Hangman (Latah) Creek Erosion Inventory

Introduction

Hangman Creek, also known as Latah Creek, is a trans-boundary watershed located in both Idaho and Washington, with a drainage area of approximately 689 square miles. The watershed covers most of southern Spokane County and part of the northeast corner of Whitman County in Washington, and parts of Benewah and Kootenai Counties in Idaho. The Hangman Creek watershed comprises approximately ten percent of the Spokane River watershed.

For the purposes of this assessment, four major stream sections have been characterized according to geologic and geomorphic conditions. Corresponding reaches can be found in the Conservation District's Proper Functioning Condition Report (PFC). These areas were defined below.

Watershed Area	River Miles	Reach(es)	Percent of Watershed
1. Upper Hangman Area	RM 58.5 – RM 34.2 (24.3)	1 - 11	42
2. Hangman Canyon Area	RM 34.2 – 17.9 (16.3)	12 - 17	28
3. Valley Floor Area	RM 17.9 – 14.6 (3.3)	18	5
4. Lower Hangman Area	RM 14.6 – 0.0 (14.6)	19 - 22	25

Dominant fluvial geomorphic conditions and processes within these watershed areas are distinct and defined by a combination of geologic and human influences.

Geologically, The Upper Hangman Creek area is defined by rolling loess hills and reworked channel sediments. Bedrock outcrops can be found throughout these upper reaches. Dryland agricultural operations are dominant throughout this portion of the watershed.

The Hangman Canyon Area is characterized by a deep basalt canyon that confines the vertical and lateral movement of the stream. The basalt is highly resistant to erosion and where the channel bed has cut through overlying materials and exposed the basalt, a vertically stable condition has resulted. The basalt formations create a laterally stable condition when the channel contacts the valley walls. Talus material weathered from basalt contributes bedload material to the channel. There are no intensive types of land use within this portion of the watershed.

The Valley Floor Area contains former lake bottom fine-grained sediment deposits known as the Latah Formation. The Latah Formation has a low resistance to bank erosion. Channel meander development within the valley floor areas is active. Remnant floodplains, channel scars and high flow channels and chutes are common within this formation. Agricultural operations and some limited building construction have been practiced on these former lake bottom surfaces. The Latah Formation contains active and historic flood plains and low terraces. These areas are highly subject to channel change and are completely within the active meander migration belt. The low terrace areas represent former flood plains that were abandoned during the process of base level lowering.

High sandy bluffs characterize the Lower Hangman Creek Area. Base level lowering of the channel has been active throughout this area. Glacial Lake Missoula flood related sediments were deposited within this area as many as 40 times during the Quaternary Period (US Government Printing Office 1974). Over the last ten to 12 thousand years, Hangman Creek has been vertically downcutting through these sediments. As the channel bed lowers it eventually approaches a new state of vertical equilibrium. Much of the project area appears to have largely completed this downcutting process and has entered a phase of lateral adjustment and meander development. Significant impacts to channel banks have occurred throughout this reach. Bridge constrictions, confinement by road construction, and residential development are a few of the existing issues.

Climate

The Hangman Creek watershed is in a maritime-continental transition climatic zone and has characteristics of both damp coastal weather and more arid interior conditions. In general, the Hangman Creek watershed has an arid climate during the summer months and a mild coastal climate during the winter months. The mouth of Hangman Creek is at an elevation of approximate 1,700 feet. The headwaters are at an elevation of approximately 3,600 feet. Because of the higher headwater elevation, the headwater area experiences an orographic effect that increases the annual average precipitation from less than 18 inches per year at the mouth, to over 40 inches per year in the southeastern headwaters (SCCD, 1994).

Regional Geology

The headwaters of the Hangman Creek watershed begin in mountains formed by the Idaho Batholith. Hangman Creek then flows through the rolling loess hills of the Palouse region and into an area of basalt cliffs and canyons. In reaches below Rock Creek Hangman Creek flows through sedimentary hills of sand, gravel, and cobbles deposited during the ancestral Glacial Lake Missoula floods.

Bedrock in the lower watershed is mainly Miocene basalt flows with pockets of Tertiary biotite granite and granodiorite (WDNR, 1998). During the Miocene, the basalt flows would periodically dam rivers and form lakes. Material deposited in these lakes formed dense laminated clay and silt deposits that are resistant to erosion. Wind-blown silt (loess) accumulated up to 200 feet over most of the basalt flows and formed dune shaped hills.

During the Pleistocene period, lobes from glacial ice sheets blocked several major drainages and produced extensive lakes. The largest of these was Glacial Lake Missoula, which at one time covered over 3,000 square miles. There were approximately 40 separate flood events from Glacial Lake Missoula (SCCD, 1994). The floods left major channels in the eastern Washington region, removed loess deposits, and deposited much of the sand, gravel, cobble, and boulders found in the lower reaches of Hangman Creek.

Upper Hangman Creek Sediments
Soils above Rock Creek in the Hangman Creek watershed have formed from a wide variety of materials. The materials include volcanic ash, silty loess, glacial deposits, alluvium deposited by streams, and material weathered from basaltic, granitic, and metamorphic bedrock. In the upper Hangman Creek area, much of the farmed soil is derived from loess deposits. The loess was windblown soil that settled in the eastern Washington area approximately 100,000 years ago. The loess deposits were up to 200 feet thick and formed dune-like hills. Significant areas of the loess deposits were removed with the glacial flooding. The present day loess deposits are areas where sheet and rill erosion tends to account for almost 90 percent of the soil loss from cropland (USDA, 1978).

Lower Hangman Creek Sediments
The easily erodible stream bank material influences the Hangman Creek flow regime below the confluence with Rock Creek. The unconsolidated material generally consists of one or more of three major alluvial deposit types. The deposits are the Latah Formation, consisting of lake deposits; Glacial Lake Missoula flood deposits of sand, gravel, and cobbles; and post-Missoula flood alluvium (SCCD, 1994).

The Latah Formation consists of fine laminations of silts and clays with low permeability that tends to perch water above the formations. Slumping can occur as water removes sediment from above the confining silt and clay layers. The silts and clays generally form resistant bands when they are near the water edge with steep banks above them. If unconsolidated sands and gravels underlie the Latah Formation, then the sands and gravels tend to wash out undercutting and exposing the silt and clay layers. This undercutting results in block slumps and rapid bank loss.

The Glacial Lake Missoula flood deposits consist of sorted to unsorted, silt, sands, gravels, cobbles, and boulders. The unconsolidated material erodes easily along streams, producing steep unstable slopes over 100 feet high. The major type of erosion is toe failure caused by the stream removing the material at the base of the stream bank. Once the toe material is removed, the bank is over-steepened. The over-steepened bank fails and deposits large amounts of material directly into the stream. The newly deposited material is then available to be mobilized under most flow conditions.

Post-Missoula flood alluvium generally overlies all the other sediment layers. The post-Missoula flood material is unconsolidated and easily eroded. The erosional characteristics are similar to the Glacial Lake Missoula flood deposits discussed above.

Sediment Loading
Suspended sediment and bedload samples were collected from three sites within the Hangman Creek watershed. Two sites were in the center of the watershed, Rock Creek and Bradshaw Road, and one site was at the mouth of Marne Bridge. The site at the mouth of Hangman Creek used an automated sampler to collect suspended sediment samples. The suspended sediment samples were generally collected daily, with increased

frequency during high flow events. The suspended sediment samples were used by the USGS to estimate daily-suspended sediment discharges in tons per day at the mouth of Hangman Creek. Bedload samples were obtained at the mouth of Hangman Creek for a number of different flow rates and a predictive regression equation was developed from the data. The predictive regression equation was used to estimate daily bedload discharges in tons per day.

The total amount of sediment discharged from Hangman Creek for water years 1998 and 1999 was estimated at 52,000 and 211,000 tons, respectively. For water year 1998 the total sediment discharge consisted of an estimated 35,000 tons of suspended discharge and 17,000 tons of bedload discharge. For water year 1999 the total sediment discharge consisted of an estimated 188,000 tons of suspended discharge and 23,000 tons of bedload discharge. The average annual flow in 1998 was 166 cfs, and in 1999 it was 315 cfs.

Over the past one hundred years, Hangman Creek has delivered excessive amounts of sediment to the Spokane River. Estimations of sediment discharged from Hangman Creek for the past ninety years is summarized below.

Estimations for Total Sediment Load and Bedload, 1906 through 1996

Estimate Source	Bedload (Million Tons)	Total Sediment Load (Million Tons)
NHC Consultants, 1996	3.6	N/E
PSIAC Sediment Yield Model	3.1	15.8
SCCD Regression Equations	0.96	27.6

Notes:

1. NHC consultants estimated infilling behind Nine-Mile dam using original 1906 topographic maps.
2. PSIAC is Pacific Southwest Inter-Agency Committee.
3. SCCD regression equations were derived from four years of data (1998-2001) and used USGS average annual flow numbers.
4. Total sediment load is the combination of estimated bedload and suspended sediment load.
5. N/E is not estimated.

Bedload

Bedload discharge samples from the upper reaches of the watershed contained minimal sediment. At Rock Creek the highest sediment discharge was 24 grams at a discharge of 540 cfs. At Bradshaw Road, the highest sediment discharge was less than one gram at a discharge of 837 cfs. At the lower site, Marne Bridge, even low flows had significant sediment discharge. At the lower site, the sediment discharge for a flow of 111 cfs was 1,530 grams. The highest sediment discharge was 11,500 grams at a discharge of 2,530 cfs. Based on the lack of bedload discharge at the upper sites, probably only a minimal amount of bedload is moving into the Spokane River from the upper reaches of the Hangman watershed (except for extreme flood events). Bedload samples were not obtained at flow rates over 5,000 cfs at any station because of sampling equipment limitations.

Suspended Sediments

The suspended sediment discharge provided the majority of the total sediment load from the watershed, 67 and 89 percent respectively for water years 1998 and 1999. The higher the average annual flow rate, the higher the percentage of suspended sediment. The suspended sediment is derived from both bank and field erosion, but it is suspected to be primarily from agricultural field erosion. The suspended sediment concentration generally increased downstream between the sites, but this is probably due to an increase in discharge and water velocity.

Only bedload discharge samples from the Marne Bridge site contained enough sediment to sieve. The bedload sample particle size analyses were similar for all flow ranges. The particle size analysis ranged from very fine sand (0.125-0.062 mm) through fine gravel (8.0-4.0 mm). The d_{50} for the sediment ranged from one to two millimeters, a very coarse sand.

Erosion Inventory

As part of a larger Shoreline and Inventory Project on Hangman Creek, all actively eroding sites were measured and documented. The average height and length of eroded bank were documented using a Garmin™ global positioning system (GPS). All erosion data can be found in table below.

Erosional areas were further delineated into five height classes:

Erosion Class	Bank Height
I	3 – 9
II	10 – 28
III	29 - 65
IV	66 – 125
V	126 – 300

Upper Hangman Creek Area (Approximately 24.3 miles, Reaches 1-11)

This portion of the watershed is located higher in the watershed and is not as adversely affected by the high flow events that significantly damage the lower sections of the watershed. The channel banks are typically erosion class I. Bare vertical banks and slumping banks are common. The first twelve miles has approximately 2,145 ft of erosion (down to RM 46.7). The next twelve miles contains almost 10,000 feet of Class I erosion. There is a general lack of riparian vegetation throughout this area with a mix of livestock and agricultural influences. The riparian areas are dominated by reed canarygrass and common tansy. The last reach (# 11) has a small amount of erosion Class II (211 ft).

Hangman Canyon Area (Approximately 16.3 miles, Reaches 12-17)

This area has approximately 8,870 feet of Class I erosion, 3,941 feet of Class II erosion, and a minor area of Class III erosion (106 feet). The area contains a deep basalt canyon where the lateral migration is confined by valley walls. The gradient is steeper through the canyon and erosional processes appear to be natural. Reach 16 and 17 are just out of the canyon and contain no erosion.

Valley Floor Area (Approximately 3.3 miles, Reach 18)

This reach is considered the only non-functional reach in Spokane County. It is aggressively migrating across the valley floor. It contains 739 ft of class I erosion, 2218 ft of class II erosion, 686 ft of class III erosion, and 1426 ft of class IV erosion (total of 5,105 ft). This area contains more erosion than any other reach. Approximately 30 % of it is eroding. The land uses are passive farming and pasture, but the riparian vegetation is absent. Bedrock is sparse throughout the reach.

Lower Hangman Area (Approximately 14.6 miles, Reaches 19-22)

The lower channel of Hangman contains the tallest sand bluffs within the watershed. This area has had major channel modifications and impacts by humans. The construction of Highway 195 removed ¾ of a mile of stream meander. This activity artificially constrained the creek, increased the gradient and stream energy. The stream has difficulty transporting its sediment load and is actively seeking equilibrium through lateral migration into the tall sand bluffs. It has a total of 11,034 feet of active erosion. The area has approximately 422 feet of Class I erosion, 4,223 feet of Class II erosion, 1,600 feet of Class III erosion, 3,749 feet of Class IV erosion, and 2,482 feet of Class V erosion.

Hangman Creek Erosion Inventory Table

Reach Id	Reach Length (mi)	Erosion Class I 3-9 (ft).	Erosion Class II 10-28 (ft)	Erosion Class III 29-65 (ft)	Erosion Class IV 66-125 (ft)	Erosion Class V 126-300 (ft)	Total Erosion length (ft.)
1	4.7	456	0	0	0	0	456
2	0.4	211	0	0	0	0	211
3	2.6	422	0	0	0	0	422
4	0.5	158	0	0	0	0	158
5	3.6	898	0	0	0	0	898
6	5.3	3,115	0	0	0	0	3,115
7	1.4	1,478	0	0	0	0	1,478
8	2.0	1,742	0	0	0	0	1,742
9	1.5	2,323	0	0	0	0	2,323
10	1.1	475	0	0	0	0	475
11	1.2	845	211	0	0	0	1,056
12	2.1	1,320	0	0	0	0	1,320
13	7.4	2,376	370	0	0	0	2,746
14A	1.9	1,531	264	0	0	0	1,795
14B	1.1	2,059	106	106	0	0	2,295
15	2.3	1,584	3,221	0	0	0	4,805
16	0.8	0	0	0	0	0	0
17	0.7	0	0	0	0	0	0
18	3.3	739	2,218	686	1,426	0	5,105
19	4.1	0	950	475	370	0	1,795
20	2.4	0	1,214	475	0	0	1,673
21A	1.3	0	1,056	0	475	1,056	2,587
21B	1.0	0	264	0	0	0	264
21C	3.8	211	739	650	792	1,426	3,818
22	2.0	211	0	0	686	0	897
Totals	58.5	22,154	10,613	2,392	3,749	2,482	41,434

Blue reaches are designated as the Upper Hangman Area
Green reaches are designated as the Hangman Canyon Area
Red reaches are designated as the Valley Floor Area
Black reaches are designated as the Lower Hangman Area

Erosion Summary Table

Watershed Area	Reach Length (mi)	Erosion Class I 3-9 (ft)	Erosion Class II 10-28 (ft)	Erosion Class III 29-65 (ft)	Erosion Class IV 66-125 (ft)	Erosion Class V 126-300 (ft)	Total Erosion length (ft)
Upper Hangman	24.3	12,123	0	0	0	0	12,173
Canyon	16.3	8,870	3,961	106	0	0	12,937
Valley Floor	3.3	739	2,218	686	1,426	0	5,105
Lower Hangman	14.6	422	6,441	2,286	3,749	2,482	15,380
						Total	**45,595**

Project Priority

The following areas were prioritized for restoration based on the geomorphological processes, current land use, funding opportunity, and landowner cooperation potential.

1. Valley Floor Area
2. Upper Hangman Area
3. Canyon Area
4. Lower Hangman Area

The Valley Floor Area was chosen as the top priority due to its non-functional status, potential for sediment contribution, and cooperative landowners. Furthermore, it constitutes the beginning of major erosion sites after the stream leaves the canyon. Addressing these areas and moving downstream will benefit the entire system. This area can be addressed through riparian corridor management, revegetation, sediment reducing structures and selected bank shaping.

The Upper Hangman Area was chosen as the second priority because the erosion can be addressed primarily through revegetation and some sediment reducing structures. The problems are not as serious as in the lower reaches. The establishment of riparian woody shrubs and trees will further stabilize the banks and provide habitat and shade to the stream.

The Canyon Area is the third priority because it is mostly stabilized. Reach 15 has some erosion issues that need to be addressed. This would constitute sediment reducing structures, live fascines, and other revegetation techniques.

The Lower Canyon Area is most problematic and expensive. The largest single problem is toe erosion. High flows, ice, trees and other debris constantly remove the toe of the bank. It is often difficult to work with these banks due to their unconsolidated and unstable nature. Hundreds of thousands of dollars have been previously spent with minor to moderate success. These areas may be addressed, but it may consist of high priced engineering to reduce the sediment inputs.

Project Costs
The following cost estimates are approximate and based on various factors as indicated.

Priority 1: The Valley Floor - $250,000 to 350,000.

- $15-20/ft for revegetation and sediment structures
- Additional bank shaping costs may increase the project costs substantially ($100 – 200K)

Priority # 2: The Upper Hangman Area – $300,000 – 400,000
$2-3/ft – revegetation, sediment structures

Priority # 3: The Canyon Area - $225,000 -350,000

- $15-20/ft – revegetation, sediment structures, live fascines.
- Additional bank shaping costs may increase the project costs substantially ($100 – 200K)

Priority # 4: The Lower Hangman Area - $3 – 5 million. This is based on alternatives listed in the Flood Hazard Management Plan developed in 2000. A combination of structural and revegetation projects will be required.

Total Cost is approximately $ 4 – 5 million dollars.

Timeline – unknown at this time. Projects will be dependent upon funding opportunities and cooperation of landowners.