pieces mobilized and recovered in 2006 were identified in 2004 as important key pieces of a log jam (#s 11, 12, 13) that was scoured by the 2006 flood. None of the four had moved since originally marked in 2004. The four recovered pieces moved similar distances downstream, averaging 1,100 ft.

In general, each year of the large wood transport experiment produced some attrition in the number of marked pieces recovered. Beginning in 2004 with 36 marked wood pieces, we relocated 30 pieces in 2004, 26 pieces in 2005, and only 13 pieces in 2006. The attrition increased with increasing snowmelt flood magnitude/duration in RY 2006 (Table 5). The percentage of marked wood pieces transported by high flows also increased in response to the RY 2006 snowmelt flood magnitude; the percentage of wood pieces moved more than doubled from 2005 to 2006. Finally, we observed a general pattern of LWD "clumping" within discrete depositional reaches characterized by increased channel braiding, visually higher channel complexity, and potentially more fish habitat. These reaches were isolated by straight, homogenous channel sections with relatively little or no wood deposition (Figure 12). These observations fit our prediction of the ecological functions of different hydrograph components in different runoff year types (in this case LWD transport and accumulation from Snowmelt Floods during Wet runoff years) presented in the RY 2003-04 Annual Report (Figure 18).

3.3 Geomorphic Termination Criteria Review

In 2006, the stream scientists reviewed the geomorphic, riparian, and fisheries Termination Criteria specified in State Water Resources Control Board (SWRCB) Order Nos. 98-05 and 98-07 and recommended changes to the SWRCB regarding these criteria. The status and recommended changes to the fisheries Termination Criteria are reported separately by Chris Hunter. The memorandum prepared by Bill Trush to the SWRCB is provided in Appendix A of this report.

Table 5. Large wood transport experiment conducted during RYs 2004-06.

	RY 2004 Mark	RY 2004 Recovery	RY 2005 Recovery	RY 2006 Recovery
No. LWD Pieces Recovered	36	30	26	13
No. LWD Pieces Moved		11 out of 36	8 out of 30	15 out of 26
Percentage of LWD Pieces Moved		31%	27%	58%

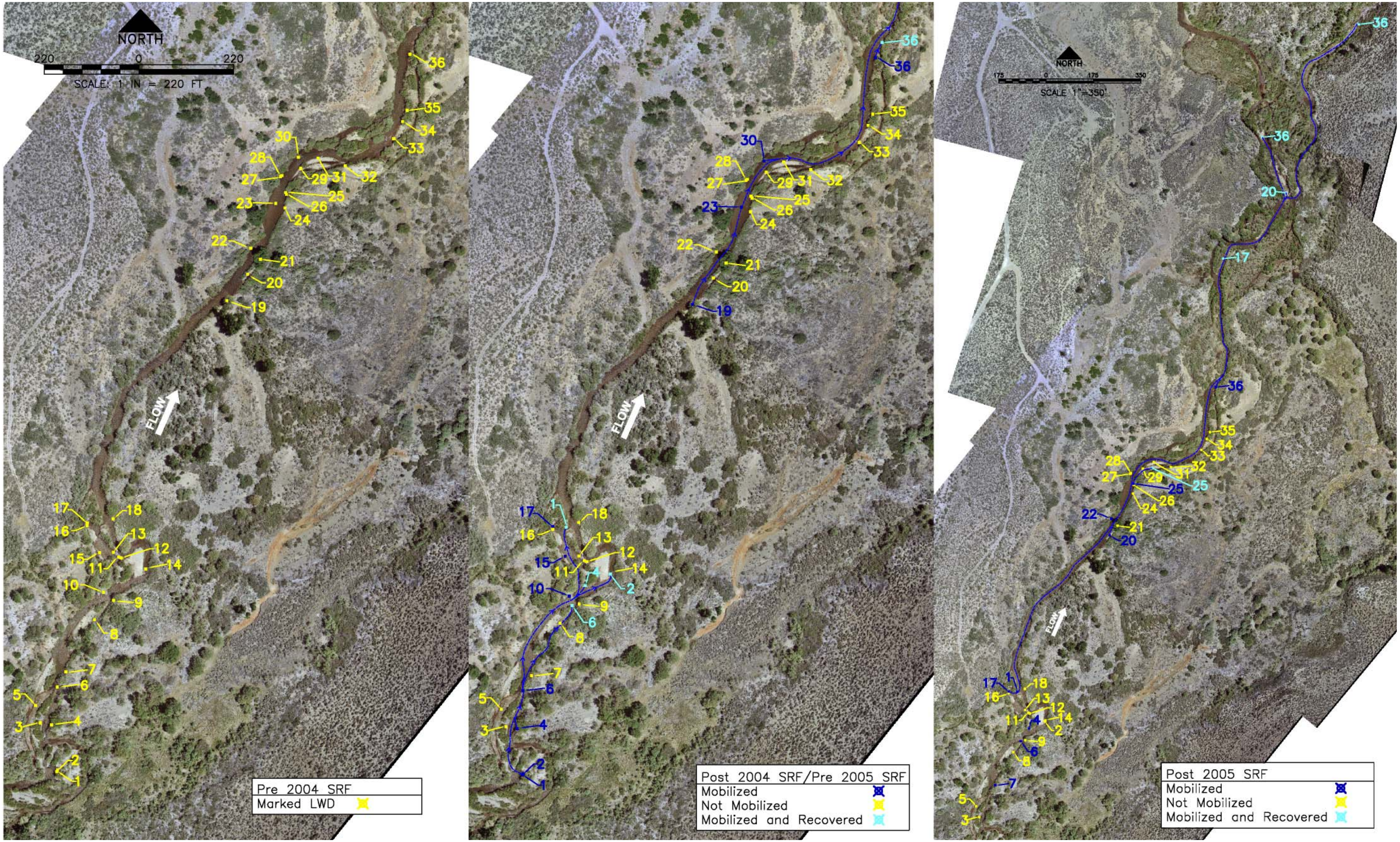

Figure 11. Runoff Year 2004 large wood transport tracking in Lower Rush and Lee Vining creeks.

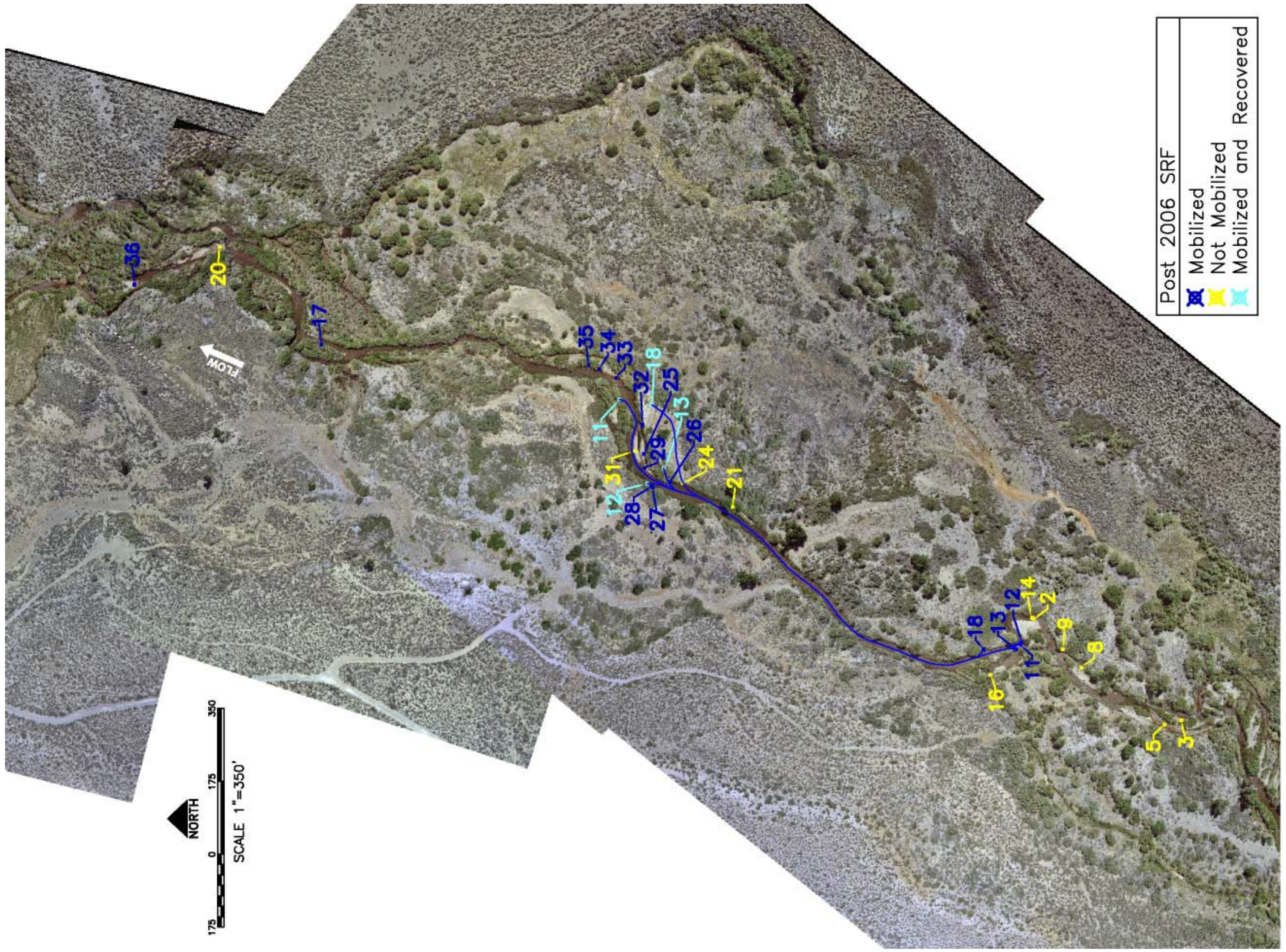

Figure 12. Runoff Year 2006 large wood transport recovery in Lower Rush Creek.

4 RIPARIAN VEGETATION MONITORING

4.1 Riparian Vegetation Response Monitoring

Introduction

In 2002, a floodplain/side-channel complex was constructed in reach 3D above the Narrows and the 8 Channel entrance was re-opened. Runoff Year 2006 marked the fourth monitoring season since construction. No further manipulation to the 3D side-channel entrance has occurred, but several adjustments have been made to the 8 Channel entrance. During RY 2004 SRF releases, the entrance was enlarged to increase the extent and duration of inundation, and to promote riparian recruitment. Prior to RY 2005 snowmelt releases, the entrance was again expanded to lower the threshold for flow entering the side-channel and increase the extent and duration of inundation (and riparian response). Finally in RY 2006, the channel entrance continued to evolve, encouraging more flow into the 8 Channel. Similar to RY 2005, the upstream end of the 8 Channel remained inundated throughout the growing season in RY 2006, whereas the downstream end was inundated until snowmelt releases receded.

A monitoring program was established in the spring of 2004 to quantify the response of riparian and desert plant species to channel and floodplain inundation. Nested frequency plots have been monitored annually in the fall for thee years. Plots were re-sampled in 2006 and compared to those from 2004 and 2005.

Methods

In October 2006, 16 plots across the 8 Floodplain and 16 plots across the 3D Floodplain were sampled. Quadrats were sampled using methods similar to the nested frequency plots described in previous annual reports (McBain and Trush 2005). At each quadrat we recorded species presence, relative abundance, and density of riparian hardwood species. Presence data were used to calculate frequencies for desert species, herbaceous riparian species, and riparian hardwood species.

Results & Discussion

Thirty-eight species were sampled during 2006 at both sampling sites combined, three more species than in 2005. Twenty four species were riparian species and 14 were desert species. Most species have been sampled previously; over 50 species have been documented since 2004.

Species richness in 2006 was still higher at the 3D Floodplain than at the 8 Floodplain. Overbank flows from the mainstem and the 3D side-channel deliver seeds to geomorphic settings appropriate to their life history strategies to a much greater extent than at the 8 Channel. In addition, riparian hardwood recovery continues to be faster at the 3D Floodplain than the 8 Floodplain. However, riparian woody plant initiation was notable at the 8 Floodplain in RY 2006, resulting from increased flows in the 8 side-channel.

In 2006, 247 riparian hardwood plants of three species (black cottonwood, yellow willow, and narrowleaf willow) were sampled in 16 quadrats at the 3D Floodplain. This was nearly a 33% reduction in the number of hardwood seedlings observed in 2005 at the 3D Floodplain. The high numbers of seedlings on the 3D Floodplain contrast sharply with the 8 Floodplain. Despite a significant increase in the number of species and the number of seedlings at the 8 Floodplain in 2006, only 55 plants of the same three species were observed in 16 quadrats, which was much lower than at the 3D Floodplain.

Prolonged high flows deposited fine sediment in small patches across the 3D Floodplain in 2006. We observed less bed scour and channel migration than in previous years. The density of riparian hardwood stems in sampled quadrats was lower than in previous years (Figure 13). While most

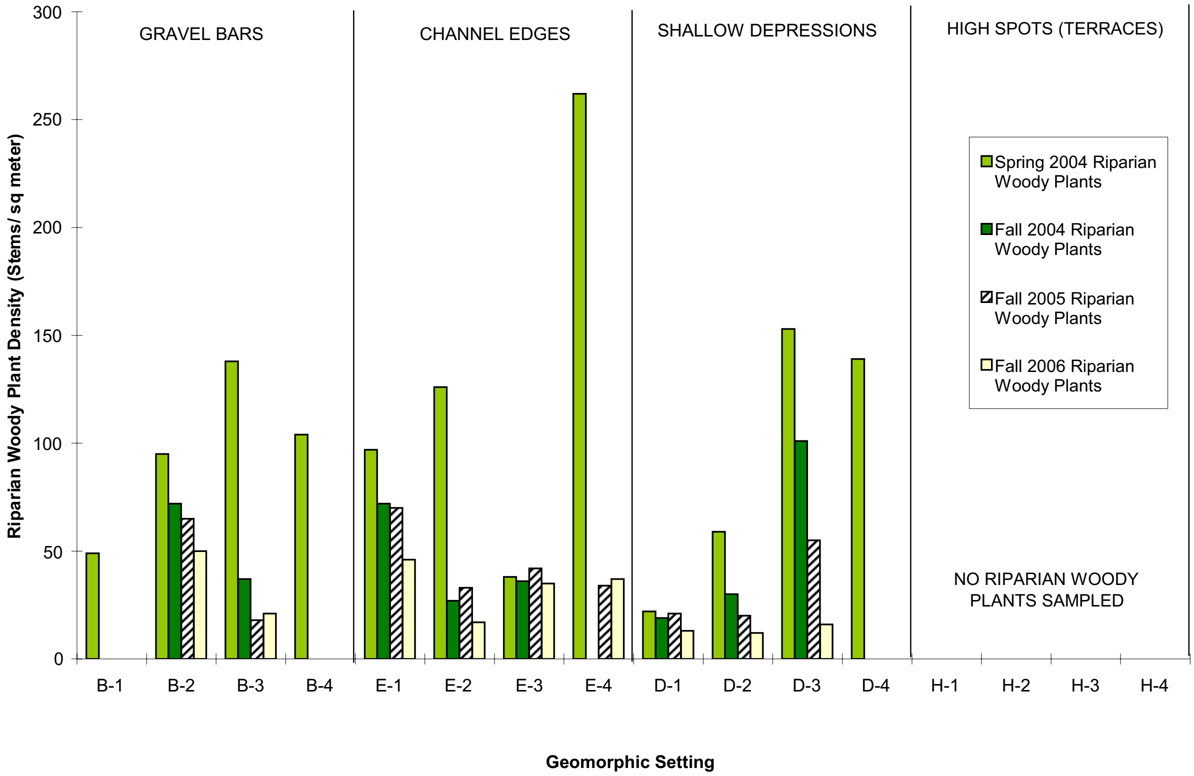

Figure 13. Hardwood seedling density in vegetation monitoring plots at the 3D Floodplain site.

quadrats exhibited reduced woody plant stem density (Figure 13), there were no reductions in vegetative cover. Inter and intra-specific competition between established woody plants is the likely cause of lower riparian hardwood densities at 3D Floodplain than scour or desiccation. Gravel bars, edges of the main side-channel, and depressions in the constructed 3D Floodplain surface continued to have the highest frequencies of riparian hardwood species of any quadrats sampled (Figure 13). No riparian hardwoods have been documented on high spots in the constructed 3D Floodplain in any monitoring event, but a few riparian herbaceous species began colonizing higher surfaces in 2005 and 2006 (Table 6).

At the 8 Floodplain, riparian hardwood regeneration increased in 2006, but hardwoods were observed only in quadrats adjacent to the 8 Channel (Figure 14). Riparian hardwoods were sampled in 25% of the terrace plots (Table 7), increasing from 0% in 2005. High flows in the 8 channel during RY 2005 and RY 2006 deposited fine sand and silts, creating suitable seed beds next to the wetted 8 Channel. Even though upstream quadrats were all underwater during the seed release period and during the October sampling, many narrowleaf and yellow willow seedlings germinated along the wetted channel nearby in fine textured deposits (Figure 15). And although the downstream end of the channel was inundated for prolonged periods in 2006, few seedlings survived (Figure 16). A few cottonwood seedlings survived near the downstream quadrats, but none (alive or dead) were observed upstream. This observation suggests seed dispersal at the 8 Floodplain is mostly downstream. Terrace plots toward the mainstem had high densities (34 seedlings/m^2) of hardwood seedlings for the first time since sampling began. Sampling this area in 2005 yielded 9 to 10 seedlings/m^2.

Table 6. Desert and riparian species' responses to the re-opening of the 3D Channel entrance in RY 2004, RY 2005, and RY 2006.

		Bars on Main Side Channel (n=4)	Edges of Main Side Channel (n=-4)	Depressions in Constructed Surface (n=4)	High Spots on Constructed Surface (n=4)
SPRING 2004	Total Number of Desert Species	3	3	2	0
	Total Number of Riparian Species	16	9	11	0
	Frequency of Desert Species in Plots	33%	58%	8%	0%
	Frequency of Riparian Herb Species in Plots	83%	42%	75%	0%
	Frequency of Riparian Hardwood Species in Plots	100%	100%	100%	0%
FALL 2004	Total Number of Desert Species	2	1	0	4
	Total Number of Riparian Species	8	7	13	0
	Frequency of Desert Species in Plots	25%	25%	0%	75%
	Frequency of Riparian Herb Species in Plots	42%	42%	50%	0%
	Frequency of Riparian Hardwood Species in Plots	50%	75%	75%	0%
FALL 2005	Total Number of Desert Species	3	3	2	9
	Total Number of Riparian Species	8	14	8	8
	Frequency of Desert Species in Plots	25%	58%	17%	100%
	Frequency of Riparian Herb Species in Plots	25%	75%	50%	58%
	Frequency of Riparian Hardwood Species in Plots	50%	100%	75%	0%
FALL 2006	Total Number of Desert Species	5	3	0	9
	Total Number of Riparian Species	11	12	6	5
	Frequency of Desert Species in Plots	42%	75%	0%	92%
	Frequency of Riparian Herb Species in Plots	42%	83%	17%	58%
	Frequency of Riparian Hardwood Species in Plots	58%	92%	75%	0%

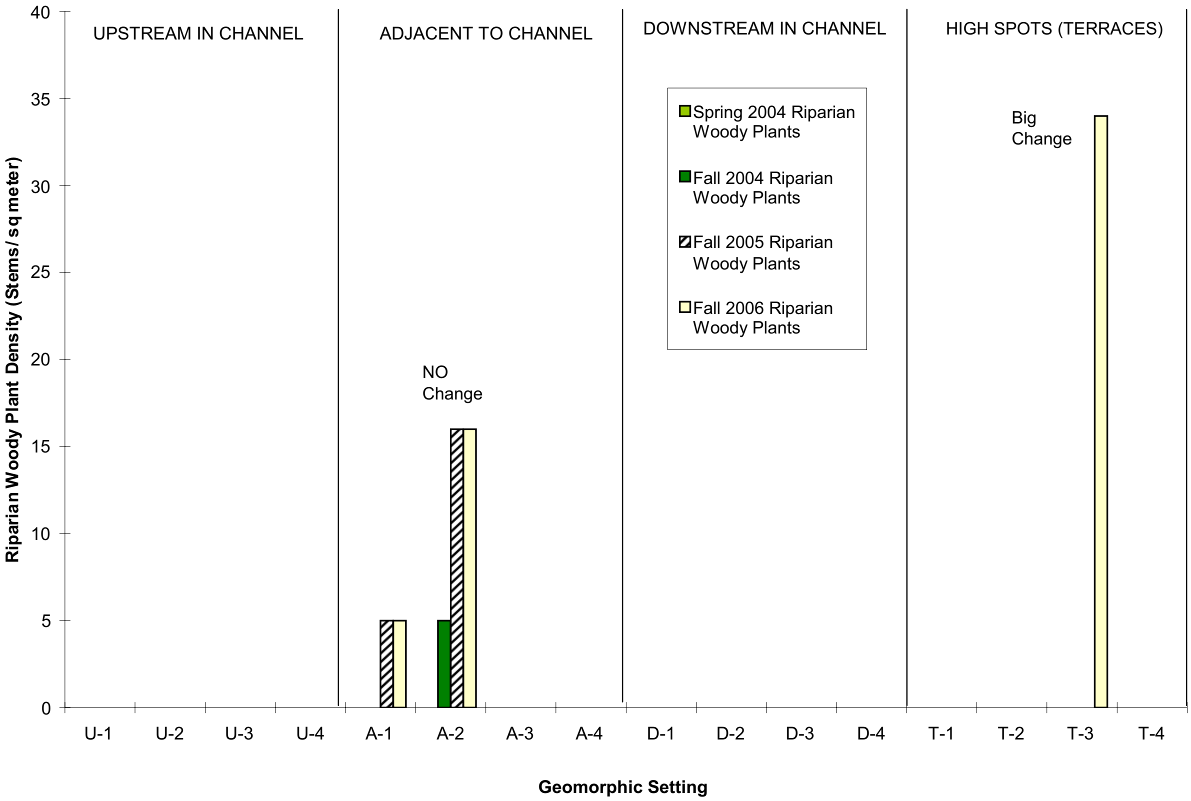

Figure 14. Hardwood seedling density in vegetation monitoring plots at the 8 Floodplain site.

Figure 15. Narrowleaf and yellow willow seedlings growing along the 8 Channel near the entrance. Date of photo: October 19, 2006.

Table 7. Desert and riparian species' responses to the re-opening of the 8 Channel entrance in RY 2004, RY 2005, and RY 2006.

		Upstream in 8 Channel (n=4)	Adjacent to the 8 Channel (n=4)	Downstream in the 8 Channel (n=4)	Terrace Surface between the 8 Channel and mainstem Rush Creek (n=4)
SPRING 2004	Total Number of Desert Species	4	9	1	8
	Total Number of Riparian Species	0	2	0	1
	Frequency of Desert Species in Plots	50%	50%	17%	92%
	Frequency of Riparian Herb Species in Plots	0%	17%	0%	17%
	Frequency of Riparian Hardwood Species in Plots	0%	25%	0%	0%
FALL 2004	Total Number of Desert Species	4	8	1	4
	Total Number of Riparian Species	0	2	0	1
	Frequency of Desert Species in Plots	75%	33%	50%	67%
	Frequency of Riparian Herb Species in Plots	0%	17%	0%	17%
	Frequency of Riparian Hardwood Species in Plots	0%	25%	0%	0%
FALL 2005	Total Number of Desert Species	0	9	2	8
	Total Number of Riparian Species	0	8	0	6
	Frequency of Desert Species in Plots	0%	100%	25%	75%
	Frequency of Riparian Herb Species in Plots	0%	58%	0%	75%
	Frequency of Riparian Hardwood Species in Plots	0%	33%	0%	0%
FALL 2006	Total Number of Desert Species	0	10	4	9
	Total Number of Riparian Species	0	8	1	8
	Frequency of Desert Species in Plots	0%	75%	25%	83%
	Frequency of Riparian Herb Species in Plots	0%	75%	8%	58%
	Frequency of Riparian Hardwood Species in Plots	0%	33%	0%	25%

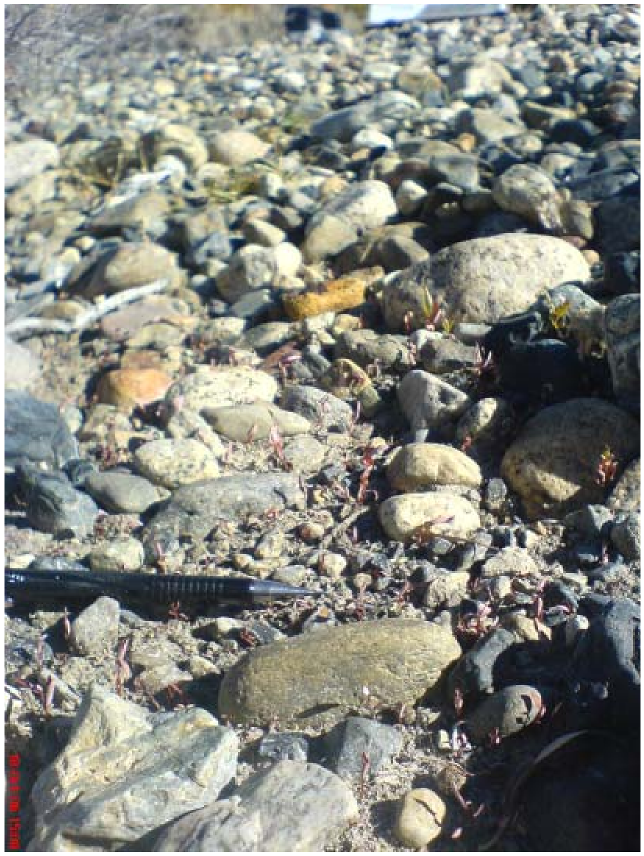

Figure 16. Dead and surviving cottonwood and willow seedlings along the 8 Channel at the downstream end. Date of photo: October 19, 2006.

Figure 17. Desert toad tadpoles (Bufos punctatus) in the wetted 8 Channel July 16, 2006.

Plant species number increased overall across the 8 Floodplain, with a reduction in the number of desert species sampled and an increase in the number of riparian species (Table 7). The areas around the downstream quadrats had dead sage brush and antelope brush and abundant *Cyperus squarrosus* (a good indicator of areas that potentially support cottonwood seedlings). The rise of local groundwater during the growing season might kill desert species, and create conditions that support riparian herbaceous species..

Red spotted or Desert Toad (*Bufos punctatus*) tadpoles were observed in the 8 Channel below piezometer 8C-8 in July 2006 (Figure 17), indicating ponded water had persisted long enough on the floodplain for an amphibian species to complete early stages of its life cycle.

4.2 8 Channel and 4 Floodplain Inundation Mapping and Vegetation Response

The 4bii and 8 channel openings were intended to increase groundwater and soil moisture available to existing plants and to maintain surface moisture at nursery sites where woody riparian plants could germinate. The channel openings, combined with the SRF flow releases, appear to have enhanced growing conditions on the 4bii and 8 floodplains and created nursery areas for willow and cottonwood initiation.

In July and October 2006 during and after the 2006 Rush Creek SRF releases, floodplains surrounding the 8 and 4bii channels were mapped to show (1) areas inundated by overbank and side-channel flow that displayed standing water, (2) areas wetted by groundwater or the capillary fringe intersecting the ground surface that displayed moisture but not standing water, and (3) locations where cottonwood and willow seedlings initiated in RY 2005 and RY 2006. The objective for floodplain mapping in July was to estimate the area of wetted and inundated floodplains, evaluate suitable areas where willow and cottonwood seedlings *could* germinate in 2006, and map seedlings that had survived from 2005. The objective for floodplain mapping in October was to estimate the area of wetted and inundated floodplains and map areas that *did* germinate willow and cottonwood seedlings.

The 8 and 4bii floodplains were mapped on July 16 and October 9, 2006. Laminated aerial photographs were used for field mapping, then digitized to produce floodplain inundation maps. As in previous mapping, boundaries for floodplain inundation mapping were defined by the riparian corridor boundaries which extend to the base of the valley walls at the back of the 4 and 8 floodplains.

The 2005 annual report hypothesized that an increase in flood magnitude may not increase saturated area on the 4 Floodplain, but a longer duration flood or a lowered 4bii Channel invert might increase the saturated area by exposing surfaces farther inland and downstream to more groundwater recharge. During the 2006 SRF releases the inverts to both channels were modified. Flows accessed both floodplains for a longer duration than in 2005. The 2006 SRF flood magnitude was also higher, thus confounding explanation of our observations of greater seedling initiation than had been observed previously. Also, observer bias cannot be discounted in explaining the difference in how saturated areas are mapped (Table 8) between RYs 2004, 2005, and 2006. Floodplain inundation peaked during the latter days of the SRF releases in 2006 (Figure 18) as streamflows receded from prolonged peak releases.

Areas saturated across the 4bii and 8 floodplains in RY 2006 were similar to RY 2005 (Table 8). Streamflows continued to access the 8 and 4bii channel into October. RY 2006 was the first year in which areas of the 4bii and 8 floodplains had continued to be inundated through October since floodplain inundation mapping began and the 4bii and 8 channels were re-watered (Table 8).

Despite difficulties in detecting seedlings because of their size (Figure 19), many willow and cottonwood seedlings germinated and survived on the 4 and 8 floodplains. Yellow willow (*Salix lutea*), the most common riparian woody plant in the Rush Creek riparian corridor, had the highest densities of seedlings at the 4 and 8 floodplains. Black cottonwood was the second most frequently observed species, with highest seedling densities clustered near female trees then dropping off sharply approximately 300 ft from the source tree. Cottonwood seedlings were also found on open areas adjacent the 4bii Channel along the right valley wall. If an area was open and saturated in July, willow and cottonwood seeds (depending on which species was closest) likely germinated and survived into the fall.

In a few locations where dead seedlings were mapped, individual seedlings were dug up and the distance to visible soil moisture measured. We questioned whether (1) lack of soil moisture caused the seedlings to desiccate, or (2) maximum daily air temperatures had “cooked” the seedlings. Most seedlings had grown roots of similar lengths (Figure 20), suggesting soil moisture conditions were fairly uniform when seedling mortality occurred. When the seedlings were excavated in October, soil moisture was visible within 0.2 ft of the ground surface and all the dead seedlings’ roots had grown deep enough to access this water source (Figure 21). Based on similar work we have done on the Trinity River in Northern California, we surmised that the soil moisture observed in October was not present when the seedlings died. Because of the dead seedling’s size, we estimated that they had died sometime between the high flows recession in July, and our sampling in October. Coincidentally, the 4bii Channel dried up briefly in late July and soil moisture likely declined beyond the seedling roots. In August, flows again accessed the 4bii Channel and rewetted the soil, which is the likely source for the soil moisture observed in October. We concluded that perennial flow in the 4bii Channel would have sustained soil moisture and facilitated the survival of these seedlings.

5 SIDE-CHANNEL AND CONSTRUCTION SITE MONITORING

In 2006 the stream scientists reviewed the status of historic primary channels (mainstem channels) and secondary channels (side-channels) in Rush Creek below the Narrows designated to be re-watered in SWRCB Order No. 98-05. Bill Trush presented a memorandum to the SWRCB with recommendations regarding the re-watering of the 1A, 4bii, 8, 11, 13, and 14 channels of the Rush Creek bottomlands. The recommendations considered commentary regarding the Order's re-watering provisions by Lisa Cutting of the Mono Lake Committee (dated January 13, 2005), Sacha Heath and Chris McCreedy of the Point Reyes Bird Observatory (dated January 13, 2005), and Chris Hunter's fish crew. The final memorandum (dated April 21, 2006) submitted to the SWRCB is provided in Appendix B.

Table 8. Acres inundated and saturated on the 8 and 4 floodplains in RY 2005 and RY 2006.

		8 Channel		4bii Floodplain	
		Acres	Percent	Acres	Percent
RY2004 SRF Release (June)	Saturated Area	2.7	15%	18.8	49%
	Dry Areas	15.8	85%	19.9	51%
	Total	18.5	100%	38.7	100%
RY2005 SRF Release (June)	Inundated Area	2.5	14%	7.8	20%
	Wetted Areas	2.5	14%	18.1	47%
	Dry Areas	13.4	73%	13.0	33%
	Total	18.5	100%	38.8	100%
RY2006 SRF Release (July)	Inundated Area	2.8	15%	9.7	25%
	Wetted Areas	2.6	14%	15.2	39%
	Dry Areas	13.1	71%	13.9	36%
	Total	18.5	100%	38.8	100%

		8 Channel		4bii Floodplain	
		Acres	Percent	Acres	Percent
RY2004 Fall Baseflows (October)	Inundated Area	0.0	0%	0.0	0%
	Wetted Areas	0.0	0%	0.0	0%
	Dry Areas	18.5	100%	38.7	100%
	Total	18.5	100%	38.7	100%
RY2005 Fall Baseflows (October)	Inundated Area	0.0	0%	0.0	0%
	Wetted Areas	0.0	0%	0.0	0%
	Dry Areas	18.6	100%	38.8	100%
	Total	18.6	101%	38.8	100%
RY2006 Fall Baseflows (October)	Inundated Area	1.0	6%	3.9	10%
	Wetted Areas	NA	0%	NA	0%
	Dry Areas	17.4	94%	35.0	90%
	Total	18.6	101%	38.8	100%

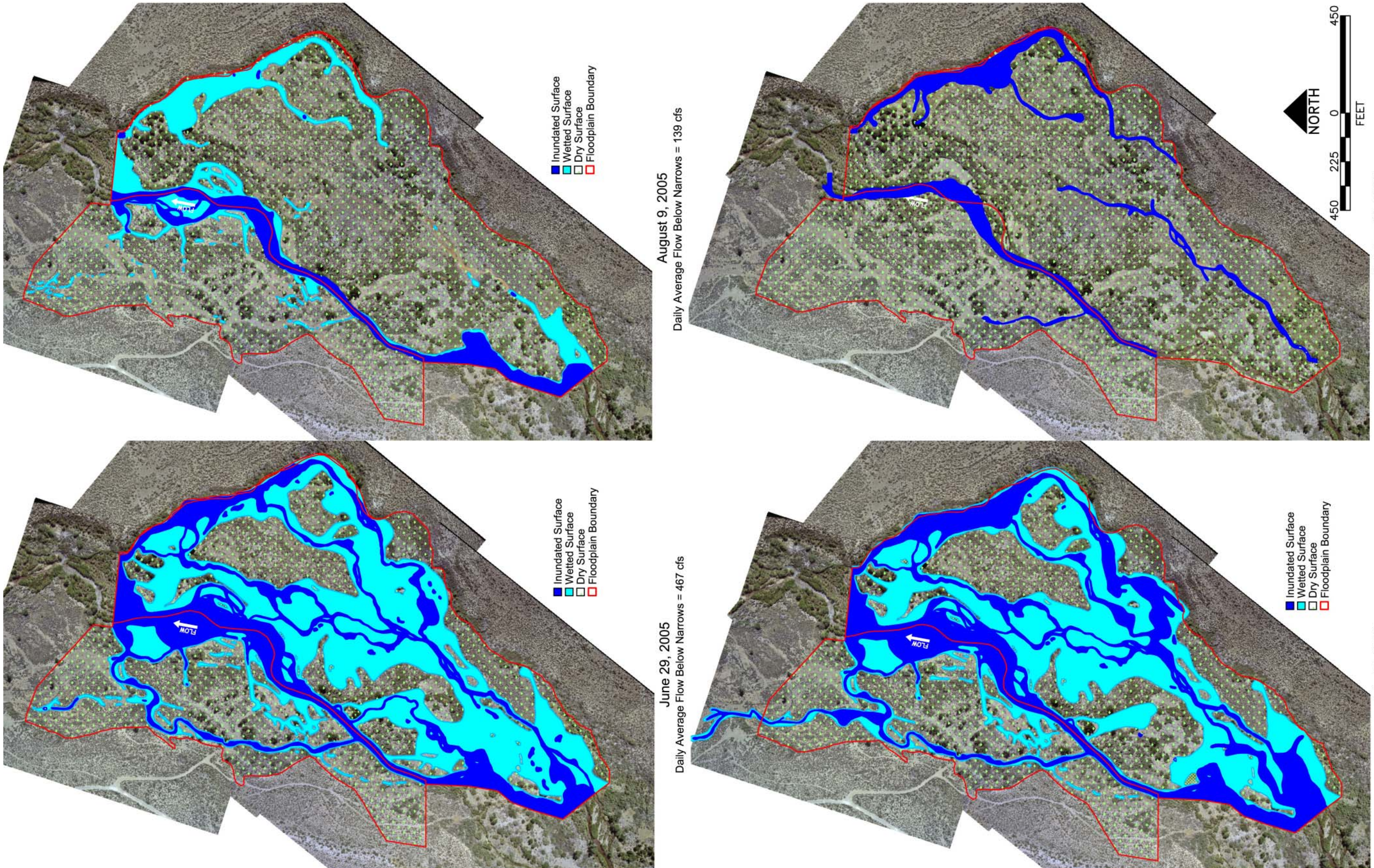

Figure 18. The 8 and 4 floodplains with the extent of wetted and inundated areas on June 28, 2005, August 9, 2005, July 16, 2006 and October 19, 2006.

Figure 19. Black cottonwood (Populus balsamifera ssp. trichocarpa), yellow willow(Salix lutea), and narrowleaf willow(Salix exigua) seedlings that initiated on the 4 Floodplain in RY 2006. Date of photo: October 19, 2006.

Figure 20. Dead yellow willow seedlings dug up on the 4 Floodplain showing root lengths.

Figure 21. Soil pit showing soil moisture close to the ground surface in a field of dead yellow willow seedlings. Date of photo: October 19, 2006.

6 REFERENCES

McBain and Trush. 2004. Monitoring results and analyses for runoff year 1999: Lee Vining, Rush, Walker, and Parker Creeks. Annual Report prepared for Los Angeles Department of Water and Power, Los Angeles, California.

McBain and Trush. 2005. Monitoring results and analyses for runoff year 1999: Lee Vining, Rush, Walker, and Parker Creeks. Annual Report prepared for Los Angeles Department of Water and Power, Los Angeles, California.

APPENDIX A

TERMINATION CRITERIA MEMO

McBain & Trush
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Memorandum

December 21, 2006

Ms. Victoria Whitney, Chief
Division of Water Rights
State Water Resources Control Board
1001 I Street
Sacramento, California 95812

Subject: Status and Recommended Revisions to the State Water Resources Control Board Order Nos. 98-05 and 98-07 Riparian Vegetation and Geomorphic Termination Criteria

Dear Ms. Whitney

The purpose of this memo is to report on the status of geomorphic and riparian vegetation termination criteria specified in State Water Resources Control Board (SWRCB) Order Nos. 98-05 and 98-07 and to recommend changes to the SWRCB regarding these criteria.

Woody Riparian Vegetation Termination Criteria

SWRCB Order Nos. 98-05 and 98-07 established termination criteria for restoring pre-diversion riparian vegetation conditions. The 1929 aerial photographs archived in the Fairchild collection have been the primary pre-diversion baseline from which riparian vegetation has been quantified. Jones and Stokes Associates (JSA) evaluated 1929 and 1940 aerial photographs to estimate pre-diversion riparian vegetation in the Mono Basin Environmental Impact Report. Technologies for directly overlapping original pre-diversion estimates from the 1929 aerial photographs onto contemporary estimates from recent aerial photographs have improved considerably since the early-1990s.

McBain and Trush re-evaluated pre-1941 woody riparian acreages by re-mapping riparian vegetation on the highest quality digital images of the 1929 aerial photos obtainable. For our evaluation, the 1940 aerial photos were not used because they were of poor quality. Film diapositives of the original 1929 aerial photo negatives were obtained, scanned at high resolution (1200 dpi), and color corrected in Adobe Photoshop to improve contrast and interpretability. Using AutoCAD Map, the photos were rubbersheeted from 1996 USGS Digital Orthorectified Quarter Quadrangles (DOQQs) to locate coincident ground control points (typically road intersections). The photos were then printed at 1:1800 scale (1 inch = 150 feet). These spatially accurate photographs were used to categorize and quantify 1929 woody riparian acreages for Rush, Lee Vining, Parker, and Walker creeks from vegetation classes consistent with vegetation mapped in 1999 by McBain and Trush. The original film diapositives were viewed concurrently through an enlarging “photo loop” on a light table for additional accuracy of patch determination. After delineating the patches on the laminated photo set, the 1929 aerial photos were orthorectified using ERDAS Imagine software with OrthoBASE module. The images were rectified using horizontal control points located on the 1996 USGS DOQQs, automatic tie points using the spectral characteristics of the overlapping imagery, and Digital Elevation Models (DEMs) to correct for topographic relief distortion produced from the relations between the topography and the flat photographic film. Because there was no camera calibration report available for the 1929 photos, interior parameters of the camera were estimated using the flight scale and measurements of the fiducial marks in the photos. The root mean square error (the degree of correspondence between the control points on the resulting 1929 orthophotos and the 1996 DOQQ basephotos) was less than one meter for the Lee Vining Creek block and less than 3 meters for the Rush/Walker/Parker creek block.

By spatially correcting the 1929 aerial photos and mapping vegetation patches directly onto those photos, we produced a more accurate and reproducible inventory of the 1929 woody and herbaceous riparian vegetation than was possible 15 years ago. Table 1 provides the present SWRCB termination criteria (Column 2), which are the 1929 acreages traced back to JSA’s efforts, and revised 1929 acreages from our re-assessment.

Application of the Rush Creek and Lee Vining Creek termination criteria as standards by which to document/verify recovery assumes today’s stream corridor has the same potential to grow and sustain woody riparian vegetation as the 1929 stream corridor. Unfortunately, some acreages within Rush Creek and Lee Vining Creek corridors that were woody riparian in 1929 cannot be restored to woody riparian vegetation, either through natural processes by the year 2100 or by planting cottonwoods/Jeffrey pine. Extensive channel downcutting, being more pronounced closer to the Mono Lake shoreline, has isolated many former floodplain and terrace surfaces from the mainstems’ influence by peak flow releases on surface inundation/saturation and shallow groundwater dynamics. In other valley bottom locations, burial of former floodplain surfaces by 3 ft to 6 ft of coarse bedload material has made woody riparian initiation difficult, if not highly improbable, by distancing pioneer seedlings from a reliable water source.

Are Rush Creek and Lee Vining Creek stream corridors in 2006 capable of recovering and ecologically sustaining the same acreages of woody riparian vegetation revealed on the 1929 aerial photographs? If the answer is no, then the termination criteria should be revised downward. If the answer is yes, the termination criteria should be revised upward. To answer this question, our assessment charted two pathways that initially diverged yet ultimately converged.

The first pathway was to use the 1929 woody riparian acreages (proposed for revision by McBain and Trush above) within the administrative framework of termination criteria and with the following overall perspective: wherever an acre of 1929 woody riparian vegetation acreage was lost post-1941, LADWP would restore that acre. Restoration could be through natural ecological processes, promoted by the SRFs, and through planting. Natural processes are highly preferred, but the timeframe within which natural processes were expected to accomplish restoration was never stated explicitly. There are three timeframes adopted in our assessment: short-term (by 2025), long-term (by 2100), and beyond 2100. SWRCB Order No. 98-07 adopted a wait-and-see perspective, allowing for 8 to 10 years of SRF streamflow releases before determining if, and to what extent, woody riparian recovery was possible without intervention (e.g., planting).

We have monitored and assessed, and have ascertained that the prognosis (i.e., recovery by 2100) is good for many 1929 riparian areas, fair for others, and poor or futile for some. Perhaps the epitome of bad (the far end of futile) is the young RB (right bank looking downstream) willow stand below the Rush Creek ford. Though part of an actively depositing emergent floodplain prior to 1941, the now dead willow stand is perched many feet above the present floodplain. No planting of cottonwoods or Jeffrey pine would succeed here. Nor is this perched floodplain, due to pervasive mainstem downcutting (extensive and deep close to Mono Lake and tapering-off approaching the Narrows), likely to be eroded away in the short-term or long-term to be converted to floodplain. This patch of former 1929 woody riparian habitat cannot be accommodated ecologically to satisfy the termination criteria. For another example, the 1929 woody riparian vegetation in Rush Creek Segment 3A and Segment 3B consisted of extensive aspen, cottonwood, and willow stands. There was very little riparian herbaceous or desert vegetation within the riparian corridor in 1929 in these segments. As a result of land management activities since 1929 much of the riparian woody vegetation was converted to riparian herbaceous vegetation, desert vegetation, or human disturbance. Much of the unrecoverable (defined in next paragraph) acreage in Segment 3A is currently riparian herbaceous vegetation which was 1929 woody riparian vegetation; in Segment 3B much of the unrecoverable woody acreage has been converted to human disturbance (e.g., expansion of Hwy. 395) or riparian herbaceous vegetation. Of the total 239.5 acres of original 1929 woody riparian acres in Rush Creek (Column 3, Table 1), approximately 55 acres are not recoverable to woody riparian vegetation by 2100.

Table 1 uses the modifier ‘recoverable’ woody riparian acreage for 1929 and non-1929 woody riparian patches. There are two kinds of ‘recoverable.’ Short-term recoverable (up to 2025) woody riparian acreage will result from these natural processes created by SRF releases and encouraged by removal of domestic grazing: (1) the stream channel migrating into a high terrace and depositing a floodplain in its wake, (2) natural seeding and/or suckering during shallow groundwater saturation in late-spring on low terraces, and (3) seasonal and perennial side-channel surface flows accessing previously inaccessible terrace surfaces. Long-term recoverable acreage (to the year 2100) will result from: (1) changing shallow groundwater dynamics as increasing channel roughness increases flood stage and increases the extent and duration of floodplain saturation, (2) better seedling success as adjacent areas already with maturing woody riparian vegetation favorably change the microclimate, (3) main channel avulsions, and (4) slow cottonwood and willow suckering that will require infrequent wetter years combined with other favorable factors (e.g., no late-season cold snap that can kill catkins). Long-term recovery also can be promoted by selectively planting to jump-start these processes, particularly where a terrace surface approaches a 6 ft elevation above the stream channel (declining success with greater elevation) and where mainstem migration may eventually topple matured trees directly into the channel as LWD (thereby providing a positive feedback loop to channel roughness). In a few instances a short-term prognosis could be transformed to a long-term one if rapid local mainstem downcutting occurred, particularly at side-channel entrances. The use of 'non-recoverable' means woody riparian recovery not expected by 2100.

Our second assessment pathway was more ecological rather than administrative: estimate acreages of woody riparian vegetation that both future stream corridors are capable of recovering, and not base/measure performance by the 1929 acreages. Although not all 1929 woody riparian acreages can be returned to a similar status, some acreages that were not woody riparian in 1929 have been converted. In 2004, woody riparian vegetation has become established in 60.4 acres of Rush Creek that were not woody riparian habitat in 1929 (Column 7, Table 1). As the SRF's are released, side-channels are re-watered, and time marches on (thus encountering more favorable hydrologic years for establishing seedlings), other portions of both valley corridors presently not supporting woody riparian vegetation will recover or be transformed into woody riparian habitat. Patches in 2004 inventoried as herbaceous riparian habitat were not included in the woody riparian acreage totals.

Table 2 presents a similar woody riparian acreage analysis for Lee Vining Creek in Segments 2B, 3A, 3B, and 3C. Segments 1 and 2A are above Hwy. 395 and no future restoration actions are being considered. Differences between McBain and Trush's revised 1929 acreages (Column 3, Table 2) and the 2004 acreage plus recoverable acreage (Column 9, Table 2) for Segments 3A and 3B are relatively large (8.1 acres and 13.7 acres respectively) compared to Rush Creek. In current Lee Vining Creek, over 60% of the 1929 woody riparian vegetation is unrecoverable in Segment 3A and Segment 3B. In 1954 a catastrophic fire destroyed much of the pre-diversion woody riparian vegetation. Furthermore, there is considerable anecdotal evidence to suggest that, before diversion, well developed soils existed in the riparian corridor but were washed away in the 1960 floods. Today, many locations where 1929 woody riparian grew are now much higher in elevation from the stream channel, having deeply incised through areas that were frequently inundated or were close to the shallow groundwater table. The combination of much less fines in the soil, the groundwater dropping away quickly within short distance from the channel, and many surfaces being no longer inundated greatly inhibits/prevents recovery of the 1929 woody riparian vegetation where it once historically existed. In 2004, woody riparian vegetation has become established in 10.4 acres on Lee Vining Creek that were not woody riparian vegetation in 1929 (Column 7, Table 2).

Woody Riparian Termination Criteria Recommendation

Recovery of all woody riparian vegetation acreages by designated stream reaches in the SWRCB termination criteria cannot be accomplished through natural processes and/or intervention solely on former 1929 woody riparian acreages. Some 1929 floodplain and low terrace surfaces that once supported woody riparian vegetation are now too high relative to the shallow groundwater dynamics within both valley corridors due primarily to progressive channel downcutting instigated by lowering Mono Lake. As of 2004 (the latest woody riparian inventory), woody riparian vegetation throughout Rush Creek is established on 123.1 acres of former 1929 riparian surfaces and on an additional 60.5 acres where woody riparian vegetation did not exist in 1929. This Rush Creek total, 183.6 acres, is 55.9 acres short of our revised 1929 acreage total (239.5 acres) and 56.2 acres short of the SWRCB termination criteria.

Application of the Rush Creek termination criteria, using either the present criteria or McBain and Trush’s 1929 revisions, as standards by which to document/verify recovery assumes today’s and future stream corridor has/will have the same capacity to grow and sustain woody riparian vegetation as the 1929 stream corridor. Assuming all 2004 woody riparian vegetation persists, we predict an additional 48.0 acres are recoverable over the short-term (by 2025) and long-term (by 2100). While adoption of the 1929 acreages was an excellent strategy in drafting the Orders, our research subsequently indicates that the short- and long-term outlook is for a Rush Creek stream corridor with slightly less capacity. Our basic guiding principle has been to promote an ecologically sustainable restoration program and to make ecologically defensible recommendations. Mathematically, the difference between 239.5 acres (1929 total acreage) (Column 3, Table 1) and 231.5 acres (2004 acreage + 48.0 recoverable acres) (Column 9, Table 1) seems small (8.0 acres). On a reach-by-reach basis, however, some reaches will be above the revised McBain and Trush 1929 acreages and others will be below (contrast Column 3 with Column 9, Table 1 and Table 2).

We recommend that the ecological capacities for creating and sustaining woody riparian vegetation (i.e., 2004 woody riparian acreage and recoverable woody riparian acreage) (Column 9, Table 1 for Rush Creek and Column 9, Table 2 for Lee Vining Creek) be adopted by SWRCB as the termination criteria.

Following the 2009 woody riparian inventory, acreages identified as 'recoverable' (i.e., short-term and long-term, as defined) will be re-assessed. Those patches still with evident recovery trajectories (short-term or long-term) will be tallied and left alone. Other patches still considered 'recoverable' will be tallied and evaluated for planting, but only where long-term recovery was suspect and where accelerated long-term, or possibly short-term, recovery would substantially benefit channel hydraulics (e.g., providing LWD). Patches of riparian woody vegetation recovered by 2009 and recoverable through stream migration and channel re-opening will be re-assessed. Planting Jeffrey pine or a cottonwood/willow mix would be recommended on a site-by-site basis. Documentation of planting success will require two monitoring periods at 5-yr intervals as stipulated by the SWRCB. For planting performed in 2010, monitoring in 2014 and 2019 should establish whether intervention did remove the doubt of ecological recovery. If the 2009 re-assessment unveils more 'recoverable' acreages than predicted by McBain and Trush, LADWP would be required to address acreages up to those specified in McBain and Trush's revised 1929 woody riparian acreages.

Geomorphic Termination Criteria

SWRCB Order No. 98-07 established three geomorphic termination criteria: main channel length, gradient, and sinuosity. All have numeric targets for each stream reach in Rush Creek and Lee Vining Creek intended to represent pre-diversion conditions. Specific stream reaches were established by Woody Trihey in the early-1990s based on contour breaks in the May 1991 aerial survey. The 2003 low-altitude aerial photographs were orthorectified with photogrammetry developed at a contour accuracy of ±1 ft. This digital terrain model was ideally suited to quantify the geomorphic termination criteria. Values for main channel length, gradient, and sinuosity were replicated from the 2003 aerial photogrammetry and compared to the SWRCB Order No. 98-07 termination criteria values.

Geomorphic criteria were calculated as follows:

- Main Channel Length: The main channel for each reach of Rush and Lee Vining creeks was identified on the 2003 aerial photographs, the left and right edges of water were digitized in AutoCAD, and a centerline was established in the middle of the low-flow channel. Length of the main channel centerline was then measured in AutoCAD.

  = CHANNEL LENGTH (L)

- Channel Gradient: The channel gradient for each reach of Rush and Lee Vining creeks was calculated using elevations from the 2004 aerial photogrammetry at the Trihey (1993) reach boundary locations, calculating the change in elevation from top to bottom of each reach, and dividing elevation change by the reach length.

  = Δ ELEVATION / CHANNEL LENGTH (ΔEL/L)

- Channel Sinuosity: Channel sinuosity for each reach of Rush and Lee Vining creeks was calculated as the ratio of main channel length to valley length. Valley length was estimated by establishing a valley longitudinal profile line running mid-way between the riparian corridor boundary lines.

  = CHANNEL LENGTH / VALLEY LENGTH (L/VL)

The primary geomorphic termination criterion is main channel length. A comparison of the 2003 main channel lengths for each stream reach in Rush Creek to the SWRCB length criteria (refer to Rush Creek termination criteria, Table 3) shows the following shortfalls:

(1) The Stream Scientists are not recommending any change to the Rush Creek Reach 1 termination criterion at this time.
(2) Stream Reach 3B is shorter than the SWRCB length by 144 ft. This shortfall is real. Upstream of the old Hwy. 395 bridge the decision was made to split the mainstem baseflow at an ‘island’ immediately downstream of the planmapping/fish survey study reach. Streamflows to the right (looking downstream) were directed down the present main channel and streamflows to the left were directed toward the former channel to re-water the floodplain. This previous main channel was more sinuous than the present main channel;
(3) Stream Reach 3D is shorter than the SWRCB length by 135 ft. The RTC scientists originally planned to re-direct the entire main channel toward the right valley wall, to reoccupy its pre-diversion location. However, when the 3D floodplain project was designed, the decision was made to keep the mainstem in its present location, but direct some flow onto the evolving floodplain (with no intention of permanently maintaining a side-channel

against the right valley wall, i.e., on the backside of the evolving floodplain);

(4) Stream Reach 4C is shorter than the SWRCB length by 967 ft. Mainstem channel downcutting, due to declining Mono Lake water levels (post-diversion) and channel realignment associated with the culvert at the Ford, has headcut and abandoned the 14 Channel. In 2006, the decision was made not to re-water the abandoned 14 Channel segment. The portion of the 14 Channel cutoff was 2006 ft long and the 2003 main channel (i.e., the cutoff channel) is 476 ft;

(5) Stream Reach 5A is shorter than the SWRCB length by 247 ft. This reach of main channel has undergone many feet of downcutting (due to lake lowering) through highly erosive volcanic bed and bank material. A planmapping and fish survey study site was selected here to document the main channel's evolution as lake levels rise. We anticipate the evolution of a more sinuous channel, and therefore anticipate increasing main channel length. Re-mapping in 2005 documented an additional 69 ft of main channel length (i.e., in addition to the length of 7320 ft inventoried in 2003). Projections of how the main channel might migrate in the next 15 to 20 years indicate the SWRCB length could be achieved.

A comparison of the 2003 main channel lengths to the SWRCB length criteria (refer to Lee Vining Creek termination criteria, Table 4) for stream reaches in Lee Vining Creek, beginning slightly downstream from Hwy. 395 and ending at the 1941 Mono Lake shoreline, shows the following shortfalls: Stream Reach 2B is shorter than the 1929 reach length by 38 ft (the Termination Criterion is lumped together as Reach 2, but was divided into Reaches 2A and 2B based on 1929 lengths), Stream Reach 3A is shorter than the SWRCB length by 361 ft, Stream Reach 3B is shorter by 405 ft, and Stream Reach 3C is shorter by 150 ft. Lee Vining Creek has undergone significantly greater change than Rush Creek and its recovery will take much longer. While the termination criteria accurately represent pre-1941 main channel lengths, their use as tangible restoration goals is highly questionable. This is especially true for Stream Reach 3B. The present-day, main channel flows close to the right valley wall, while the historic main channel flowed close to the left valley wall and is now considered a secondary channel (e.g., the A4 and B1 channels). The present-day main channel is showing signs of returning to a single thread and asserting a prominent thalweg, rather than being widely braided. Eventually main channel length will increase.

But a forecast for when this new main channel will increase by 405 ft is not possible at this time. There are just too many interacting variables, including very active channel headcutting and patchy maturing woody riparian stands, that will determine which braided channel in the present-day main channel may become the future single thread main channel. The main channel length termination criteria for Lee Vining Creek are feasible, but so are many other main channel lengths feasible (and desirable) for a restored condition. SWRCB Order No. 98-05 considers these two primary factors for restoration: (1) whether fish are in good condition and (2) whether the stream restoration and recovery process has resulted in functional and self-sustaining systems with healthy riparian ecosystem components for which no extensive physical manipulation is required on an ongoing basis. Meeting the termination criteria for main channel length guarantees neither.

Main channel gradient and main channel sinuosity require estimates of main channel length. Both also require other estimates: channel bed elevation at the top and bottom of each reach (to calculate Main Channel Gradient) and valley length for each reach (to calculate main channel sinuosity). Because gradient and sinuosity are a function of channel length, the only way to attain these other two criteria is to increase channel length. Past estimates of channel bed elevation and valley length have introduced additional error. In some cases, the error creates the need for channel lengths longer than prescribed in the termination criteria. For example in Rush Creek Stream Segment 2A, an additional 159 ft would be needed above the historic 4820 ft to meet the gradient termination criteria. The 2003 estimates, derived from more accurate maps, could be used to replace the present termination criteria for gradient. But neither termination criteria offers a better performance measure or practical restoration guidance than main channel length: measure main channel length, and functionally you are accounting for main channel gradient and main channel sinuosity. We recommend removing main channel gradient and main channel sinuosity as termination criteria for Rush Creek and Lee Vining Creek.

As a footnote, the RTC scientists considered monitoring main channel curvature by measuring the radius of curvature of individual channel bends. The thinking at the time was that the main channel would become more sinuous as confinement improved. The measurement for main channel curvature was the radius of curvature (r_C), the radius of a circle fit to the curvature of an individual channel bend (i.e., a straight section of river would have an infinite r_C). Calculation of r_C (ft) does not require an estimate of valley length, but does require professional judgment in fitting a circle to each channel bend. This measure is independent of main channel length, and would have been more sensitive to change than Main Channel Sinuosity. Since the mid-1990s our research indicated that the pre-diversion main channel was not as sinuous as ‘typical’ alluvial channels, the RTC scientists’ original hypothesis. Alluvial channels have values around a ratio of r_C /w_{bf} = 1.5, where w_{bf} is bankfull width (ft). Estimation of a pre-diversion mean r_C ratio as a geomorphic goal or termination criteria, was possible (using the few abandoned pre-diversion main channel segments still reasonably intact) but would have required a wide margin of error, greatly reducing its effectiveness as a performance measure for recovery.

SWRCB Order 98-07 stipulates that two other geomorphic characteristics of the main channel be considered candidate termination criteria, thalweg diversity and channel confinement, as a way to address the physical quality of the mainstem channels rather than length of main channel. The RTC scientists’ original hypotheses were that increasing channel complexity could be measured by the variability of the thalweg's longitudinal profile and that increasing channel confinement could be measured by increases in bed averaged shear stress. In the 2000 Annual Report, both were presented, quantified, and evaluated as termination criteria. While thalweg diversity and bed averaged shear stress could serve as termination criteria, the physical processes necessary to achieve confinement and a dynamic channelbed are being specifically targeted in the SRFs. Floodplain deposition, creating the main channel confinement by building the floodplain, will take longer than 2025, the projected date for filling Mono Lake. An extended time period will be needed for two primary reasons. Much of the thalweg diversity will depend on the time necessary to have cottonwoods and Jeffrey pines grow sufficiently big, topple into the channel (many by a migrating channel), and affect/direct physical channel processes. Second, each episode of floodplain deposition will subsequently require an even larger, and less frequent, higher flood to deposit even more fine bed material in the floodplain. The first foot of floodplain deposition will take much less time, and be more predictable, than the second foot (refer to McBain and Trush Annual Report 2000). Lee Vining Creek is a distant second to Rush Creek to reaching either confinement or channel complexity. I recommend not considering thalweg diversity or bed averaged shear stress as termination criteria. The success of creating a physically complex and confined main channel in Rush Creek and Lee Vining Creek (and the geomorphic setting for side-channel formation and maintenance) will greatly depend on maximizing the magnitude of peak flow releases in wetter SRF annual flow regimes.

Parker Creek and Walker Creek
Woody Riparian and Geomorphic Termination Criteria

Parker and Walker creeks do not require geomorphic termination criteria because no mitigative actions are contemplated. Under the current SWRCB Orders, streamflows will be mostly unimpaired and sediment will be routed past the existing diversion structures. We anticipate conversion of the riparian corridor along Walker and Parker creeks to a narrower riparian corridor with more dry riparian vegetation patch types, given the recent cessation of irrigation practices. However once this conversion occurs, the riparian boundary will then more closely track with the stream as the groundwater table sharply tapers-off from the stream. Termination criteria for riparian vegetation along Walker and Parker creeks would be difficult to formulate under these conditions and unnecessary.

If streamflow diversions increase, grazing is re-instated, and/or bedload passage not restored soon, then monitoring tied to mitigation requirements should be considered. Simple trend monitoring would be helpful for documenting the anticipated riparian corridor conversion. Both creeks should be included in all future aerial photography conducted for Rush Creek and Lee Vining Creek mainstems.

Summary of Termination Criteria Recommendations

SWRCB Order 98-07 states: "*This order provides for revising the quantified "termination criteria" when existing conditions make it infeasible to restore a pre-project condition or when new information provides a better understanding of how to evaluate stream restoration progress*." Recommended changes in SWRCB Order No. 98-07 regarding geomorphic and woody riparian vegetation termination criteria are:

(1) adopt the McBain and Trush ecologically based woody riparian acreages as the termination criteria for Rush Creek (Column 9 in Table 1) and Lee Vining Creek (Column 9 in Table 2),

(2) remove main channel gradient and main channel sinuosity as termination criteria for Rush Creek and Lee Vining Creek, but retain main channel length,

(3) adopt the following revisions to the Rush Creek termination criteria for main channel lengths (Table 3): adjust Stream Reach 3B to account for decisions to split the mainstem baseflow to rewater the left bank floodplain (i.e., 2,956 ft rather than 3,100 ft); adjust Stream Reach 3D to account for decisions to not move the main channel when re-constructing the floodplain (i.e., 3,032 ft rather than 3,370 ft); and adjust Stream Reach 4C by removing the length of the 14 Channel and replacing it with the length of its cutoff channel (i.e., 2,830 ft rather than 4,360 ft),

(4) adopt the following revisions to the Lee Vining Creek termination criteria for main channel lengths (Table 4): eliminate termination criteria for Stream Reaches 1 and 2A because no future restoration actions are being considered, and retain the 1929 reach length for Reach 2B,

(5) eliminate thalweg diversity and channel confinement from further consideration as candidate termination criteria, and

(6) do not consider geomorphic or riparian vegetation termination criteria for Parker Creek or Walker Creek.

Thank you for carefully considering our recommendations,

Sincerely,

Bill Trush,
Stream Scientist

Table 1. Riparian vegetation acreages and termination criteria for Rush Creek.

RUSH CREEK			(ACRES)					
Segment	***SWRCB Termination Criteria***	***M&T revised 1929 Woody Riparian***	***2004 Woody Riparian in 1929 Woody Riparian***	***2004 Herbaceous Riparian in 1929 Woody Riparian***	***Recoverable Woody Riparian in 1929 Woody Riparian***	***2004 Woody Riparian in non-1929 Woody Riparian***	***Recoverable Woody Riparian in non-1929 Woody Riparian***	***2004 Woody Riparian plus Recoverable Woody Acres***
1	6.2	6.2	0.2	0.1	4.3	1.7	0.0	6.2
2	5	5.0	3.5	0.0	0.1	3.1	0.0	6.7
3A	21.5	25.7	10.5	2.6	4.0	3.1	2.2	19.9
3B	2.9	3.8	0.6	0.0	1.2	2.2	3.1	7.1
3C	11.2	17.4	6.4	0.2	1.8	3.1	2.4	13.7
3D	10	9.9	2.1	0.0	1.5	3.1	1.4	8.0
4A	26.3	37.3	20.5	0.8	5.1	4.7	1.3	31.6
4B	80.2	72.5	42.9	8.3	10.3	19.7	3.3	76.2
4C	38.7	28.3	22.2	1.6	0.7	7.7	0.7	31.2
5A	37.8	33.4	14.2	0.0	2.7	12.1	2.0	31.0
5B	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	239.8	239.5	123.1	13.7	31.6	60.4	16.4	231.5

Table 2. Riparian vegetation acreages and termination criteria for Lee Vining Creek.

LEE VINING CREEK			(ACRES)					
Segment	***SWRCB Termination Criteria***	***M&T revised 1929 Woody Riparian***	***2004 Woody Riparian in 1929 Woody Riparian***	***2004 Herbaceous Riparian in 1929 Woody Riparian***	***Recoverable Woody Riparian in 1929 Woody Riparian***	***2004 Woody Riparian in non-1929 Woody Riparian***	***2004 Recoverable Woody Riparian in non-1929 Woody Riparian***	***2004 Woody Riparian plus Recoverable Woody Acres***
1	20	0	0	0	0	0	0	0
2A	30.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2B	Combined with 2A	9.0	7.9	0.1	0.1	2.2	0.3	10.4
3A	22.2	18.5	4.4	0.6	2.6	2.3	1.1	10.5
3B	32.9	36.5	14.9	1.4	3.5	3.1	1.3	22.8
3C	4.0	4.0	2.1	0.2	0.3	2.8	0.2	5.4
3D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Total	59.1 Total for Segements 3A-3C	68.0 Total for Segements 2B-3C	29.3 Total for Segements 2B-3C	2.3 Total for Segements 2B-3C	6.5 Total for Segements 2B-3C	10.4 Total for Segements 2B-3C	2.9 Total for Segements 2B-3C	49.1 Total for Segements 2B-3C

Table 3. Geomorphic termination criteria for Rush Creek

RUSH CREEK	MAIN CHANNEL LENGTH (FT)			
Segment	***SWRCB Termination Criteria***	***2004 Lengths***	***M&T Revised Termination Criteria***	***Length Deficit***
1	4,100			4,100
2	4,820	4,820	4,820	0
3A	3,800	3,800	3,800	0
3B	3,100	2,956	2,956	0
3C	6,940	6,964	6,940	0
3D	3,370	3,235	3,032	0
4A	3,070	3,078	3,070	0
4B	7,810	8,071	7,810	0
4C	4,360	3,393	2,830	0
5A	7,320	7,073	7,320	247
5B	N/A			
Total	48,690	43,388	42,578	4,347

Table 4. Geomorphic termination criteria for Lee Vining Creek

LEE VINING CREEK	MAIN CHANNEL LENGTH (FT)			
Segment	***SWRCB Termination Criteria***	***2003 Lengths***	***M&T Revised Termination Criteria***	***Length Deficit***
1	4,500			
2A	7,400			
2B	Combined with 2A	2,112	2,150	38
3A	3,500	3,139	3,500	361
3B	4,200	3,795	4,200	405
3C	1,360	1,210	1,360	150
3D		1,880		
Total	20,960	12,137	11,210	953

APPENDIX B

SIDE-CHANNEL MEMO

McBain & Trush
FISHERIES
HYDROLOGY
RIPARIAN ECOLOGY
STREAM RESTORATION
FLUVIAL GEOMORPHOLOGY
P.O. Box 663, Arcata, CA 95518 • 980 7th Street, Arcata, CA 95521
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April 21, 2006

To: Mark Hanna, Los Angeles Department of Water & Power
Eastern Sierra Environmental Issues
111 N. Hope Street, Room 1468, Los Angeles, CA 90012

From: Bill Trush
Re: Side-Channel and Floodplain Recommendations for the Rush Creek Bottomlands

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Introduction

SWRCB Order No. 98-05 designates the re-watering of specific historic primary channels (mainstem channels) and secondary channels (side-channels) in Rush Creek below the Narrows. Since the 1998 Order, our understanding of physical and biological processes governing the lower Rush Creek ecosystem has improved substantially. A healthy and self-maintaining stream ecosystem remains a restoration goal all concerned parties desire. Self-maintenance can be accomplished only if the annual streamflows, and the physical/biological processes these streamflows empower, are in harmony with the existing stream and floodplain morphology and sediment supply. The SWRCB recognized that today's model or scientific perspective of how lower Rush Creek functions can, and almost certainly will, change tomorrow. SWRCB Order No. 98-05 reserves the prerogative of the stream scientists, Chris Hunter and myself, to request modifications to the Order's instructions as new data, and interpretations of those data, evolve. This memo presents my recommendations regarding the re-watering of the 1A, 4bii, 8, 11, 13, and 14 channels of the Rush Creek bottomlands. Background information can be obtained from the McBain and Trush monitoring and analyses reports submitted annually to the SWRCB. Written commentary regarding the Order's re-watering provisions provided by Lisa Cutting of the Mono Lake Committee (dated January 13, 2005), Sacha Heath and Chris McCreedy of the Point Reyes Bird Observatory (dated January 13, 2005), and Chris Hunter's fish crew were greatly appreciated and consulted frequently in making my recommendations.

Recommendations

Chris Hunter and I want to avoid mechanical repairs as much as possible, partly because once they have been made, everyone presumes the problems have been fixed. Not so. The RTC scientists stressed physical and biological processes, while much of SWRCB Order 98-05 stresses static goals. Controversy over what to do about the side-channels originates from these two widely different (though not mutually exclusive) perspectives.

Take this scenario, though it applies directly to the Rush Creek 1A Channel. We excavate the aggraded entrance to this former (pre-1941) mainstem channel, now cut-off by a 'new' mainstem channel, to allow perennial baseflows so that more channel length (requiring perennial baseflows for fish habitat) can be created to meet the termination criteria. However following excavation, both banks of the entrance would remain unconfined (especially the left bank that is simply part of a mainstem channel point bar deposit). Without confinement, having opposing banks high and steep, the entrance would be extremely vulnerable to woody riparian encroachment and subsequent aggradation. The repair would have fixed nothing, only provide short-term gratification. Neither would the repair action have created sustainable channel length as expected in the Order. If an agreement was made to walk-away from this side-channel entrance once the entrance's excavation had been completed (i.e., require no more repair, including maintenance), would the Order's intent be met if the entrance aggraded the next Wet year flood? I don't think so.

1A Channel

This segment of the Rush Creek bottomland's channel network cannot yet sustain multiple channels. While occasionally painful, we want real self-sustaining solutions that could allow two confined channels to coexist at this location. I don't know, once the 'new' mainstem channel aggrades its right bank and emerging point bar/floodplain, whether one or both will carry the surface baseflow. Or, if one will carry all the baseflows (and thus provide perennial fish habitat) while the other will exhibit shallow groundwater seepage in pools during the summer and take some of the high flows in spring and early-summer (much as the 1A Channel functions today). Undoubtedly, the 1A Channel, in its present hydraulic role, is slowing-down the new mainstem channel's confinement process by reducing peak flows and reducing sediment deposition onto the right bank's slowly aggrading floodplain. If the maximum recovery rate was sought, the 1A entrance could be walled-off to keep all flood flow in the new mainstem channel. This however would be too intrusive and likely spawn more headaches than cure. Or, physically restrict the present mainstem channel to a few cfs of baseflows, and re-direct most flow back into the 1A Channel. Again this would be too intrusive, would not be oriented properly to the upstream mainstem channel, and would spawn more headaches than cure.

Therefore, I recommend no action be taken to modify the 1A Channel or its entrance. In my opinion, the benefit of slightly improving local groundwater conditions (as an indirect result of creating fish habitat with perennial streamflows as specified in SWRCB Order 98-05) does not offset the additional impairment to the geomorphic recovery advancing in the present mainstem channel. Given the straight orientation of the present mainstem channel upstream, the 1A entrance seems stable and unlikely to be scoured-out anytime soon. As a mainstem meander develops upstream, changing the mainstem's orientation relative to the 1A entrance, the 1A Channel easily could capture all baseflows and most flood flows in the future. Meanwhile, the present mainstem channel will be narrowing and deepening (depositing higher banks). The 1A Channel, downstream from its entrance, does have a more confined morphology than the present mainstem channel. Mainstem headcutting does not appear to be an issue this close to the Narrows. By leaving the 1A Channel alone, an ideal restoration goal can be realized: two confined, self-maintaining channels each capable of carrying most, or sharing similar portions of, the annual hydrograph. At present, the aggraded 1A entrance likely has a mainstem flow threshold of less than 100 cfs before flows begin entering the 1A Channel. These streamflow-stage data are not as good as those for the 4bii side-channel and 8 side-channel entrances, and I have not personally observed high flows in the 1A Channel in RY2004 or RY2005.

4bii Side-Channel and 4 Floodplain

The main 4bii side-channel entrance is not a remnant mainstem channel (as was the 1A Channel), but rather an historic side-channel to the 4 Floodplain. The 4bii main side-channel entrance should be lowered to allow mainstem discharges 100 cfs and greater to flow into the 4 Floodplain. This will require excavating the main side-channel entrance 0.6 ft to 0.7 ft deep for approximately 120 ft, a task accomplished by hand labor. This recommendation will increase seasonal floodplain inundation and surface wetting (capillary fringe up to the floodplain's surface) close to pre-1941 duration levels (refer to table provided).

This table is not perfect. There are errors in estimating unimpaired streamflows below the Narrows, and past regulated (actual) annual hydrographs will not be duplicated in the future due to many reasons unique to each runoff year (e.g., repair of the Mono Ditch). Mainstem flows lap up to the present main 4bii side-channel entrance at approximately 160 cfs, and begin actively flowing at approximately 190 cfs. These measurements were taken in RY2005 and could change (i.e., use of the modifier "approximately" at every opportunity), as the upstream mainstem channel approaching the 4bii side-channel entrance is extremely unsettled.

Opening the 4 Floodplain more, than what overflows into the 4bii main side-channel today, will affect mainstem channel confinement processes. However Rush Creek mainstem below the 4bii main side-entrance already is significantly confined (still a remnant of the pre-1941 channel morphology). Several developing mainstem floodplains on the inside bank of a few migrating channel bends, and particularly the large right-bank mainstem floodplain (used in our emerging floodplain depositional studies and reported in our RY2005-06 annual report) at the base of the 4 Floodplain, will not respond as rapidly (i.e., confine itself) by sharing flood flows with the 4 Floodplain and 8 Floodplain. Recovering woody riparian vegetation on the relatively large expanse of the 4 Floodplain was considered more important than the negative impact on channel confinement processes in the adjacent mainstem channel.

Wet meadows occupied about 1/3 of the 4 Floodplain in 1929. Today, wet meadows dominated by sedges, rushes, and some grasses are much less common than areas identified as dry grasslands (dominated solely by true grasses). Wet meadows can occur in seasonally inundated areas and can tolerate prolonged inundation within a season, but not perennial inundation over multiple years. The stand of old yellow willows at the bottom of the 4 Floodplain also would likely be highly stressed, or die, if exposed to perennial streamflows creating a groundwater surface very close to the surface (as observed in RY2005). If perennially inundated, established wet meadows along the downstream margin of the 4 Floodplain would likely convert to cattails in 5 years (maybe sooner) wherever standing water or slow moving streamflows up to 3.5 ft to 4.0 ft deep occurred. I do not recommend a lower threshold entrance flow specifically to prevent perennial surface streamflows from passing into the 4 Floodplain.

Mature cottonwood and willow stumps occupy approximately half the 4 Floodplain. Mature cottonwoods and willows will die if the ground surfaces they are rooted on are continually inundated or the groundwater table is very close to the surface. Their roots need to breathe. Temporary inundation of the roots is accommodated physiologically by structures in the bark called lenticels. Uprooted and partially excavated stumps on the 4 Floodplain do not indicate a shallow water table. If these stumps were to suddenly come to life, and then perennial flows were released down the 4bii main side-channel entrance, those trees with their surfaces inundated or with the groundwater table within inches of the surface would most likely die within 3 years. This hypothetical scenario begs the question of how would the stumps (i.e., living trees in the scenario) would have gotten there in the first place. Not under perennial streamflows. During the 4 Floodplain mapping in RY2005, many areas had water flowing among mature cottonwood and willow stumps.

Presently 4 Floodplain areas with cottonwood stumps are interlaced with sagebrush, and at slightly higher 4 Floodplain elevations (still with cottonwood stumps), interlaced with Woods' rose. The sagebrush in these areas already is noticeably stressed, and in some places already dying, presumably from the much higher soil moisture since the early 1990's. The likely beneficiary of the sagebrush's demise will be Woods' rose.

Opening the 4bii main side-channel should not impact the wet meadow (making it too wet) near the head of the 4 Floodplain. Another entrance for mainstem streamflows occurs along the right braided mainstem channel migrating through wet meadowland. This entrance is located approximately upstream of the main 4bii side-channel entrance. Its vertical undercut bank is just overtopped by a 390 cfs mainstem streamflow (refer to rating curve provided). During the RY2005 4 Floodplain mapping near peak mainstem streamflow, floodplain flows, a few inches deep and 1 ft to 2 ft wide, meandered through dense sedges and eventually joined the 4bii main side-channel downstream.

A valid concern is whether the streamflow-stage relationship at the 4bii main entrance existed pre-1941. Channel headcutting is clearly evident farther down Rush Creek mainstem. If headcutting did reach the 4bii main side-channel entrance, even if muted (compared to downstream), the Q-stage relationship could have changed appreciably, given how minor changes in mainstem flow stage give rise to large changes in mainstem streamflow (refer to rating curve provided). Any evidence supplied for, or against, headcutting at the 4bii main entrance will be circumstantial and not singularly decisive. However, the right bank main channel, at the meadow side-channel entrance just discussed, overtops the right bank at approximately the historic bankfull discharge indicating that downcutting, if it has extended this far upstream, has been extremely small.

8 Side-Channel and 8 Floodplain

The origin/history of the 8 side-channel still perplexes me. Was it historically a mainstem channel, an historic side-channel regularly allowing flood flows onto the 8 Floodplain, or a scour channel formed by a large flood(s) that then occasionally allowed flood flows to access the 8 Floodplain surface? The 8 side-channel entrance has the confinement that is missing at the 1A side-channel entrance. The 1929 aerial photographs show water in the 8 side-channel. But the cottonwood and willow stumps on the 8 Floodplain indicate that the groundwater table was not near the floodplain's surface all year, or that the mature trees (now mostly stumps) grew up next to perennial flow.

I recommend lowering the 8 side-channel entrance to allow mainstem discharges 100 cfs and greater to flow into the 8 Floodplain. This will require excavating the 8 side-channel entrance an additional (from the last excavation in May 2005) 0.6 ft deep for approximately 80 ft, a task accomplished by backhoe or possibly by hand labor. This recommendation will give the 8 Floodplain shallow groundwater conditions similar to those in the 4 Floodplain to facilitate woody riparian recovery. A 100 cfs threshold also should not affect mainstem trout habitat availability at baseflows.

Prescribing perennial flows of several cfs down the 8 side-channel would create woody riparian acreage faster than seasonal flows. However, the 8 side-channel entrance is oriented such that it will get clogged by floating woody debris, particularly with its narrow slot excavated through the band of dense young willows along the mainstem's bank. This entrance will likely evolve into a self-sustaining side-channel that captures a share of the higher flows, but perhaps only allows seepage during mainstem baseflows.

As demonstrated in the RY2005 releases, the 8 Floodplain farther downstream (below the location where the 8 side-channel rejoins the mainstem) also will respond to the recommendation. This area (by the lone Jeffrey pine and farther downstream) displays a few stumps closer to the mainstem, but has otherwise been dominated by sagebrush. Initial conversion to patchy Woods' rose is likely, which will increase overall riparian acreage, but will do so where there wasn't woody riparian vegetation before.

11 Channel

Channel headcutting has decisively altered the landscape. We must work with this change, rather than fight it, to achieve a healthy self-sustaining stream ecosystem. This factor weighs heavily on how historic side-channels and floodplains now function farther downstream of the 8 Floodplain.

I recommend no action be taken on the 11 Channel. This site would require substantial excavation while contributing only minor additional benefits to the shallow groundwater dynamics. The constantly changing flow relationship between the 10 Channel and the mainstem channel also makes this site questionable.

13 Side-Channel and 13 Floodplain

Headcutting in the main channel below the 10-Falls, even evident since the mid-1990's, increased the flood flow magnitude needed to enter the 13 Floodplain complex of shallow side-channels. The 13 Floodplain still recently received surface flows from the mainstem nevertheless, but by a small channel (2 ft wide in many locations and only a few inches deep) hugging the right valley wall that received streamflow from the 10 Channel at the top of its waterfall (the 10-Falls) that spilled back into the mainstem. With the scour retreat of the 10-Falls crest, this channel was abandoned approximately two years ago, effectively curtailing any surface flows from entering the 13 Floodplain. I recommend no action be taken on the 13 Floodplain. The mainstem channel between the ‘10 Falls’ and the Ford is beginning to meander (refer to aerial photograph enclosed), slowly excavating the 13 Floodplain and creating a new self-sustaining floodplain compatible with the new flow regime and today’s headcut mainstem channel. While channel migration into the 13 Floodplain will take time, the mainstem downcutting through this mainstem channel reach demands a patient expectation for recovery. One piezometer should be installed on the backside of the 13 Floodplain with a data logger to monitor annual shallow groundwater fluctuation, given concerns over willow flycatcher habitat in the 13 Floodplain.

14 Channel

No action should be taken on the 14 Channel. Mainstem channel downcutting, due to past declining Mono Lake water levels and channel realignment associated with the culvert at the Ford, has headcut and abandoned the 14 side-channel. Reconstructive work would entail major excavation of the 14 Channel, from its intersection with the present mainstem channel and down the upper third of the 14 Channel. Another option, one detailed in the Order, would require excavation as well, but also re-watering via the 13 Channel. Neither option is warranted. The pre-1941 mainstem channel already was deeply incised, with a high terrace on the inside of the arching bend of the overall 14 Channel. This terrace surface is dominated by sagebrush, with no evidence of former cottonwoods and willows. Opening the 14 Channel would promote woody riparian vegetation only as a narrow band within its narrow and steep banks.

Summary

The Order’s recommendations for perennial re-watering of the above side-channels emphasized the creation of additional fish habitat. Since 1998, the critical role of the side-channels in directing flood flows across the aggraded floodplain surface quickly, and the influence of this process on woody riparian vegetation, has become apparent. These guidelines governed my recommendations: (1) only recommend repairs that really do fix, or can fix, the problem of restoring a self-maintaining channel network and woody riparian floodplain, (2) promote mainstem channel confinement processes as much as possible because this will, among other vital functions, best promote the creation of adult fish habitat, (3) work with the effect of channel headcutting rather than arm wrestle it, and (4) consider natural patterns of floodplain inundation when faced with uncertainty. These recommendations, if implemented, will require physical maintenance and minimal monitoring. The 4bii and 8 entrances need to grow-up, to give them the best opportunity at becoming self-sustaining. Operation of a piezometer in the 13 Floodplain will allow scientific evaluation of changes in the woody riparian vegetation, should those changes become a trend … downward or upward.