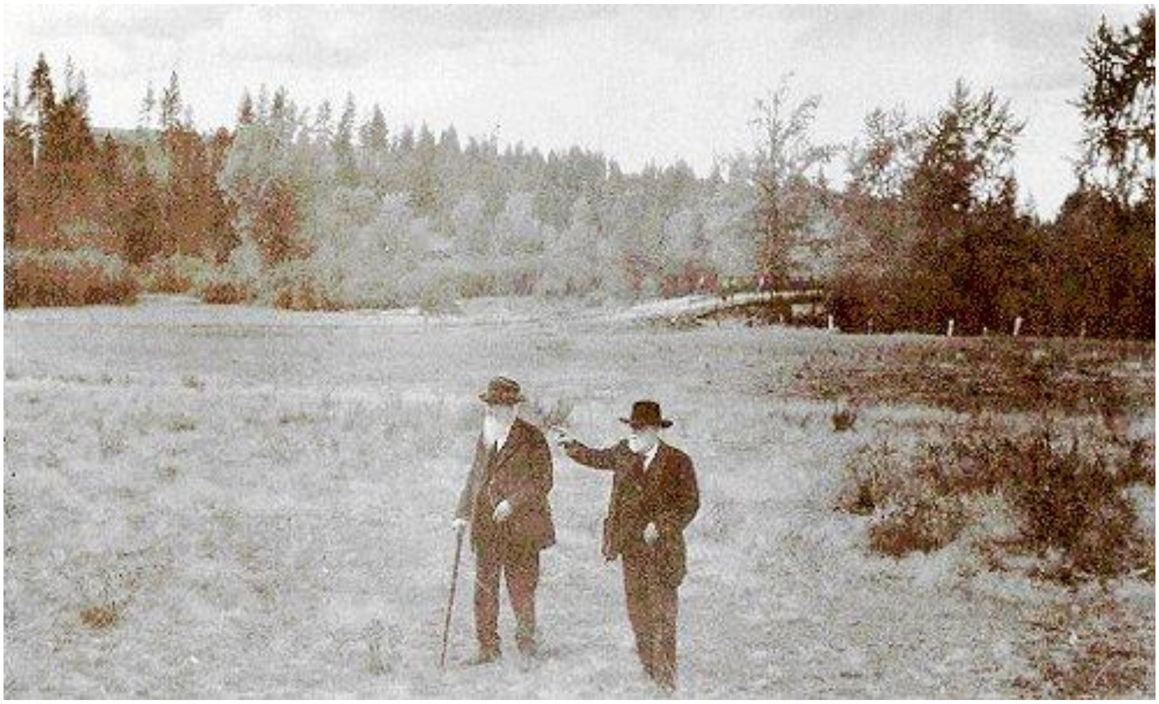

# Pre-Settlement Vegetation of the Hangman Creek Watershed

*(DRAFT)*

*June 26, 2003*

*Sponsored by*

*The Spokane County Conservation District*

*The Hangman Creek Watershed Planning Unit*
*(WRIA 56)*

## Introduction and Background Information

The degraded water quality observed throughout the Hangman Creek watershed raises questions regarding the historical conditions of the watershed. The water quality problems associated with high peak flows and low summer flows compound the water quantity issues in the watershed. There is a common perception that summer water levels were significantly higher in the past, but have fallen throughout the 20th century due to human impacts in the watershed. This investigation provides an assessment of the historic condition of the native vegetative cover and estimates how changes in land use throughout the watershed have influenced the overall water availability and soil loss.

Pre-settlement watershed conditions were evaluated using historic plant community cover as described in early section line surveys. The section line surveys were part of the Public Land Survey System (PLSS) conducted under standards set forth in the 1785 Land Ordinance (BLM, 2003). The rectangular survey system, also know as the cadastral survey, subdivided public lands into townships, ranges, and sections across the western United States.

The original land surveys of Washington were conducted by the Surveyor General's Office in Olympia, WA during the late 19th Century. Similarly, surveys of the Idaho portions of the watershed were supervised by the Surveyor General's Office in Boise, ID in the early 20th Century. Copies of the surveyor notes and plats (maps) are stored at the Cadastral Survey's office on microfiche at Bureau of Land Management regional offices throughout the United States.

Surveys established each Township into six-mile squares. Each township has 36 square miles, and each square mile is called a Section. Surveyors walked each six-mile township boundary line and each one-mile section line. They recorded observations in their field notes, and drew plats and designated boundaries along the line walked. In general, most surveyors' field notes included descriptions of vegetation, landforms, soil type, water availability, and suitability for settlement. These qualitative descriptions of vegetation found in the field notes, along with the hand drawn plats, were used to estimate the historic vegetation cover for the Hangman Creek watershed. The information from the original PLSS was gathered and processed in ArcView 3.2 GIS.

Native vegetative cover in the watershed was once a combination of various shrub/steppe and forested habitat types. These habitat types were described by Daubenmire (1942, 1970) and Daubenmire and Daubenmire (1968). The Palouse bioregion, which composes those plant communities indicative of forming on loessal soils, is now listed as one of most endangered ecosystems in the United States. The onset of settlement in the Palouse region of southeast Washington has resulted in widespread conversion of native prairie and forested lands to agriculture (Black et. al.). This conversion has resulted in the loss of wildlife habitat and native biological diversity for the region.

Alteration of land cover combined with other cumulative effects has contributed to water quality concerns and may directly influence the water availability in the watershed. For example, forest removal can increase peak flows and contribute to valley flooding (EPA, 1991). Activities such as channelization, removal of riparian vegetation, grazing, road building and increasing urbanization has influenced the water quality and quantity.

Hangman Creek has been listed on the Washington State Department of Ecology 303(d) list of impaired waterways for exceedences of high temperature, pH, and fecal coliform bacteria. These water quality issues are further influenced by high sediment concentrations from nonpoint sources, lack of adequate riparian vegetation cover, and extremely low summer flows (SCCD, 1994).

The degradation in water quality raises questions about the historical conditions of the watershed. Based on accounts from Native Americans and early settlers, the watershed at one time supported a salmon fishery. Recent federal Endangered Species listing of five native salmonids found in Washington waterways has the restoration of fish habitat throughout the Northwest a top priority. After the completion of the Grand Coulee Dam in 1942, anadromous salmon were no longer able to migrate and spawn in Hangman Creek. However, recent studies by Eastern Washington University have located small populations of resident redband trout in the tributaries of Hangman Creek. This finding, coupled with the changes in peak floods and low summer flows, brings added attention to water quantity issues in the watershed. There is a common belief that water levels have fallen due to human impacts in the watershed. This report provides an assessment on the historic condition of the native vegetative cover.

**Assumptions necessary to use the PLSS**

The information contained in the PLSS is qualitative and was sometimes difficult to interpret. Surveyors often used different terminology to describe common plant species and other observations. The vegetative communities and individual species listed in the notes often required interpretation because the surveyors did not use uniform vegetation information. The surveyors did not typically provide detailed accounts of species abundance or use scientific names. Loose terminology, and/or vernacular were often used to describe vegetation. Similarly, handwriting on both the plats and in the notes was sometimes not very clear.

The Washington State surveys ranged from 1869 to 1880, and are considered by the BLM to be the first official surveys for the area. It was assumed that the vegetation observed by surveyors was native and that the conversion to agriculture and the introduction of non-native plants was not yet widespread. Settlements were cited as early as 1870, but the largest farm recorded at that time was approximately 55 acres in T 25 N, R 42 E, sec. 23 & 26.

The earliest reliable Idaho State surveys available for this project ranged from 1903 to 1906. Earlier Idaho surveys were considered fraudulent by the BLM. Settlement was widely expanding into Idaho by this time. Inferences of historical vegetative communities were based on topography and available field notes describing the surrounding landform and plant species. The GIS maps reflect some settlements in Washington, whereas the Idaho settlements were changed to estimates of the original vegetation.

**Vegetative Community Delineation**

Vegetation types described by the surveyors were categorized into seven major groups based on plant communities and dominant landforms. The categories included:

- Bunchgrass prairie
- Open Ponderosa pine and grasses
- Open Ponderosa pine on rocky surface
- Wetland or lake
- Evergreen forest
- Cottonwood, alder, or willow groves
- Cultivated

In most cases, surveyors wrote a summary labeled "General Description" for each section. The general descriptions, notes, and plats were used to assign the plant community type for each section. The vegetative communities in each section were adjusted using the features and landforms on the surveyor's plat. GIS tools were utilized to produce a historical vegetation map (Figure 1) and to calculate the area of each vegetative community. These areas were further divided into five sub-watersheds (Table 1) to re-calculate a historical water balance similar to the work conducted by Buchanan and Brown (2003).

Table 1: Historic Vegetation Coverage for the Hangman Creek Watershed

| Vegetation Types | Vegetation Area by Sub-watershed (acres) | | | | | |
|---|---|---|---|---|---|---|
| | Upper Hangman | Lower Hangman | Marshall Creek | Rock Creek | California Creek | Watershed Total |
| Bunch grass Prairie | 110,236 | 13,650 | 8,999 | 33,257 | 662 | 166,803 |
| Open Ponderosa Pine with grasses | 32,295 | 24,175 | 22,798 | 40,365 | 8,554 | 128,186 |
| Open Ponderosa Pine on rocky surface | 3,583 | 4,058 | 6,546 | 239 | 449 | 14,875 |
| Wetland or Lake | 0 | 645 | 1,995 | 0 | 0 | 2,640 |
| Evergreen Forest | 67,976 | 2,734 | 0 | 39,821 | 6,276 | 116,796 |
| Cottonwood, alder, or willow groves | 172 | 570 | 0 | 908 | 0 | 1,650 |
| Cultivated | 135 | 114 | 22 | 0 | 0 | 271 |

Notes:

1. Several categories, such as wetlands and lakes, were not originally recorded within several sub-watersheds. This may be a result of details provided by different surveyors and does not infer that they did not exist.
2. The bunchgrass prairie vegetative cover included areas defined as shrub steppe.

## Methods

### Interpreting the PLSS

Interpreting handwriting and terminology was difficult at times. For example, many recorded what they called "sunflowers". These were most likely *Balsamorhiza sagittata* or arrowleaf balsamroot. Despite the vague and obscure descriptions, the size and species of important overstory trees were recorded. The overstory trees included two trees at each quarter section marker and section corners, trees that served as guide trees for directional bearings, and any trees directly on the section line. This provided the dominant species for an area and possible habitat types and plant associations. In addition to vegetation descriptions, other landmarks such as "Indian" trails, pioneer roads, creeks, springs, settlements and farms were recorded and labeled on the plats.

Since surveyors used non-uniform descriptions for the vegetation, the interpretation of observed species was based on plant names provided by the surveyors and referenced to their occurrence for a given habitat type found in the area as described by Daubenmire (1970). Names given to a plant not found in this region were correlated to a local species within the same genus or family. Such was the case for "buck brush", a common name for a species found in the South and Midwest United States of the same genus as the common snowberry (*Symphoricarpus albus*). A species list, interpretation of terms used for the plant observed by surveyors, and comments relating to the plants observed can be found in Table 2.

### Water Balance

The current water balance for the Hangman Creek watershed incorporated precipitation and ET rates for existing vegetation based on land uses supplied by the USGS. The water balance provided an estimate of how much water (surplus) is available for infiltration to groundwater systems or as surface run-off measured by the USGS. A surplus of 192,854 acre-feet per year was estimated for the entire watershed using data provided by Buchanan and Brown (2003). The same method was then used to predict a water balance for pre-settlement conditions using the historic vegetation map. Table 3 lists the vegetation categories and the corresponding ET values that were used in the historic water balance.

## Results and Discussion

### Pre-settlement Vegetation Cover

The map in Figure 1 represents the estimated vegetative cover for the Hangman Creek watershed prior to mass settlement. Large changes have occurred in the conversion of prairie/grasslands and open Ponderosa pine communities to agriculture. Table 4 lists the total acres by vegetation types for each sub-watershed based on the PLSS.

## Pre-settlement Vegetation Cover of Hangman Creek Watershed (based on PLSS)

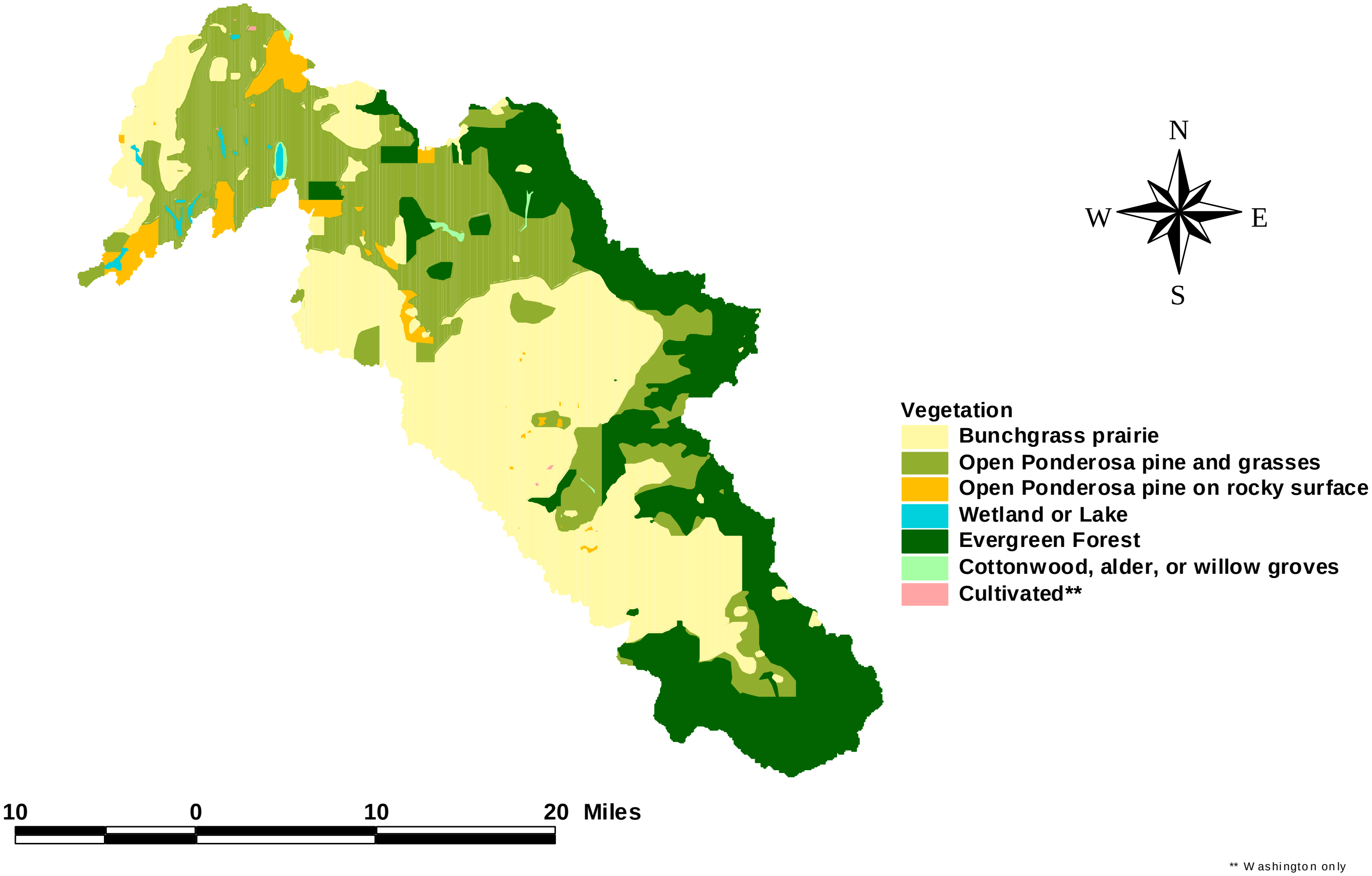


Figure 1.0

The historical vegetative communities in the Hangman Creek watershed prior to settlement were significantly different than today (Table 5). The watershed was primarily covered with rolling hills of bunchgrass prairie that extended into scattered populations of Ponderosa pine (*Pinus ponderosa*) forests. The Ponderosa pine communities often included a shrub understory such as snowberry (*Symphoricarpus albus*) and wood's rose (*Rosa woodsii*).

Table 2: Public Land Survey Terms and Descriptions

| **Original Vegetation Type** | **Description** | **Comments** |
|---|---|---|
| Rolling prairie | Native bunchgrasses with or without shrubs | Surveyors often used the term "rolling prairie" to describe rolling grasslands that were easily cultivated and often cited "prairie soil", "1st rate soil", or "black loam", thus indicating prairie/grasslands. |
| Open Ponderosa pine | Open or scattered stands of Ponderosa pine with variable understory of grasses, shrubs, and herbs | Surveyors used the term "Yellow Pine" and often referred to these areas as "scattering timber". |
| Open Ponderosa on rocky substrate | Open Ponderosa pine on rocky scabland | Surveyors often referred to this area as "scattering timber and rocky". It is delineated from the Open Ponderosa pine vegetation type because it was not farmable and considered to be "grazing land" and not suitable for farming. |
| Wetland or lake | Standing, perennial water and/or wetland | Surveyors often used terms like "marsh", "swamp", "bog", or "lake" to describe these sites. These are not well documented. |
| Mixed Conifer | Closed canopy forest composed of two or more conifer species. | Surveyors often used the term "heavy forest" and listed multiple species including fir, tamarack, pine, cedar, and hemlock. |
| Willow, alder, cottonwood, or aspen | This includes any area where willows, alder, cottonwood, or aspen were prominent | These areas were not well documented by most surveys, but did occur and were recorded to some extent. |
| Level prairie | Bunchgrass prairie | Surveyors often used the term "level prairie" when the land was not rolling and easily tilled. |
| Cultivated | Any area that had been farmed | Surveyors recorded the presence of a few farms early as 1870. |

Table 3: Historic Vegetation Evapotranspiration Rates

| Vegetation Type | Evapotranspiration Rate (inches) |
|---|---|
| Bunchgrass prairie | 11 |
| Open Ponderosa pine | 17 |
| Open Ponderosa pine on rock | 17 |
| Wetland or lake | 47 |
| Mixed conifer | 22 |
| Cottonwood, alder, aspen, willow | 40 |
| Cultivated | 16 |
| Notes: Evaportransporation rates based on Buchanan and Brown (2003) | |

Table 4: Historic Vegetation Coverage for the Hangman Creek Watershed

| | Area of Vegetation Types by Watershed (acres) | | | | | |
|---|---|---|---|---|---|---|
| Vegetation Types | Upper Hangman | Lower Hangman | Marshall Creek | Rock Creek | California Creek | Hangman Creek |
| Bunchgrass Prairie | 110,236 | 13,650 | 8,999 | 33,257 | 662 | 166,803 |
| Open Ponderosa Pine | 32,295 | 24,175 | 22,798 | 40,365 | 8,554 | 128,186 |
| Open Ponderosa Pine on Rock | 3,583 | 4,058 | 6,546 | 239 | 449 | 14,875 |
| Wetland or Lake | 0 | 645 | 1,995 | 0 | 0 | 2,640 |
| Mixed Conifer Forest | 67,976 | 2,734 | 0 | 39,821 | 6,276 | 116,796 |
| Cottonwood, alder, aspen, or willow | 172 | 570 | 0 | 908 | 0 | 1,650 |
| Cultivated | 135 | 114 | 22 | 0 | 0 | 271 |

The streams, springs and drainages were densely vegetated with various shrubs and small trees including; hawthorn (*Crataegus*) willows (*Salix*), aspen and cottonwood (*Populus*), alders (*Alnus*), serviceberry (*Amelanchier alnifolia*) and chokecherry (*Prunus virginiana*). Higher elevations, canyon lands, and northern aspects supported a mix of coniferous forest species including Western Larch (*Larix occidentalis*), Douglas fir (*Pseudotsuga menziesii*), Grand fir (*Abies grandis*), Engelmann spruce (*Picea engelmanni*), Western hemlock (*Tsuga heterophylla*), and Western red cedar (*Thuja plicata*).

Table 5: Land Use Changes in Hangman Creek (approximately 1870 to 2003)

| Sub-watershed | Land Use | Land Uses: Pre-settlement (acres) | Land Uses: Current (acres) | Net Change (percent) |
|---|---|---|---|---|
| California Creek | Agriculture | 0 | 8,801 | NA |
| | Developed | 0 | 332 | NA |
| | Forested | 15,257 | 3,687 | (-)75.8 |
| | Rock/Transitional | 0 | 41 | NA |
| | Shrub/Steppe | 662 | 3,018 | (+)357 |
| | Wetland or Lake | 0 | 29 | NA |
| Lower Hangman | Agriculture | 114 | 13,697 | (+)11,915 |
| | Developed | 0 | 6,554 | NA |
| | Forested | 30,820 | 8,329 | (-)73.0 |
| | Rock/Transitional | 0 | 103 | NA |
| | Shrub/Steppe | 13,547 | 16,730 | (+)23.5 |
| | Wetland or Lake | 1,207 | 193 | (-)84.0 |
| Marshall Creek | Agriculture | 21 | 10,624 | (+)50,490 |
| | Developed | 0 | 2,243 | NA |
| | Forested | 28,655 | 13,906 | (-)51.5 |
| | Rock/Transitional | 0 | 338 | NA |
| | Shrub/Steppe | 8,706 | 11,032 | (+)26.7 |
| | Wetland or Lake | 1,930 | 919 | (-)52.4 |
| Rock Creek | Agriculture | 0 | 92,634 | NA |
| | Developed | 0 | 1,524 | NA |
| | Forested | 81,062 | 11,181 | (-)86.2 |
| | Rock/Transitional | 0 | 98 | NA |
| | Shrub/Steppe | 33,058 | 8,324 | (-)74.8 |
| | Wetland or Lake | 902 | 73 | (-)91.9 |
| Upper Hangman | Agriculture | 133 | 149,750 | (+)112,494 |
| | Developed | 0 | 2,798 | NA |
| | Forested | 102,935 | 45,335 | (-)56.0 |
| | Rock/Transitional | 0 | 1,128 | NA |
| | Shrub/Steppe | 109,404 | 12,271 | (-)88.8 |
| | Wetland or Lake | 169 | 140 | (-)17.2 |

Notes:
1. Agriculture is historic cultivated.
2. Developed and rock/transitional have no historic equivalent.
3. Forested is historic open Ponderosa pine, Ponderosa pine on rocks, and mixed conifers.
4. Shrub steppe is historic bunchgrass prairie.
5. Wetland or lake is historic wetland or lake and alder, cottonwoods, aspen, or willow groves.

Agriculture has become the dominant land use for the watershed at over 275,000 acres. This is approximately the pre-settlement prairie and forested areas combined. Overall forestland cover reductions average between 50 to 75 percent for the sub-watersheds with the exception of Rock Creek (approximately 86 percent). The harvest and conversion of these of forested areas, especially in headwater tributaries, probably had significant impacts to the hydrology of the watershed.

The base flow of Hangman Creek may have been affected by the early land use conversions at the turn of the century. Actual increases of base flows following the removal of forested land have been reported in many different studies (Bates and Henry 1928; Troendle 1983; Van Haveren 1988). However in arid environments with high evapotranspiration rates, such as eastern Washington, these increases may be more dependent upon sufficient summer precipitation.

Local watershed residents have reported that summer flows during the 1940 and 50s were much higher than what is currently observed (SCCD, 1998). This may have been a response to the clearing of forest canopies throughout the watershed. For the months of July through October (1948 – 1959), the USGS records indicate that the average monthly flow was never less than 12 cfs. However, based on the USGS low flow statistics, during the critical base flow period (July – October) for Hangman Creek, there is a 50 percent probability that the 30-day low flow will be less than 12 cfs.

**Historical Water Balance**

The historical water balance was developed through the application of the pre-settlement vegetative communities for each sub-watershed. The same methodology used by Buchanan and Brown (2003) was applied to calculate a new water balance. The most significant adjustment to the calculation, besides the vegetative cover, was the new evapotranspiration (ET) rates.

The ET rates of pre-settlement times were, on average, greater than the current rates due to the amount and density of the vegetation. One of the major current vegetation land uses is small grains. Small grains have ET rates of approximately 11 inches per year, whereas the previously existing forested areas had ET rates ranging between 17 and 22 inches per year. This change in vegetation type results in an increased water surplus because less water is currently taken up and used by the vegetation than in historic times.

The historical water balance suggests that there was less water during pre-settlement times than what is seen today. The current estimated watershed surplus is 192,854 acre-feet per year. The historical water balance calculations indicated a surplus of only 152,773 acre-feet per year (Table 6). A 40,000 acre-feet per year difference is probably minor, but this data strongly suggests that there was less water historically than there is today.

The increased moisture surplus seems reasonable when one looks at the land use changes that have occurred. In the Hangman Creek watershed, thousands of acres of forest canopy have been lost. This likely resulted in a substantial reduction of snow and rain interception. However, the rate of snowmelt would be increased. The additional snowpack accumulation and the frequent rain on snow events would melt the snow faster and substantially increase the size of peak flows in major flood events. It is during these major storm events that Hangman Creek suffers severe stream bank and channel damage along with significant sediment transport.

In December of 1996 and January of 1997, heavy snowfall and rains triggered successive flooding events that severely impacted Hangman Creek. The 1997 event recorded a flow of over 21,000 cfs. This was the peak flood of record. The small towns, residential homes, golf courses, and businesses within the floodplain experienced extensive damage. The damage costs for these two recent events totaled over three million dollars.

Sediment transport through the Hangman Creek system is significant, especially during extreme flood events. A cooperative study by the SCCD and USGS (1998-2001) estimated annual sediment discharge (suspended and bedload) ranging from 4,740 to 189,000 tons. The SCCD also estimated the total sediment load from 1906 to 1996 to be approximately 27.6 million tons. These studies illustrate the magnitude of water quality problems in the watershed.

Table 6: Historic and Current Water Balance Parameters and Surplus

| Water Balance Sub-Watershed Parameter | Sub-Watershed | | | | | Total Hangman Watershed |
|---|---|---|---|---|---|---|
| | Upper Hangman | Lower Hangman | Marshall Creek | Rock Creek | California Creek | |
| Area (acres) | 214,383 | 45,947 | 40,359 | 114,590 | 15,942 | 431,221 |
| Precipitation (inches) | 22.3 | 17.8 | 17.4 | 19.6 | 19.9 | NA |
| Historic ET (inches) | 15.5 | 16.2 | 17.1 | 17.2 | 18.7 | NA |
| Current ET (inches) | 14.9 | 15.9 | 15.6 | 14.7 | 19.5 | NA |
| Historic Surplus (acre-feet per year) | 121,168 | 6,051 | 860 | 23,125 | 1,569 | 152,773 |
| Current Surplus (acre-feet per year) | 132,203 | 7,275 | 6,054 | 46,791 | 531 | 192,854 |
| Change in Surplus Historic to Current (acre-feet per year) | 11,035 | 1,223 | 5,194 | 23,666 | -1,037 | 40,081 |

Notes:
1. ET is evapotranspiration.
2. NA is not applicable.
3. Evapotranspiration is a weighted value based on percentage of vegetation type for each sub-watershed.

**Soil Erosion and Possible Changes in Erosion Rates**

The evaluation of historic soil erosion was done using the NRCS Revised Universal Soil Loss Equation (NRCS Field Office Guide Book). This equation is usually used to predict soil loss from different farm practices and crop rotations. The historic soil loss was based on changes that would affect different factors in the soil loss equation and historic erosion rates. The final estimation of soil loss is based on a percentage of current possible losses.

A percentage is used because the actual RUSLE soil losses for the entire watershed cannot be estimated. The factors that would change in the equation and how the predicted soil losses would also change can be evaluated. The soil loss equation is:

A = RKLSCP, where

A is the computed soil loss per unit area, usually expressed in tons per year
R is the rainfall and runoff factor
K is the soil erodibility factor
L is the slope-length factor
S is the slope-steepness factor
C is the cover and management factor
P is the support practice factor

Of all these factors, R, K, L, and S will be approximately the same for both current and pre-settlement conditions. The only conditions that would change are the cover and management conditions and the support practice factors. When these are evaluated, it is assumed that pre-settlement conditions would have been most like the no-till/low-till grass conditions with support practices better than contour farming. The assumed historic conditions are evaluated against current conditions of winter wheat, fallow, peas and spring grain crop rotations with support practices of up and down hill and contour farming.

For the cover and management factor C, the percent decrease in soil loss is approximate:

Percent of current soil loss for C factor = (0.01/.10)*100 = 10 percent
(numbers are from NRCS Field Office Guide Book, RUSLE section)

For the support practice factor P, assuming the pre-development conditions would be approximately half of the contour-farming factor. The current P factor is based on the average of up and down hill and contour farming (approximately 0.70). The percent decrease in soil loss is approximately:

Percent of current soil loss for P factor = (0.25/.70)*100 ≈ 37 percent
(numbers are from NRCS Field Office Guide Book, RUSLE section)

The total estimated soil loss would be approximately the reduction in C times the reduction in P, or

Total percent of current soil loss = (10 percent)(37 percent) = (0.10)(0.37) ≈ 4 percent of the current soil loss from farmland.

This represents a decrease in soil loss rates of approximately 96 percent. Using the PSIAC estimated soil loss from farmland (SCCD, 1994) for the entire Hangman Creek watershed of 176,000 tons, the pre-settlement non-bank erosion soil loss is estimated to have been approximately 7,000 tons per year. As a check on the validity of this estimation, during recent suspended sediment measurements, the suspended sediment measured by the USGS for water year 2001 was less than 3,500 tons. The 2001 overland flow conditions probably reflect conditions similar to the overland flow on the pre-settlement watershed vegetation as outlined by the section line surveyors.

Another factor resulting in the net increase of water availability may be the effects from the past removal of riparian vegetation. The removal of streamside areas that were once composed of woody, wetland species presumably sequestered and transpired water at a high rate. The removal of vegetative communities may contribute to the current increase in water surplus. This analysis did not reflect the historic condition of riparian vegetation or its conversion to other uses. However, the removal of riparian vegetation along the creeks was a widespread practice of early farmers that was encouraged by the Soil Conservation Service around World War II (Edelen and Allen, 1998).

# Current Land Use within the Historic Extent of Prairie (shrub/steppe) Vegetation in Upper Hangman Sub-Watershed

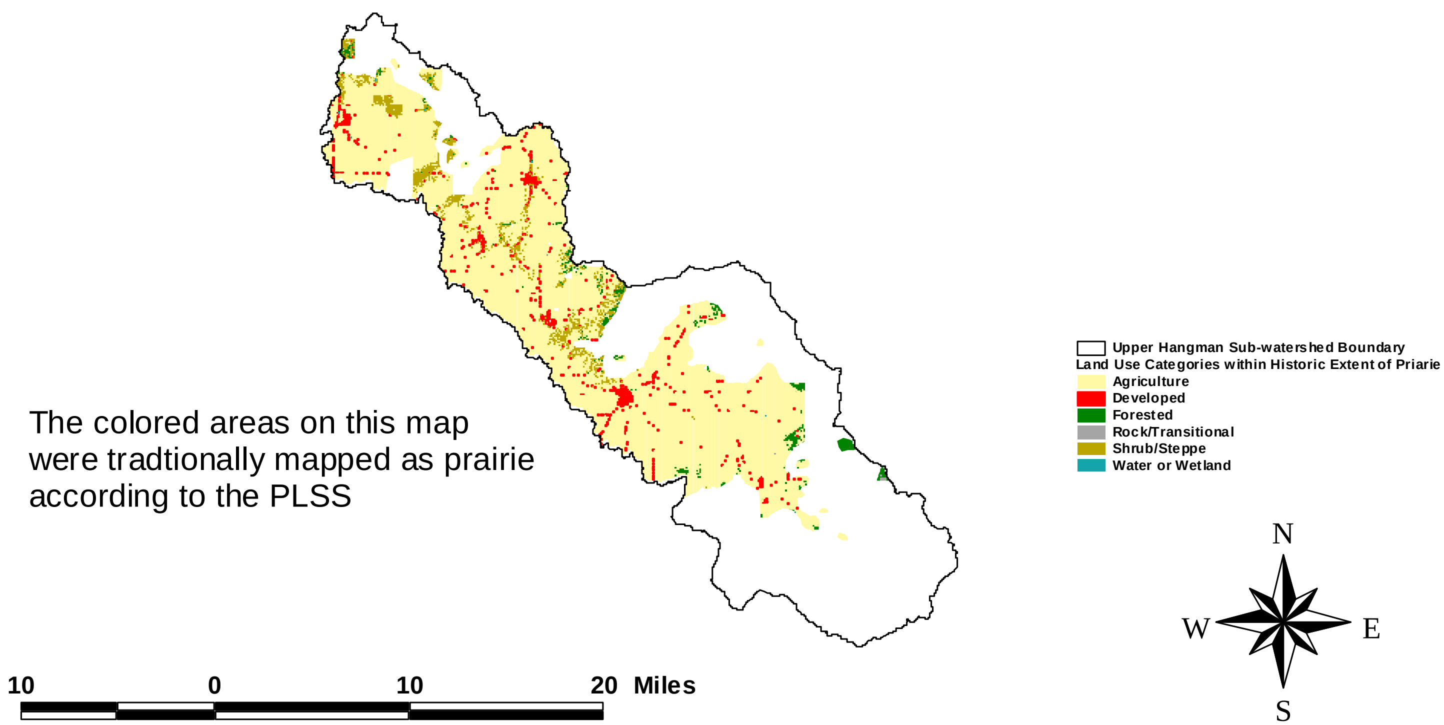


Figure 2

Species list and interpreted terms for plants observed by surveyors

| Terms used by Surveyors | Species list as interpreted by SCCD | Comments on observations |
|---|---|---|
| "sunflowers" | Arrowleaf balsamroot *Balsamorhiza sagittata* | Often found in association with Ponderosa pine or bunchgrass prairies |
| "weeds" | Any herbaceous understory plant | Surveyors who used the term "weeds" did not elaborate on species, use a common names, or describe these plants |
| "buck brush" | Common snowberry *Symphoricarpos albus* | "buck brush" is a common name for a similar species found in the southern Midwest of the US that surveyors may have been more common with. They often found this in forested hills of Idaho and grasslands of Washington |
| "pine grass" | Pine reedgrass *Calamagrotosis rubescens* | Noted amidst pine stands and prairies |
| "bunchgrass" | Bluebunch wheatgrass *Pseudorogeneria spicata* or Idaho fescue *Festuca Idahoensis* | Found in prairies and as dominant understory in many forested communities described by surveyors |
| "rye grass" | Basin wild rye *Leymus cinereus* or *Lolium spp.* | Rye grass is mentioned is association with other grasses |
| "service" | Serviceberry *Amelanchier alnifolia* | Commonly found in grassland and forested communities |
| "tamarack" | Western larch *Larix occidentalis* | Tamarack is the common name for Eastern larch (*Larix laricina*) found in the Northeastern US and was presumably observed as the same species |
| "rose" | Nutka rose *Rosa nootkana* or Pearhip rose *Rosa woodsii* | Found in prairies and forested communities |
| "willow" | *Salix spp.* Or Scouler willow *Salix scouleriana* | Willows were found in both ravines or streams and in forested, upland communities. When found in the upland situation, it is assumed to be Scouler willow |
| "cherry" | Choke cherry *Prunus virgiana* or Bitter cherry *Prunus emarginata* | Cited as an understory plant in forested communities |
| "thornbush" or "thicket" | Douglas hawthorn (*Crataegus douglasii*) | Often describe as being in ravines, which is characteristic of Douglas hawthorn |

| Terms used by Surveyors | Species list as interpreted by SCCD | Comments on observations |
| --- | --- | --- |
| "maple" | Rocky mountain maple *Acer glabrum* | Observed in forested communities as understory |
| "yellow pine" | Ponderosa pine *Pinus ponderosa* | Yellow pine is an accepted common name for Ponderosa pine. Old growth Ponderosas were often referred to as "yellow bellies" by pioneers because of the yellowish bark found only on old, large trees. |
| "red fir" or "fir" | Douglas fir *Pseudostuga menziesii* | Found in association with Ponderosa pine and in mixed forests in the upper watershed |
| "white fir" | Grand fir *Abies grandis* | Found mostly in the Idaho portions of the upper watershed |
| "white pine" | Western white pine *Abies monticola* | Once abundant in northern Idaho, but populations were decimated by white pine blister rust in the early 1900s |
| "black pine" | Unknown | Observed in Idaho in mixed conifer stands. Possibly young Ponderosa pines, which often exhibit black bark. |
| "spruce" | Engelmann spruce *Picea Engelmanni* | Found only in the upper reaches of watershed in Idaho |
| "cedar" | Western red cedar *Thuja plicata* | Observed in drainages and northern facing slopes of hills amidst mixed conifers |
| "hemlock" | Western hemlock *Tsuga heterophylla* | Often found with western red cedar in draws or north facing slopes |
| "cottonwood" | Black cottonwood *Populus tricocarpa* | Often found along creeks |
| "aspen" | Quaking aspen *Populus tremuloides* | Often observed adjacent to wetlands or creeks |
| "alder" | Thinleaf alder *Alnus incana* Or Red alder *Alnus rubra* | Often found in ravines, but usually only mentioned in the General Description of a section |
| "hazel" | Unknown | "Hazel" was cited as an understory plant in many forested areas. Possibly, the surveyor confused red alder or thinleaf alder for hazel alder *Alnus serrulata* found in throughout the Midwest and Eastern states |

Sub-watershed Evapotranspiration Calculations

Upper Hangman Sub-Watershed ET Calculations

| Historic Vegetation Type | Area (acres) | Proportion (percent) | USGS Land Use Code | ET Rate (inches) | Weighted ET |
|---|---|---|---|---|---|
| Prairie | 108,730 | 0.50 | 71.0 | 11.0 | 5.7 |
| Open Ponderosa | 31,854 | 0.20 | 42.0 | 17.0 | 2.6 |
| Ponderosa on Rock | 3,534 | <0.01 | 42.0 | 17.0 | 0.3 |
| Mixed Conifer | 67,036 | 0.30 | 42.0 | 22.0 | 7.0 |
| Cottonwood, alder, aspen, willow | 169 | <0.01 | 91.0 | 40.0 | 0.0 |
| Cultivated | 133 | <0.01 | 83.0 | 16.0 | 0.0 |
| | | | | | |
| Total | 211,456 | 1.0 | NA | NA | 15.6 |

Rock Creek Sub-Watershed ET Calculations

| Historic Vegetation Type | Area (acres) | Proportion (percent) | USGS Land Use Code | ET Rate (inches) | Weighted ET |
|---|---|---|---|---|---|
| Prairie | 33,058 | 0.29 | 199.4 | 11.0 | 3.2 |
| Open Ponderosa | 40,123 | 0.35 | 242.0 | 17.0 | 6.0 |
| Ponderosa on Rock | 238 | 0.00 | 1.4 | 17.0 | 0.0 |
| Mixed Conifer | 39,582 | 0.35 | 238.7 | 22.0 | 7.6 |
| Cottonwood, alder, aspen, willow | 902 | 0.01 | 5.4 | 40.0 | 0.3 |
| | | | | | |
| Total | 113,903 | 1.00 | NA | NA | 17.1 |

California Creek Sub-watershed ET Calculations

| Historic Vegetation Type | Area (acres) | Proportion (percent) | USGS Land Use Code | ET Rate (inches) | Weighted ET |
|---|---|---|---|---|---|
| Prairie | 661 | 0.04 | 71.0 | 11.0 | 0.5 |
| Open Ponderosa | 8,535 | 0.54 | 42.0 | 17.0 | 9.1 |
| Ponderosa on Rock | 448 | 0.03 | 42.0 | 17.0 | 0.5 |
| Mixed Conifer | 6,262 | 0.39 | 42.0 | 22.0 | 8.7 |
| | | | | | |
| Total | 15,906 | 1.00 | NA | NA | 18.8 |

Lower Hangman Creek Sub-watershed ET Calculation

| Historic Vegetation Type | Area (acres) | Proportion (percent) | USGS Land Use Code | ET Rate (inches) | Weighted ET |
|---|---|---|---|---|---|
| Prairie | 13,547 | 0.30 | 71 | 11 | 3.3 |
| Open Ponderosa | 23,993 | 0.53 | 42 | 17 | 8.9 |
| Ponderosa on Rock | 4,027 | 0.09 | 42 | 17 | 1.5 |
| Mixed Conifer | 566 | 0.01 | 91 | 40 | 0.5 |
| Cottonwood, alder, aspen, willow | 2,714 | 0.06 | 42 | 22 | 1.3 |
| Cultivated | 114 | 0.00 | 83 | 16 | 0.0 |
| Wetland/Lake | 641 | 0.01 | 11 | 47 | 0.6 |
| | | | | | |
| Total | 45,602 | 1.00 | NA | NA | 16.1 |

Minnie/Marshall Creek Sub-watershed ET Calculation

| Historic Vegetation Type | Area (acres) | Proportion (percent) | USGS Land Use Code | ET Rate (inches) | Weighted ET |
|---|---|---|---|---|---|
| Prairie | 8,706 | 0.22 | 71 | 11 | 2.5 |
| Open Ponderosa | 22,056 | 0.56 | 42 | 17 | 9.6 |
| Ponderosa on Rock | 6,333 | 0.16 | 42 | 17 | 2.8 |
| Cultivated | 21 | <0.01 | 83 | 16 | 0.0 |
| Wetland/Lake | 1,930 | 0.05 | 11 | 47 | 2.3 |
| | | | | | |
| Total | 39,046 | 0.99 | NA | NA | 17.2 |