

Estimated Spring Inflow to the Frenchglen Area of Malheur NWR

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There are four spring systems that contribute flow to the Frenchglen or P Ranch Area of Malheur NWR. One of these systems flows into the Blitzen River and the other three flow into East or West Canals. Flow estimates are needed from each of these spring systems to evaluate the total inflow to this part of the refuge. The purpose of this report is to identify and discuss each spring system and provide flow estimates for each.

Page Springs

The main source of water for Malheur NWR is the Blitzen River. The Blitzen enters the refuge at the southern boundary near Page Springs. Page Springs is the largest spring system in the P Ranch area and one of the largest spring systems in the area. The spring system contributes a significant but unmeasured volume of flow to the Blitzen River just upstream of the refuge. The total inflow from the Blitzen River to the refuge includes the contribution from Page Springs. Because the spring flow is diffuse and emanates from a number of sources, it can not be measured directly. However, spring flow will be fairly constant and less variable than the flow in the river. The purpose of the analysis is to estimate the discharge from the springs for use in evaluating the total inflow to the refuge from the Blitzen River.

The USGS operates a gaging station on the Blitzen River (site no. 10396000, Donner und Blitzen River nr Frenchglen, OR) about one mile upstream of the southern boundary of the refuge. The period of record is from 1911 to 1921 and 1938 to the present. The discharge from Page Springs enters the river downstream of the gage and is not included in the measured flows from this site. Therefore, flow measurements at the gaging station do not provide a measure of the total inflow to the refuge since the station is upstream of Page Springs.

The FWS has a continuous gage below Page Springs Dam that has operated since September 1993. This gage is downstream of Page Springs but is also downstream of the refuge diversions to West Canal and East Canal. Both diversions are unmonitored. Flow measurements at this station do not provide a measure of the total inflow to the refuge unless the diversions to the canals are measured and accounted for.

A number of times in the past few years, instantaneous flow measurements have been made at the East and West Canal diversions to estimate the spring discharge from Page Springs and the total inflow to the refuge from the Blitzen. The approach used has been to simultaneously measure the flow in the Blitzen below Page Springs Dam, the

diversion to East Canal, and the diversion to West Canal, sum these three flows, and subtract the Blitzen flow upstream of Page Springs as measured at the USGS gage. The difference is the estimated spring flow at Page Springs. Flows are measured instantaneously at the diversions to East and West Canal but are determined from staff gages readings and rating curves at the other two sites. The Portland Office of the USGS was contacted for the flows at specific times corresponding to the time of the measurements at East and West Canal.

One problem with this approach is that the flows in the Blitzen River vary diurnally, especially during the runoff period in spring and early summer. It can require a couple of hours to measure the diversions in the East and West Canals and the river flows below Page Springs Dam and at the USGS gage can change during that time. The estimates of Page Springs flows during the runoff period may be problematic because of the diurnal variability in flows at this time of year. In addition, water is lost to flooding and bank storage during these periods and rating curves are typically less accurate at higher flows, creating other problems with the spring flow estimates during high water.

The resulting spring inflow estimates are shown in Figure 1 and Table 1. Measurements were made in 1997, 1998, 2002 and 2003. The measurements span wet years (1997 and 1998) and dry years (2002 and 2003) and the spring discharge estimates reflect this. 1997 and 1998 estimates are higher than 2002 and 2003. The flow from Page Springs is estimated to range from 6 cfs in 2002 and 2003 to 12 to 16 cfs in 1997 and 1998. The average of all four years is 10 cfs. Adding 10 cfs to the USGS flows measured on the Blitzen River will provide a reasonable estimate of the total inflow from the Blitzen River to the refuge. Subtracting the flow below Page Springs Dam (FWS 357003) from the total refuge inflow as estimated above will provide an estimate of the combined volume of water diverted to the East Canal and West Canal.

The springs at Page Springs are cold water springs and probably function to cool water temperatures in the Blitzen River. During summer, this cooling may be significant.

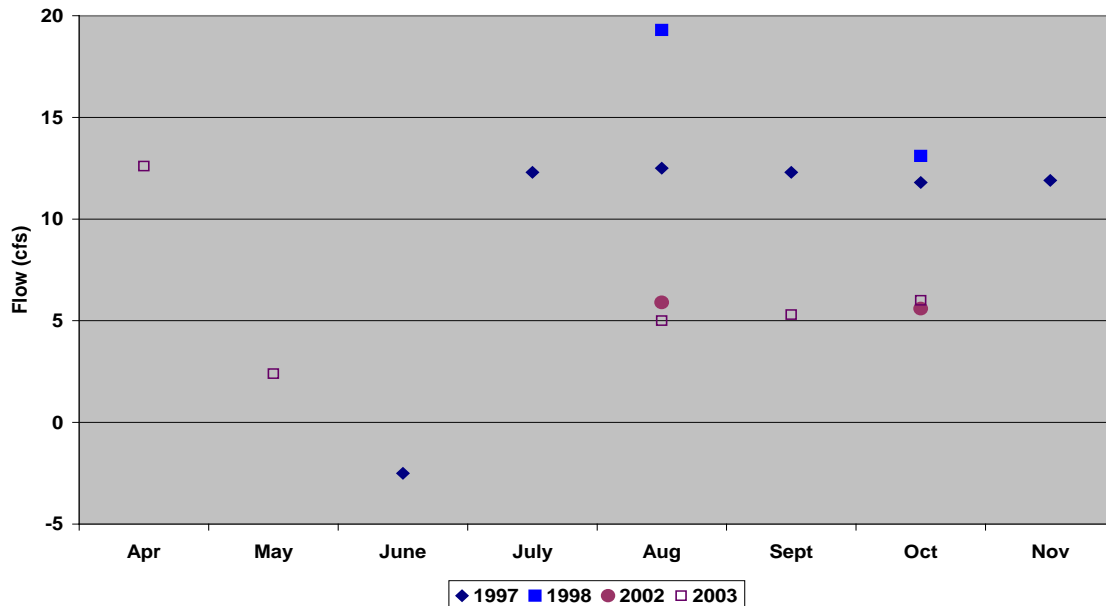


Figure 1: Estimated Spring Discharge at Page Springs near Frenchglen, OR, for the years 1997, 1998, 2002, and 2003.

Warm Springs

Warm Springs is located just south of the refuge between Frenchglen and Page Springs. It is a smaller spring system than Page Springs and contributes flow into the West Canal. As with Page Springs, the flow emanates from several sources and can not be measured directly. Estimates of the contribution from Warm Springs were made by measuring the West Canal upstream of the springs at the Blitzen River and downstream of the springs at the Frenchglen Road. This approach measures the net contribution of the springs since there is some loss from evapotranspiration in the marshy areas along West Canal in the vicinity of the springs. Measurements were made when there were no diversions from West Canal along this reach. Paired measurements were made on the following four dates in 2003: March 12, August 4, August 27, and October 1.

The net contribution of flow from Warm Springs was 2.5 cfs in March, 0.2 to 0.3 cfs in August, and 0.6 cfs in October. A seasonal pattern is apparent with a maximum contribution in the spring and minimum in summer. This variation may reflect the greater evapotranspiration loss in the summer from the adjacent wetland and meadow as well as variability in spring flow. The specific conductance of the water in West Canal increased 1.4 to 1.5 times between the two measurement sites. The increase was probably resulted from the evapotranspiration losses as well as the inflow of higher conductivity water from the springs. These are warm water springs and the water temperature in West Canal increased between the two measurement sites significantly (about 5°C based on two measurements in August). For purposes of estimating total

inflow to the refuge, an average inflow of 2.5 cfs can be assumed in spring, 0.25 in summer, and 0.5 cfs in fall.

Five Mile Springs

These springs are located along West Canal just south of Five Mile Road. Estimates of the contribution of flow from these springs were very small (<0.5 cfs), based on three sets of paired measurements on West Canal upstream and downstream of the springs.

Knox Springs

These springs are located on East Canal just east of Knox Swamp and Knox Ponds. Flow from these springs is collected in a channel and can be diverted directly into East Canal or across East Canal into Knox Swamp. The channel is too small for flow measurements with a current meter but inflow was estimated visibly at about 1 cfs. The spring flow appears fairly constant throughout the season. These are cold water springs.

Table 1: Synoptic flow measurements for estimates of Page Springs inflow.

Water Year 1997	time	6/17/97	time	7/8/97	time	8/20/97	time	9/18/97			Average
East Canal	1405	49.5	1520	38.4	1500	20.2	1140	33.1			
West Canal	1300	45.0	1530	34.4	1700	21.4	1330	5.7			
Blitzen River	1135	183.0	1550	54.5	1105	19.9	1230	20.5			
Total Refuge Inflow at Page Springs		277.5		127.3		61.5		59.3			
USGS Blitzen abv Page Sprs	1300	280.0	1530	115.0	1300	49.0	1200	47.0			
Estimated Spring Inflow		-2.5		12.3		12.5		12.3			12.1
Water Year 1998	time	10/23/97	time	11/18/97			time	8/10/98	time	10/29/98	
East Canal	1417	3.3	1335	2.9			1435	12.3		5.0	
West Canal	930	2.6	1515	7.5			1300	6.8	915	2.0	
Blitzen River	1040	53.9	1420	45.5			?	76.2	1015	65.2	
Total Refuge Inflow at Page Springs		59.8		55.9				95.3		72.1	
USGS Blitzen abv Page Sprs	1200	48.0	1400	44.0			1400	76.0	1200	59.0	
Estimated Spring Inflow		11.8		11.9				19.3		13.1	16.2

Table 1: Synoptic flow measurements for estimates of Page Springs inflow (continued).

Water Year 2002	time	8/8/02	time	9/9/02							Average
East Canal	1325	9.9	1515	8.2							
West Canal	1400	5.4	1640	3.9							
Blitzen River	1315	27.6	1620	28.6							
Total Refuge Inflow at Page Springs		42.9		40.6							
USGS Blitzen abv Page Sprs	1400	37.0	1530	35.0							
Estimated Spring Inflow		5.9		5.6							5.8
Water Year 2003	time	4/3/03	time	5/1/03	time	8/3/03	time	8/27/03	time	10/1/03	
East Canal	1040	20.8	1150	15.9	1020	4.6	840	8.2	1520	8.55	
West Canal	900	37.2	1030	33.2	1100	6.4	930	4.7	1600	2.97	
Blitzen River	1000	60.6	1100	65.3	1100	38.0	900	26.5	1545	26.5	
Total Refuge Inflow at Page Springs		118.6		114.4		49.0		39.3		38.0	
USGS Blitzen abv Page Sprs	1000	106.0	1100	112.0	1300	44.0	1000	34.0	1600	32	
Estimated Spring Inflow		12.6		2.4		5.0		5.3		6.02	6.3
										Average:	10.1
All USGS flows are instantaneous values at the time of the other flow measurements, obtained from the Portland office (Jo Miller, 503 251-3201)											

Table 2: Synoptic flow measurements for estimates of Warm Springs inflow.

Date	West Canal Flow at Page Springs	West Canal Flow at Frenchglen/Page Springs Rd	Estimated Net Spring Inflow	Temperature (C) at Page Springs	Temperature (C) at Frenchglen/Page Springs Rd	Conductivity (uS/cm) at Page Springs	Conductivity (uS/cm) at Frenchglen/Page Springs Rd
3/13/03	1.33	3.83	2.50				
8/4/03	6.20	6.39	0.19	14.2	19.1	90	129
8/27/03	4.67	4.93	0.26	17.5	21.2	101	151
10/1/03	2.97	3.53	0.56				