20 March 2014

Jerry Basler
Assistant Planner
Whitman County Public Works, Planning Division
310 N. Main Street
Colfax WA 99111

Re: Proposed Whitman County Shoreline Jurisdiction

Dear Jerry:

The Watershed Company has developed the attached proposed maps of shoreline jurisdiction, illustrating the minimum jurisdiction option and the additional full floodplain option. The wetland buffers option is not illustrated, but is described below. This information is provided to assist the County in selecting its preferred shoreline jurisdiction option.

EXISTING SHORELINE JURISDICTION PER CURRENT SMP

Under the County's current Shoreline Master Program (SMP), the following waterbodies are shorelines of the state:

- Snake River
- Palouse River (mainstem, north and south forks)
- Rock Creek
- Pine Creek
- Latah Creek (Hangman Creek)
- Union Flat Creek
- Across Highway Lake
- Alkali Lake
- Bonnie Lake
- Crooked Knee Lake
- Folsom Lake
- Lavista Lake
- Rock Lake
- Sheep Lake
- Snyder Slough
- Stevens Lake
- Texas Lake
- Tule Lake

Existing shoreline jurisdiction includes the shorelands extending 200 feet from the ordinary high water mark and identified associated wetlands, and includes the floodway and 200 feet of floodway-adjacent floodplain where present. The County's adopted map also does not recognize the expansion of the cities since 1974, or depict the extent of the shorelands.

PROPOSED SHORELINE JURISDICTION

The first step in updating the map of shoreline jurisdiction is to collect data relevant to the jurisdiction assessment, namely:

1. Waterbodies: National Hydrography Dataset. An overlay of the data with the aerial generally revealed a close match with existing conditions.

2. Shoreline Management Act Suggested Points, Arcs and Polygons: Under contract to Ecology, the United States Geological Survey (USGS) has identified the upstream limits of shoreline streams and rivers based on projected mean annual flow of 20 cubic feet per second (cfs) (Higgins 2003). Ecology also provided a data set of lakes that are 20 acres or greater in size. Data representing lake shorelines was compared to 2013 aerial photos. Verification of the lake size was conducted using a GIS-based area calculator, which confirmed Ecology's suggested list of lakes that meet the shoreline size threshold.

3. Floodways and Floodplains: FEMA Q3 digital data representing floodways and floodplains was collected through Ecology. Investigation of the Q3 data, published in 1980, showed registration issues between it and more recent geospatial data from reliable sources. As suggested in earlier personal communication with data stewards at FEMA regarding issues with the Q3 data, features in the FEMA Q3 dataset were manually realigned to better reflect the published Flood Insurance Rate Maps (FIRMs) and to agree with USDA 2013 NAIP aerial photos and data from other reliable sources. Realignment was conducted by visual assessment of the Q3 data against FIRMs accessed through FEMA's online FIRMETTE application.

4. Wetlands: The U.S. Fish and Wildlife Service National Wetlands Inventory data set was used to identify wetlands that are potentially associated with the shoreline. For mapping purposes, all wetlands are shown as potentially being an element of shoreline jurisdiction if they are in or partially in the area 200 feet upland of the OHWM or are in or partially in the floodway or floodplain. Wetlands that extend up a non-shoreline stream outside the boundaries of the floodplain (such as in Steptoe Canyon) are excluded from shoreline jurisdiction mapping. Wetlands outside those parameters may also be shoreline-associated wetlands, but that assessment would need to be made at the site-specific scale at the time of a development application.

MINIMUM JURISDICTION

The proposed illustration of the minimum shoreline jurisdiction is provided on the *Minimum Shoreline Jurisdiction* exhibit. The basic steps are to illustrate 200 feet upland of OHWM, add floodways and floodplains, and then clip jurisdiction to extend the greater of 200 feet from the OHWM or 200 feet of floodplain upland from the floodway (where present). Shoreline-associated wetlands remain a separate feature on the shoreline jurisdiction map because they have lower accuracy and are more subject to variation based on future site-specific delineation and analysis. The minimum upland shoreline jurisdiction area, including the potentially associated wetlands, is approximately 24,257 acres.

Rivers/Streams

Fourmile and Cottonwood Creeks

Based on the USGS study, portions of Fourmile Creek (a tributary of the South Fork Palouse River) and Cottonwood Creek (a tributary of Rock Creek) have been added to shoreline jurisdiction. Anecdotal information provided by County staff and area property owners suggested that these streams may not meet the minimum flow required. Aerial photo review and the reported margin of error in the USGS study also supported a need for further analysis of these two systems.

On January 24, 2014, Patricia Olson (Ecology's Senior Hydrogeologist) provided additional analysis in a memo (attached) that placed the upstream limit of shoreline jurisdiction substantially farther downstream than the original USGS point.

Latah Creek

The Ecology-suggested shorelines data do not identify the segment of Latah Creek above its confluence with Rock Creek as a Shoreline of the State. However, because this segment of Latah Creek was previously identified by both the County and Ecology as a Shoreline of the State, stream flow data for Latah Creek were reviewed. USGS currently maintains a gaging station (12422990) at the State Line Road bridge, 2.6 miles southeast of Tekoa. The USGS Water-Data Report 2012 (U.S. Geological Survey 2013) was reviewed for mean annual flow at this station. For the period of record (2008-2012), the report states that mean annual flow at this station was 85.4 cfs. As this stream flow is well above the 20 cfs cutoff, we have included the entire length of Latah Creek in the County as a Shoreline of the State even though the period of record is less than 10 years.

Union Flat Creek

Similar to the case of Latah Creek, the Ecology-suggested shorelines data do not identify Union Flat Creek as a Shoreline of the State; however, because this segment of Union Flat Creek was previously identified by both the County and Ecology as a Shoreline of the State, stream flow data for Union Flat Creek were reviewed. Although no known State or federal gaging stations are currently located along Union Flat Creek, a gaging station (13350500) was formerly maintained by USGS near Colfax from 1953 to 1971. For this period of record, mean annual flow at this gaging station was 37.1 cfs (Higgins 2003). As this stream flow is well above the 20 cfs cutoff, the segment of Union Flat Creek up to the former location of the gaging station near Colfax should clearly be included as a Shoreline of the State. The following parties were contacted in an effort to obtain data or local expert opinion, and limited information relevant to this shoreline jurisdiction determination surfaced:

- Washington Department of Transportation: Tammie Williams (Environmental Manager), Tom Baker (Bridge and Structures Engineer), and Jay Christianson (Hydraulics)
- Washington Department of Fish and Wildlife: Jason Kunz (Area Habitat Biologist) and Paul LaRiviere (Instream Flow Biologist)
- Washington Department of Ecology: Mitch Wallace
- Washington State Water Research Center

A 2007 WDFW memo related to a water right transfer noted that Union Flat Creek flows were "less than five cubic-feet per second mean annual flow." It could not be determined from the memo where this flow characterization applied. Unfortunately, no other known data exist to provide a more precise indication of how much farther upstream the 20 cfs cutoff occurs.

Based on the USGS stream gage record and the lack of any other information, the proposed shoreline jurisdiction maps retain Union Flat Creek in shoreline jurisdiction consistent with the past 40 years of regulation by the County.

Lakes

According to Ecology's shoreline data, there are 12 suggested "waterbodies (lakes, wetlands, etc)" present in the County that are 20 acres or greater. These lakes are identical to those listed in the County's current SMP, with the possible exception of "Across Highway Lake." That lake was not found in the data, nor could it be located in an online search. Ecology's data include Duck Lake, which was not previously listed in the County's SMP. It is possible that the lake has had two different names over time.

OTHER JURISDICTION OPTIONS

The information above describes assembly of the minimum shoreline jurisdiction. The County, Cities and Towns may further elect to expand jurisdiction to include 1) all or part of the 100-year floodplain, and/or 2) buffers of associated wetlands[1] that would otherwise encompass areas outside of shoreline jurisdiction. Under either of these options, the area of shoreline jurisdiction increases and additional properties or areas of properties would be subject to the SMP and its additional layer of permitting requirements. These options should be considered by each jurisdiction.

Floodplain

The 100-year floodplain option is illustrated by a bright aqua boundary that encompasses the minimum shoreline jurisdiction and the remaining floodplain that is beyond the 200 feet of floodplain adjacent to floodways. The resulting optional jurisdiction is illustrated on the *Minimum Shoreline Jurisdiction* exhibit. This option increases the total area of jurisdiction by 6,607 acres (a 27% increase), most of which is found along Union Flat and Pine Creeks and the Palouse and Snake Rivers.

Use of this option would allow for maximum integration and consistency of the SMP with Whitman County Municipal Code Chapter 19.50: Flood Management Overlay District, and similar codes for each City and Town.

Wetland Buffers

The attached maps do not depict the expansion of shoreline jurisdiction to include wetland buffers. Classification of associated wetlands, which would ultimately determine the regulatory buffer, has not been conducted and would be done on a site-by-site basis at the time of a development application.

RCW 36.70A.480(6) says "If a local jurisdiction's master program does not include land necessary for buffers for critical areas that occur within shorelines of the state, as authorized by RCW 90.58.030(2)(f), then the local jurisdiction shall continue to regulate those critical areas and their required buffers pursuant to RCW 36.70A.060(2)." Ecology's SMP Handbook chapter on Shoreline Jurisdiction explains the implications of this RCW as follows:

> If the local government chooses not to extend its shoreline jurisdiction under *RCW 90.58.030(2)(f)(ii)*, the CAO will protect the entire critical area and its buffers (see *RCW 36.70A.480(6))*. The CAO will continue to apply to the entire critical area and its buffers, even after SMP approval. However, the SMP will <u>also</u> apply

[1] The RCW actually allows for expansion of jurisdiction to include *critical area* buffers, not just wetland buffers. However, this generally is limited to wetland buffers in practice. The nature of non-shoreline streams as a mostly perpendicular element to a shoreline waterbody already brings their full buffer into shoreline jurisdiction. Geologically hazardous areas are generally assigned a setback, not a buffer. Critical aquifer recharge areas (CARAs) are not addressed in the SMA or SMP Guidelines, and CARAs further are not assigned a setback or a buffer.

to the portion(s) of the critical area and its buffers that lie within shoreline jurisdiction. This means the subject critical area and some or all of its buffers will have "dual coverage" with regulation by both the SMP and the CAO.

Please call if you have any questions.

Sincerely,

Amy Summe
Environmental Planner

Enclosures

Memo

To: Jeremy Sikes, Shoreline Planner, SEA ERO
Jaime Short, Shoreline Planner, SEA,ERO
From: Patricia L Olson, Senior Hydrogeologist, SEA, HQ
CC: Sara Hunt, ERO SEA Program Manager
Brian Lynn, Coastal Zone and Shorelines Unit Manager, SEA, HQ
Date: January 24, 2014
Re: Jurisdiction determination request for Four-mile and Cottonwood Creeks, Whitman County

---

SMP Jurisdiction determination: Fourmile and Cottonwood Creeks, Whitman County

Jeremy Sikes requested assistance in determining if Fourmile and Cottonwood Creeks are in SMP jurisdiction. The most recent USGS study that estimates the upper SMP jurisdiction points (Higgins 2003) identifies Cottonwood Creek and Fourmile Creek as SMP streams. Other questions relate to Union Flat Creek and Latah/Hangman Creek and their status.

Summary

Union Flats and Latah/Hangman Creeks are SMP streams. Union Flats MAF is 37.1 cfs at the gaging station and an estimated 29.6 cfs at the SMP jurisdiction point. The MAF for Latah/Hangman Creek is 76.8 as measured at the USGS gage on Washington side of border between Washington and Idaho (Figure 1). Both are on the SMP_ARC GIS layer which has the streams listed in the SMA. They are not on the suggested SMP stream GIS layer which caused some confusion. During the Phase 1 of SMP updates, the SMP jurisdiction area has to be determined. The communities or their consultants need to be reminded to look at both GIS layers.

Three USGS regression equations developed to estimate mean annual flow (MAF) were initially used in this analysis to estimate MAF for Fourmile and Cottonwood Creek:

1) Determination of upstream boundary points on southeastern Washington streams and rivers under the Requirements of the Shoreline Management Act of 1971 (Higgins 2003)
2) NHDPlus v2, Enhanced Runoff Method (EROM) http://www.horizon-systems.com/nhdplus/NHDPlusV2_documentation.php
3) NHDPlus v2, Vogel http://www.horizon-systems.com/nhdplus/NHDPlusV2_documentation.php

The regression equations' results were compared with long term continuous discharge data from USGS gages (Table 1). The estimates were not consistent. The Higgins (2003) regression equations MAF estimates were closer to MAF from USGS gage data than EROM or Vogel. The latter two regressions appear to overestimate MAF considerably (Table 1).

I used additional analyses because the MAF estimates from the 3 USGS regression methods were not similar enough to support decisions. The additional analyses are described in more detail under the Methods section.

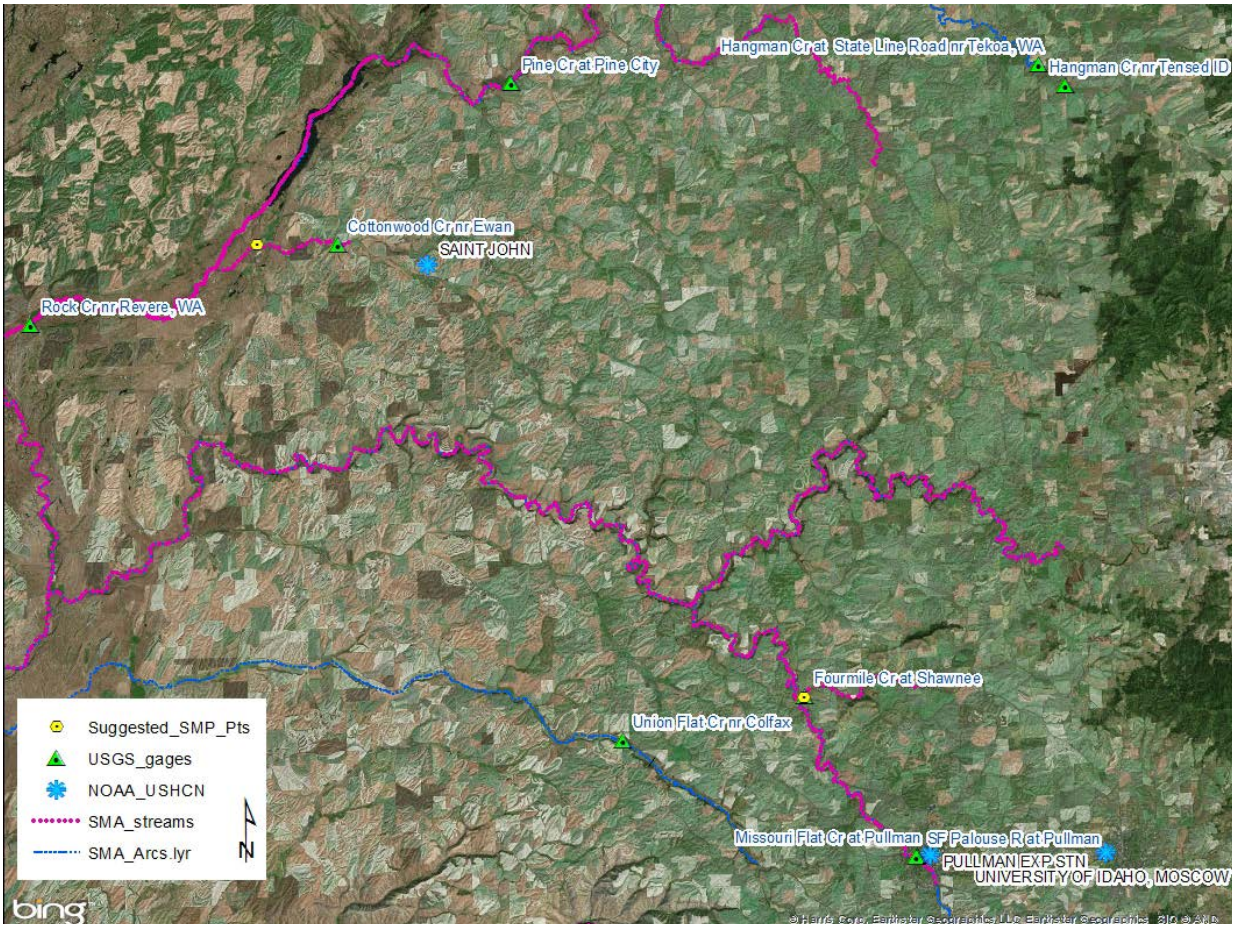


Figure 1: This map shows the USGS gages and NOAA US Historical Climate Network precipitation gages used in the analysis. SMA_streams are the layer that has suggested jurisdiction points and SMA_Arcs are the streams listed in the SMA. Both need to be used to identify jurisdiction. The yellow circles show suggested SMP upstream jurisdiction points based on this analysis.

Three USGS regression equations developed to estimate mean annual flow (MAF) were initially used in this analysis to estimate MAF for Fourmile and Cottonwood Creek:

4) Determination of upstream boundary points on southeastern Washington streams and rivers under the Requirements of the Shoreline Management Act of 1971 (Higgins 2003)
5) NHDPlus v2, Enhanced Runoff Method (EROM) http://www.horizon-systems.com/nhdplus/NHDPlusV2_documentation.php
6) NHDPlus v2, Vogel http://www.horizon-systems.com/nhdplus/NHDPlusV2_documentation.php

The regression equations' results were compared at gaged locations including gages with long term continuous discharge data (Table 1, Figure 1). The estimates were not consistent. The Higgins (2003) regression equations MAF estimates were closer to measured MAF than EROM or Vogel. The latter two regressions appear to overestimate MAF considerably (Table 1).

I used additional analyses because the MAF estimates from the 3 USGS regression methods were not similar enough to support decisions. The additional analyses are described in more detail under the Methods section.

Recommendations

Fourmile Creek likely is a SMP stream but not at the suggested SMP jurisdiction point. The data doesn't supply enough information to know where the point is located. Regression analysis between Fourmile Creek discharge data and SF Palouse discharge data provide additional information to identify the jurisdiction point. The estimates suggest that the lower reach from the confluence to the inactive gage likely meets the criteria (Figure 1, Table 1). In this reach, the streamflow is augmented by groundwater (Sinclair and Kardouni 2009). This flow may not have been measured by the limited gage records because groundwater discharge to Fourmile Creek during dry months (in this case August) occurs just downstream of the gage (K Sinclair personal communication 12/2013).

Cottonwood Creek has very little data. The USGS operated a non-continuous monitoring gage from 11/30/64-1/30/65 for measuring suspended sediment downstream of suggested SMP point on Cottonwood Creek (Figure 1). Since the primary interest was suspended sediment, discrete discharge measurements were mostly measured during higher flow periods The USGS also had a non-continuous gage on Rock Creek (Figure 1). Discrete discharge measurements covered low, normal and high flows. Pine Creek had a continuous USGS gage from 1962-1975 (Figure 1). The Pine Creek and Rock Creek data plus EROM regression equation the MAF at the gage location is 19 cfs (Table 1). The data suggests that the SMP point lies between the USGS gage and the confluence with Kamiche Creek. Since the precipitation station near Cottonwood Creek suggests a downward trend which may affect streamflow I suggest the point to be at the confluence with Kamiche Creek.

Data in for these 2 streams are very limited. The analyses done to estimate upper jurisdiction point are accepted hydrologic methods without doing more intensive hydrologic runoff modeling. However, if there is real current discharge data with adequate years (at least 2 years of dry, 2 years of normal and 2 years of wet conditions but preferably 10 years) then these should be used.

Methods and Results

Union Flats Creek and Latah/Hangman Creek

The SMP jurisdiction on these two streams is straightforward. Union Flat and Latah/Hangman Creeks were designated as SMA streams in 1971. The USGS study (Higgins 2003) does not include them because they were already on the SMA list. However, the SMA_Arc_Suggested GIS layer does not have these 2 streams in the database. They are in the SMA_Arc GIS data because they were in the SMA lists. But local communities or their consultants may only use the GIS data for identifying SMP jurisdiction. The SMA_Arc layer and SMA_Arc_Suggested layer should be merged again so there are not missing SMP streams in the SMA_Arc_Suggested database. Also both layers should be consulted in identifying jurisdiction.

The mean annual flow for Union Flat Creek near Colfax is 37.1 cfs (USGS 13350500 Union Flat Creek near Colfax, WA streamflow gage, Figure 1). The USGS gage record is from water year 1954-1971. Three U.S. Historical Climatology Network (USHCN) stations —station WA45678 at Washington State University, Pullman, station ID106152_6675 at the University of Idaho at Moscow, and station WA457267_6208, Saint John's were also consulted (Figure 1). Yearly precipitation at these stations indicates that water years 1954-

71 were greater than the average annual precipitation at Pullman but lower at Moscow and Saint John's stations (Table 1).

Mean annual flow at Latah/Hangman Creek at the state line between Washington and Idaho is 76.8 (USGS 12422990 Hangman Creek at State Line Road near Tekoa, WA). The gage record is from 2007-2013. An upstream gage in Idaho (USGS 12422950 Hangman Creek near Tensed ID) has a mean annual flow of 85.6 cfs for 1982, 1989-90 (Figure 1).

Fourmile Creek

Fourmile Creek is a tributary to the South Fork Palouse River. The USGS study for identifying upper SMP jurisdiction (Higgins 2003) suggests that the SMP jurisdiction point is at river mile 7.1. A USGS gage (USGS 13349000 Fourmile Creek at Shawnee, WA) was located 0.5 miles upstream from the confluence (Figure 1). The gage operated from 4/1/1934-09/30/1940 with 6 concurrent water years (WY—Oct 01-Sept 30). Using only complete water years (WY 1935-40) the mean annual flow (MAF) was 14.9 cfs.

Fourmile Creek hydrologic characteristics, like other streams in this area, are spiky with the ratio of maximum daily flows to MAF >29. Greater than 82% of total flow occurs from January- April 15 (Figure 2). Fourmile Creek average discharge for January- April 15 is 49 cfs. This type of hydrologic regime can be misleading on identifying the location of 20scfs MAF point if only aerial photos (mostly taken during low flow periods) and or on ground observations made between mid April to early January are used. For example, the SF Palouse River at Pullman MAF is 39.1 cfs. However the mean flow for April and December 31 is 14 cfs (Figure 2).

Since Fourmile Creek has only a short gage record other information was used to evaluate the stream's MAF in relation to longer records. Other data include additional USGS regression equations (EROM and Vogel), precipitation, and discharge data from nearby USGS continuous, long term gages. Information from studies related to surface and groundwater interactions in this area were considered. Groundwater discharge to Fourmile Creek has been observed below the inactive gage location. Studies for the SF Palouse TMDL show that the reach by Fourmile Creek just downstream of the gage location is a gaining reach during low flow conditions (Sinclair and Kardouni 2009; personal comm. with K. Sinclair 12/13/2013). The Airborne Thermal Infrared Remote Sensing study (Watershed Sciences 2006) shows that the SF Palouse stream temperature during late July 2005 decreases in the Fourmile confluence reach which is a signal for groundwater discharge.

Precipitation data from two USHCN weather stations—NOAA station ID WA45678_1878 at Washington State University, Pullman and NOAA Station ID106152_6675 at the University of Idaho, Moscow were used to determine if the gage record for Fourmile Creek occurred during a wet, normal or dry period (data from USHCN http://cdiac.ornl.gov/epubs/ndp/ushcn/state_WA.html). The University of Idaho station is approximately 7 miles east of Pullman and is representative of Fourmile Creek's headwater precipitation (Figure 1).

The precipitation data suggests that the Fourmile Creek discharge data were collected during a dry period (Table 1, Figure 3a, b). For example, the Pullman weather station precipitation data based on water year had an average annual precipitation of 17.4 inches for WY 1935-1940. The long term average annual precipitation is 20.6 inches. During WY

1935-1940, the deviation from mean annual precipitation ranged -4.7 to -1.1 inches (Figure 3a).

Because there was not a mix of dry, wet and normal years the Fourmile Creek discharge data is not representative of mean annual flow for SMP jurisdiction purposes. For SF Palouse River and Missouri Flat Creek gages the average discharge during water years 1935-1940 was lower than the long-term MAF by approximately 30% (Table 1). Precipitation records at Pullman don't indicate any trend in precipitation (Figure 3a). However, precipitation records representative of Fourmile Creek headwaters indicate an upward trend in precipitation (Figure 3b, Table 1). An upward trend in precipitation may lead to increased runoff in Fourmile Creek headwaters.

Table 1: Average annual precipitation from the NOAA USHCN gages and MAF at USGS gages are shown for different time periods to identify wet, normal (all years), and dry periods (Figure 1). Three different USGS regression equations were used to estimate MAF (cfs) at the USGS proposed SMP jurisdiction points and at USGS gage locations. The regression estimates are variable between methods but generally Higgins (2003) method is closer to MAF at gages. Cottonwood Creek is separated because it has a somewhat different hydrologic regime that is more like Pine Creek. The acronym na means data not available or not applicable.

	Average Precipitation (in) by WY			MAF (cfs)				
WY	Pullman, WA	Moscow, Id	St John's, WA	SF Palouse	Missouri Flats	Fourmile	Union Flat	Cottonwood
1935-40	17.4	19.7	18.6	28	6	14.9	na	na
1954-1971	22.2	23.1	19.4	36 [1]	7.4 [1]	na	37.1	na
1961-1981	20.1	25.4	19.4	43	9.2	na	na	na
2002-2012	19.9	27.24	18.4	39.6	na	na	na	na
Total record	20.6	23.9	19.7	39.1	8.5	na	37.1	na
Three USGS developed regression estimates for MAF were used to calculate MAF at SMP jurisdiction points								
Higgins 2003				26.9	na	20.0	29.6	26.6
EROM				47	na	27	74.5	17
Vogel				47	na	28	82.5	33
Regression equation estimates at USGS gage locations (Figure 1)								
USGS gage discharge				39.1	8.5	14.9	37.1	na
Higgins 2003				40.6	5.9	20.5	32.7	26.8
EROM				67	12.2	33	78.2	17.3
Vogel				72	13.2	36	78.3	33.5
Regression with SF Palouse				na	na	22.6	na	na
Cottonwood Creek: Median inches of runoff per square mile extrapolated from Pine and Rock Creek data converted to cfs								
Suggested SMP point				na	na	na	na	18.2
USGS gage				na	na	na	na	18.9
Confluence with Kamiche Ck				na	na	na	na	23.4

[1] SF Palouse and Missouri Flats record doesn't include 1952-1960.

Since Fourmile Creek discharge data were collected during a drier precipitation period regression analyses were used to extend the Fourmile Creek data. Two USGS streamflow gaging stations in close proximity to Fourmile Creek were operating during the same period as Fourmile Creek (Figure 1). The 2 stations are USGS 13348000 South Fork Palouse River at Pullman, WA, 40 years of record (1934-02-01 -09/30/42, 01/01/1960-09/30/1981; 05/25/2001 to present); and USGS 13348500 Missouri Flat Creek at Pullman WA, 25 water years of record (02/01/1934-09/30/42-10/03/1979)daily data and 1934-1980 annual data by water year (WY). The discharge data were normalized by converting cfs to inches of runoff per unit area. Normalization allows comparison between different sized watersheds and provides regression equation(s) that can be applied to any stream point based on drainage area above the point.

Even though the sample size (6 years) to compare Fourmile Creek discharge with the 2 other gages is small both gages have good linear relationships with Fourmile Creek (Figure 4). In order to check if the relationship holds for a larger data set, a linear regression analysis was done between the daily mean flow for Fourmile Creek and SF Palouse. There is a significant linear relationship with an adjusted r^2=0.91, SEE=3.5 (cfs), p<0.001.

SF Palouse River regression relationship with Fourmile Creek was used to estimate mean annual discharge. SF Palouse data were used because the gage is still operating and the gage has a longer discharge record than Missouri Flat Ck. The results of regression analysis are similar for both gages (Figure 4). Runoff estimated by the regression equation between SF Palouse and Fourmile Creek was converted to mean annual discharge for points along Fourmile Creek using watershed area above the point. The mean annual discharge estimates suggest that the SMP upstream jurisdiction point is located at the USGS gage location (Table 1, Figure 1).

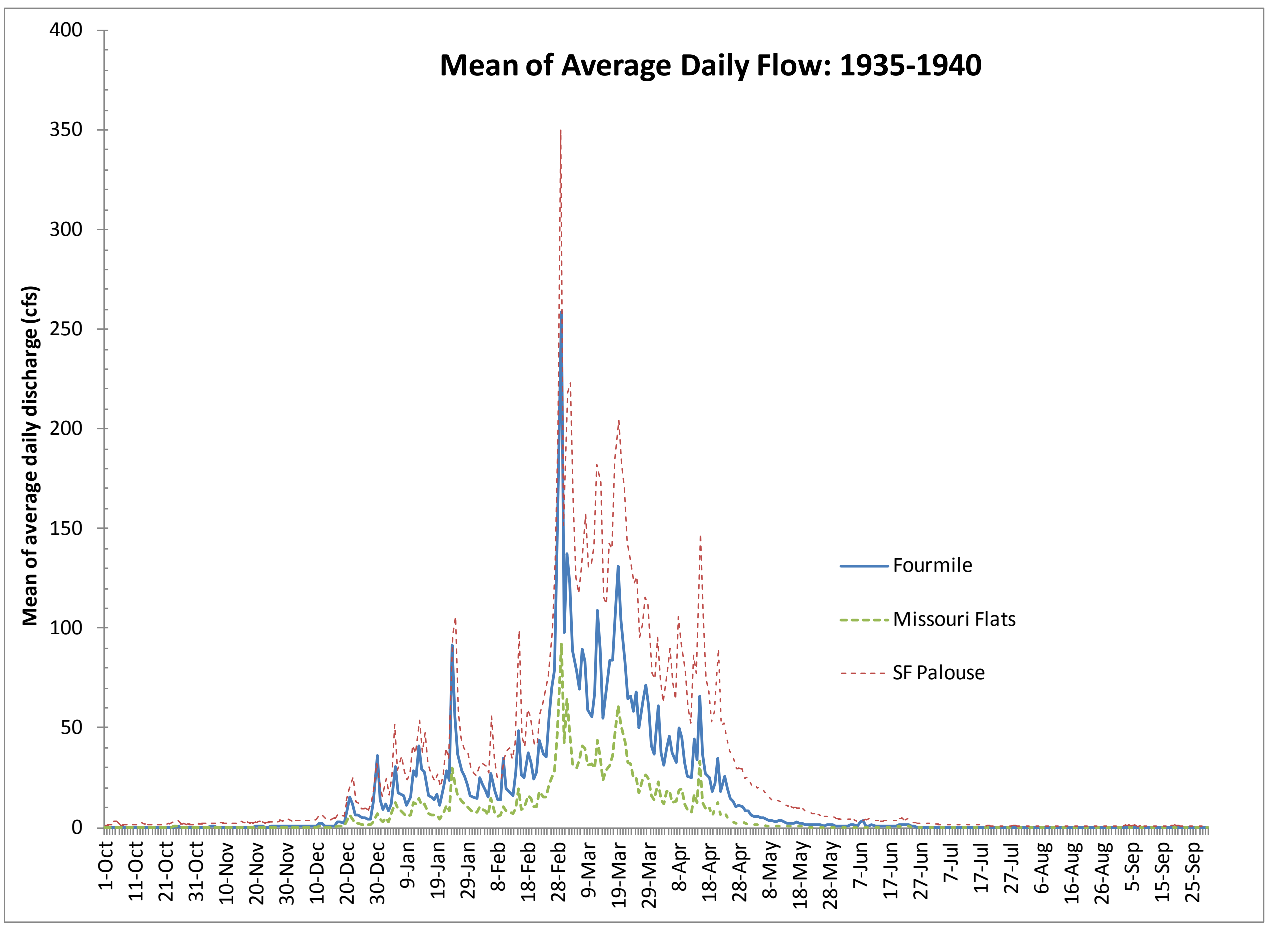
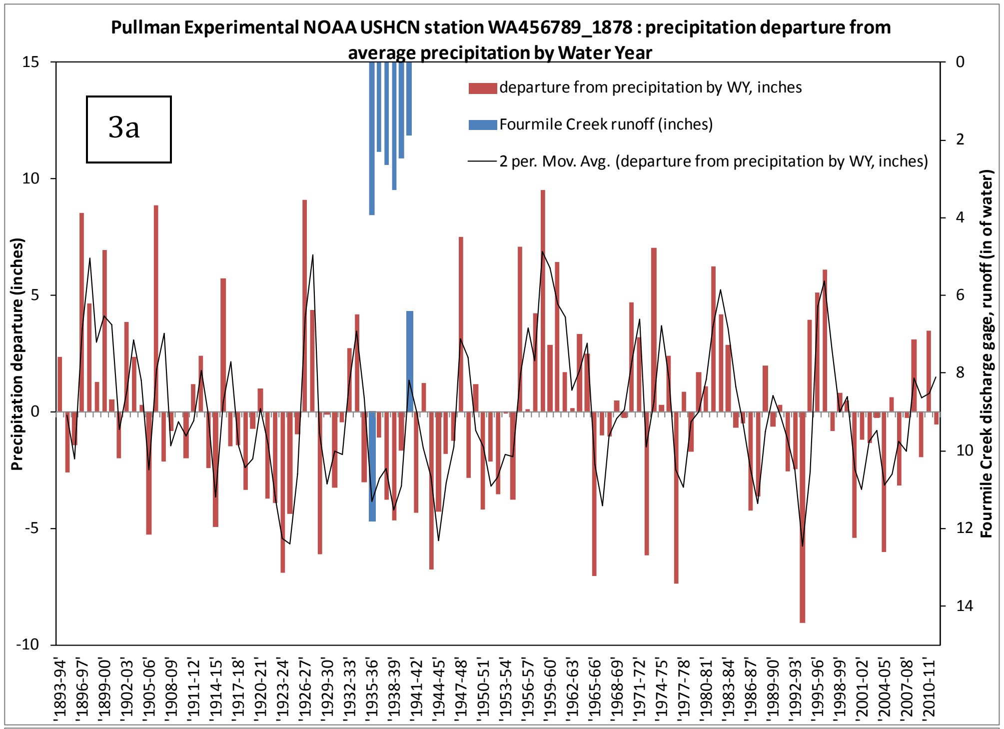
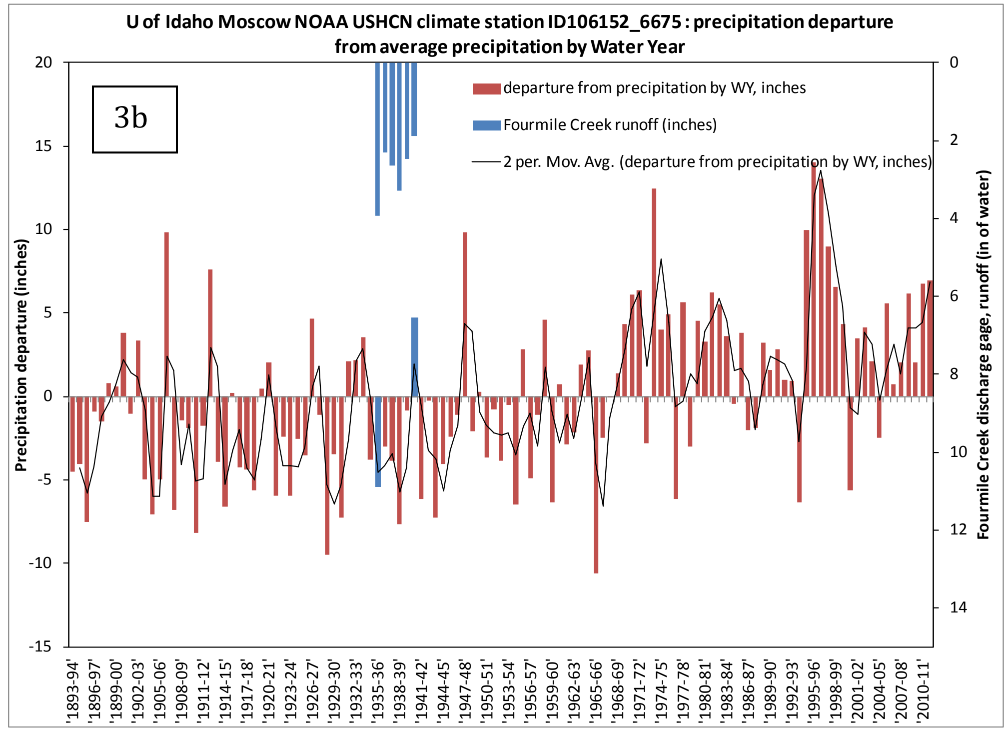


Figure 2: Mean of the average daily discharge at Fourmile Ck (USGS 13349000), Missouri Flats Ck (USGS 13348500) and SF Palouse R (USGS 13348000). The mean values are based on flow from 1935-1940. The hydrographs show that the hydrologic regimes and response to precipitation are similar. Station locations are shown on Figure 1. .





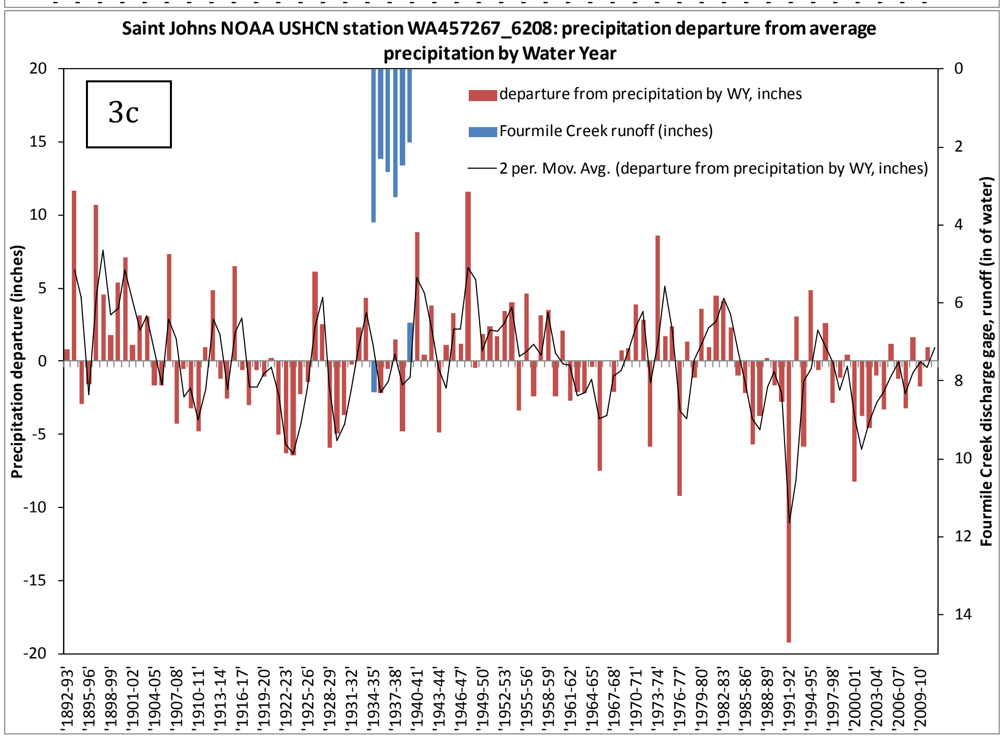


Figure 3: Graphs show annual precipitation departure from the long-term mean annual precipitation for three NOA USHCN climate stations located near Fourmile Creek, 3a and 3b, and Cottonwood Creek 3c. The black lines are 2 period moving average which smoothes some of the variability making dry and wet periods more visible. The top axis (blue bars) is average annual discharge as inches of runoff per unit area. The precipitation departure bars are red except those that coincide with Fourmile Creek discharge record (1935-40). Those are blue. The Pullman Experimental station (3a) and U of Idaho, Moscow station (3b) graphs show that precipitation was less than normal for the Fourmile Creek discharge record. The Pullman precipitation records don't show any downward or upward trend in precipitation. However, the U of Idaho, Moscow Station (3b) indicates an increase in precipitation (upward trend). This station is representative of precipitation in the headwaters of Fourmile Creek. Increasing precipitation may cause an increase in streamflow. The Saint John's station (3c) precipitation is representative of precipitation patterns in lower Cottonwood Creek watershed (Figure 1). There appears to be a slight downward trend in precipitation at this station.

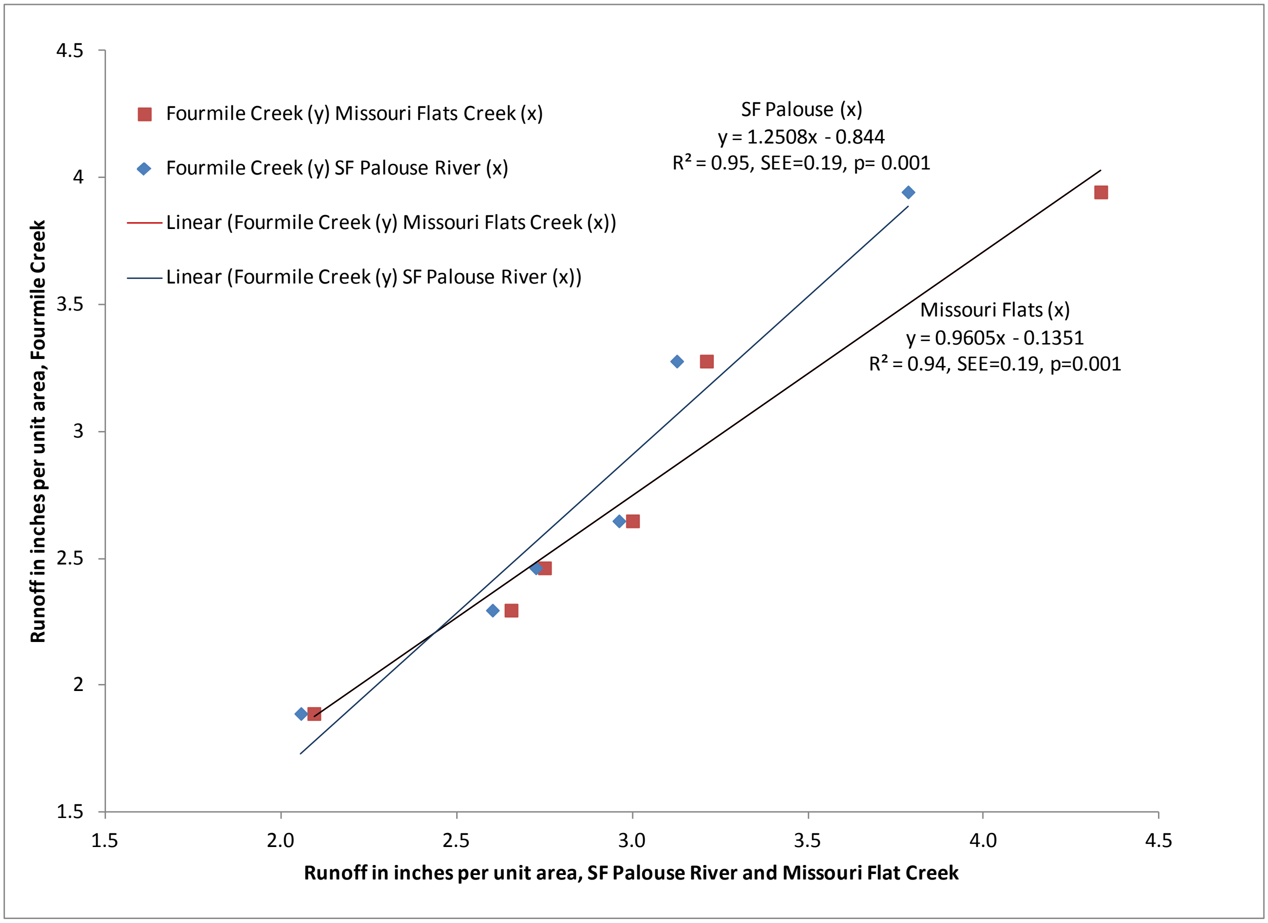


Figure 4: This graph illustrates the strong liner regression relationships between Fourmile Creek and the SF Palouse River and Missouri Flat Creek. SEE is the standard estimate of error for the regression equation in inches of runoff. P is the probability associated with the regression equation. The probability is much less than 0.05 (standard) suggesting that equation is significant. The regression equation results are given in inches of runoff per unit area so that discharge can be calculated given drainage area above a stream point. Conversion of run off to discharge (cfs) is: $\frac{\boldsymbol{Drainage\ area\ above\ pt\ (sq\ mi)} \times 5280\ (ft)^2 \times \boldsymbol{runoff\ (inches)}}{(12\ ft \times 3600\ secs \times 24\ minutes \times 365\ days)}$**. The standard error is approximately ± 1 cfs about the mean.**

Cottonwood Creek

There is not much data for Cottonwood Creek. The stream characteristics are more similar to Pine Creek than SF Palouse River. The USGS had a sediment sampling gage on Cottonwood Creek (Figure 1) but only discrete discharge measurements were measured from 11/30/64-3/15/65. The purpose of the gage was to measure sediment load so discharge was mostly measured during high flow. There were some miscellaneous discharge measurements on Rock Creek from 3/20/2001-9/2/2008 (Figure 1). The measurements included low to high flow months. The average flow from this data was 134.2 cfs.

Since there is little data, I extrapolated runoff per unit area from Pine Creek. I used the median runoff value from Pine Creek because the annual precipitation from Saint John's NOAA, USHCN station located near Cottonwood Creek (Figure 1, Figure 3c) appears to have a slight downward trend. Medians are not as sensitive to slight trends as average values. The available discharge data were measured on Pine Creek when precipitation appeared to have no obvious trend (Figure 3c, 1962-1975). The median unit runoff for Pine Creek is 2.31 inches. The average unit runoff for Rock Creek is also 2.31 inches. Since there was agreement this runoff value was used to estimate a SMP point on Cottonwood Creek (Table 1). The analyses indicate that the 20 cfs point is close to Cottonwood and Kamiche Creek confluence.

References

Higgins, J.L., 2003, Determination of upstream boundary points on southeastern Washington streams under the requirements of the Shoreline Management Act of 1971, USGS Water-Resources Investigations Report 03-4042, Tacoma, WA.

Sinclair, K. and J. Kardouni, 2009, Surface-water/groundwater interactions and near-stream groundwater quality along the Palouse River, South Fork Palouse River, and Paradise Creek, Ecology Publication Number 09-03-007 https://fortress.wa.gov/ecy/publications/SummaryPages/0903007.html .

Watershed Sciences, 2006, Airborne Thermal Infrared Remote Sensing Palouse River Basin, WA/ID, *Submitted to:* Washington Department of Ecology Environmental Assessment Program and City of Moscow, Water Department, Moscow, ID.