Sediment Source Analysis
North Fork Coeur d'Alene River Subbasin

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1.0 INTRODUCTION

An estimate of sediment sources was prepared for the North Fork Coeur d'Alene (CDA) subbasin as part of the 2001 TMDL efforts (IDEQ 2001). As a result of that work, several water bodies within the subbasin were listed under section 303(d) of the Clean Water Act for sediment excesses (Table 1, Figure 1). In 2001, sediment sources were estimated based primarily on GIS and map data. As part of TMDL implementation planning, IDEQ requested a more detailed analysis of sediment sources in the subbasin to aid in identifying the best methods to reduce sediment inputs to listed water bodies in the North Fork Coeur d'Alene subbasin. The current sediment source study was based on field inventories, checking of current sediment sources, and an aerial photograph study to look at past and current sediment sources.

Table 1. Streams on the 303d List – Impaired by Sediment

Subbasin	Stream
Middle North Fork CDA River	North Fork Coeur d'Alene River (Tepee Creek to Yellowdog Creek)
	Yellowdog Creek
	Lost Creek
Tepee Creek	Tepee Creek (headwaters to Big Elk Creek)
	Big Elk Creek (headwaters to Tepee Creek)
North Fork above Tepee Creek	Calamity Creek (headwaters to Jordan Creek)
	Cub Creek (headwaters to Lost Fork Creek)
Shoshone Creek	Shoshone Creek (Sentinel Creek to North Fork Coeur d'Alene River)
Shoshone Creek	Falls Creek
Prichard Creek	Prichard Creek (Barton Gulch to North Fork Coeur d'Alene River)
	East Fork Eagle Creek (headwaters to Eagle Creek)
	Cougar Gulch (headwaters to Prichard Creek)
Middle and Lower North Fork CDA River	North Fork Coeur d'Alene River (Yellow dog Creek to South Fork Coeur d'Alene Creek)
Lower North Fork CDA River	Steamboat Creek (Barrymore Creek to North Fork Coeur d'Alene River) Beaver Creek (headwaters to North Fork Coeur d'Alene River)
Little North Fork CDA River	Little North Fork Coeur d'Alene River (headwaters to Laverne Creek)
	Copper Creek (headwaters to Little North Fork Coeur d'Alene River)
	Burnt Cabin Creek (headwaters to Little North Fork Coeur d'Alene River)

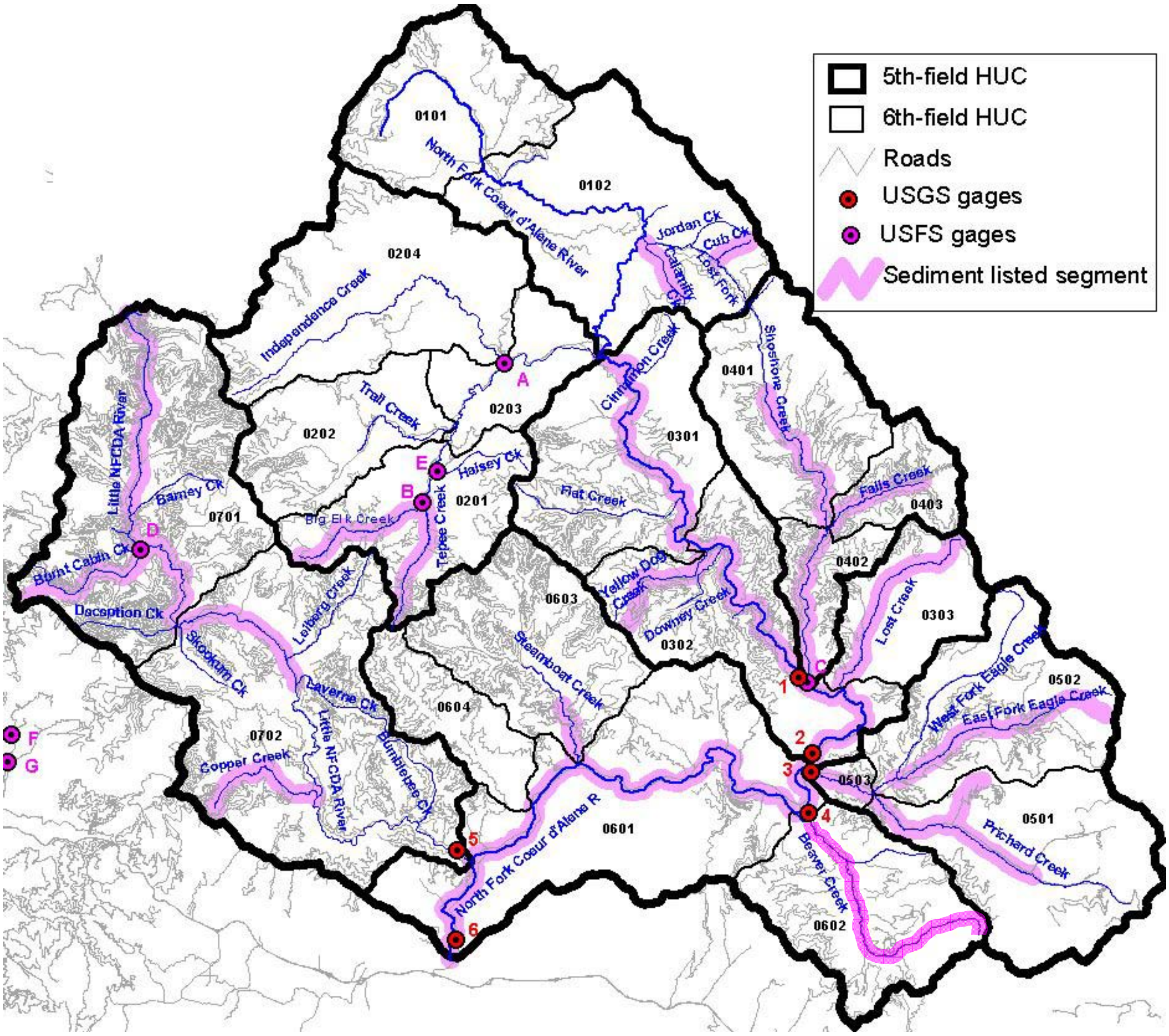

Figure 1. Listed Reaches, Subbasins, and Stream gages within the NFCDA Subbasin.

The 2001 sediment study considered the sources listed below and was based on the watershed conditions (miles of road, acres under different land uses) at that time:

- Agricultural Land
- Forested lands
    - Conifer forest
    - Non-stocked forest (timber harvest units)
    - Double wildfire burn area
    - Highway (paved roads)
- Forest Roads
    - Surface erosion
    - Road failures
    - Road encroachment (erosion of road fill located within 50 feet of streams)

- Streambank Erosion

The present (2006-7) study provides information on the legacy (historic) sediment inputs as well as current rates of the following sediment sources:

- Agricultural Land
- Mining
- Timber Harvest
- Wildfire
- Landslides (Mass Wasting)
- Road Erosion (forest roads and paved roads)
    - Gully/culvert washouts
    - Surface erosion
    - Road encroachment on stream channels
- Streambank erosion
- Channel filling/entrenchment

Since the TMDL and load reduction goals for the subbasins are based on the 2001 sediment analysis, the methods and results from both the 2001 and current study are presented in the following sections for comparison.

2.0 METHODS

2.1 2001 SEDIMENT SOURCE STUDY

The 2001 sediment source study used GIS road and land use data to determine sediment inputs. Sediment input rates were determined based on sediment production coefficients, Revised Universal Soil Loss Equation rates, Cumulative Watershed Effects (CWE) yields, or estimated road fill erosion rates (Table 2). More detail on these methods can be found in the Subbasin Assessment of Total Maximum Daily Loads of the North Fork Coeur d'Alene River (IDEQ 2001). Sediment rates listed in Table 2 were assumed to be delivered sediment rates (e.g. all eroded sediment was delivered to waterbodies). The TMDL document reports that this likely over-estimates sediment inputs by a factor of 1.5-2.3.

Table 2. Summary of sediment methods used in 2001 sediment source study.

Sediment Source	Method	Total Acres or Miles
Agricultural land	RUSLE; 0.03-0.06 t/ac/yr	3,935 acres
Conifer forest (background)	Sediment production coefficient: 0.023 t/ac/yr applied to non-harvested land	543,493 acres
Non-stocked forest (timber harvest units)	Sediment production coefficient: 0.027 t/ac/yr applied to clearcut areas	21,544 acres
Double wildfire burn area	Sediment production coefficient: 0.004 t/ac/yr applied to areas burned twice	49,481acres
Highway	Sediment production coefficient: 0.019 t/ac/yr applied to paved road prisms	2,372 acres
Forest road surface erosion	CWE yield: 16.5 t/ac/yr applied to all road lengths within 200 feet of a stream crossing	904 crossings
Forest road failures	CWE yield: 0.17 t/mi/yr applied to roads on unstable lands	2,032 miles
Road encroachment	50 t/mile/yr of fill erosion from total length of roads within 50 feet of streams (¼ inch from 3 foot high fill every 10 years)	1,319 miles
Streambank erosion	NRCS measurements of streambank erosion along North Fork between Prichard Creek and confluence with South Fork	Field measurements

2.2 SUMMARY OF CURRENT METHODS

The methods to estimate sediment input in this report were based on field measurements and historic aerial photograph analysis to help identify site-specific locations of past and current sediment sources and to provide information on erosion rates and delivery to water bodies. Estimates of sediment sources under 2006 watershed conditions were made, as well as quantitative and/or qualitative estimates of sediment sources under historic (1900-1960s) conditions. The analysis team felt it was important to understand the historic sediment inputs because these legacy sources of sediment, particularly course sediment (gravel/cobble), can continue to have an influence on stream conditions for decades or centuries as they are processed by the stream. The current sediment source methods are summarized in Table 3 for comparison with the 2001 methods. Detailed information on the methods is provided in the following sections.

Table 3. Summary of sediment methods used in present (historic and 2006 conditions) sediment source study.

Sediment Source	Method	Total Acres or Miles
Background (natural) erosion	Sediment production coefficient: 0.023 t/ac/yr applied to entire watershed	559,360 acres
Wildfire burn area	Historic: no quantitative estimate, but assumed large Current: Aerial photograph inventory shows these areas have revegetated; no increased erosion included	none
Agricultural land	RUSLE; 0.03 t/ac/yr; 25% delivery	576 acres
Mining	Historic inputs: USGS report Current inputs: included in streambank erosion estimate (below) based on aerial photographs and site visits	Placer/hydraulic mining, 9 major mine tailings, 5 miles of flotation dredging
Non-stocked forest (timber harvest units)	Historic: no quantitative estimate, but assumed large Current: Increased sediment production coefficient (0.027/ac/yr) applied to all harvest areas	Average harvest over past five years: 1,610 acres/year
Mass wasting (landslides)	Aerial photograph analysis of slide area/delivery	6 slides inventoried (1933-2003)
Road surface erosion (Highway and Forest roads)	Field inventory of road conditions/lengths/delivery on all active roads in Big Elk and Upper Little North Fork. Erosion/delivery estimates from SEDMODL and WEPP; extrapolation to rest of watershed. Historic: estimate based on all roads in database. Current: estimate based on all active (open system) roads in database	Historic: 3,838 crossings Current: 933 crossings
Road/culvert washouts and gullying	Field inventory of washouts and gullying on active roads in Big Elk and Upper Little North Fork; some USFS data on washouts; extrapolation to rest of watershed. Historic: based on all roads in database Current: based on all roads in database except decommissioned roads and culverts upgraded to 100-year flood volumes	Historic: 3,838 crossings Current: 3,106 crossings
Road encroachment	Field inventory to identify actual road segments susceptible to road encroachment (length, height, width); estimated recurrence intervals ranging from 10-30 years	20 miles of road susceptible to encroachment
Streambank erosion	Measurements of streambank erosion along North Fork between Prichard Creek and confluence with South Fork	Extrapolated to all streams in subbasin
Channel entrenchment	Measurements of entrenchment along North Fork between Prichard Creek and confluence with South Fork	Extrapolated to all streams in subbasin

2.3 AERIAL PHOTOGRAPH ANALYSIS

A series of historic aerial photographs were viewed to look for past and present sediment sources, and trends of disturbance through time. Table 4 lists the photographs available along with large floods/storm events. The primary types of evidence looked for in the sediment source analysis were bare ground, sparse vegetation, areas of wide road prisms, landslides, and road washouts at creek crossings. In addition, locations where roads ran closely parallel to streams were observed to look for evidence of fill slope erosion or artificial channel confinement.

The entire North Fork Coeur d’Alene watershed was covered in the 1996 photos. These were taken following the 1996 high flow event, the second largest on record. In addition, 1937, 1968, and 1983/84 photos were analyzed in the two detailed study areas; Big Elk Creek and the Little

North Fork above Burnt Cabin Creek to look at trends of sediment inputs. A magnifying stereoscope was used to view the air photos, which shows topographic relief and allowed additional details to be seen.

Table 4. Aerial photographs available for sediment source analysis

Date	Type	Scale	Source
12/15/33	*High flow (48,200) at NF Coeur d'Alene River gage USGS 12413000*		
1933 & 1935	Oblique low-elevation air photos	<<1:12000	USFS (from CD)
1937	B&W vertical air photos	1:20000	USFS (from CD)
4/15/38	*High flow (40,400) at NF CDA gage USGS 12413000*		
12/23/64	*High flow (34,800) at NF CDA gage USGS 12413000*		
1968	B&W vertical air photos	1:15840	USFS
1/16/74	*Very high flow (61,000) at NF CDA gage USGS 12413000*		
1975	Color air photos	1:24000	USFS
12/27/80	*High flow (34,800) at NF CDA gage USGS 12413000*		
2/21/82	*High flow (38,800) at NF CDA gage USGS 12413000*		
1983/1984	Color air photos	1:12000	USFS
2/9/96	*High flow (56,600) at NF CDA gage USGS 12413000*		
1996	Color air photos	1:15,840	USFS
4/15/03	*High flow (32,700) at NF CDA gage USGS 12413000*		
2004	Color air photos	GIS 1m resolution	USDA NAIP

2.4 Agricultural Lands

An assessment of erosion and delivery from agricultural lands within the North Fork Coeur d'Alene subbasin was prepared in 2005 as part of the agricultural TMDL implementation plan (ISCC 2005). This assessment used the same erosion rates as the 2001 report, but modified actual acres of agricultural lands to reflect 2005 land use and reduced delivery from 100% to 25% based on site assessments.

2.5 Mining

Mining activities in the watershed are concentrated in the Prichard, Eagle, and Beaver Creek subbasins. Historic mining activity began in the North Fork Coeur d'Alene basin in the early 1880s with placer gold operations on Prichard Creek, lower Eagle Creek, and Trail Creek (Box et. al 2004). Information on the mining history and volumes of sediment produced was found in Box et. al (2004) and was based on historic records of mining activities and tailings pile volumes.

2.6 Timber harvest units

Based on photographs of early harvest practices (early 1900s) and aerial photograph evidence of harvest practices and intensities from the mid-1900s, historic timber harvest activities in the North Fork Coeur d'Alene watershed likely resulted in large amounts of erosion and impacts to stream channels. No quantitative estimate of historic harvest inputs was made since no site-specific rate data was available.

Several recent timber harvest units in the Upper Little North Fork subbasin were visited in August 2006 to determine site conditions following harvest and to check for evidence of erosion.

The 2001 sediment source analysis used an erosion rate of 0.027 tons/acre/year for timber harvest units. This rate was obtained from the range of sediment yield coefficients developed from instream sediment measurements on similar geologies. Several Disturbed WEPP runs were made for comparison with this erosion rate.

The web version of the Disturbed WEPP model (http://forest.moscowfsl.wsu.edu/cgi-bin/fswepp/wd/weppdist.pl) was used to calculate erosion from timber harvest units under several scenarios. For all runs, the Wallace ID climate, silt loam soils, and 20% rock content was used. For the harvest (upper) unit, a low severity fire, 35% hillslope gradient, 200-foot long slope, and 50% groundcover was used to represent the harvest unit immediately after harvest. A mature (20-year) forest with a decreasing gradient (35% middle to 20% at the bottom of the hill) and 100% cover was used to represent the stream buffer (lower unit) below the harvest unit to provide information on delivery from harvest units. Delivery from a variety of buffer widths was estimated (Table 5).

Table 5. Disturbed WEPP results, harvest unit simulations

Buffer width (ft)	Erosion rate (t/ac/yr)	Delivered sediment rate (t/ac/yr)
30	3.6	0.60
50	3.6	0.32
75	3.6	0.16
100	3.6	0.08
200	3.6	0.04

Based on the WEPP runs and field observations of harvest units, the erosion rate used in the 2001 sediment analysis (0.027 tons/acre/year[1]) appears reasonable, particularly when applied to the total number of acres harvested, including acres that are far from streams (only 30% of the total watershed area is within 300 feet of a stream and therefore has some potential to deliver sediment to a stream). Field observations made during the 2006 field season in harvest units show that the units revegetate quickly, and the micro-topography and roughness elements (slash, stumps, etc.) form numerous small sediment traps, limiting the actual runoff length to short lengths within each harvest unit. As a result, the actual amount of sediment that leaves a harvest unit would be much less than the WEPP model predicts since the WEPP model assumes that there is an unobstructed flow path of 200 feet through the unit and then through the 30 to 200 foot long buffer.

For the current sediment analysis, the 2001 rate (0.027 tons/acre/year) was applied to the total acres of harvest (all types of harvest with Activity Codes in the 4000 series) reported in the USFS IPNF GIS layer (downloaded from http://www.fs.fed.us/ipnf/eco/yourforest/gis/#veg 6/29/06 version). The majority (60%) of harvest in the past 5 years has been salvage harvest.

[1] Note that the 0.027 tons/acre/year as applied in the 2001 analysis included the background fully-stocked conifer rate of 0.021 tons/acre/year. Therefore, the increased erosion in the 2001 analysis was 0.006 tons/acre/year. The harvest rate estimate in this analysis is applied in addition to the background rate since the WEPP model shows essentially no surface erosion delivered to streams from fully stocked conifer forest areas.

Harvest reported in the past 5 years (2002-2006) was summed and divided by 5 years to provide average acres harvested/year. The 0.027 tons/acre/year was applied to this average rate of harvest to determine tons/year.

2.7 MASS WASTING

Mass wasting sites were inventoried in the entire North Fork Coeur d'Alene watershed on the 1996 aerial photographs as part of the aerial photograph inventory. Mass wasting sites in the two intensive study subbasins were also inventoried on the 1937, 1968, and 1983/84 aerial photographs. The USFS provided the locations of known mass wasting sites in the watershed, and two sites in Steamboat Creek were visited during the August 2006 field inventory.

2.8 ROAD SURFACE EROSION

Field inventories of all active (open) road segments in the Upper Little North Fork and Big Elk study areas were conducted in August 2006 to determine hydrologic connectivity, road surfacing, width, cutslope, and fillslope characteristics. Several closed roads were also visited to determine revegetation and surface erosion characteristics. It was not possible or feasible given the short time frame for this study to measure surface erosion, so the information collected during the field visits was used to estimate road surface erosion using two different models: WEPP:Roads and SEDMODL.

The models were run for actual road conditions and lengths of road hydrologically connected in the two intensive subbasins (Upper Little North Fork and Big Elk). The road characteristics and average length of road that was hydrologically connected in these two subbasins were used to extrapolate road surface erosion to other portions of the watershed based on the number of stream crossings in the road GIS database.

2.8.1 Road GIS Layers

Both the road surface erosion and road washouts/gullies analyses relied upon the road GIS database to extrapolate results from the intensive study basins to the remainder of the watershed. Two different GIS layers containing road information were available from the USFS at the time of this analysis:

1. USFS System road GIS database available on the USFS website (http://www.fs.fed.us/ipnf/eco/yourforest/gis/). This database contains information on system roads (roads that are officially in the USFS road network). Data relevant to the sediment input study includes road location, road name, average road width, and maintenance/use levels.
2. USFS System plus Non-system road GIS database obtained separately from the USFS. This database contains system and non-system roads (very old, usually overgrown roads that no longer receive maintenance). Information on road restoration/decommissioning projects is included in this database, but road width and maintenance/use levels are not.

Unfortunately there is no link between the two databases, and information from both databases was needed for various parts of the historic road input analyses. The methods used to extrapolate to historic road conditions are described in the sections below, where applicable.

2.8.2 WEPP:Roads

The Water Erosion Prediction Project (WEPP) model is a physically-based model that estimates surface erosion, rill development, and transport/deposition of eroded sediment through buffer zones. The USFS has developed the WEPP:Road interface to allow model users a convenient way to run the model (http://forest.moscowfsl.wsu.edu/cgi-bin/fswepp/wr/wepproad.pl). This interface was used to estimate road surface erosion for each of the hydrologically connected road segments inventoried in the two intensive study areas. Each segment was run using the Wallace Idaho climate, a silt loam soil with 20% rock content, low traffic, and either an insloped/vegetated ditch or outsloped road configuration as appropriate based on site conditions. Road segment gradient, segment length, road width, and surfacing were based on inventoried road conditions for each segment. For roads that delivered to streams directly via ditches, the fillslope and buffer lengths were set to 1 foot to reflect direct delivery. For road segments that delivered over the fillslope, a 50 foot fillslope length with a 50% gradient was used.

The WEPP:Road results were extrapolated to the rest of the watershed based on modeling of an “average” road with the following characteristics: 4% gradient, insloped configuration, 200 foot long segment. Scenarios with native and gravel surfacing and high and low traffic levels were run. An Excel file with lookup tables was created and an estimate of surface erosion based on the width, surfacing, and maintenance/traffic levels using values in Tables 6, was developed for each stream crossing location identified in the USFS System Road GIS database.

Table 6. WEPP:Road Values Used for Extrapolation (values in average tons/year)

LOW TRAFFIC	**Road Width (ft)**							
USFS Surfacing	**10**	**12**	**14**	**15**	**16**	**18**	**24**	**26**
AGG	0.0202	0.02425	0.0283	0.0303	0.03235	0.0364	0.0485	0.0525
BST	0.0202	0.02425	0.0283	0.0303	0.03235	0.0364	0.0485	0.0525
IMP	0.0264	0.03165	0.03695	0.0395	0.0422	0.0475	0.0633	0.0685
NAT	0.0264	0.03165	0.03695	0.0395	0.0422	0.0475	0.0633	0.0685
P -	0.0202	0.02425	0.0283	0.0303	0.03235	0.0364	0.0485	0.0525
HIGH TRAFFIC	**Road Width (ft)**							
USFS Surfacing	**10**	**12**	**14**	**15**	**16**	**18**	**24**	**26**
AGG	0.0665	0.07985	0.09315	0.0997	0.10645	0.11975	0.1597	0.1728
BST	0.0665	0.07985	0.09315	0.0997	0.10645	0.11975	0.1597	0.1728
IMP	0.0785	0.094	0.1099	0.1176	0.1257	0.14125	0.18835	0.2038
NAT	0.0785	0.094	0.1099	0.1176	0.1257	0.14125	0.18835	0.2038
P -	0.0665	0.07985	0.09315	0.0997	0.10645	0.11975	0.1597	0.1728

Results were extrapolated to historic conditions by multiplying the estimated historic road surface erosion results in each 6th field HUC by the ratio of the number of stream crossings in the System Road database (which had the road information needed for the analysis) to the number of stream crossings in the All Roads (system and non-system) database.

2.8.3 SEDMODL

SEDMODL is an empirical road surface erosion model that estimates surface erosion and delivery to streams based on road conditions such as road width, gradient, surfacing, traffic, ditch width, cutslope height and cover (http://www.ncasi.org/support/downloads/Detail.aspx?id=5). The SEDMODL computational algorithm was run for each of the road segments inventoried in the intensive study watersheds based on current road conditions and traffic use. The results were extrapolated to other parts of the subbasin based on modeling information in the system road GIS database (precipitation factor, average width, surfacing, and maintenance/traffic levels) using an average hydrologically connected road segment length of 200 feet at each crossing.

2.9 ROAD WASHOUTS AND GULLYING

Road washouts and gullying can occur at locations where roads cross streams. The following sources of data were used to analyze washouts and gullying:

- The USFS provided GIS data on road repairs and restoration efforts undertaken since approximately 1988. This database was queried to show instances of road repair work completed to fix roads that had washed out or were damaged. The data are not inclusive of all road repair work completed in the watershed, but provides an indication of problem areas and types of road repairs that are common.
- The USFS provided a 1988 road structure inventory report, which summarized a culvert inventory completed on system and non-system roads in portions of the Big Elk Creek and North Fork Coeur d'Alene River drainages (USFS 1988)
- The USFS conducted road/culvert inventories on system and non-system roads in the Iron/Honey Creek areas (Upper Little North Fork drainage) in 1996, and in tributaries of Big Elk Creek in 1999. Digital information was not available on these inventories, but paper files were perused. A summary document was available for the Iron/Honey inventory.
- Current gully/washout locations on open roads were noted, along with dimensions of washouts, in the Upper Little North Fork and Big Elk intensive study basins.

Information from the USFS road inventories was compiled to calculate the percent of stream crossings that had failed (19-22% in Iron/Honey and Big Elk, respectively) and volume of sediment delivered to streams by these failures (average 135 and 675 tons/failure in the two inventories).

The volume of "road repairs" completed from the USFS Road Restoration database was also computed. The average volume was 638 tons/repair. It was unclear exactly what the "road repairs" volumes represented; it is likely that they included many other types of repairs such as road encroachment washouts (see next section), multiple plugged culverts, and decommissioning. This volume was not averaged into the culvert washout analysis.

Based on average failure volumes in the Iron/Honey and Big Elk drainages, an overall average of 469 tons of sediment per culvert washout was computed. This was distributed over the total number of culverts inventoried (only 22% had washouts) to produce an average of 103 tons/culvert. Culvert washouts are episodic. However, in order to compare this source with other sources in the sediment budget, the rate was annualized to obtain an average rate/culvert/year. A recurrence interval of 50 years was chosen to annualize the sediment input based on the fact that most of the road system was in place since the 1950-60s (30 - 40 years from construction to the mid 1990s road inventories) and had seen several large storm events (1964, 1974, 1996) that likely resulted in the failure of the most vulnerable culverts. Although it is possible that a few of the culverts had failed multiple times and were under-represented in the inventory, it is also possible that some of the remaining culverts that were in good shape will not fail.

Based on the 50-year recurrence interval, an average of 2.1 tons/culvert/year was used to estimate sediment input from culvert washouts and gullies. It was assumed that there was 100% delivery to streams since culvert washouts are caused by flowing water, which would deliver the sediment to a stream. The 2.1 tons/culvert/year is equal to 1.3 cubic yards per year. Since the road system has been in place approximately 50 years, this rate is the equivalent of 65 cubic yards of sediment erosion at every stream crossing in the watershed over the cumulative 50 year period. This is a volume equal to 25 feet long by 10 feet deep by 7 feet wide. While some stream fills are larger than this (e.g. the large railroad fills that are still in place), this is not an unreasonable size for the "average" road fill. Applying the 2.1 tons/culvert/year to all culverts is the equivalent of assuming the vast majority of culverts have washed out. The fact that there are still many original culverts functioning in the subbasin suggests that this rate may result in somewhat of an over-estimate of culvert washout/gully erosion.

Culvert/gully input was computed by multiplying the average washout rate (2.1 tons/culvert/year) by the total number of culverts for historic and current conditions. Historic culverts included all culverts on system and non-system roads in the database. Current culverts included all culverts on system and non-system roads that have not been decommissioned (708 culverts that were removed during decommissioning) or upgraded to 100-year culvert sizing (24 culverts).

2.10 ROAD ENCROACHMENT ON STREAM CHANNELS

Erosion of roads built within stream channels or flood plains was identified as a large sediment source in the 2001 TMDL study. In order to verify the length and location of roads that are vulnerable to erosion due to encroachment on stream channels, a combination topographic map/aerial photograph study and field inventory was performed.

Road locations adjacent to stream channels, or where stream meanders had the potential to impinge upon road fill, were marked on the 1:24,000 scale topographic maps for the entire subbasin. These locations were inspected on aerial photographs and/or visited in the field to determine if road/stream encroachment erosion had occurred. The aerial photograph inventory was conducted for the entire watershed on the 1996 photos, and on all available photos for sites along the lower mainstem North Fork, Little North Fork, and Big Elk Creek areas.

The field inventory included visiting roads adjacent to streams to determine if road encroachment was occurring as well as to measure typical widths and heights of road fill in locations where the road has likely been partially or totally washed out in the past. USFS information on past road washout locations was also collected (USFS 1964, Ed Lider, USFS, personal communication).

2.10.1 Mainstem North Fork Field Inventory

The stream channel analyst inventoried roads along the mainstem North Fork Coeur d'Alene River as part of her field work. The field inventory covered the North Fork in the Steamboat Creek, Grizzly Creek, Prichard, and Pond Peak quadrangles. This covered nearly the entire length of the Middle North Fork (USFS Road 208), ending at Cinnamon Creek a short distance downstream of Tepee Creek. The field inventory in the Lower North Fork started about 1.5 river miles upstream of the Little North Fork confluence, omitting the lower 6 miles of Old River Road (USFS Road 1C) and a similar length of USFS Highway 9. No field inventory was completed upstream of Tepee Creek.

Road sections adjacent to the river were assigned one of three categories and mapped by eye on topographic maps:

- HIGH washout/repair potential: riprapped bank with lots of missing toe rock and usually a deep scour pool at toe of slope. This typically was associated with sharp bends.
- MODERATE: riprapped bank with little missing toe rock and shallow bed adjacent to toe. This typically was associated with flow parallel to the road, or the outer sections of sharp bends. In many cases this category had a well vegetated bank/road shoulder.
- LOW: road is away from river despite appearing close on map, or the road is close but built on a bedrock slope with no placed riprap or fill in floodplain. (Note: even these areas were riprapped on Highway 9, but this appeared to be precautionary rather than an indication of past failure).

Road top width in feet was measured from shoulder to shoulder with a tape. Width of the slope was not measured because it was so variable depending on slope. Original width could be calculated assuming typical fill slopes for new road construction. For Old River Road, width was measured for each HIGH road segment since it appeared likely the entire width could be easily eroded during a major flood. For USFS Road 209, typical width and pullout width was measured at one location and assumed to be uniform throughout (unlikely that the current road washes out full width any more; pullouts have been built in most locations where the river impinges at a sharp angle. This juts out into the river an extra distance, so the river would have to erode the full width of the pullout before damaging the road itself. The pullouts also deflect flow away from the bank upstream and downstream.) For USFS Highway 9, width was not measured as there was only one HIGH segment and it is probably irrelevant since it is very unlikely that bank erosion would take out the full road width.

Vertical height in feet from toe of riprap to road surface was estimated by eye from the top edge of the bank. This was done for all HIGH and most MODERATE segments on all the roads except USFS Highway 9 for which only about half the MODERATE segments were estimated.

Following the completion of field work, the 1975 aerial photographs were viewed in stereo to identify road segments with damage from the 1974 flood that had not been repaired, or (more commonly) newly riprapped banks with no streamside vegetation. Air photo coverage was fairly continuous from Township 51N downstream. South banks were indeterminate due to shade. Most of the HIGH and about half of the MODERATE areas appeared to have been damaged in the flood. There was no way to determine the proportion of the roadway that had been eroded. The 1975 air photos were used to designate HIGH and MODERATE segments for the Kellogg West and Cataldo quadrangles. The designations for these two quadrangles were not field checked.

2.10.2 Upper Little North Fork, Steamboat, Shoshone, and Other Creeks

The sediment source analyst inventoried road encroachment in the field along roads identified as potentially encroaching the Little North Fork watershed, the East and West forks of Steamboat Creek, the East and West forks of Eagle Creek, Shoshone and Rampike Creek, Yellowdog Creek, and Big Elk Creek (see list of roads in Section 3.2.11). Height of road fill (from toe to top of rip rap), estimated width of visible road width loss, and length of road affected was visually estimated or paced out at each of these locations. A high, moderate or low potential for future stream erosion was assigned to each site based on the ratings described in Section 2.10.1.

2.10.3 Estimate of Road Encroachment Amounts

Erosion associated with road encroachment is an episodic process that occurs during peak flow events. Different levels of peak flows likely are responsible for different levels of road encroachment washouts, with smaller events (e.g., a 5-year flood) resulting in less erosion than larger events (e.g., a 100-year flood).

The volume of sediment that could be eroded at each site was estimated by multiplying the height, width, and length of potential fill erosion at each site and converted to tons using a density of 1.65 tons/cubic yard. In order to estimate the average annual amount of past and future sediment input, the total volume at each site was divided by an estimated recurrence interval (in years). Two likely scenarios were developed for each time frame based on the known flood record since construction of the majority of roads (3 major floods over 42 years), evidence from sequential historic aerial photographs, and information from USFS records and personnel (Ed Lider, USFS, personal communication, USFS 1964). In all cases it was assumed that sites with low/no potential were stable and were not subject to streambank erosion.

Historic conditions:

- Estimate 1: All high potential sites along the mainstem North Fork Coeur d'Alene River and all sites (high and moderate potential) along the Little North Fork and Steamboat Creek were eroded with a recurrence interval of 15 years; all moderate potential sites were eroded with a recurrence interval of 30 years.
- Estimate 2: All sites along USFS Highway 1-C and Steamboat Creek washout out every 10 years; all sites in remainder of watershed washout once every 15 years.

Current/Future conditions (assumes road improvements, bank protection in susceptible areas, and removal of some roads has reduced frequency of erosion):

- Estimate 1: All high potential sites along the mainstem, Little North Fork, and all USFS Road 1-C (Old River Road) sites will wash out once every 30 years. All other sites are stable. Sites along Road 1-C wash out the top 2 feet of fill only (reduced height of erosion).

- Estimate 2: All sites along USFS Road 1-C washout out every 10 years (top 2 feet of fill only; rest of rip rap holds). All sites along USFS Highway 9 are stable. In the rest of the watershed, the high potential sites wash out once every 15 years and 75% of the moderate potential sites wash out once every 30 years.

2.11 STREAMBANK EROSION AND CHANNEL ENTRENCHMENT

The stream channel report contains more detailed information on stream channels and bank erosion. The stream-related sediment sources are summarized in this report. Channel erosion rates for the two detailed-study watersheds were estimated for both historic and current conditions. Historic erosion was predominantly in the form of widespread channel entrenchment (incision and enlargement), whereas the two watersheds currently have localized areas of accelerated streambank erosion and negligible channel incision.

The magnitude of sediment production from channel entrenchment was calculated by comparing bankfull channel cross section areas (from field measurements and USFS surveys) with cross section area between terraces in areas where detailed measurements were made in the past. Bank erosion rates were based on stream surveys on portions of channels in Big Elk and the upper Little North Fork drainages. This was extrapolated to the rest of the watershed based on channel evolution stage and channel type.

Channel erosion rates from Big Elk and the upper Little North Fork were extrapolated to the remainder of the North Fork Coeur d'Alene River watershed for the purpose of evaluating the relative magnitude of sediment contributions from each fifth-field HUC and evaluating the relative differences in magnitude between channel and road sources. This extrapolation is based on limited to no field reconnaissance surveys, depending on the location. These numbers are far less accurate than estimates made for Big Elk Creek and the upper Little North Fork.

3.0 RESULTS

3.1 Subbasins Chosen for Intensive Study

Due to the large size of the watershed, it was not possible to conduct an intensive field analysis of the entire North Fork Coeur d'Alene watershed. Instead, two subbasins were chosen for more intensive study, and the results of the intensive study were extrapolated to provide an estimate of sediment inputs in other portions of the basin, as appropriate. The two basins chosen were the Upper Little North Fork (upstream of Burnt Cabin Creek) and Big Elk Creek (upstream of the confluence with Teepee Creek). These basins were chosen because: 1) there was a stream gage available with a long enough record to provide data for hydrologic modeling; 2) they had a varied intensity of past land use that was representative of most of the rest of the watershed; and 3) they were placed on the 303(d) list for exceedences in sediment load in the 2001 analysis.

Sediment-related work in these two subbasins included aerial photo analysis of the entire available aerial photograph record and field inventory of the entire open road system to check for hydrologic connectivity, road gullying/washouts, sediment sources, and road/streambank encroachment. In addition, several recent timber harvest units were visited. The stream channel analyst conducted stream channel inventories and surveys in these watersheds as described in the stream channel report. The sediment inputs from streambank erosion and entrenchment are included in the sediment summary below.

3.1.1 Upper Little North Fork

The Upper Little North Fork was one of the areas chosen for more intensive study. The Upper Little North Fork includes the subbasin area upstream of Burnt Cabin Creek. The subbasin was heavily harvested in the 1960s, with road building throughout the basin. There has been little recent harvest; the primary current land use is recreation, with ATV and motorcycle use in the flats and stream areas near the landing strip and on trails in the northern portions of the basin. Many of the roads in the watershed have been closed to use or decommissioned. There is no mining or agricultural use.

3.1.1.1 Aerial Photograph Inventory

A series of historic aerial photographs was reviewed, and potential sediment sources on the 1937, 1968, 1983/84, and 1996 photos were mapped on the 1:24,000 "B" transportation maps provided by the USFS.

<u>1937 Photos:</u> There were few sediment sources on the 1937 photos; the area was vegetated with a few roads, and mostly stable. One large slide on Sob Creek was noted that persisted through all the photos.

<u>1968 Photos:</u> Wide-spread roads and timber harvest were noted on the 1968 photos in most of the upper Little North Fork drainage basin. There was evidence of skid trails and/or fire roads along small channels. Stream adjacent roads were constructed in parts of Iron, East Fork Hudlow, and Tom Lavin Creeks, and along sections of East Fork Hudlow Creek. This was likely an era of large sediment inputs.

1983/84 Photos: The previously harvested areas of the watershed were beginning to stabilize; a few new areas of harvest and road construction were evident.

1996 Photos: The area was revegetating well and there were only a few continuing areas of sediment input evident, primarily along stream-adjacent roads.

3.1.1.2 Timber Harvest

Several recent timber harvest units were visited in the upper Little North Fork watershed. No signs of increased surface erosion or mass wasting were apparent in these areas, and the area was revegetating quickly (see Photo 1). Current timber harvest practices are protective of stream channels and are intended to limit erosion and delivery of sediment to streams. Field observations indicate that they are effective.

There has been relatively little harvest in recent years; approximately 230 acres between 2002-2006. The majority has been sanitation and improvement logging (64%). The remainder has been shelterwood harvest.

Photo 1. Recent Timber Harvest Unit

3.1.1.3 Mass Wasting

One slide was noted on all the aerial photographs on the north side of Sob Creek near the mouth. It did not appear that the slide delivered sediment directly to the stream, and since it was evident on the 1937 photos, prior to harvest, it is apparently not related to land management activities.

3.1.1.4 Road Surface Erosion

The open road system in the Upper Little North Fork was inventoried for hydrologic connectivity and road prism characteristics to model road surface erosion (USFS Roads 209, 385, 392, 409, 425, 437, 794, 1507, 1525, 1532, 1580, 1587, and 1590). A total of 104 crossings were inventoried; 20 drained directly to streams, 25 drained directly to streams via a gully, and an additional 40 were outsloped but delivered some amount of sediment to a stream over the fillslope.

Estimates of delivered road surface erosion were made using WEPP:Road and SEDMODL, with predicted average annual sediment inputs of 8 tons/year and 21 tons/year from the two models, respectively. Road surface erosion is not a large source of sediment in the Upper Little North Fork drainage.

3.1.1.5 Road Washouts and Gullying

Road washouts and gullying were inventoried by the USFS for parts of the Upper Little North Fork drainage in 1988 and 1996 (USFS 1988 and unpublished data).

Culverts on non-system roads in portions of the Leiberg, Honey, and upper Little North Fork drainages were inventoried in 1988 (USFS 1988). A total of 34 structures were inventoried. Four had failed and another 2 were plugged but not failed. Total sediment produce from the failed culverts was reported as 5,426 cubic yards in Leiberg (3 failed culverts).

An inventory of culverts on 129 of the total 289 miles of roads in the Iron/Honey drainages was completed in 1996 (USFS unpublished data). Of the 322 crossings inventoried, 72 had problems (22%). No volumes of sediment were summarized, but a perusal of some of the individual culvert data sheets showed a total of 794 cubic yards of erosion from 9 culverts; this included gullies and culvert washouts.

During the 2006 inventory of open roads competed for this report, culvert washout/gullies were noted. Of the 104 stream crossing culverts inventoried, 4 had erosion (gullies/washouts) and 6 were partially plugged or had other maintenance concerns that could lead to erosion during a large storm event.

3.1.1.6 Road Encroachment on Streambanks

Evaluations of aerial photographs and topographic maps identified several roads in the upper Little North Fork study area with potential to erode as a result of encroachment of fill parallel to stream channels. All identified open roads in the study area were visited in the field. The following observations were made:

- Several locations of USFS Road 209 along the Little North Fork were identified on topographic maps with potential encroachment erosion. Re-location of the road between Beaver and Nicholas creeks moved most of that portion of the road out of the floodplain. One location just downstream from Nicholas Creek has continuing road encroachment erosion (Table 7). USFS Road 209 is blocked just upstream from Tom Lavin Creek. The road continues up along the Little North Fork and Honey Creek. Five locations along this stretch were marked as potential erosion sites on the 1984 aerial photographs but were not visited in the field.
- USFS Road 1587 along Nicholas Creek had no observed stream encroachment erosion.
- USFS Road 392 along Hudlow Creek had no observed stream encroachment erosion.
- USFS 3013 along East Fork Hudlow is blocked. The stream is too small to have enough power to erode the road fill under most high flow conditions.
- USFS 794 along Iron Creek had no observed stream encroachment erosion.
- USFS 385 along Tom Lavin Creek had no observed stream encroachment erosion.

Most of the smaller streams in the study area did not have enough power to erode the rip rap that has been placed on the road fill. It is possible these locations have eroded in the past, but they currently appear to be stable. It is likely that there is some potential for erosion of road fill along the blocked sections of USFS Road 209 (upstream of Tom Lavin Creek), but this road was not visited in the field.

Table 7. Current Road Encroachment Locations Inventoried in Upper Little North Fork Study Area.

Stream	Road	Erosion Potential	Height (ft)	Width (ft)	Length (ft)	Estimated Erosion (tons/yr)
Little North Fork	209	M	10	5	60	183

3.1.1.7 Streambank Erosion and Stream Entrenchment

Streambank erosion and stream entrenchment in the Upper Little North Fork is reported in the Stream Channel Report.

3.1.1.8 Motorized Use of Trails

During field inventories of roads, several locations were noted with motorized (ATV and motorcycle) use of trails (both marked as open and closed to off road vehicle use) in the Upper Little North Fork subbasin. In many locations, this use posed no erosion concerns, but in other locations heavy use on steep slopes was resulting in development of ruts, erosion, and in two cases, delivery to streams. Casual ATV/motorcycle trails occur along and through Iron Creek in the Horse Heaven Landing Strip area and upstream of the landing strip. This area is popular with campers and motorized users; several locations were noticed where ATVs and motorcycles were driven through the stream, increasing the fine sediment load.

Erosion on a trail at Davis Saddle had caused trail erosion, a gully, and delivery of eroded sediment to a stream. Erosion from off-road vehicle use in the subbasin likely causes localized effects, but is probably not a substantial source compared to other inputs.

Photo 2. Trail erosion cause by off-road vehicle use

3.1.2 Big Elk Creek

Big Elk Creek was the other area chosen for intensive study. Big Elk Creek drains into Tepee Creek. The eastern quarter of the Big Elk Creek drainage was not harvested (it had been burned in the 1910 fire). The western portions were heavily roaded and logged in the 1950s-1960s. There are few recent harvest units, and the primary current land use is recreation (hunting/camping). Many of the roads have been closed to use or decommissioned. There is no mining or agriculture use of the watershed.

3.1.2.1 Aerial Photograph Inventory

A series of historic aerial photographs was reviewed, and potential sediment sources were noted on the 1937, 1968, 1983/84, and 1996 photos. A few areas of stream-adjacent roads were noted, but most of the roads were constructed as midslope or ridge top roads. No major slides were noted in any of the photos. A few eroding road cutbanks were noted along the Leiberg-Magee Road in areas where steep valley walls confined the mainstem of Big Elk Creek.

There were likely large sources of sediment from new road construction in the 1950s and 1960s, but these areas are revegetating and there appear to be few sediment sources at present.

3.1.2.2 Timber Harvest

No recent timber harvest units were observed in Big Elk Creek. The western portion of the basin had been heavily harvested in the 1950s and 1960s and there were likely large sources of sediment from these activities in the past, but little sediment input currently.

3.1.2.3 Mass Wasting

No mass wasting features were noticed in Big Elk Creek.

3.1.2.4 Road Surface Erosion

The open road system in Big Elk Creek was inventoried for hydrologic connectivity and road prism characteristics to model road surface erosion (USFS Roads 422, 912, and 914). Twenty stream crossings were inventoried; 7 drained directly to streams and an additional 7 were outsloped but delivered some amount of sediment to a stream over the fillslope.

Estimates of delivered road surface erosion were made using WEPP:Road and SEDMODL, with predicted average annual sediment inputs of 0.4 tons/year and 1.7 tons/year from the two models, respectively. Road surface erosion is not a large source of sediment in the Big Elk Creek drainage.

3.1.2.5 Road Washouts and Gullying

Culverts on non-system roads in the Big Elk, First, Boundary, and US Creek drainages were inventoried in 1988 (USFS 1988). A total of 47 structures were inventoried. Fourteen had failed and another 22 were plugged or plugging but not failed. Total sediment produced from the failed culverts was reported as 629 cubic yards (14 failed culverts).

During the 2006 inventory of open roads competed for this report, culvert washout/gullies were noted. Of the 25 stream crossing culverts inventoried, 1 had erosion (gullies/washout) and 2 were partially plugged or had other maintenance concerns that could lead to erosion during a large storm event.

3.1.2.6 Road Encroachment on Streambanks

The majority of roads in the Big Elk Creek watershed are located in areas that are not susceptible to streambank erosion. Two small potential locations of road encroachment were identified on the aerial photographs and topographic maps in the lower Big Elk Creek watershed (on the Leiberg-Magee Road just upstream of the mouth and just upstream of the bridge). These locations were visited in the field, and no evidence of streambank erosion was noted.

3.1.2.7 Streambank Erosion and Stream Entrenchment

Streambank erosion and stream entrenchment in the Upper Little North Fork is reported in the Stream Channel Report.

3.2 NORTH FORK COEUR D'ALENE WATERSHED

3.2.1 Observations from Aerial Photographs

In general, there were few current sources of sediment observed in the 1996 aerial photographs (note that river response and channel migration are discussed in a separate section). Much of the watershed was well vegetated, with few areas of bare soil or landslides. It was obvious that there was extensive road building and timber harvest in the past that likely were a large source of sediment, but many of these areas have revegetated and stabilized. The current most disturbed areas are the spoil piles and mining areas in Beaver, Prichard, and Eagle creeks. Other potential sediment sources noted on the photos included areas that had previously burned and roads.

Previously burned areas – Much of the northern portion of the watershed that was burned in the fires in the early 1900s has revegetated, even in the 1937 photos. However, there are also many sparsely vegetated areas, primarily on southern-facing slopes in areas underlain by what is mapped as the Wallace Formation (Munts 2000). These areas are prevalent in the Independence Creek and upper North Fork Coeur d'Alene River areas (Callis, Hamilton, and Owl creeks), as well as along the high ridges on the eastern side of the watershed, areas of Lost Creek, and in the upper Beaver and Prichard Creek drainages.

Roads – There is evidence of four types of road-related erosion that were observed on the aerial photographs: road washouts at stream crossings, cutbank or fillslope erosion on steep slopes, fillslope erosion on stream-parallel roads, and surface erosion from hydrologically connected road segments (roads that drain to stream channels).

There were a few road washouts observed on the aerial photographs, but no very large washouts. It is likely that there were small washouts that were not visible on the air photos.

Landslides in the watershed are rare; a few cutbank/fillslope slides were noted. Cutslope failures can be sources of sediment to streams if they occur near stream crossings or on roads that run parallel to streams.

Fillslope erosion on roads that run parallel to streams was noted in several locations. Stream-parallel roads were built in the early part of the 1900s since stream valleys provide the easiest access routes. As a result, most of the streams in the lower watershed have stream-parallel roads.

Many of the intensively harvested areas in the past had a very dense road network. When this road network was first constructed, it undoubtedly was a large source of sediment to streams until the roads stabilized. It is likely that areas with very high road densities had large sediment inputs in the 1950s and 1960s, including the Little North Fork, Steamboat Creek, Shoshone/Falls Creek, Flat Creek, Yellowdog Creek, Downey Creek, Eagle Creek, and Beaver Creek. As mentioned previously, many of these roads have revegetated and stabilized and are not a very large source of sediment at present.

3.2.2 Background (natural) Erosion

Sediment input to streams is a natural occurrence, and provides streams with coarse and fine substrate that create diverse aquatic habitat. Natural sediment input is often used to judge the relative amount of management-related sediment loading that a watershed can handle.

In the North Fork Coeur d'Alene watershed, natural sources of sediment include mass wasting and streambank erosion fed by soil creep, natural channel migration, and erosion following natural fires. Since all areas of the Coeur d'Alene watershed have been disturbed in some manner, it is not possible to measure or directly determine an appropriate background sediment input. The North Fork TMDL estimated background sediment based on an average sediment yield of 14.6 tons/square mile/year (0.023 t/ac/yr) for forested Belt series geology (IDEQ 2001). Background erosion was estimated using the same methods as the 2001 assessment.

There were several areas noted on the aerial photographs, primarily in some areas burned in the 1910 fires and in the upper elevations on the west side of the watershed, that were sparsely vegetated and appeared to have many areas of talus (loose, cobbly to bouldery rocks covering the hillside). It is not known if this is a natural condition or if the areas did not revegetate following the 1910 fire, but these are likely areas with the potential for large natural inputs of cobbly material to streams. These types of talus slopes were observed on aerial photographs and along the road leading to the Grove of the Patriarchs. These features could be one of the causes of high coarse sediment input to the streams in the unmanaged West Fork Eagle Creek watershed upstream of the Grove, and likely in other unmanaged portions of the watershed.

Photo 3. Talus slopes in the West Fork Eagle drainage and similar angular sediment choking the stream

3.2.3 Fire

Two subbasins were nearly completely burned by the 1910 fires: Tepee Creek and the Upper North Fork above Tepee Creek. Sediment loads to the creeks were probably elevated for a least a few years following the 1910 fires as a result of the removal of ground cover. Rill and gully erosion likely occurred in some locations of intense fire from rainfall on bare slopes. Fire can be a naturally occurring phenomenon that is considered part of background sediment inputs.

No quantitative assessment of erosion from the 1910 fire was made as part of this analysis. WEPP modeling of high severity fire indicates that high surface erosion rates (up to 12 tons/acre/year) could have occurred immediately following the fire in areas of intense burns. Fires normally do not burn entire watershed at an intense level, but contain a mosaic of intensely burned, less intensely burn, and lightly burned areas. It is likely that most areas revegetated fairly quickly (hence the grazing on new grasslands reported following the fire) and erosion rates dropped after a few years.

The majority of the burned areas are now stocked with forests and/or meadows so current erosion rates are low. A few locations on exposed southern slopes were noted with relatively low vegetation levels. These were correlated with outcrops of Belt Group rocks. Similar areas were seen in other parts of the North Fork CDA watershed. Field visits to some of these areas showed that they contain unconsolidated gravel and cobble sized rock that are not well vegetated, but appear as talus or scree slopes. Most of these are not close to streams, but in locations where they are undercut by streams they provide a continuing source of course sediment.

3.2.4 Agricultural Lands

The few acres currently devoted to agricultural uses in the North Fork Coeur d'Alene subbasin are located in the lower watershed and are primarily in pasture and hay production. In the past, farming in the lower watershed was more extensive, and grazing occurred in the upper watershed.

Heavy grazing by sheep occurred within at least parts of the burned areas in both the Tepee and upper North Fork HUCs from the 1910s through the 1930s. There were lower levels of cattle, sheep and horse grazing in Tepee and Trail Creeks in the 40s through 50s, and on Independence Creek in the 1940s through 1960s. The Forest Service has had no grazing allotments in any of these basins since then (Sherri Lionberger, USFS, phone call 5/18/07). Sheep herds may have worsened erosion in the burned areas or caused it to persist for longer than would have occurred without grazing pressure.

An assessment of erosion and delivery from agricultural lands within the North Fork Coeur d'Alene subbasin was prepared in 2005 as part of the agricultural TMDL implementation plan (ISCC 2005). This analysis determined that an estimated 17 tons/year of sediment was produced from 576 acres of agricultural lands in the lower North Fork subbasin. An estimated 4 tons/year of sediment was delivered to streams from agricultural uses.

3.2.5 Mining

Mining activities in the watershed are concentrated in the Prichard, Eagle, and Beaver Creek subbasins. Historic mining activity began in the North Fork Coeur d'Alene basin in the early 1880s with placer gold operations on Prichard Creek, lower Eagle Creek, and Trail Creek (Box et. al 2004). Hydraulic mining of gravel deposits began around 1900 in the hills north of Prichard Creek. Between 1917 and 1926, a floating dredge worked 5 miles of Prichard Creek and left large cobble dredge spoil piles in the valley that are still visible today. Each of these activities likely introduced large quantities of sediment into the streams.

Beginning in the early 1900s and continuing through the 1920s, ore-concentration mills operated as gravity (jig) mills producing piles of mine tailings and trains of tailings down streams in Prichard, Eagle, and Beaver creeks. Ore concentration methods changed in the 1920s to flotation methods, which produced large quantities of tailings contained to some extent in tailings ponds at most locations. Box et. al (2004) reported the amount and locations of mining tailings. These data were used to estimate sediment inputs from historic mining activities, with delivery to streams based on descriptions of extent of tailing pile erosion from Box et al. (Table 8).

Table 8. Estimated sediment inputs from historic mining activities

Timing	Tons	Percent Delivery	Delivered tons	Comments
170103010501 Prichard Creek above Eagle Creek				
1880s	??	??	??	Placer mining
1900s	??	??	??	Hydraulic mining
1917-1926	2,217,600	30	665,280	Floating dredge (est. 5 miles long, 20 feet wide, 3 feet deep of disturbance)
1900-1920	50,000	50	25,000	Jig tailings Monarch
1910s	7,000	50	3,500	Jig tailings Paragon
1920s	35,000	30	10,500	Flotation tailings Silver strike
1920s	400	30	120	Flotation tailings Giant Ledge
170103010502 Eagle Creek				
1880s	??	??	??	Placer mining
1900-1920	25,000	50	12,500	Jig tailings Bear Top
1925-1960	570,000	30	171,000	Flotation tailings Jack Waite
170103010602 Beaver Creek				
1880s	??	??	??	Placer mining
1910s	12,000	50	6,000	Jig tailings Idora
1910s	11,000	100	11,000	Jig tailings Carlisle
1945-1952	440,000	10	44,000	Flotation tailings Carlisle

While the majority of sediment from historic mining operations is no longer directly delivered to streams, the large quantities of sediment delivered to the channels are still being processed and eroded by Prichard, Eagle, and Beaver Creeks and their tributaries. An estimate of this on-going processing is included in the current sediment input calculations as part of bank erosion and channel entrenchment. In addition, mining operations continue at a much smaller scale in these subbasins. A detailed assessment of the extent of current mining activities was not included in this report since it will be addressed in a separate metals TMDL. However, casual field observations of some recent mining activity suggest that tailings and/or mining-related sediments are still being delivered to streams in some locations.

3.2.6 Timber Harvest

Current timber harvest practices include stream buffers and yarding methods that result in minimal sediment inputs to streams. However, it is evident from the air photos that past harvest resulted in more sediment inputs to streams.

Timber harvest in the North Fork Coeur d'Alene subbasin began in the early part of the 1900s in the lower, easily accessible portions of the watershed. Timber was moved to mill by a system of flumes and splash dams that likely caused localized large inputs of sediment and erosion of streambanks. In some areas, timber was salvaged after the 1910 fires and transported down some creeks in log drives. This occurred in 1910-1912 in the lower 4 miles of Independence Creek, Tepee Creek "down from Magee", the North Fork CDA River from above Cathedral Rocks (Russell 1984).

Photo 4. Early 1900s timber harvest showing lack of stream buffers and effects of log drives (photo from University of Idaho).

Intensive harvest in the middle parts of the subbasin occurred in the 1950s and 1960s. Timber was moved to mills on trucks utilizing a dense network of roads to accommodate jammer harvest methods. This was also a period of high harvest-related sediment inputs since there were few or no stream buffers, skid trails and/or fire roads were constructed up small stream channels, and many miles of new roads were constructed using methods that do not meet today's standards (Photo 5). Most of these areas have revegetated and are no longer sediment sources (Photo 6).

Current timber harvest practices greatly reduce the potential for sediment inputs to streams. Best Management Practices (BMPs) include measures such as stream buffers, yarding away from streams, keeping skid trails away from streams, installing water bars on roads, and utilizing a much lower density of roads. Several recent harvest units on USFS land in the Upper Little North Fork Coeur d'Alene were visited during the 2006 field inventory. No evidence of delivery of sediment from the harvest units was seen.

An estimate of erosion from recent timber harvest units was developed based on the average acres of harvest (all types) over the past 5 years (2002-2006). A total of 8,051 acres of harvest has occurred over the past 5 years; an average of 1,610 acres/year. A sediment production coefficient of 0.027 tons/acre was applied to this average harvest rate to produce an estimate of 43.5 tons/year delivered to the watershed from recent timber harvest units (Table 9, Appendix 1).

Photo 5. 1968 Aerial Photograph of Barney Creek showing timber harvest and road building practices.

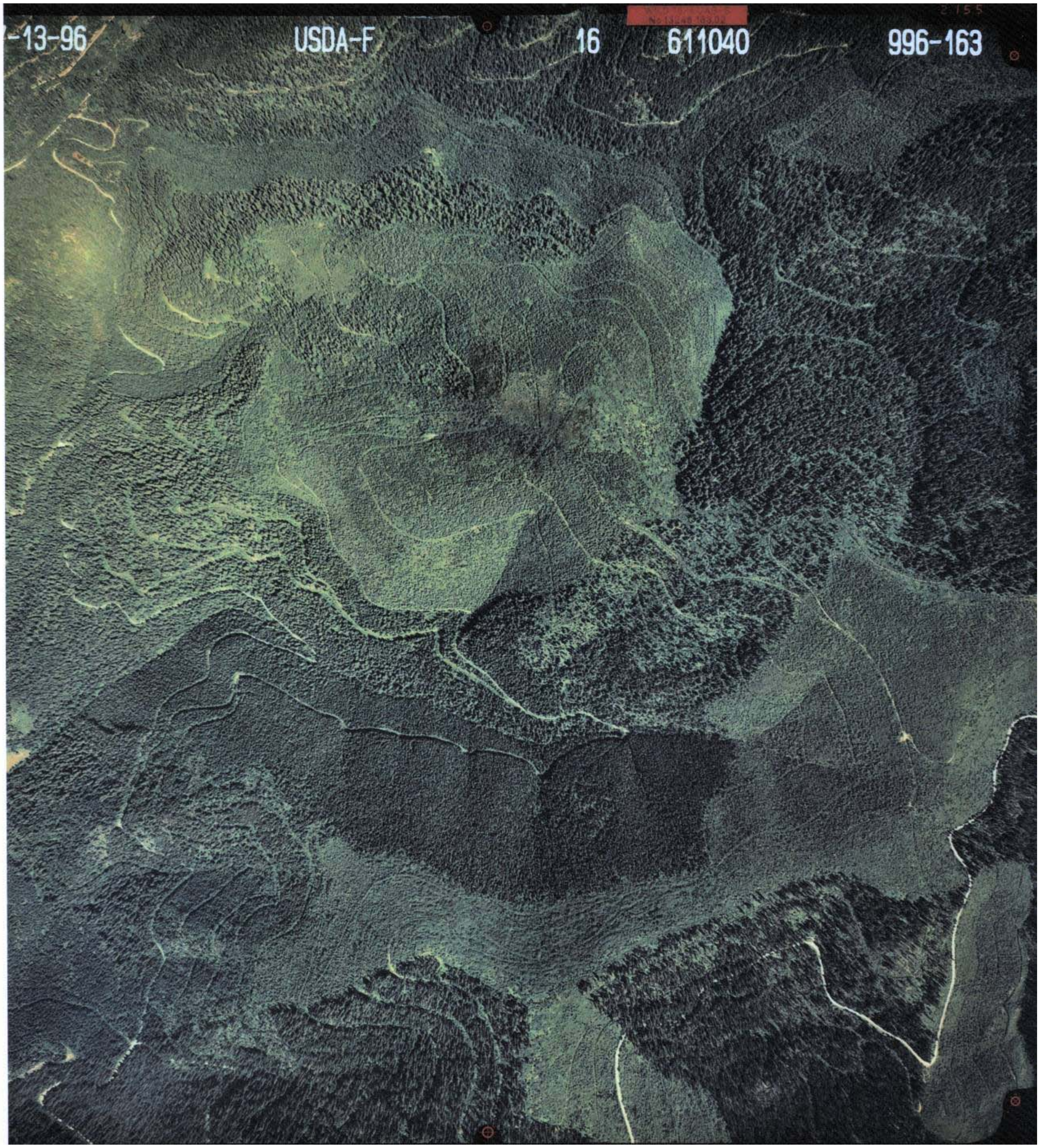

Photo 6. 1996 Aerial Photograph of Barney Creek showing revegetation on past harvest units and non-system (inactive/closed) roads.

Table 9. Recent harvest and estimated sediment inputs.

HUC	2002 Harvest (ac)	2003 Harvest (ac)	2004 Harvest (ac)	2005 Harvest (ac)	2006 Harvest (ac)	Total Harvest (ac)	Average Sediment Delivered (tons/yr)
170103010101: NF Coeur d'Alene River above Marten Cr	1	38	43	242	0	323	1.7
170103010102: NF Coeur d'Alene River above Tepee & below Marten Cr	107	34	8	195	59	403	2.2
170103010204: Independence Cr	0	0	0	437	131	568	3.1
170103010401: Shoshone Cr above Falls Cr	0	0	0	0	0	0	0.0
170103010203: Tepee Cr below Trail Cr	0	0	0	0	0	0	0.0
170103010701: Little NF Coeur d'Alene River above Cabin Cr	169	45	5	14	0	233	1.3
170103010702: Little NF Coeur d'Alene River below Cabin Cr	10	119	91	7	0	227	1.2
170103010301: NF Coeur d'Alene River above Yellowdog Cr	0	71	0	0	0	71	0.4
170103010202: Trail Cr	0	0	197	267	0	464	2.5
170103010403: Falls Cr	8	0	0	29	0	37	0.2
170103010201: Tepee Cr above Trail Cr	19	178	0	0	515	712	3.8
170103010302: NF Coeur d'Alene River above Prichard Cr & below Yellowdog	21	22	0	85	0	128	0.7
170103010303: Lost Cr	0	0	0	118	0	118	0.6
170103010402: Shoshone Cr below Falls Cr	0	47	0	0	0	47	0.3
170103010603: Steamboat Cr	0	0	0	6	0	6	0.0
170103010502: Eagle Cr	723	132	253	40	0	1,148	6.2
170103010604: Cougar Gulch	0	86	0	9	0	95	0.5
170103010601: Lower NF Coeur d'Alene River below Prichard Cr	54	27	301	790	0	1,171	6.3
170103010503: Lower Prichard Cr	373	62	5	0	0	440	2.4
170103010501: Prichard Cr above Eagle Cr	89	0	0	0	0	89	0.5
170103010602: Beaver Cr	463	426	418	463	0	1,769	9.6
Total	2,036	1,287	1,321	2,703	705	8,051	43.5

3.2.7 Mass Wasting

Mass wasting (landslides) can be a large source of sediment in steep, unstable watersheds. Landslides typically occur during large storm events and are an episodic source of sediment. Mass wasting was inventoried over the entire watershed on the 1996 aerial photographs, and USFS personnel provided information on slides they were familiar with in the subbasin (Ed Lider USFS, personal communication 11/9/05). Two slides that were related to road construction were visited in the Steamboat Creek watershed during the field inventory.

A total of six landslides were inventoried in the entire subbasin:

- Large slide in the Sob Creek drainage, visible on all air photos. Does not appear to deliver sediment to stream or be related to management activities.
- Three small slides in the Hamilton Creek drainage, visible on the 1996 aerial photographs. One slide may deliver a small amount of sediment. Do not appear to be related to management activities
- A slide complex in the West Fork Steamboat Creek drainage along the 965 road includes several active shallow translational slides and several re-vegetating (inactive) slides and

was visited during the field inventory. These slides are not currently delivering sediment to the stream, but reportedly have delivered small amounts in the past.

Additional small areas of sliding or raveling road cutbanks are likely present throughout the subbasin, but none were inventoried that appeared to deliver large amounts of sediment to a stream. Due to the small number and size of the slides, a quantitative estimate of sediment production from mass wasting was not made.

3.2.8 Road Network

Roads can be a large source of ongoing management-related erosion in forested watersheds. The majority of roads in the North Fork Coeur d'Alene watershed were constructed to access timber as harvest technology shifted from splash damming to railroad logging to truck transport. The advent of railroads and then roads to transport logs reduced direct impacts to streams that were associated with flumes and log drives, but many railroad and road systems were constructed within the flat floodplains or directly adjacent to streams. The railroads and roads often resulted in fill at stream crossings or parallel to streams that constricted channels. Roads constructed in the 1950s and 1960s were engineered to serve jammer operations which required a network of roads spaced 300 feet apart across a hillside. As a result, areas harvested during the mid 1900s have a legacy of closely-spaced "spaghetti" roads along the hillsides (Figure 2 and Photo 5). These are particularly evident in the middle of the watershed, where early harvest had not taken place. The lack of roads in the northern watershed is the result of the large 1910 fires that burned that area; there were no trees to harvest, so few roads were constructed.

The total of 5,011 miles of road (Table 10) and 3,838 road/stream crossings (Table 11) were included in the current sediment source analysis. Roads were classified into three main groupings for analysis: currently open roads, currently closed roads, and decommissioned roads. Currently closed roads includes both system roads (those roads that are still considered part of the USFS transportation network) and non-system roads (old roads that have been abandoned for many years and are still on the landscape but are not in the USFS transportation network).

Open roads receive maintenance and traffic. Open roads have fewer culvert washouts (they are occasionally cleaned and some have been replaced with larger pipes) but more surface erosion due to use by traffic. Closed roads are not regularly maintained and do not receive traffic. They are often vegetated and/or overgrown, so surface erosion is minimal. However, they are probably more susceptible to culvert washouts because culverts are not cleaned and often are older wood or undersized pipes that are nearing the end of their expected life. Decommissioned roads have had culverts removed, and in some cases, road fill pulled back and are no longer considered to be a source of sediment.

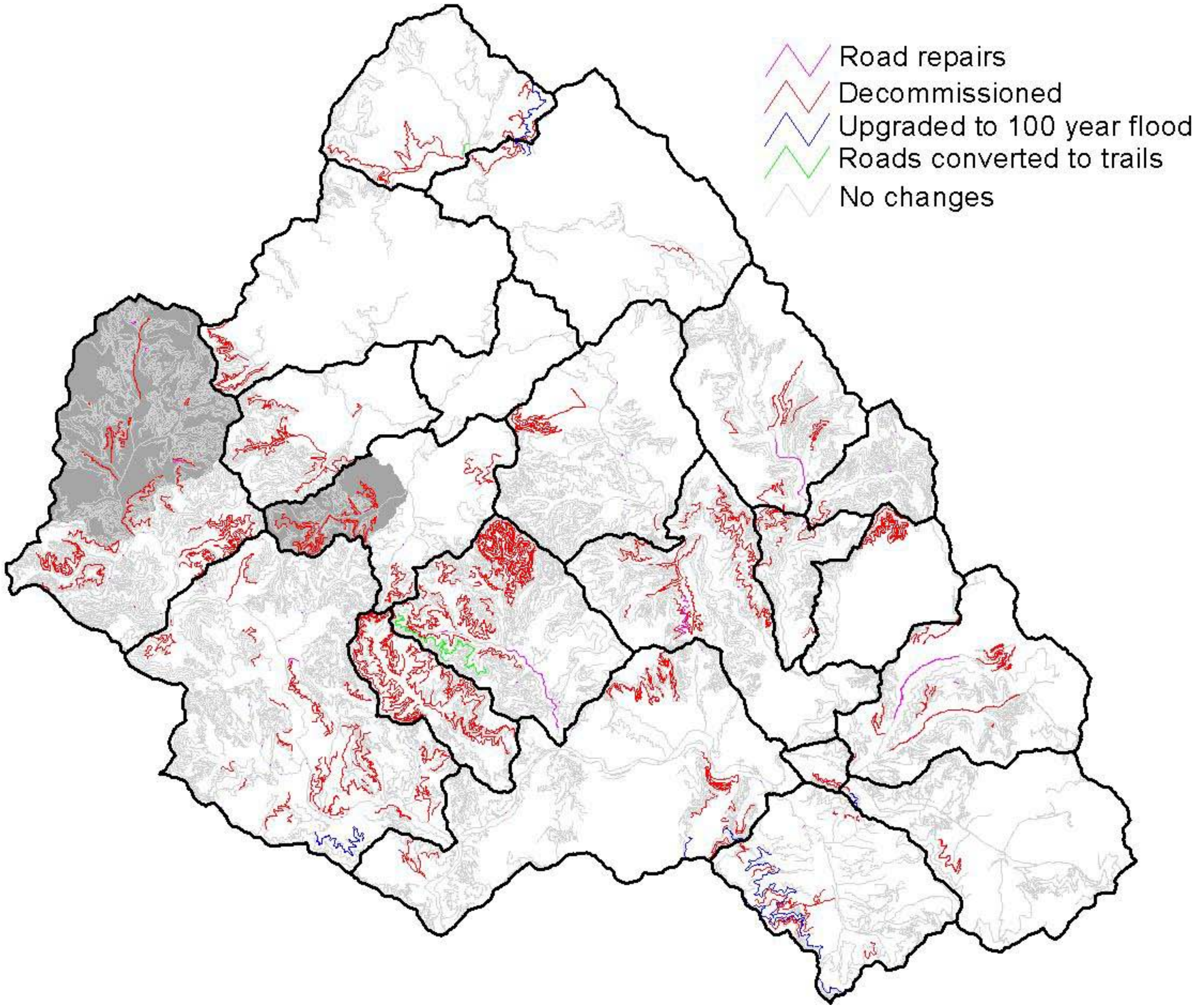

Figure 2. Location and Status of Roads used in Analysis (note intensive study basins shaded in gray).

Table 10. Miles of Road Analyzed in North Fork Coeur d'Alene Subbasin.

HUC	Open Roads	Closed Roads	Decommissioned Roads	Total Roads
170103010101: NF Coeur d'Alene River above Marten Cr	26	58	24	108
170103010102: NF Coeur d'Alene River above Tepee & below Marten	36	24	7	68
170103010201: Tepee Cr above Trail Cr	44	97	43	184
170103010202: Trail Cr	41	94	27	162
170103010203: Tepee Cr below Trail Cr	13	6	0	19
170103010204: Independence Cr	31	64	18	112
170103010301: NF Coeur d'Alene River above Yellowdog Cr	45	224	18	286
170103010302: NF Coeur d'Alene River above Prichard Cr	86	235	54	375
170103010303: Lost Cr	26	23	22	71
170103010401: Shoshone Cr above Falls Cr	31	191	20	242
170103010402: Shoshone Cr below Falls Cr	43	60	13	116
170103010403: Falls Cr	34	115	3	152
170103010501: Prichard Cr above Eagle Cr	13	148	4	166
170103010502: Eagle Cr	54	148	26	227
170103010503: Lower Prichard Cr	0	18	3	22
170103010601: Lower NF Coeur d'Alene River below Prichard Cr	81	285	49	416
170103010602: Beaver Cr	69	120	22	210
170103010603: Steamboat Cr	91	221	108	419
170103010604: Cougar Gulch	29	64	89	182
170103010701: Little NF Coeur d'Alene River above Cabin Cr	202	473	80	756
170103010702: Little NF Coeur d'Alene River below Cabin Cr	177	466	76	719
TOTAL	**1,171**	**3,133**	**707**	**5,011**

Table 11. Number of Stream Crossings on Roads Analyzed in North Fork Coeur d'Alene Subbasin.

HUC	Open Roads No Culvert Upgrade*	Open Roads with Culvert Upgrade*	Closed Roads**	Decomm -issioned Roads	Total Roads***
170103010101: NF Coeur d'Alene River above Marten Cr	12	3	28	29	72
170103010102: NF Coeur d'Alene River above Tepee & below Marten	19	2	24	8	53
170103010201: Tepee Cr above Trail Cr	30	0	47	36	113
170103010202: Trail Cr	31	0	40	42	113
170103010203: Tepee Cr below Trail Cr	16	0	5	0	21
170103010204: Independence Cr	20	0	27	20	67
170103010301: NF Coeur d'Alene River above Yellowdog Cr	45	0	132	27	204
170103010302: NF Coeur d'Alene River above Prichard Cr	92	0	101	61	254
170103010303: Lost Cr	17	0	24	17	58
170103010401: Shoshone Cr above Falls Cr	27	0	117	12	156
170103010402: Shoshone Cr below Falls Cr	37	0	39	12	88
170103010403: Falls Cr	34	0	75	1	110
170103010501: Prichard Cr above Eagle Cr	24	0	159	7	190
170103010502: Eagle Cr	54	0	99	34	187
170103010503: Lower Prichard Cr	0	0	14	9	23
170103010601: Lower NF Coeur d'Alene River below Prichard Cr	60	1	253	39	353
170103010602: Beaver Cr	35	16	151	25	227
170103010603: Steamboat Cr	72	0	197	95	364
170103010604: Cougar Gulch	17	0	46	70	133
170103010701: Little NF Coeur d'Alene River above Cabin Cr	152	0	319	74	545
170103010702: Little NF Coeur d'Alene River below Cabin Cr	115	2	300	90	507
TOTAL	**909**	**24**	**2,197**	**708**	**3,838**

* Open roads crossings (with and without culvert upgrade to 100 year flood) used for current surface erosion assessment
** Total Open not Upgraded and Closed Roads used for current culvert/crossing washout analysis
*** Total Roads used for historic surface erosion and washout estimates

3.2.9 Surface Erosion

Road surface erosion can occur on all unvegetated roads. Surface erosion is generally higher on native surfaced roads, steeper roads, and on roads that receive high traffic use. Good gravel surfacing, gentler slopes, less traffic, and more frequent cross drains can all reduce surface erosion.

Sediment produced from road surface erosion generally does not travel farther than 200 feet from the outlet of a culvert on an insloped road, and only about 10-15 feet from the edge of a road on outsloped roads (Haupt 1959, Megahan and Ketcheson 1996). Open roads in the Upper Little North Fork and Big Elk Creek drainages were inventoried to determine delivery from hydrologically connected segments as well as road attributes that control surface erosion (road width, length delivering, surfacing, gradient, tread drainage configuration, and cutslope height and cover.) The inventory results were used to model road surface erosion and to extrapolate results to roads in the rest of the subbasin that were not inventoried.

The majority of open major forest roads in the North Fork Coeur d'Alene subbasin are gravel surfaced with a 15-20 foot wide tread, and receive primarily administrative and recreational traffic. Open secondary roads are narrower, with a 10-15 foot wide tread and receive light recreational use. Secondary roads often have some vegetation growth on the tread. Closed roads are generally revegetate after 1-2 years of closure.

Photo 7. Examples of main roads, secondary open roads, and closed/overgrown non-system roads

Estimates of surface erosion were made using two road surface erosion models: WEPP:Road and SEDMODL (Table 12, Appendix 2). WEPP:Road generally estimates less surface erosion than SEDMODL, but does not provide the ability to model as many different traffic scenarios. The estimates are based on the currently open road system (1,171 miles, 933 stream crossings) since closed roads were vegetated and are assumed to have little to no surface erosion. Historic estimates were based on the entire road system (system and non-system roads) since most roads were open during times of peak logging operations and would have had much higher traffic levels.

Table 12. Estimated Road Surface Erosion (average tons/year).

HUC	Current SEDMODL Estimate	Current WEPP:Road Estimate	Historic SEDMODL Estimate	Historic WEPP:Road Estimate
170103010101: NF Coeur d'Alene River above Marten Cr	10	2	70	3
170103010102: NF Coeur d'Alene River above Tepee & below Marten	10	3	40	3
170103010201: Tepee Cr above Trail Cr	10	2	140	4
170103010202: Trail Cr	15	2	120	4
170103010203: Tepee Cr below Trail Cr	10	1	20	1
170103010204: Independence Cr	10	1	60	2
170103010301: NF Coeur d'Alene River above Yellowdog Cr	25	7	170	12
170103010302: NF Coeur d'Alene River above Prichard Cr	40	9	200	11
170103010303: Lost Cr	5	1	40	2
170103010401: Shoshone Cr above Falls Cr	10	5	120	8
170103010402: Shoshone Cr below Falls Cr	15	4	60	5
170103010403: Falls Cr	20	2	110	4
170103010501: Prichard Cr above Eagle Cr	5	2	100	6
170103010502: Eagle Cr	20	3	140	6
170103010503: Lower Prichard Cr	0	0	10	1
170103010601: Lower NF Coeur d'Alene River below Prichard Cr	20	5	150	12
170103010602: Beaver Cr	10	3	160	9
170103010603: Steamboat Cr	40	9	310	16
170103010604: Cougar Gulch	10	2	100	4
170103010701: Little NF Coeur d'Alene River above Cabin Cr	85	13	570	23
170103010702: Little NF Coeur d'Alene River below Cabin Cr	60	14	490	21
TOTAL	430	92	3,180	156

3.2.10 Road Washouts and Gullying

Road stream crossings can be locations where the interaction of the road prism and the stream channel result in sediment input to the stream. In order to keep a relatively flat road running surface, fill is usually placed across the stream channel at the crossing. Under current construction practices and BMPs, a large corrugated metal (or plastic) pipe is laid in the stream channel prior to fill placement, the stream is directed through the pipe (often pumped or diverted around the construction area), and the fill is surfaced with large rocks or rip rap to reduce the potential for erosion. Pipes are sized to handle the estimated 100-year flow and, in high sediment or debris load streams, a trash rack is sometimes placed at the upstream end to reduce the chance of plugging. Downspouts can be constructed at the downstream end if a large or erodible fill is being traversed. Historic construction practices often did not take these measures, and resulted in a much higher probability of the culvert plugging or failing. Historically smaller metal culverts, wood culverts, or Humboldt crossings (logs placed in the stream parallel to the flow) were used at stream crossings, and fill was placed on top of these crossings. The majority of the road system was constructed prior to the 1960s, so some of these pipes are reaching the end of their life cycle and either rusting or rotting.

Culverts that are deteriorated or too small to handle high flows or high sediment or debris loads can plug, resulting in water ponding upstream of the fill and either flowing over the road and into the stream or down the road tread to the next crossing. Either way, gullies generally form under these circumstances and deliver sediment to streams. If the road fill saturates, the fill can fail, washing out the road prism and delivering the sediment to the stream.


Photo 8. Examples of Road Washouts (left) and Gullies (right) in the Upper Little North Fork Drainage.

Culvert washout and gully erosion was estimated based on past inventories of erosion at culverts conducted by the USFS on open and closed (system and non-system) roads and a smaller scale on open roads during the current study. The USFS inventory showed that an average of 22% of the culverts had failed to some extent on system and non-system roads at the time of the inventories (1988 or 1996). An average of 470 tons of fill had been delivered to streams at these failures (range: 2 - 1,100 tons). This number was converted to an average rate of 2.1 tons/culvert/year and applied to the number of potential culverts on the historic and current road system (Table 13, Appendix 2).

The USFS has been working on reducing the risk of culvert failure by decommissioning roads (pulling culverts and re-shaping the road fill in the vicinity of the stream channel) as well as upgrading culverts on roads that will remain in the system to be able to handle the 100-year peak flow. These continued efforts will continue to decrease the potential volume of sediment delivered to streams from culvert washouts and gullying.

Table 13. Estimated Road Culvert Washout/Gully Inputs (average tons/year).

HUC	Historic	Current
170103010101: NF Coeur d'Alene River above Marten Cr	150	80
170103010102: NF Coeur d'Alene River above Tepee & below Marten	110	90
170103010201: Tepee Cr above Trail Cr	230	160
170103010202: Trail Cr	230	150
170103010203: Tepee Cr below Trail Cr	40	40
170103010204: Independence Cr	140	100
170103010301: NF Coeur d'Alene River above Yellowdog Cr	420	370
170103010302: NF Coeur d'Alene River above Prichard Cr	520	400
170103010303: Lost Cr	120	80
170103010401: Shoshone Cr above Falls Cr	320	300
170103010402: Shoshone Cr below Falls Cr	180	160
170103010403: Falls Cr	230	220
170103010501: Prichard Cr above Eagle Cr	390	380
170103010502: Eagle Cr	390	320
170103010503: Lower Prichard Cr	50	30
170103010601: Lower NF Coeur d'Alene River below Prichard Cr	730	650
170103010602: Beaver Cr	470	380
170103010603: Steamboat Cr	750	560
170103010604: Cougar Gulch	270	130
170103010701: Little NF Coeur d'Alene River above Cabin Cr	1120	970
170103010702: Little NF Coeur d'Alene River below Cabin Cr	1050	860
TOTAL	7,910	6,430

3.2.11 Road Encroachment on Stream Channels

Early road construction in the North Fork Coeur d'Alene subbasin commonly followed the easiest routes – right up river and stream valleys. The majority of these roads are still in use today; many forming the primary access routes in the subbasin. While these routes are the easiest from a road construction standpoint, the road prism in many locations encroaches upon the stream channel and/or floodplain. The effects on stream morphology (constricting the channel and/or flood plain, armoring banks, loss of riparian vegetation) are discussed in the Stream Channel report. Encroaching roads have additional sediment source effects during flood events if the stream power is sufficient to erode the road fill, washing out sections of road and delivering the eroded sediments to the stream. Erosion from road encroachment was estimated to be the largest sediment source during the 2001 TMDL study. The 2001 estimate was made using ¼ inch of erosion/year from all lengths of road within 50 feet of a stream based on the GIS coverages available at the time of the analysis. Since the result was such a relatively large sediment source, additional aerial photograph and field assessments of this source were made for the current analysis.

All areas with potential stream encroachment concerns were identified on the 1996 aerial photographs of the subbasin. Areas were identified where a stream impinged upon the roadfill. Many of these areas were field checked for evidence of past stream encroachment erosion in August 2006, and road fill lengths, widths, and heights subject to erosion were estimated in the field. In addition, each site was rated as having a High, Medium, or Low susceptibility to road encroachment erosion based on the location of the road relative to the stream and the angle that the stream impinged upon the road fill (e.g., generally roads at the outside of meanders were rated as having a High potential; roads that paralleled the streamflow at straight sections were rated as Moderate).

Sections of the following roads were identified as having potential road encroachment concerns on the aerial photographs. Roads that are underlined were not field checked; the remainder were visited in the field. Figure 3 maps the locations of encroaching roads. Descriptions of the road encroachment locations along inventoried roads in the subbasin follow the list of roads below.

- USFS Highway 9 along the mainstem North Fork from mouth to Prichard Creek
- The Fernan Road/Old River Road (USFS Road 1-C) along the mainstem North Fork from mouth to bridge at Beaver Creek
- USFS Road 208 along the mainstem North Fork from Prichard Creek to Teepee Creek
- USFS Road 209 along the Little North Fork (including blocked section upstream from Road 385)
    - USFS Road 796 along Bumblebee Creek
    - <u>USFS Road 413 along Copper Creek</u>
    - <u>USFS Road 919 along Laverne Creek</u>
    - USFS Road 422 along Leiberg Creek
    - <u>USFS Road 1517 along Bootjack Creek</u>
    - <u>USFS Road 3027 along Picnic Creek</u>
    - USFS Road 379 along Cascade Creek
    - USFS Road 206 along Burnt Cabin Creek
    - USFS Road 411 along Lone Cabin Creek
    - USFS Road 1587 along Canyon Fork
    - USFS Rod 392 along Hudlow Creek
    - USFS 3013 along East Fork Hudlow
    - USFS 794 along Iron Creek
    - USFS 385 along Tom Lavin Creek
- USFS Road 400 along Steamboat Creek
    - USFS Road 409 along West Fork Steamboat Creek
    - USFS 400 along East Fork Steamboat Creek
- <u>USFS Road 207 along Brown Creek</u>
- <u>USFS Road 456 along Beaver Creek</u>
- <u>USFS Highway 9 along Prichard Creek</u>
    - USFS 805 along West Fork Eagle Creek
    - USFS 152 along East Fork Eagle Creek
- <u>USFS Road 442 along Lost/Stack Creek</u>
- USFS Road 412 along Shoshone Creek
    - USFS Road 799 along Rampike Creek
- USFS Road 513 along Yellowdog Creek (note: this road has been removed by USFS)
- <u>USFS Road 812 along Teepee Creek</u>
- USFS Road 422 along Big Elk Creek

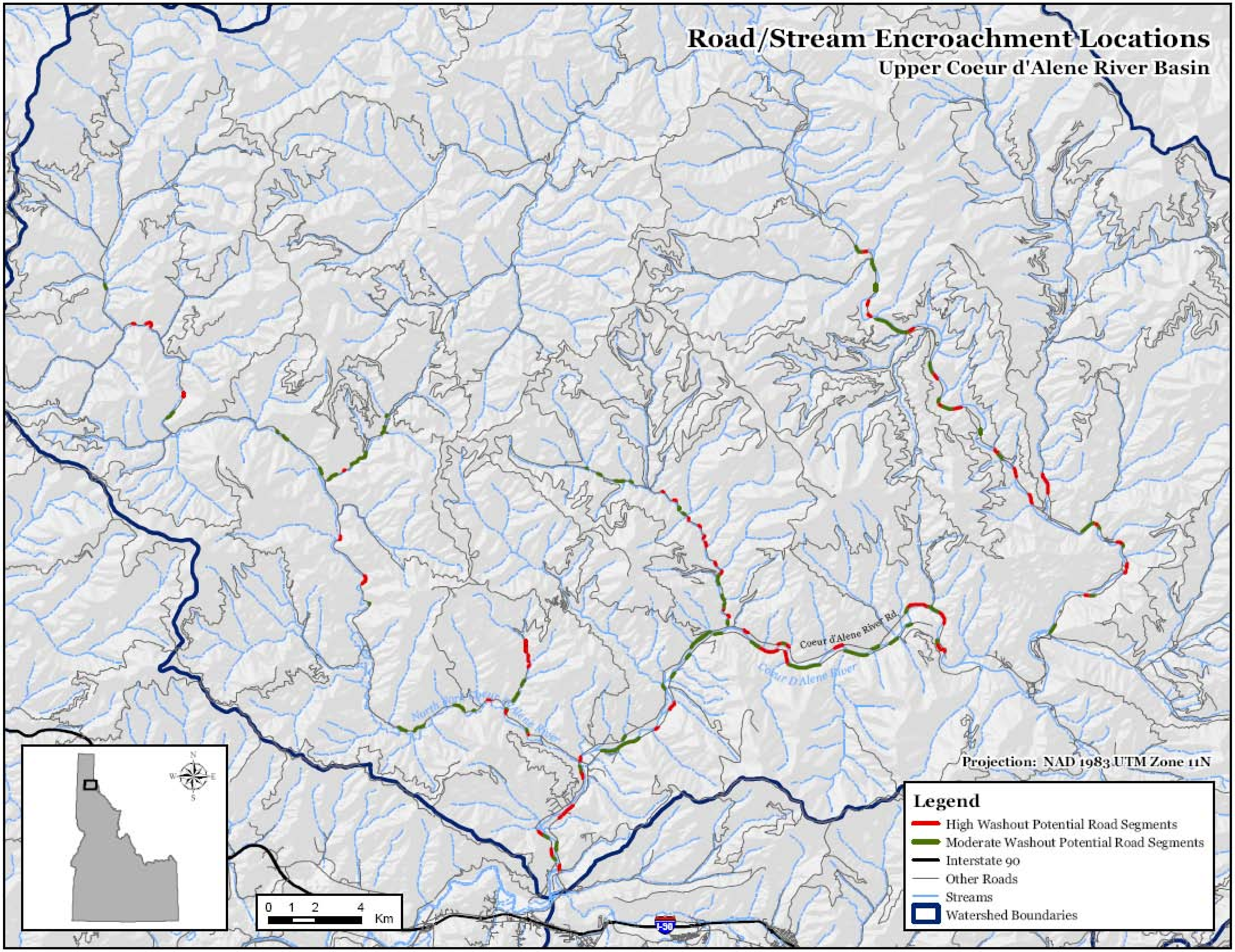

Figure 3: North Fork Coeur d'Alene Road Encroachment locations.

3.2.11.1 USFS Highway 9 and USFS Road 1-C

The Lower North Fork CDA River flows in a broad valley, with low gradient. USFS Highway 9, along the south and east side of the Lower North Fork, is a major highway. The estimated height of road fill is 15 to 20 feet. Most areas adjacent to the river had only Moderate failure potential. The Old River Road (USFS Road 1-C) goes along the north and west side of the river and has more frequent, and longer, exposure to the river (Photo 9). It has a top width of 20 to 25 feet and the fill is 10 to 20 feet above the river (see maps). There are many locations of High failure potential. At Steamboat Rock, the road fill has been built out into the river which deflects the thalweg away from the former river bank, presumably in response to former washouts, so it appears unlikely to wash out the road in the future.

Photo 9. Old River Road riprap along Grizzly Creek bend. Most of this bend was rated High failure potential.

3.2.11.2 USFS Road 208

Road 208 (Photo 10) goes upstream from Prichard along the Middle segment of the North Fork CDA. It has a typical width of 30 feet plus 15-foot wide pullouts at locations with bank erosion problems. The river is steeper, very confined, and clearly capable of eroding large riprap. Estimated height of road fill is 8 to 15 feet. Side slopes were steeper than 1:1 where there was river impingement at an angle. Downstream of Venus Creek, 8-10 ft diameter riprap has been placed on the bank and some has washed into the river. This location has a pullout. Even areas without a scour pool at the toe commonly have oversteepened riprap. There are some straight segments where the river flows parallel to the road and trees have grown up on the riprap embankment.

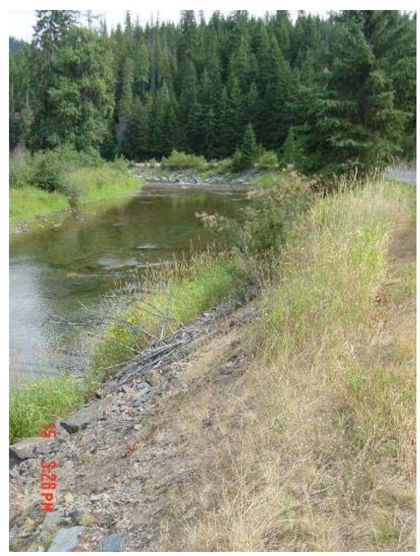

Photo 10. Road 208 looking downstream about 2 miles below Big Hank meadow. This section of road was rated Moderate failure potential in foreground and High failure potential in background.

3.2.11.3 USFS 209 and other roads in the Little North Fork Drainage

USFS Road 209 has been constructed along the Little North Fork Coeur d'Alene River. The road follows the west side of the valley up to the bridge near Burnt Cabin Creek where it crosses to the west side of the valley. The road is constructed along the hill away from the river for much of its length, but the evaluation of topographic maps indicated that several locations of USFS Road 209 along the Little North Fork have potential encroachment erosion where the valley narrows. A total of 20 locations of stream channel encroachment erosion were noted in the field. In addition, five locations in the currently closed section (upstream of Tom Lavin Creek) were marked as potential erosion sites on the 1984 aerial photographs but were not visited in the field.

Ten locations along USFS Road 796 (Bumblebee Creek) had road encroachment erosion, and represented much of the length of road along the creek. Gabions have been constructed at several locations in the upper, confined valley where the road takes up a good portion of the valley width.

Road encroachment erosion was noted at seven locations on USFS Road 422 along Leiberg Creek, primarily in locations where the valley was confined and the road was immediately adjacent to the stream. Evidence of road encroachment erosion was also found along one short location on USFS Road 379 along Cascade Creek and along another section on USFS Road 206 along Burnt Cabin Creek.

No stream encroachment erosion was observed in the field along the following roads:

- USFS Road 411 along Lone Cabin Creek;
- USFS Road 1587 along Nicholas Creek;
- USFS Road 392 along Hudlow Creek;
- USFS 794 along Iron Creek;
- USFS 385 along Tom Lavin Creek; and
- USFS 3013 along East Fork Hudlow (blocked road).

The streams along these roads are too small to have enough power to erode the armored road fill under most high flow conditions.

3.2.11.4 USFS Roads 400 and 409 in the Steamboat Creek Drainage

USFS Road 400 is located along the east valley wall of Steamboat Creek. The valley is confined, and road fill encroaches on the stream and/or floodplain in at least 16 locations. The road has washed out several times in the past; large rip rap has been placed at most outside meander locations to protect the road fill. Road 400 continues up the East Fork of Steamboat Creek. Two additional road encroachment locations were inventoried in this reach.

USFS Road 409 has been constructed along the West Fork of Steamboat Creek. The road has been constructed through the middle of the floodplain, cutting off part of the valley width and confining the stream to one side of the valley. Five locations with evidence of road fill erosion were noted in the field. This stream appears to be more severely affected by the location of the road than most others.

3.2.11.5 USFS 805 along West Fork Eagle Creek and USFS 152 along East Fork Eagle Creek

Open portions of the roads along both West Fork and East Fork Eagle Creek were inventoried; no road encroachment locations were seen.

3.2.11.6 USFS Road 412 along Shoshone Creek

USFS Road 412 has been constructed along Shoshone Creek. In many locations, the Shoshone Creek valley is wide and flat, and the stream is far from the road. However, in a few locations the stream impinges on the road fill as it has migrated close to the valley walls. The road was inventoried from the mouth up to Rampike Creek. Six locations with evidence of road encroachment erosion were noted, and gabions had been constructed in several locations to protect the road fill. The road upstream of Rampike Creek was not inventoried; several potential erosion locations were marked in this area.

3.2.11.7 USFS Road 799 along Rampike Creek

USFS Road 799 is constructed along the west side of Rampike Creek. It is located far enough away from the creek so that it is not causing stream encroachment concerns.

3.2.11.8 USFS Road 513 along Yellowdog Creek

Road 513 was constructed immediately adjacent to, and within much of the valley of Yellowdog Creek. The USFS determined that the road was affecting the stream and was no longer needed for their transportation system, so they have decommissioned the road by pulling back the road fill and re-configuring the creek to improve access to the full valley width. This is an effective way to reduce road encroachment impacts to the stream.

Photo 11. Decommissioned Road along Yellowdog Creek

3.2.11.9 USFS Road 812 along Tepee Creek

Road failure potential was not inventoried on Tepee Creek. From a couple miles below Magee downstream to nearly the confluence, the valley is narrow. The main road commonly lies against the north valley wall and it appears likely that the creek erodes away at the road during floods. River bends are riprapped either with imported rock or native, slabby rock (talus) that may have been excavated from the valley wall when constructing the road (Photo 12).

Photo 12. Road along Tepee Creek.

The crumbly rocks along the creek are clearly a major source of cobble-gravel sediment, and the presence of the road disrupts sediment delivery from the cliffs to the creek. At the same time, the road fill provides sediment whenever floods big enough to mobilize the riprap occur. The road height above the creek is about 6 to 8 vertical feet. The creek has riprapped sections adjacent to the road from a couple miles downstream of Trail Creek to a couple miles above the mouth. About 2,000 to 3,000 ft of road are probably subject to washouts during the large flood events that occur every 10 to 15 years, with a rough estimate of 2000 to 3000 cubic yards of erosion if all these areas eroded lost about 5 feet of road.

Road failures occurred on Potter and Stewart Creeks, in the headwaters of Trail Creek, during floods in the 1970s, 1980s and 1990s (Ed Lider, 2/2/07 email). Potter Creek Road 534 was damaged by mudflows and slides in the vicinity of Washout Draw and Bear Creek (USFS typed report Historic Flood Information, undated).

3.2.11.10 Estimate of Road Encroachment Erosion Inputs

USFS personnel indicated that peak flows in 1965, 1974, and 1996 caused major damage to roads along streams. Lower peak flows can cause damage to extremely susceptible roads (e.g. portions of Old River Road is flooded and a few feet of surfacing wash out every few years). The field inventory of roads included an estimate of the height, length, and width of fill erosion at each of the potential encroachment sites, as well as the relative susceptibility to erosion. Appendix 3 lists the road encroachment locations and data that were used to estimate historic and current/future sediment inputs from road encroachment.

Road encroachment erosion is an episodic process. In order to compare the input from this source with other sediment sources in the watershed, an average annual rate was computed based on an estimated recurrence interval between washouts at each site. Since precise records of past washouts were not available, and road repairs and fillslope armoring will likely result in a decrease in this source in the future, two different scenarios with different erosion recurrence intervals were used for both the historic and current/future time frames (Table 14). The recurrence intervals were based on discussions with USFS personnel who have worked in the basin for many years. Confidence in the locations of road encroachment is high, but an estimate of erosion amounts is moderate since actual volumes and recurrence intervals are not known precisely.

Photo 13. Erosion of surfacing material along the old river road (just above Browns creek) on March 17, 2007 .

Table 14. Estimated Road Encroachment Sediment Inputs (average tons/year).

Sub-Basin	Historic Road/Stream Encroachment	Current/Future Road/Stream Encroachment
170103010101 NF Coeur d'Alene River above Marten Creek	0	0
170103010102 NF Coeur d'Alene River above Tepee & below Marten Creek	80 -160	0 -60
170103010201 Tepee Cr above Trail Creek	360 -430	0 -140
170103010202 Trail Creek	150 -150	0 -150
170103010203 Tepee Cr below Trail Cr	590 -990	90 -480
170103010204 Independence Cr	0	0
170103010301 NF Coeur d'Alene River above Yellowdog Cr	7,400 -9,760	2,520 -6,810
170103010302 NF Coeur d'Alene River above Prichard Cr & below Yellow	3,610 -5,500	850 -3130
170103010303 Lost Creek	0	0
170103010401 Shoshone Cr above Falls Creek	0	0*
170103010402 Shoshone Cr below Falls Creek	210 -260	80 -200
170103010403 Falls Creek	0*	0*
170103010501 Prichard Cr above Eagle Creek	0	0
170103010502 Eagle Creek	0*	0*
170103010503 Lower Prichard Cr	0	0
170103010601 Lower NF Coeur d'Alene River below Prichard Creek	35,240 -52,540	10,500 -11,540
170103010602 Beaver Creek	0	0
170103010603 Steamboat Creek	570 -850	0 -410
170103010604 Cougar Gulch	0	0
170103010701 Little NF Coeur d'Alene River above Burnt Cabin Creek	100 -100	0 -40
170103010702 Little NF Coeur d'Alene River below Burnt Cabin Creek	960 -960	190 -600
Entire North Fork Coeur d'Alene Watershed	**49,270-71,720**	**14,230-23,560**

* likely some input in these subbasins, but not inventoried

3.2.12 USFS Road Repair Data

The USFS provided data on road decommissioning, restoration, and repairs that have been completed since 1988. These data are not complete, but they do provide a sense of the type and frequency of repairs needed, which is likely linked to sediment sources from road washouts/gullies and stream channel encroachment. The database was sorted to look at road repairs only (not decommissioning) and data were summarized by reason for repair and year.

The length of roads that were repaired was used as a comparison metric (most records did not have information on volume of material needed to repair the road, although that would have been a good indicator of sediment lost to erosion). The miles of road by year, and reason for repair are listed in Table 15. The frequency (number) of road repairs by reason and year is also shown in Figure 4.

Table 15. Miles of Road Repaired by Year (from USFS Data, 1991-1997). Data were tabulated only for the 3 years shown, and may or may not represent the intervening years.

Reason for Repair	1991	1995	1997	Total Miles
Access	12.47	0	0.47	12.93
Bridge repair	0	0	0.18	0.18
Move road, bank stabilization	0	1.18	0.35	1.53
Remove fish barrier, reduce erosion	0	0.84	4.08	4.92
Replace culverts, repair road	0.22	0	0	0.22
Road repair	0	2.90	6.55	9.45
Stabilize bank	0	0	2.72	2.72
Total Miles	12.68	4.92	14.34	31.95

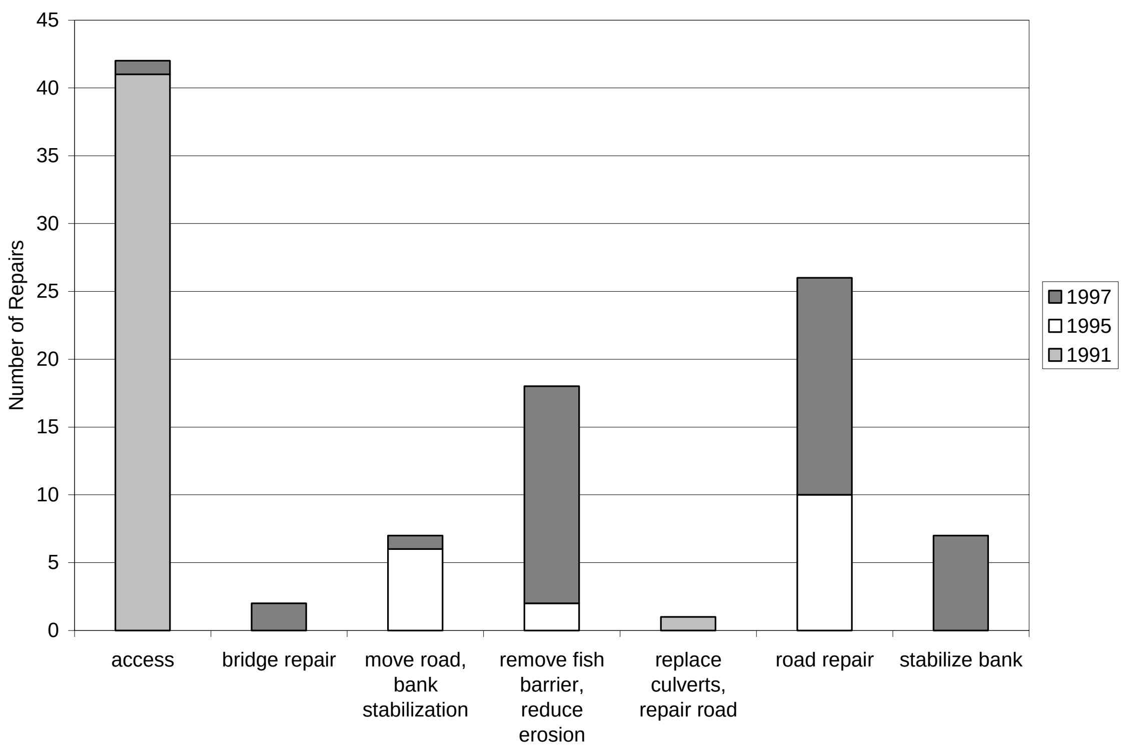

Figure 4. Number of road repairs by year and reason for repair.

Road repairs to provide access, or general road repair were the most frequently listed road issues. These include culvert failures, washouts, and general repairs. The next most frequent repair was to remove fish barriers, followed by bank stabilization, or moving roads away from streams. These data may not be complete or totally representative of road erosion processes occurring in the North Fork Coeur d'Alene area, but they are consistent with observations from the aerial photographs, and suggest that small culvert/road washouts and stream-parallel roads are the primary road erosion issues.

3.2.13 Streambank Erosion and Stream Entrenchment

Channel erosion rates from the upper Little North Fork CDA River and Big Elk Creek were extrapolated to the rest of the North Fork Coeur d'Alene River watershed using the methods described Section 2.5.4 of the Stream Channel Report. These rates are more speculative than the rates for the two watersheds that were studied in detail. The extrapolation was done for the purpose of identifying the relative magnitudes of erosion types and source areas.

The peak rate of channel entrenchment may have been as high as 400,000 tons per year if all channel entrenchment occurred within a 30 year period (Table 16). If the same volume of erosion occurred in two separate 30 year periods, such as the early 20th century logging using water-based transport followed by the later logging with extensive road building, the rates would be approximately halved. The extent and magnitude of channel entrenchment in the northern watersheds that were burned and then heavily grazed is unknown; however, these were likely sources of substantial quantities of sediment.

Table 16. Channel Entrenchment and Bank Erosion for Historic and Current Conditions in the North Fork Coeur d'Alene River Subbasin (average tons/year)

HUC	Historic Channel Entrenchment and Bank Erosion	Current Bank Erosion	Current Channel Entrenchment
170103010101: NF Coeur d'Alene River above Marten Cr	1,500	10	0
170103010102: NF Coeur d'Alene River above Tepee & below Marten	0	0	0
170103010201: Tepee Cr above Trail Cr	3,000	10	0
170103010202: Trail Cr	2,700	60	600-6,000
170103010203: Tepee Cr below Trail Cr	0	0	0
170103010204: Independence Cr	1,700	10	0
170103010301: NF Coeur d'Alene River above Yellowdog Cr	11,200	50	0
170103010302: NF Coeur d'Alene River above Prichard Cr	10,700	50	0
170103010303: Lost Cr	8,000	190	0
170103010401: Shoshone Cr above Falls Cr	13,800	330	0
170103010402: Shoshone Cr below Falls Cr	4,500	110	0
170103010403: Falls Cr	4,600	110	0
170103010501: Prichard Cr above Eagle Cr	81,800	1,800	1,600-16,000
170103010502: Eagle Cr	74,300	1,080	
170103010503: Lower Prichard Cr	5,800	80	
170103010601: Lower NF Coeur d'Alene River below Prichard Cr	18,800	90	0
170103010602: Beaver Cr	69,800	1,020	700-7,000
170103010603: Steamboat Cr	9,200	40	0
170103010604: Cougar Gulch	4,300	150	0
170103010701: Little NF Coeur d'Alene River above Cabin Cr	25,200	610	0
170103010702: Little NF Coeur d'Alene River below Cabin Cr	30,900	750	0
TOTAL	381,800	6,550	3,000-30,000

Current channel entrenchment appears to be limited to just a few watersheds, most notably in the mining district. The current entrenchment erosion rate is estimated at 3,000 to 30,000 tons per year, which is one to two orders of magnitude lower than historic peak rates.

The estimated bank erosion rate for the total watershed is about 7,000 tons per year (Table 16). This is equivalent to about 7 tons per square mile per year and is in addition to the background erosion rate of 14.7 tons per square mile per year. Total current channel erosion from bank erosion plus entrenchment is estimated as between 10,000 and 37,000 tons per year.

4.0 SEDIMENT INPUT BUDGET

Estimated sediment inputs from all sources were compiled for two time periods: historic and current.

4.1 HISTORIC SEDIMENT INPUTS

The analysis team felt that an understanding of the magnitude of historic sediment inputs (1900-2000) was important because there were such large inputs of coarse sediment (cobble, gravel) in the past that it was quite likely that the river channel was still being affected by the routing of these sediments. The historic inputs were quantified to the extent possible (Table 17, Appendix 4). Where quantification was not possible, an estimate of the relative magnitude (high, low) was noted. The sediment inputs from historic activities were annualized; however, the peak of some sediment inputs occurred for several decades (e.g. mining, timber harvest) and were not as high during other decades in the 1900s. Table 17 summarizes major sediment inputs that occurred during the 1900s but does not differentiate inputs by decade.

The largest historic sediment input was from channel entrenchment and bank erosion. These sources are related to the channel responding to loss of structure, log drives, riparian vegetation removal, and inputs of course sediment from other sources. The channel destabilized, widened and downcut, and mobilized large amounts of stored alluvium in response to these changes. Channel entrenchment is an episodic source of primarily course-grained material (alluvium).

Sediment inputs from erosion of encroaching road fill is estimated to be another historically large source of sediment. The easiest place to construct roads and railroad grades is in flat stream valleys, but these roads are generally within the floodplain of the river and vulnerable to erosion by the stream during peak flow events. Road encroachment is an episodic source of course and fine sediment (road fill). Sediment input from culvert washouts/gullies was a moderate, episodic source associated with roads. Sediment input from road surface erosion was a smaller, chronic source of primarily fine-grained material (sand, silt, clay).

Sediment inputs from mining activities was a major source of sediment in the Prichard, Eagle, and Beaver creek drainages. Early mining practices resulted in large quantities of spoils being supplied to the streams, as well as disruption and sediment inputs from the stream channels themselves from dredging along many miles of stream. Sediment input from mining activities occurred relatively continuously over several decades and included fine and coarse sediment (mining spoil and alluvium).

Timber harvest practices in the early and middle parts of the 1900s likely resulted in large sediment inputs to streams as well as the destabilization of the streams themselves by log drives down the channels. These sources were likely relatively large and a chronic input.

The 1910 fires undoubtedly resulted in increased fine-grained sediment inputs from burned land as surface erosion occurred for several years following the fires. Heavy sheep grazing on the burned areas as grass began to grow likely also resulted in some erosion. These sources were not quantified.

Table 17. Summary Sediment Input Budget, Historic Time Period. All inputs in average tons/year

6th-field HUC	Area (sq mi)	Back-ground	Fire	*Management Related*								
				Bank Ero-sion	Channel Entrench-ment	Road/Stream Encroach-ment	Road Surface Erosion	Road Culvert Washout/ Gullies	Agri-cul-ture	Mining	Timber Harvest	Land-slides
170103010101 NF Coeur d'Alene River above Marten Cr	37	540	Large after 1910 fires	Included in channel entrenchment	1,500	0	70	150	Possible moderate from sheep grazing after fire	0	Small	Unknown but small
170103010102 NF Coeur d'Alene River above Tepee & below Marten Cr	65	960			0	80 -160	40	110		0		
170103010201 Tepee Cr above Trail Cr	35	520			3,000	360 -430	140	230		0		
170103010202 Trail Cr	30	440			2,700	150 -150	120	230		0		
170103010203 Tepee Cr below Trail Cr	19	290			0	590 -990	20	40		0		
170103010204 Independence Cr	59	870			1,700	0	60	140		0		
170103010301 NF Coeur d'Alene River above Yellowdog Cr	51	750			11,200	7,400 -9,760	170	420		0		
170103010302 NF Coeur d'Alene River above Prichard Cr & below Yellow	49	710	Unknown but likely small		10,700	3,610 -5,500	200	520	0	0	Likely large from 1900 through 1970's	
170103010303 Lost Cr	24	360			8,000	0	40	120	0	0		
170103010401 Shoshone Cr above Falls Cr	42	610			13,800	0	120	320	0	0		
170103010402 Shoshone Cr below Falls Cr	14	200			4,500	210 -260	60	180	0	0		
170103010403 Falls Cr	14	200			4,600	0	110	230	0	0		
170103010501 Prichard Cr above Eagle Cr	50	740			81,800	0	100	390	0	14,100		
170103010502 Eagle Cr	45	660			74,300	0	140	390	0	3,700		
170103010503 Lower Prichard Cr	3	50			5,800	0	10	50	0			
170103010601 Lower NF Coeur d'Alene River below Prichard Cr	86	1,260			18,800	35,240 - 52,540	150	730	17	0		
170103010602 Beaver Cr	42	620			69,800	0	160	470	0	1,200		
170103010603 Steamboat Cr	42	620			9,200	570 -850	310	750	0	0		
170103010604 Cougar Gulch	19	280			4,300	0	100	270	0	0		
170103010701 Little NF Coeur d'Alene River above Burnt Cabin Cr	76	1,120			25,200	100 -100	570	1,120	0	0		
170103010702 Little NF Coeur d'Alene River below Burnt Cabin Cr	94	1,380			30,900	960 -960	490	1,050	0	0		
TOTAL Entire NF CDA Watershed	**896**	13,180	**1910 large**		**381,800**	**49,270- 71,720**	**3,180**	**7,910**	**17**	**19,000**	**1900's-1970's large**	**Small**

Table 18. Summary Sediment Input Budget, Current Time Period. All inputs in average tons/year

				Legacy Sources		*Current Management Sources*						
6th-field HUC	**Area (sq mi)**	**Back-ground**	**Fire**	**Bank Ero-sion**	**Channel Entrench-ment**	**Road/Stream Encroach-ment**	**Road Surface Erosion**	**Road Culvert Washout/ Gullies**	**Agri-cul-ture**	**Mining**	**Timber Harvest**	**Land-slides**
170103010101 NF Coeur d'Alene River above Marten Cr	37	540	0	10	0	0	10	80	0	0	2	0
170103010102 NF Coeur d'Alene River above Tepee & below Marten Cr	65	960	0	0	0	0 -60	10	90	0	0	2	0
170103010201 Tepee Cr above Trail Cr	35	520	0	10	0	0 -140	10	160	0	0	3	0
170103010202 Trail Cr	30	440	0	60	600-6,000	0 -150	15	150	0	0	0	0
170103010203 Tepee Cr below Trail Cr	19	290	0	0	0	90 -480	10	40	0	0	0	0
170103010204 Independence Cr	59	870	0	10	0	0	10	100	0	0	1	0
170103010301 NF Coeur d'Alene River above Yellowdog Cr	51	750	0	50	0	2,520 -6,810	25	370	0	0	1	0
170103010302 NF Coeur d'Alene River above Prichard Cr & below Yellow	49	710	0	50	0	850 -3130	40	400	0	0	0	0
170103010303 Lost Cr	24	360	0	190	0	0	5	80	0	0	3	0
170103010401 Shoshone Cr above Falls Cr	42	610	0	330	0	0*	10	300	0	0	0	0
170103010402 Shoshone Cr below Falls Cr	14	200	0	110	0	80 -200	15	160	0	0	4	0
170103010403 Falls Cr	14	200	0	110	0	0*	20	220	0	0	1	0
170103010501 Prichard Cr above Eagle Cr	50	740	0	1,800	1,600-16,000	0	5	380	0	in bank eros.	1	0
170103010502 Eagle Cr	45	660	0	1,080		0*	20	320	0		0	0
170103010503 Lower Prichard Cr	3	50	0	80		0	0	30	0		0	0
170103010601 Lower NF Coeur d'Alene River below Prichard Cr	86	1260	0	90	0	10,500 - 11,540	20	650	4	0	6	0
170103010602 Beaver Cr	42	620	0	1,020	700-7,000	0	10	380	0	in bank	1	0
170103010603 Steamboat Cr	42	620	0	40	0	0 -410	40	560	0	0	6	0
170103010604 Cougar Gulch	19	280	0	150	0	0	10	130	0	0	2	0
170103010701 Little NF Coeur d'Alene River above Burnt Cabin Cr	76	1120	0	610	0	0 -40	85	970	0	0	0	0
170103010702 Little NF Coeur d'Alene River below Burnt Cabin Cr	94	1380	0	750	0	190 -600	60	860	0	0	10	0
TOTAL Entire NF CDA Watershed	896	13,180	0	6,550	3,000-30,000	14,230-23,560	430	6,430	4	--	43	0

4.2 CURRENT SEDIMENT INPUTS

Current sediment inputs (those occurring under 2006 road and land management practices) were compiled to help the TMDL implementation team understand on-going sediment sources and how current management practices could be altered to reduce sediment inputs (Table 18, Appendix 4). Total estimated sediment inputs under current conditions are 43,900 to 80,200 tons/year (50-90 tons/sq mi/yr).

Background sediment input was computed by applying the same set sediment production rate as the 2001 analysis. The TMDL used this background sediment input to help determine which drainages were sediment impaired, and to set sediment reduction goals that could be attained through the implementation planning efforts.

Two sediment sources were classified as legacy sources: bank erosion and channel entrenchment. These on-going sediment inputs are primarily related to land management practices that occurred in the 1900s (large-scale mining, historic timber harvest practices) and are no longer taking place in the manner that caused the stream instability. These both continue to be fairly large sources of course-grained sediment that are provided episodically (during peak flow events).

Sediment sources related to current management practices include road-related sources: road encroachment on stream channels, surface erosion, and culvert washouts/gullies. These are the largest sources of current management sediment in the subbasin. There is an extensive system of roads, particularly in the middle portion of the watershed (Figure 2) as a result of intensive timber harvest in the mid 1900s. The majority of roads are on USFS land and are included in either system roads or non-system road categories by the USFS. System roads (open and closed roads that are part of the USFS transportation system) receive some level of regular maintenance (approx. 1,200 miles), or are closed to current use and receive no maintenance (approx. 1,800 miles). Non-system roads are closed/abandoned roads that likely still have some drainage structures in place but receive no use or maintenance (approx. 1,200 miles). These non-system roads could be considered a legacy source of sediment, but were included in the current management practices category for this assessment. Erosion of roads encroaching on stream channel was estimated to be a large source of sediment, followed by culvert washouts, with road surface erosion a much smaller input.

There is currently little timber harvest on USFS lands. Current timber harvest practices include procedures that limit erosion and delivery of sediment to streams (i.e., stream buffers, yarding away from streams). If extensive timber harvest takes place in the future, this could become a larger source of sediment, but it is relatively small under current conditions.

Agriculture is a very minor sediment source under current conditions. A separate agriculture implementation plan has been developed for the subbasin.

4.3 RECENT SEDIMENT TRANSPORT RATES NEAR THE MOUTH OF THE NORTH FORK COEUR D'ALENE RIVER

As a check on the estimated current sediment input budget listed in Table 18, comparison with total computed sediment input was made with recent measurements in the river. In 1999 and 2000, the United State Geological Survey (USGS) measured bedload and suspended sediment load at the *North Fork CDA River at Enaville* gage and seven other gauging stations in the Coeur d'Alene River basin (Clark and Woods 2000). Rating curves were developed by the USGS to predict sediment discharge for a given water discharge (Figure 5). Bedload and suspended sediment transport rates on the South Fork Coeur d'Alene River were an order of magnitude higher than on the North Fork. The rating curves had high correlation coefficients indicating a tight fit of the data to the curves.

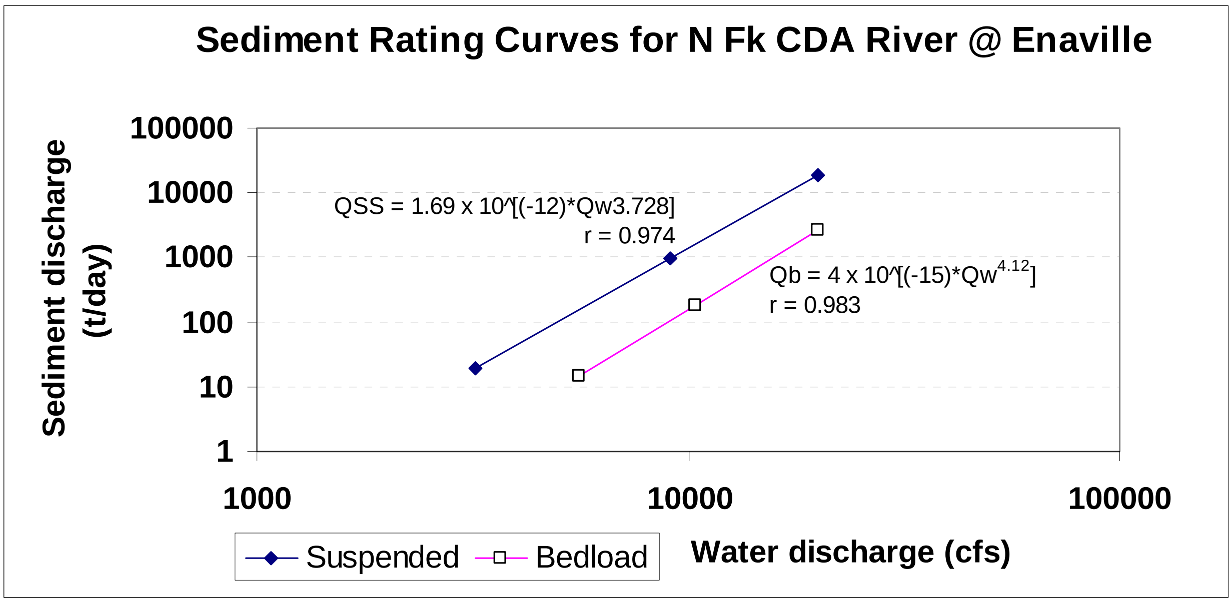

Figure 5. Sediment Rating Curves for the North Fork Coeur d'Alene River at Enaville Gage Based on Measurements made in 1999 and 2000. (Clark and Woods 2000)

The 69 years of available daily flow records (1911-1912, 1940-2007) were used to estimate average annual sediment load at the gage for the full period of record, as well as for flows that occurred in the last 20 years (Table 19). Predicted average annual bedload transport is 10,000-11,000 tons per year. Predicted average annual suspended load transport is 67,000-72,000 tons per year. Bedload is 15% of suspended load, which is on the high-end of normal for a low-gradient river. Because sediment transport rates increase steeply and exponentially with discharge, the two years with the highest floods transported 39% of the bedload and 30% of suspended load for full the 69-year period. Since flood magnitudes in 1974 and 1996 were three times larger than the 20,000 cfs maximum discharge at which sediment was actually sampled, these two years could be introducing a large error in the results.

Table 19. Estimated annual sediment transport rates at the North Fork CDA River at Enaville based on USGS 1999-2000 rating curves

Estimated Parameter	Average Annual Rate from 69-Year Flow Record	Average Annual Rate from Last 20 Years of Flow Record
Bedload discharge (average tons/year)	10,000	11,000
Suspended sediment discharge (average tons/year)	67,000	72,000
Total sediment discharge (average tons/year)	**77,000**	**83,000**
Bedload yield (tons/sq mi/yr)	11	12
Suspended sediment yield (tons/sq mi/yr)	74	81
Total sediment yield (tons/sq mi/yr)	**85**	**93**

The results in Table 19 should be regarded as average transport rates based on current supply conditions. Table 19 does not depict how much sediment actually passed the gage between 1940 and 2007 because the supply of sediment has decreased over time. The amount of suspended load is highly dependent on the amount of available sediment further upstream. Bedload transport rate is more dependent upon water discharge, but it also depends upon channel shape, gradient, roughness and grain size, all of which change during periods of higher coarse sediment load. When bedload supply was significantly higher, the channel would have adjusted in such a manner that it could transport more bedload for a given water discharge.

The total sediment yield based on analysis of USGS gage records is estimated to be 85 to 93 tons per square mile per year depending upon the discharge record used. This does not correspond directly to erosion rate, since some sediment is deposited on the valley floors of upstream tributaries. In addition, bedload moves very slowly downstream so gravel at the Enaville gage was likely eroded decades earlier. For comparison, the 2001 TMDL study calculated 34 tons of erosion per square mile per year. The regional background sediment rate is about 14.7 tons per square mile per year (IDEQ 2001). The current sediment input rate estimated in this study is about 50 to 90 tons per square mile per year.

4.4 Comparison of Current Sediment Sources to Background Input

One measure used in the TMDL process to set sediment loads is to compare management-related sediment inputs to background sediment inputs. The ratio of management:background sediment is often used as a metric to set sediment loading in a drainage. A ratio below 1.5 (e.g., management related sediment input is less than 1.5 times background) is considered acceptable; a ratio over 1.5 is not considered acceptable.

Two ratios of management to background inputs were calculated for each drainage in the North Fork Coeur d'Alene River subbasin (Table 20):

1) the sum of legacy and current management inputs relative to background inputs, and
2) current management inputs (without the continuing legacy contributions) relative to background inputs.

The ratios incorporating both legacy and current management inputs were greater than 1.5 in 52% of the drainages. Only 4 drainages (19% of the 21 drainages evaluated) had ratios greater than 1.5 when only current management inputs were considered. These drainages included 1) the North Fork Coeur d'Alene River above Yellowdog Creek, 2) the North Fork Coeur d'Alene

River downstream of Yellowdog Creek and upstream of Prichard Creek, 3) the lower North Fork Coeur d'Alene River downstream of Prichard Creek, and 4) Shoshone Creek downstream of Falls Creek (Table 20).

Table 20. Current Management-related Sediment Inputs and Ratio over Background Input. Drainages with ratios over 1.5 have shaded cells.

	Management-related Inputs (average tons/yr)		Ratio over Background Sediment	
6th-field HUC	Legacy & Current	Current Only	Legacy & Current Management	Current Management Only
170103010101 NF Coeur d'Alene River above Marten Cr	100	90	0.2	0.2
170103010102 NF Coeur d'Alene River above Tepee & below Marten Cr	130	130	0.1	0.1
170103010201 Tepee Cr above Trail Cr	250	240	0.5	0.5
170103010202 Trail Cr	900	240	2.0	0.5
170103010203 Tepee Cr below Trail Cr	350	350	1.2	1.2
170103010204 Independence Cr	120	110	0.1	0.1
170103010301 NF Coeur d'Alene River above Yellowdog Cr	5,110	5,060	6.8	6.7
170103010302 NF Coeur d'Alene River above Prichard Cr & below Yellow	2,480	2,430	3.5	3.4
170103010303 Lost Cr	280	90	0.8	0.2
170103010401 Shoshone Cr above Falls Cr	640	310	1.0	0.5
170103010402 Shoshone Cr below Falls Cr	430	320	2.1	1.6
170103010403 Falls Cr	350	240	1.8	1.2
170103010501 Prichard Cr above Eagle Cr	3,190	390	4.3	0.5
170103010502 Eagle Cr	3,020	340	4.6	0.5
170103010503 Lower Prichard Cr	110	30	2.2	0.6
170103010601 Lower NF Coeur d'Alene River below Prichard Cr	11,790	11,700	9.4	9.3
170103010602 Beaver Cr	2,110	390	3.4	0.6
170103010603 Steamboat Cr	850	810	1.4	1.3
170103010604 Cougar Gulch	290	140	1.0	0.5
170103010701 Little NF Coeur d'Alene River above Burnt Cabin Cr	1,690	1,080	1.5	1.0
170103010702 Little NF Coeur d'Alene River below Burnt Cabin Cr	2,080	1,330	1.5	1.0
TOTAL Entire NF CDA Watershed	36,270	25,820	2.8	0.2

5.0 RECOMMENDATIONS

The largest continuing sediment sources in the North Fork Coeur d'Alene River subbasin are estimated to be erosion from roads encroaching on stream channels and erosion from culvert failures and washouts. Continued efforts by the USFS to reduce road encroachment by relocating or removing stream adjacent roads or armoring the fill in areas where roads cannot be moved will help to reduce road encroachment erosion. Areas most susceptible to road encroachment erosion have been identified. Continued work to upgrade culverts on system roads and pull culverts on closed roads will help to reduce future erosion from culvert failures and gullying.

It is possible that some of the drainages listed in the 2001 TMDL document no longer need to be listed for sediment under current conditions based on a more detailed analysis. This possibility can be evaluated based on findings in this report along with stream and aquatic indicators.

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