WASHINGTON STATE DEPARTMENT OF ECOLOGY

McDonald Creek

Stream Channel Assessment

Abstract

A stream channel assessment of lower McDonald Creek was conducted to evaluate stream channel conditions before and after timber harvest activities in the watershed. Direct observation techniques were used to characterize the condition of the streambed and banks, with an emphasis on stream channel features potentially affected by changes in peak flow regimes in the drainage basin. Conditions observed in McDonald Creek over a four-year monitoring period were compared to those observed in a control stream, by scoring results from stream channel surveys and evaluating year-to-year changes observed in photo point surveys. Results showed evidence of effects in lower McDonald Creek that were associated with a major channel erosion event upstream of the study reach, which occurred during the first winter following the completion of timber harvest activities. These effects included extensive streambed scour and deposition of materials transported from upstream erosion sites, as well as stream channel widening. The observed changes in stream channel conditions in lower McDonald Creek are likely associated with increased peak flows. This may also be associated with sediment inputs from increased erosion in the watershed and changes in riparian conditions along McDonald Creek and its tributaries, or a combination of all of these factors.

Introduction

McDonald Creek flows into Hood Canal on the east side of the Olympic Peninsula. The stream channel assessment of lower McDonald Creek was conducted as part of a cooperative monitoring program designed to evaluate the effects of timber harvesting and related road construction activities on stream habitat and salmonid and other aquatic resources in the McDonald Creek watershed. Other aspects of the monitoring program carried out by the Weyerhaeuser Company, the Port Gamble S'Klallam Tribe, the Skokomish Tribe, the Point No Point Treaty Council, and Ecology's Southwest Regional Office and Environmental Assessment Program included stream temperature monitoring, Timber-Fish-Wildlife (TFW) ambient monitoring surveys, fisheries surveys, and macroinvertebrate assessments. The cooperative monitoring program was undertaken in response to concerns raised about the proposal by Weyerhaeuser to conduct clearcut timber harvests in approximately 21% of the McDonald Creek watershed. In particular, there were concerns that increased peak flows in the basin could affect salmon spawning and rearing habitat in the lower reach of McDonald Creek.

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The objectives of the stream channel assessment of lower McDonald Creek were to:

1. Qualitatively assess stream channel conditions before and after timber harvest activities in order to evaluate cumulative effects, particularly channel response to changes in peak flows; and

2. Provide the results of this assessment to participants in the cooperative monitoring program to be considered along with other information collected in the basin, in order to assess pre- and post-harvest conditions.

Methods

A number of hypotheses and monitoring objectives were identified during the preliminary scoping effort for the cooperative monitoring program. The null hypothesis identified for testing in the stream channel assessment of lower McDonald Creek is that channel conditions would not be adversely affected by peak flow increases caused by timber harvest activities on Weyerhaeuser lands in the McDonald Creek basin. The study approach employed to test this hypothesis combined before-after and treatment-control comparisons based on monitoring of stream channel conditions through direct observation techniques. Two field survey methods were employed in one 170 meter treatment reach in lower McDonald Creek, and one 174 meter control reach in S.F. Fulton Creek in an adjoining watershed. Channel condition surveys and photo point surveys were conducted on each study reach from 1993 to 1996. Field surveys were conducted in late September of each year, when low-flow conditions facilitated direct observation of stream channel features. Timber harvesting activity in the McDonald Creek basin occurred between the 1993 and 1994 surveys. One pre-treatment and three post-treatment surveys were conducted on each study reach. Post-treatment surveys conducted in 1995 and 1996 reflect conditions following winter high flow events as influenced by the altered watershed conditions.

Figure 1 shows the locations of study reaches. The treatment and control reaches have similar streambed materials and unconfined channels with step-pool morphology, and have similar drainage areas. In the lowermost part of the McDonald Creek study reach, the channel morphology becomes pool-riffle. The McDonald Creek study reach begins about 90 meters upstream of the bridge at Highway 101, upstream of the tidal influence from Hood Canal.

Observations made in the channel condition survey were recorded on a rating form modified from that developed by Metzler (1992) for evaluating peak flow damage potential and effects. The channel condition survey results from each year were scored using the scoring system developed for the TFW Cooperative Monitoring, Evaluation, and Research program sediment study conducted by Ecology (Rashin et al., 1999a and b). This provides a method of evaluating year-to-year changes in stream channel conditions, and comparing changes in the treatment reach to changes in the control reach. Replicate surveys conducted during the TFW sediment study to evaluate the variability of scores obtained using this survey technique found relatively low variability, with an average standard deviation of 3 points and an average coefficient of variation of 7% (Rashin et al., 1999a). Channel condition survey results were also scored using the peak flow considerations rating method of Metzler (1992). As shown in the project proposal (Rashin and Dickes, 1993), the peak flow considerations rating method was slightly modified to account for modifications made to the channel condition rating form. The photo point survey technique

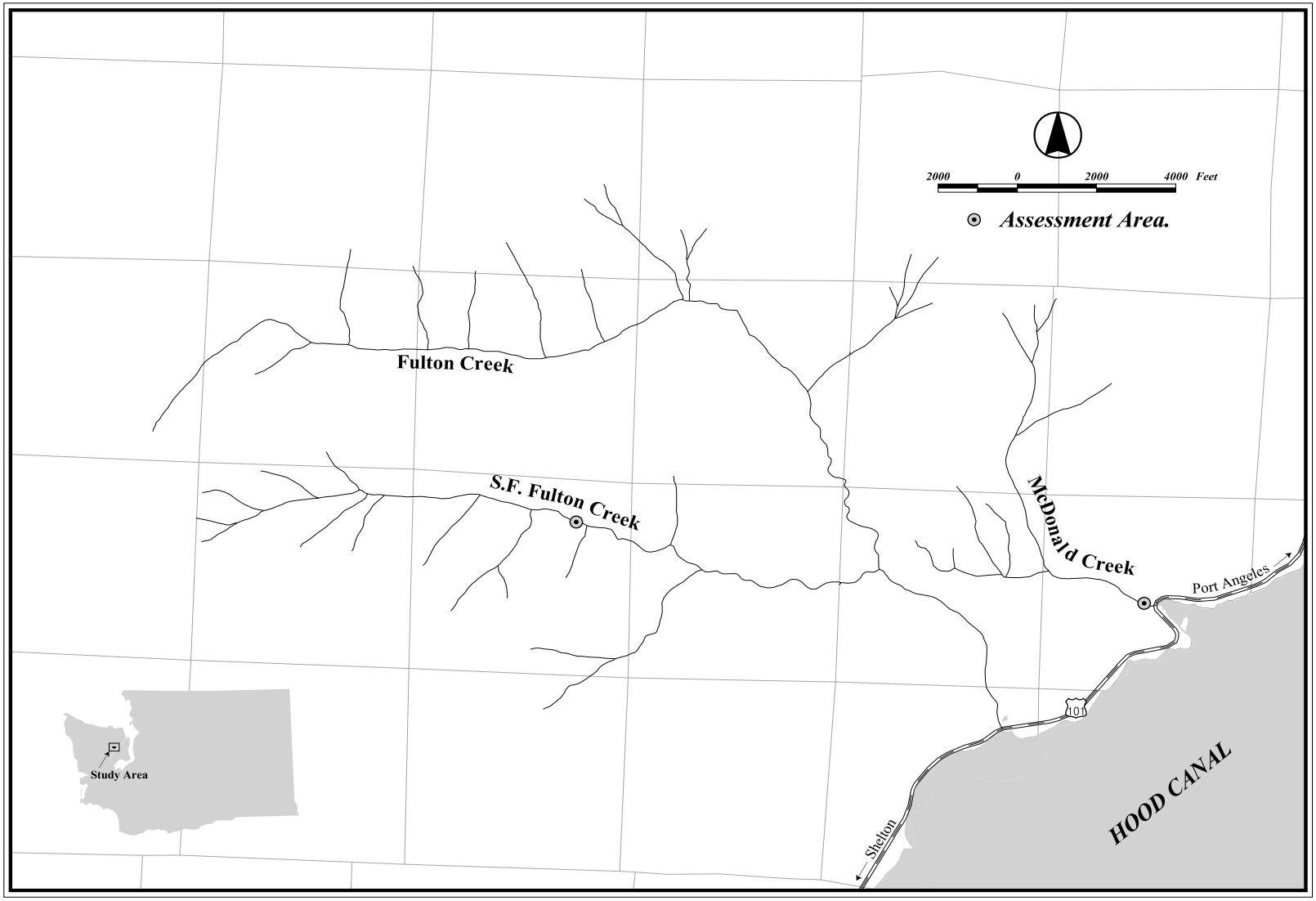

Figure 1. Assessment Areas for the McDonald Creek Stream Channel Assessment Study.

was used to evaluate year to year stream channel changes by comparing photographs and direct observations made at several observation points throughout each study reach. For detailed field protocols and examples of field forms used for the channel condition and photo point survey methods, refer to Appendix I of the TFW sediment study report (Rashin et al., 1999b).

Results

Summaries of results from the channel condition and photo point surveys conducted on the McDonald Creek study reach and a control reach on S.F. Fulton Creek are given in Appendices A and B.

Both treatment and control reaches had similar channel condition scores for the 1993 pre-treatment surveys, and similar changes in stream channel condition between the 1993 and 1994 surveys. Photo point surveys showed that streambed materials, including cobbles and small boulders, were mobile in both study reaches. Comparisons between 1993/1994 and 1995/1996 stream channel conditions showed substantial changes in the McDonald Creek treatment reach. This was reflected in a 41% decrease in channel condition score, comparing 1995 and 1996 results to 1993 results. Stream channel changes were associated with a major erosion event in the basin, likely attributable to increased peak flows. Observations made in a more confined section of McDonald Creek, upstream of the survey reach, indicated that a debris flow event had occurred between the 1994 and 1995 surveys. Materials from upstream erosion had passed through and been deposited in the study reach in lower McDonald Creek.

The following changes were observed in the 1995 and 1996 surveys in the treatment reach:

- Increased stream bank erosion;

- Increased sediment deposition, including pool filling with finer-grained sediments and aggradation of mid-channel cobble and gravel bars as well as the formation of several new gravel bars; and

- Streambed scour that resulted in the destabilization of in-channel sediment storage elements, including loss of previously anchored large woody debris. New woody debris jams were formed, which were storing fresh gravels and fine sediment but did not appear stable.

By the time of the 1996 survey, the McDonald Creek study reach had responded to the input of material from upstream erosion by widening. The average active channel width in the study reach almost doubled between 1993 and 1996. The photo point surveys documented and confirmed the stream channel changes noted in the channel condition surveys.

Overall stream channel conditions and channel condition scores in the S.F. Fulton Creek control reach showed relatively minor changes over the monitoring period, although there was evidence of bankfull and overbank flows as well as localized deposition and scour of streambed materials. While localized channel changes were observed in the control reach, as pointed out in the photo point survey summary (Appendix B), there were substantial differences in the magnitude and extent of streambed scour and sediment deposition. Changes in the control reach were localized as compared to the extensive changes observed in the treatment reach. The timing of channel

changes was also different in the control reach, where localized streambed scour was not observed until the 1996 survey.

Conclusions

Degradation of stream channel and aquatic habitat conditions in lower McDonald Creek occurred over the 1993-1996 monitoring period. This conclusion is based on changes in stream channel conditions observed in the treatment study reach in lower McDonald Creek, and comparisons to conditions in the S.F. Fulton Creek control reach over the monitoring period. The type of stream channel changes observed, and evidence of a major channel erosion event upstream of the lower McDonald Creek study reach, indicate that the observed in-stream degradation was likely caused by changes in peak flow regimes, and possibly by other factors as well. The timing of major stream channel changes in McDonald Creek, which occurred during the first winter, high-flow season following the completion of road building and timber harvesting, indicates that the observed effects may be associated with recent forest practice activities.

In addition to changes in peak flow regimes caused by removal of forest cover and changes in flow routing due to road drainage, the effects observed in lower McDonald Creek could also be associated with other factors such as increased watershed erosion with sediment delivery to streams, and changes in riparian conditions (e.g., harvest and/or windthrow of streamside trees) in the upper reaches of McDonald Creek and its tributaries.

Recommendations

Results from monitoring of channel conditions in lower McDonald Creek should be considered along with results from other monitoring conducted within the basin, to more fully evaluate cause-effect relationships.

References

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APPENDIX A

Channel Condition Survey Results Summary

McDonald Creek Channel Assessment

Treatment Survey ID#: CS-01 Lower McDonald Creek
Control Survey ID#: CS-02 S.F. Fulton Creek

Channel Condition Scoring Summary
(Scored according to the TFW sediment study method of Rashin et al., 1999. Maximum possible score equal 68 points.)

	Treatment Score	Survey Date	Control Score	Survey Date
Pre-Treatment Surveys:	57	9/23/93	59	9/23/93
(Timber harvesting in McDonald Creek watershed occurred between the 1993 and 1994 surveys.)				
Post-Treatment Survey #1:	48	9/23/94	49	9/22/94
Change from Pre-Treatment Score:	-9		-10	
Net Change (Control-Treatment):	+1			
Post-Treatment Survey #2:	34	9/25/95	61	9/2595
Change from Pre-Treatment Score:	-23		+2	
Net Change (Control-Treatment):	-25			
Post-Treatment Survey #3:	34	9/27/96	57	9/27/96
Change from Pre-Treatment Score:	-23		-2	
Net Change (Control-Treatment):	-21			

Case Narrative

The channel condition score in both treatment and control streams decreased by a similar amount between the 1993 and 1994 surveys, with changes in score attributable to minor increases in stream bank erosion, fresh sediment deposits, and streambed mobility. In both streams there was some evidence of overbank flows from the previous winter, with some shifting of in-channel sediment storage elements associated with cobble clusters, but larger elements associated with large woody debris and boulders had remained stable. Fresh sediment deposits in the control reach appeared to be associated with inputs from two tributaries, including a fining of the streambed for a short distance downstream of a left bank tributary that had transported sediment from a partial roadbed failure, evidence of which was observed along the access road in 1994.

The 1995 and 1996 surveys noted significant changes in the McDonald Creek study reach, where the channel condition score had decreased by 23 points (a 41% decrease) from the 1993, pre-treatment survey. Observations of channel and stream valley erosion upstream of the survey reach in lower McDonald Creek at the time of the 1995 survey indicated that a debris flow had occurred during the previous winter, resulting in substantial channel scour in an upper, more confined reach of the stream, and material from this erosion event had passed through and been deposited in the lower survey reach. The decrease in channel condition score was attributable to increased bank erosion (including upper banks) at three places along the reach, increased fresh sediment deposits including pool filling with finer-grained sediments, and destabilization of in-channel sediment storage elements including loss of previously anchored large woody debris. New woody debris jams had been formed, including a large, channel-spanning jam about midway through the reach just upstream of a major bend in the stream course, and these jams were storing fresh gravels and fine sediment but did not appear stable. Other changes noted included aggradation of mid-channel cobble and gravel bars and several new gravel bars since the 1994 survey. By the time of the 1996 survey, the McDonald Creek study reach had responded to the input of material from upstream erosion by widening: the average active channel width along the survey reach was 5.7 meters in 1993, increasing to 10.2 meters in 1996.

In the S.F. Fulton Creek control reach, the overall channel condition score in 1995 was slightly higher than in 1993, with less evidence of recent streambed mobility throughout the reach. The main changes noted in 1995 were fresh fine sediment deposits on the surface of a large sediment wedge and in side channels. In 1996, there was evidence of localized scour in the control reach, including scour of a marginal gravel bar and at a stream bank location where a piece of large woody debris was scoured out and deposited about 25 meters downstream. Bank and bed materials at this location were scoured to bedrock. Overall, no major changes in stream channel characteristics were observed in the control study reach over the monitoring period.

The channel condition survey results were also interpreted using the rating system for peak flow considerations developed by Metzler (1992). The rating system, which provides a score based on the channel condition survey to assess the potential for channel damage in response to increased peak flows, and a score to assess the extent of existing damage to increased peak flows, were slightly modified from that given in Metzler (1992) to account for modifications made to the channel condition survey method. Both treatment and control study reaches were found to have a *high* potential for damage in response to increased peak flows (score on potential: ≥ 4 points). The score for the treatment reach was higher due to somewhat finer-grained bank materials and, in 1995 and 1996, due to the presence of debris jams that blocked the channel. The score for the degree of existing damage related to increased peak flows indicated a *moderate* degree of existing damage (score on existing damage: 1.5-2 points) for the 1993 and 1994 survey results in McDonald Creek, but this changed to a *high* degree of existing damage (score: 5 points) for the 1995 and 1996 surveys. The S.F. Fulton control reach had a *moderate* rating for the degree of existing damage for all four survey years, with the score ranging from 2.5-3.5 points.

APPENDIX B

In-Stream Photo-Point Survey Comparison Summary

Study: **Lower McDonald Creek Channel Assessment**

Survey Years/ Dates: 1993 (9/23 & 10/1), 1994 (9/22 & 9/23), 1995 (9/25), and 1996 (9/27)

Study Reach Descriptions: 170 meter treatment reach on McDonald Cr., and 174 meter control reach on S.F. Fulton Creek

Indicators of in-channel changes	Control PS-02		Treatment PS-01	
	Yes	**No**	**Yes**	**No**
1. Is there evidence of increased stream bank erosion and /or physical disturbance of banks? * Bank erosion in control reach limited to one location.	X*		X	
2. Is there evidence of streambed scour and/or destabilization of sediment storage elements or bedforms (e.g. embedded LWD, boulder clusters, sediment wedges)? ** Localized scour observed in 1996 in control reach	X**		X	
3. Is there evidence of increased streambed mobility (e.g. change in brightness, fresh sediment deposits)?	X		X	
4. Is there evidence of increased deposition or storage of fine or coarse sediment?	X		X	
5. Are there changes in woody debris?				
Increase in large WD?	X		X	
Increase in small WD?	X		X	
Decrease in WD?	X		X	
6. Is there evidence of changes in aquatic plants due to scouring or other disturbances?		X	X	

Summary

Evidence of streambed mobility observed in both study reaches over the monitoring period included shifts in the position of individual substrate elements such as cobbles, boulders, and woody debris pieces. There were substantial differences in the magnitude of other channel changes observed over the 1993 to 1996 monitoring period, including streambed scour, sediment deposition, and bank erosion. There were also differences in the timing of streambed scour effects. A substantial amount of sediment and woody debris was deposited within the lower McDonald Creek study reach between the 1994 and 1995 surveys, resulting in the formation of new mid-channel and marginal bars and new woody debris jams. Apparently, the source of this

material was from channel erosion, and possibly also hillslope erosion, associated with a debris flow that passed through a confined reach of McDonald Creek, upstream of the photo point survey reach (evidence of such an event was observed upstream of the lower study reach at the time of the 1995 surveys). In addition to the sediment deposition noted in 1995, two significant pieces of previously anchored, channel-spanning large woody debris were scoured out of the reach. A large sediment wedge associated with one of the LWD pieces was excavated by scour, and a large pool associated with the other piece began filling (was completely filled by 1996). Photo point comparisons of channel changes in McDonald Creek between 1995 and 1996 showed bank erosion and streambed scour associated with channel widening that occurred following the sediment deposition documented in the 1995 survey. These effects were especially apparent in the upper two-thirds of the study reach. Although deposition and streambed scour were also noted in the control reach on S.F. Fulton Creek, the magnitude (i.e., the depth and/or volume of sediment involved) of these effects was much less, and rather than being extensive, evidence of scour and deposition was localized. In addition, the timing of streambed scour effects was different: in McDonald Creek scour of streambed elements was observed in 1995 and continued through 1996, while in S.F. Fulton Creek localized scour was not observed until the 1996 survey.

In-Stream Photo Point Survey Summary

Site: **McDonald Creek** Survey Dates: 09/23/93, 09/23/94, 09/25/95, and 09/27/96

Survey Id: PS-01 Treatment Reach

Water Type: 3 Reach Length: 170 meters

Indicators of in-channel changes	Yes	No	Photo/Field Notes References (Point No., Frame#) 1993	1994	1995	1996
1. Is there evidence of increased streambank erosion and/or physical disturbance of banks? * Bank erosion in '96 associated with channel widening.	X*				@P5 #2	@P1 #24 @P3 #5 @P5 #10,#12 @P8 #21
2. Is there evidence of streambed scour and/or destabilization of sediment storage elements or bedforms (e.g. embedded LWD, boulder clusters, sediment wedges)? * In 1996, included evidence of substantial channel widening from P4-P9.	X*				@P3 #18 @P9 #20	@P2 #25,#3 @P5 #11 @P6 #13 @P9 #23
3. Is there evidence of increased stream bed mobility (e.g. change in brightness, substrate movement, fresh sediment deposits)?	X			@P3 #12 @P9 #24	@P1 #12 @P8 #15	@P1 #24
4. Is there evidence of increased deposition or storage of fine or coarse sediment?	X			@P5 #16	@P2 #17 @P3 #18 @P6 #11	@P1 #23 @P3 #5
5. Are there changes in woody debris?				@P2 #10		@P2 #2
Increase in large WD?	X			@P6 #19		@P3 #8
Increase in small WD	X					@P4 #10 @P6 #14,#15 @P7 #20
Decrease in WD? * Imbedded LWD pieces @ P3 & P9 scoured out between '94 & '95 svys	X*			@P5 #15	@P3 #18 @P9 #20	@P6 #18
6. Is there evidence of changes in aquatic plants due to scouring or other disturbance?	X					@P8 #22

Summary

In all survey years, photo quality was good for making comparisons, including changes in the positions of individual streambed elements (e.g., boulders, woody debris). Relatively minor changes were noted between the 1993 and 1994 surveys, such as shifts in the position of cobbles and small boulders and woody debris pieces. Major channel changes were noted between the 1994 and 1995 surveys, apparently associated with a debris flow event that scoured the channel of McDonald Creek upstream of the survey reach. Two pieces of embedded large woody debris, one of which formed a large, channel-spanning sediment wedge, were scoured out. Both sediment and woody debris from upstream sources were deposited in the survey reach. In the mid-section of the survey reach, new woody debris jams were formed. New cobble and gravel bars were observed in the mid to lower section of the reach, in addition to sediment deposition in the new woody debris jams. In 1996, continued new sediment deposition was observed in the lower portion of the survey reach; the pool that had existed at Point 3 was completely filled with cobbles and gravel. However, the most substantial changes evident in the point-to-point photo comparisons between the 1995 and 1996 surveys were the streambed scour and channel widening that occurred from Point 4 upstream. Photo comparisons indicate a doubling of active channel width in parts of the survey reach. Some of the newly formed bars noted in 1995 were scoured out by 1996. Streambed scour and formation of a new woody debris jam was also observed in the floodway/side channel that diverges from the main channel at a meander just downstream of Point 6.

In-Stream Photo Point Survey Summary

Site: **S.F. Fulton Creek** Survey dates: 10/1/93, 9/22/94, 9/25/95, & 9/27/96

Survey Id: PS-02 Control Reach

Water Type: 3 Reach Length: 174 meters

Indicators of in-channel changes	Yes	No	Photo/Field Notes References (Point No., Frame#) 1993	1994	1995	1996
1. Is there evidence of increased streambank erosion and/or physical disturbance of banks? * At one location where LWD at stream bank was scoured out.	X*					@P5 #8,#9,#10
2. Is there evidence of streambed scour and/or destabilization of sediment storage elements or bedforms (e.g. embedded LWD, boulder clusters, sediment wedges)? * In 1996, localized scour was observed, including one piece of LWD scoured out at stream bank, and scour of mid-channel materials @ Points 1, 3, 6 & 7.	X*					@P1 #17,#19 @P3 #23,#1 @P5 #8,#9,#10 @P6 #12,#13,#14 @P7 #17,#18
3. Is there evidence of increased stream bed mobility (e.g. change in brightness, substrate movement, fresh sediment deposits)?	X			@P3 #10 @P4#14 @P6 #20,#21 @P8 #3	@P2 #2 @P6 #20	@P1 #16,#17 @P3 #24 @P6 #15 @P7 #21 @P8 #22
4. Is there evidence of increased deposition or storage of fine or coarse sediment?	X			@P6 #19	@P1 #24 @P3 #7 @P6 #17	@P3 #23
5. Are there changes in woody debris?						
Increase in large WD?	X			@P8 #3		@P4 #3
Increase in small WD	X			@P4 #13	@P4 #9	@P7 #19,#20 @P8 #22
Decrease in WD?	X					@P5 #8 @P8 #22
6. Is there evidence of changes in aquatic plants due to scouring or other disturbance?		X				

Summary

In all survey years, photo quality was good for making comparisons, including changes in the positions of individual streambed elements (e.g., boulders, woody debris). Relatively minor channel changes were noted in S.F. Fulton Creek between the 1993 and 1994 surveys, such as shifts in the position of cobbles and small boulders and woody debris pieces, and minor amounts of sediment deposition on top of pre-existing sediment wedges. Evidence of overbank flow was observed along the channel margins. Also in 1994, fresh sediment deposition was noted at the mouth of a tributary in the upper portion of the survey reach; the source of this sediment was traced to a partial roadbed failure at a culvert crossing this tributary. (At the downstream end of the survey reach, it was observed that there was sediment delivery from a relief drainage discharge along the same road, which channelized about 150 meters across the hillslope before reaching S.F. Fulton Creek.) Channel changes noted between the 1994 and 1995 surveys included localized sediment deposition (e.g., aggradation atop of pre-existing sediment wedges and cobble bars), as well as shifts in the position of both small and large boulders and woody debris pieces, and the formation of a new small woody debris jam in the mid-portion of the survey reach. In other locations, it was noted that pieces of pre-existing woody debris had remained in place. Channel changes that occurred between the 1995 and 1996 surveys indicated increased streambed mobility within the survey reach. Localized changes in the streambed substrate showed that all grain sizes, including large boulders had been mobile. There was evidence of scour in side channels as well as the main channel. In the upper portion of the survey reach, a marginal gravel bar was scoured out and a new scour pool had formed on the lee side of a large intact sediment wedge. Embedded in-channel woody debris remained in place except in one location where a log at the stream bank and associated sediment accumulations were scoured out, resulting in localized bank erosion.