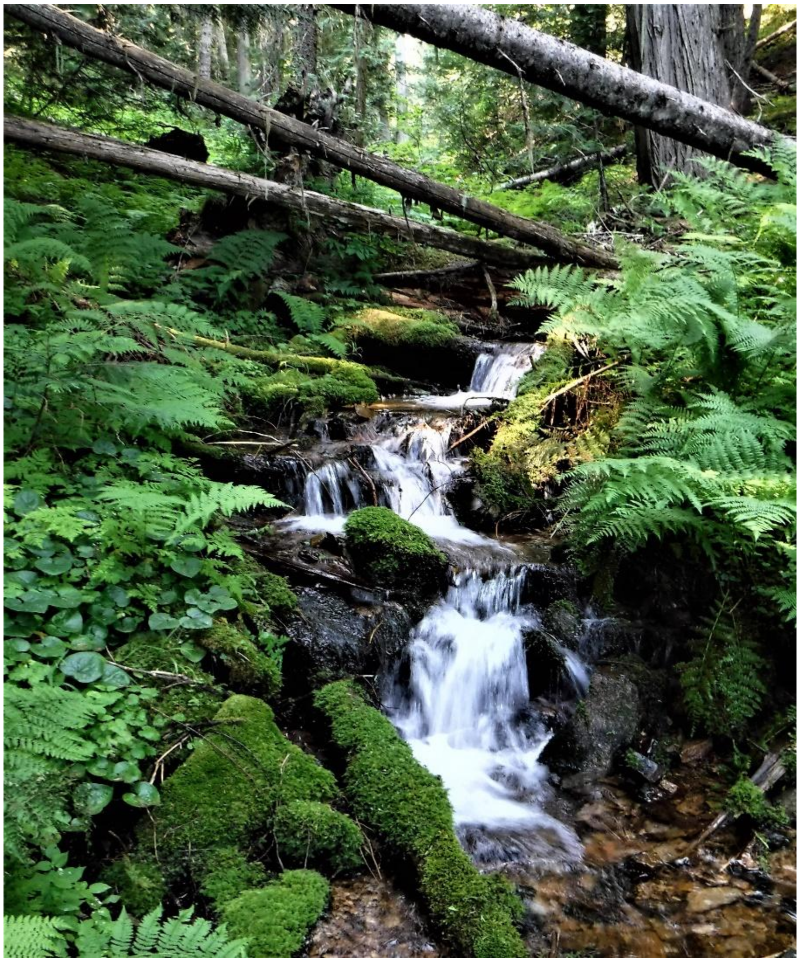
Brebner Flat Project

Hydrology Report



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Report Summary

Based on the Forest Plan (Appendix D) Watershed Disturbance modelling approach, for the St. Joe – Siwash watershed, the ranking for road density, stream crossing frequency, and ECA remained unchanged at medium, low, and low, respectively.

With the implementation of the Proposed Action, the total cumulative effect ECA acreage is 4,049 acres which is 12.8 percent of the St. Joe – Siwash (HUC12 – 170103040308), a 6.1 percent increase over the existing baseline conditions. Based on ECA modeling, no detectable increases, beyond historic variability, in peakflows would be expected from the St. Joe – Siwash watershed.

To evaluate potential impacts to fish bearing streams, ECA was modeled for Kelley, Siwash, Theriault, and Williams Creeks. Based on ECA, an increase in peakflow of 16 to 33 percent could be expected in Kelley Creek, 14 to 31 percent in Theriault Creek, 15 to 32 percent in Williams Creek producing a likely increase in the frequency of bankfull events. Siwash Creek ECA was below the detectable threshold for the ECA model.

The construction and maintenance of roads could result in sediment escaping the road buffer and entering intermittent and perennial stream channels resulting in short-term impacts to surface water quality peaking immediately following completion of the proposed road construction activities and decreasing incrementally to no effect within 1 to 5 years.

With the burning and removal of slash on hillslopes, it could be expected to result in short-term increases in hillslope surface runoff, dry ravel, and nitrate and nitrite increases impacting surface water quality until post-disturbance vegetation is reestablished. These effects should be expected to peak immediately following burning activities and diminishing to no effect in less than a year.

*Based on Idaho Department of Environmental Quality (IDEQ), no stream within the Brebner Flat boundary is rated as "not supporting" in the 2014 (final) or 2016 (draft) 305(b) integrated report. The St. Joe River, starting upstream from Williams Creek at the confluence of the North Fork of the St. Joe, is rated as "*not supporting *"cold water aquatic life due to water temperature exceedance. Kelley, Theriault, and Williams creeks discharge into this segment of the St. Joe River. No stream directly or, indirectly influenced by the Brebner Flat project area is 303(d) listed by the EPA.*

Any increase in suspended sediment and bedload transport from these drainages could result in short-term surface water quality impacts in the St. Joe due to fine sediments. However, these impacts would be minimal since the combined bankfull discharges for Kelley Creek, Siwash Creek, Williams Creek, and Theriault Creek is 149cfs compared to 7070cfs for the St. Joe River at the confluence with Kelley Creek. This is a 47:1 dispersion ratio or, 2.1% of the bankfull discharge for the St. Joe River at the Kelley Creek confluence. Also, the effectiveness of stream flows above bankfull to move sediment and bedload are diminished as they overflow onto the floodplain, which dissipates the energy of the water. As such, for above bankfull events, the impacts from increased sediment would be diminished by the floodplain.

Introduction

This report evaluates potential impacts to hydrologic processes influencing watershed conditions from the Brebner Flat Project consistent with the framework defined within the IPNF Forest Plan (2015 Revision) which is incorporated into this document by reference. Specifically, this framework includes the goals, desired conditions, objectives, standards, and guidelines for watersheds (Chapter 2, pgs. 22 -23). In addition, potential impacts to hydrologic processes will be evaluated with respect to Tribal, State, and Federal regulations.

The primary focus of the Brebner Flat project is to address forest health within the project area including improved resilience to drought, wildfire, and disease by increasing early-seral species including western white pine, western larch, and ponderosa pine. Table 1 provides a comparison between the No Action and Proposed Action for the Brebner Flat project area.

Table 1. Comparison between the No Action and Proposed Action for the Brebner Flat project

Treatment/Activity	No Action	Proposed Action
Silvicultural Treatments (acres)		
Clearcut Harvest (with reserves)	0	778
Seed-tree Harvest (with reserves)	0	273
Irregular Shelterwood/Seed Tree (with reserves)	0	260
Irregular Shelterwood (with reserves)	0	568
Total	0	**1,879**
Logging Systems (acres)		
Off Road Skyline	0	239
Skyline	0	1,032
Ground Based		608
Total	0	**1,879**
Estimated Timber Volume (million board feet)	0	23
Post-Harvest, and Vegetation Treatment		
Grapple Pile and Burn (acres)	0	608
Broadcast Burning (acres)	0	1,271
Total Vegetation Treatments (acres)	0	1,879
Road Management		
New Road Construction (miles)	0	2.5
Temporary Road Construction (miles)	0	4.2
Road Re-construction (miles)	0	5.2
Road Decommissioning (miles)	0	1.3
Total	0	13.2

Design Features

The following design feature is required to ensure compliance with the regulatory framework and to reduce the risk of adverse impacts to this resource.

1. Include all applicable best management practices (BMPs) described in the Soil and Water Conservation Handbook (Forest Service Manual 2509.22).

Anticipated Effectiveness (High)

The 2016 Idaho interagency forest practices water quality audit (IDEQ 2016) describes how the erosion control measures observed in the statewide audit are generally effective when properly installed and maintained. This audit also acknowledged the Forest Service had 97 percent compliance during the last 4-year audit cycle and averaged 99 percent compliance with best management practice rules since 1996. The same audit found slash mats were the most practical method for controlling erosion from skid trails, and road measures, such as gravelling, rocking ditches, installing rolling dips and waterbars were effective at reducing erosion. The effectiveness of road maintenance best management practices is corroborated by the Forest Service Water Erosion Prediction Project road erosion modeling results, the literature review of research on best management practices conducted by Edwards et al. 2016, and also by local monitoring completed on the Idaho Panhandle National Forests.

Regulatory Framework

The Proposed Action has been reviewed and is determined to be in compliance with the management framework applicable to this resource. The laws, regulations, policies and forest plan direction applicable to this project and this resource are as follows:

Federal Law

Clean Water Act

The Clean Water Act requires that States and Tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. Stipulations in the Clean Water Act require the Environmental Protection Agency (EPA) and the States to develop plans and objectives that will eventually restore identified stream segments of concern. The Clean Water Act requires all water bodies that are deemed to be not fully supporting their beneficial uses by the State (Idaho) be brought onto the 303(d) list as water quality limited. For waters identified on this list, states must develop a total maximum daily load for the pollutants set at a level to achieve water quality standards.

The Proposed Action would be consistent with the requirements of the Federal Water Pollution Control Act as amended by the Clean Water Act, 33 U.S.C. section 1251.

National Forest Management Act

Section 6 of the National Forest Management Act provides language to "insure that timber will be harvested from National Forest System lands only where; soil, slope, or other watershed conditions will not be irreversibly damaged; protection is provided for streams, stream-banks, shorelines, lakes, wetlands, and other bodies of water from detrimental changes in water temperatures, blockages of water courses, and deposits of sediment, where harvests are likely to seriously and adversely affect water conditions or fish habitat; and that such [harvests] are carried out in a manner consistent with the protection of soil, watershed, and fish, resources".

The Proposed Action would comply with the National Forest Management Act through the inclusion of riparian habitat conservation areas, best management practices, and project design features which are shown to protect aquatic resources.

Executive Orders

Executive Order 11988 (Protection of Floodplains) and Executive Order 11990 (Protection of Wetlands):
Executive Order 11988 requires Federal agencies to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative.

Executive Order 11990 directs Federal agencies to provide leadership and take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for conducting Federal activities and programs affecting land use, including but not limited to, water and related land resources planning, regulating, and licensing activities.

The Proposed Action is consistent with the executive orders regarding floodplains and wetlands. This project proposes no development within wetlands or floodplains. Further, the Proposed Action incorporates specific design features which would protect wetlands.

Extraordinary Circumstances:

Following are the resource conditions that should be considered in determining whether extraordinary circumstances related to the Proposed Action warrant further analysis and documentation in an environmental assessment or an environmental impact statement:

2. Federally listed threatened or endangered species or designated critical habitat, species proposed for Federal listing or proposed critical habitat, or Forest Service sensitive species
3. Floodplains, wetlands, or municipal watersheds
4. Congressionally designated areas, such as wilderness, wilderness study areas, or national recreation areas
5. Inventoried road less areas or potential wilderness areas
6. Research natural areas
7. American Indians and Alaska Native religious or cultural sites
8. Archaeological sites, or historic properties or areas

The following conditions were necessary to consider for this resource and the following determinations are made based on a review of the Proposed Action, required design features, the regulatory framework, and necessary analysis for hydrologic resources.

State and Local Law

Idaho Forest Practices Act

The Idaho Forest Practices Act regulates forest management on all ownerships in Idaho, including National Forest System lands (Title 38, Chapter 13, Idaho Code 2000).The Forest Service has agreements with the State to implement best management practices for all management activities. All activities would meet or exceed guidelines described in the Soil and Water Conservation Handbook (Forest Service Manual 2509.22)

Best management practices or soil and water conservation practices are included into the Proposed Action and all activities comply with the guidelines in the soil and water conservation handbook. A recent audit of best management practices pertaining to water quality indicates the Forest Service averaged 99 percent compliance with best management practices rules since 1996, and identifies that best management practices are effective when properly installed (IDEQ 2016).

Idaho Stream Channel Protection Act

The Idaho Stream Channel Protection Act requires that the stream channels of the state and their environment be protected against alteration for the protection of fish and wildlife habitat, aquatic life, recreation, aesthetic beauty and water quality. The Stream Channel Protection Act requires a stream channel alteration permit from Idaho Department of Water Resources before any work that would alter the stream channel may begin.

The Proposed Action is consistent with the requirements of this act. Inland native fish strategy criteria incorporates specific protections for stream channels, and is included in this project. All necessary permits would be obtained prior to any work (culvert replacements) occurring in a stream channel.

Floodplains, Wetlands, or Municipal Watersheds

Wetlands

Based on the National Wetlands Inventory (http://www.fws.gov/wetlands/), no wetlands were identified within the Brebner Flat project area. All other wetlands that may be located during field reviews or project implementation would receive appropriate protections as described in the INFS.

Extraordinary Circumstances Determination**:** The Brebner Flat project will not have extraordinary circumstances associated with the Proposed Action.

Rationale for Determination**:** There are no municipal watersheds located within the project area. The project area flood plains and wetlands would be protected by implementation of specific design features and best management practices (BMPs).

Methodology

For this analysis, the empirical Equivalent Clearcut Area (ECA) methodology (Grant et al., 2008) was used to evaluate potential changes to the frequency and intensity of peakflow events. To evaluate road surface sediment, the Water Erosion Prediction Project model (WEPP): Roads model (Elliot, 2004) was used to estimate annual sediment erosion from roads.

Spatial Boundary

The impacts analysis for the Brebner Flat project will be analyzed within the project boundary encompassing 2,952 acres of private land and 8,827 acres of Forest Service lands for a total of 11,779 acres. The cumulative effects analysis will be conducted at the St. Joe - Siwash watershed extent of 31,765 acres (HUC 170103040308).

Temporal Boundary

The analysis temporal boundary is 5 to 20 years from the start of the Brebner Flat project. Within five years, surface infiltration and surface erosion concerns should be mitigated as herbaceous vegetation reestablishes on hillslopes, road cut and fill slopes, and drainage ditches. This early succession vegetation is beneficial in-terms of reducing rain drop impacts at the soil surface, interrupting runoff, and capturing generated sediment. Within 5 to 20 years, hillslope stability, snow ablation rates, runoff timing, and water yield concerns would be mitigated as tree canopies and root networks are reestablished. A landslide inventory (Megahan et al., 1977) conducted in Idaho revealed hillslope failures were most frequent 4 to 10 years after logging, the period of minimum stability during residual root decay and subsequent regeneration. After 20 years, the occurrence of landslides returned to prelogging levels. It should be noted, only 9 percent of the inventoried slides were attributed to the removal of vegetation compared to 88 percent attributed to roads. These results were based on clearcutting. Partial cutting, which leaves a viable root mass is presumed to have a less of an impact on hillslope stability.

Environmental Consequences

No Action

Direct and Indirect Effects

With the implementation of the No Action alternative, no changes in road derived sediment, sediment transport, or surface water and subsurface water flow alterations would be expected within the Brebner Flat project area. As such, no changes to stream peak flows, peak flow timing or duration, or snow ablation (melt and evaporation), would be expected within the Brebner Flat project area resulting from Forest Service activities.

Proposed Action

Affected Environment

The planned 1,719 acres of timber harvest comprises 14.5 percent of the Brebner Flat project area and 5.4 percent of the Siwash Creek – St. Joe River watershed. Given the stream pattern, stream and hillslope slopes, and low stream orders, St. Joe – Siwash Creek watershed is very responsive to storm events with a rapid rise and fall of the hydrograph. To establish a baseline condition for the St. Joe – Siwash watershed, for cumulative effects analysis, the following analysis of the existing road density, stream crossing frequency, and equivalent clearcut area disturbance were evaluated to enable comparison between the No Action and Proposed Action conditions. The watershed acreage, stream lengths, and average stream slopes for the Brebner Flat project area are summarized in table 2.

Table 2. Listing of subwatersheds located within the Brebner Project area

Watershed	Area (acres)	Stream Length (mi)	Avg. Stream Slope
Siwash Creek*	5,847	20.0	11.2
St. Joe Face**	2,431	8.0	15.5
Kelley Creek	2,331	9.4	15.6
Williams Creek	918	4.0	20.1
Theriault Creek	252	1.7	15.5

*Includes Siwash Creek (5.53 mi/10.3%) and Blue Grouse Creek (2.73 mi/12.6%)

**Includes Roundhouse Creek (1.63mi/18.5%)

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups (A – high infiltration, B – moderate infiltration, C – slow infiltration, and D – very slow infiltration. The soils located within the project area are classified as group B having a moderate infiltration rate when thoroughly wet. Within the project area, the soil textures are comprised of silt (65%), sand (29%), and clay (6%). The Siwash-St. Joe watershed is located within the Northern Rocky Mountain physiographic province Sisters Basin and Uplands Subsection containing the upland divide between the headwaters of the Little North fork of the Clearwater River and Sisters, Siwash, and Fishhook Creeks that drain north to the St. Joe River. Bedrock in the area is highly complex with mostly belt metasediments (Pritchard, Ravalli, and Wallace rocks). The main ridge divide in the central part of the area is underlain by the Idaho Batholith, anorthosite in the southern part, and a couple small outcrops of undifferentiated volcanic outcrops.

Pfankuch (Pfankuch, 1975) as modified by Rosgen (Rosgen, 1996, 2006b) surveys were conducted on Siwash and Blue Grouse (2nd order tributary to Siwash), the modified Pfankuch rating ranged from poor to good (PH_1 and PH_2). The modified Pfankuch survey evaluates the upper banks, lower banks, and streambed. Both Siwash and Blue Grouse received poor to fair scores for bank rock content, debris jams and subsequent bank cutting, sediment and bedload deposition, and bedload brightness. Based on visual estimates, streamflows on Blue Grouse creek have scoured and deposited bedload up to 12 inches. Based on IDEQ BURP data, the D84 for Blue Grouse creek is 200mm or 7.9 inches. Olsen et al [1997], if the largest bed particles (D84 or larger) are stable, then the stream channel is likely to be stable. If conditions exist that the stream is capable of initiating movement of the D84 particle during a bankfull event, the stream is considered to be unstable and at a “threshold of concern”.

Running water and mass wasting are the primary landform shaping process in eroding, transporting, and depositing sediment. During the Pfankuch field surveys, evidence of hillslope instability were observed by the Forest Hydrologist as indicated by bank shear, hummocky lobes, and mass wasting (slump) along Blue Grouse creek. The observation of hummocky lobes and bank shear were located in the upper reaches of Blue Grouse creek on an approximately 35 to 40 percent slope along the right bank (facing downstream). The hummocky lobes and bank shear were occurring along the outside bank of a meander resulting in an undercut exposed bank approximately 5ft. high. The slump was located approximately a ½ mile above the confluence with Siwash. The slump appeared to initiate mid-slope running to the stream and didn’t appear to be associated with an existing or historic road cut.

Based on USGS StreamStats, the bankfull event, based on a 1.5 year return interval, is 35.9 ft^3/sec for Blue Grouse creek with a drainage area of 2.99 mi^2, 97.8 ft^3/sec for Siwash creek with a drainage area of 9.11mi^2, and 35 ft^3/sec for Kelley creek with a drainage area 3.64 mi^2. These are the primary watersheds potentially impacted by the Brebner Flat project.

Topography and Climate

Elevations within the project area range from a low of about 2,600 feet on the banks of the St. Joe River to a high of 5,800 feet on Siwash Peak. Records from the nearest weather station in St Maries, ID indicates January as the coldest month with average high temperature of 34.3°F and average low of 21.5°F. July is the warmest month with average high and low temperatures of 85.2°F and 49.3°F respectively. Average annual precipitation is 42.1 inches. The wettest month, on average is January with 4.06 inches and the driest month is July with 0.89 inches of precipitation.

The climate data described above was collected at an elevation of 2,140 feet, which is significantly lower than the project area’s average. The WEPP model adjusts weather station precipitation and temperature data based on elevation and topography by allowing inputs for latitude and longitude. Two representative locations within the project area were selected and results are shown in table 3.

Table 3. PRISM estimated precipitation for the Brebner Flat project area

Site	St Maries	Brebner Timber Sale
Location	47.32 ^{o} N by 116.57 ^{o} W	47.13 ^{o} N 115.47 ^{o} W
Elevation	2,140 feet	3,600 feet
Avg. Annual Precipitation	29 inches	42.1 inches

These climate values were used in the ECA and WEPP models to estimate yield changes and erosion rates from within the Brebner Flat project area.

Road Density

Currently, the road density, including county, forest service, and private roads, is 4.89 mi/mi2 within the Brebner Flat project area and 2.90 mi/mi2 for the St. Joe – Siwash watershed are summarized in Table 4.

Table 4. Summary of the current road miles and density within the Brebner Flat project area

		No Action	
Spatial Scale	Jurisdiction	Road Length (miles)	Road ** Density (mi/mi ^{2})
Brebner Flat PA	USFS	56.2	3.1
St. Joe – Siwash Watershed	All (USFS, Private, and County)	143.9	2.9

** USFS calculation is based on an area of 18.41mi ^{2} (Brebner Flat project area); All calculation is based on an area of 49.6 mi ^{2} (St. Joe – Siwash watershed)

Stream Crossing Frequency

Table 5 summarizes the current stream crossing frequency for the Brebner Flat project area. For existing forest service roads, the stream crossing frequency is 0.81 crossing per mile which is a moderate rating based on watershed disturbance rating**. For the St. Joe – Siwash watershed scale, this value drops to 0.65 crossings per mile of stream, for all roads including county, private, and Forest S5ervice, which is a low ranking based on the watershed disturbance score.

Table 5. Summary of current stream miles and stream crossing density within the Brebner Flat project area

Spatial Scale	Jurisdiction	Number of Crossings	Stream (miles)	Stream Crossing Frequency (crossing/mi)
Brebner Flat PA	USFS	35	43.1	0.81
St. Joe – Siwash Watershed	All (USFS, Private, and County)	74	114.4	0.65

** WDR – Watershed Disturbance Rating based on ECA (Appendix D, Table 212, FP 2015)

Equivalent Clearcut Acres (ECA)

The ECA values, adjusted based on treatment, have been summarized in the following table and ranked based on watershed disturbance ranking (WDR**) as summarized in table 6.

Table 6. Forest Service ECA by drainage within the Brebner Flat project area

Drainage	Drainage Area (acres)	All Roads ROW (acres)	Past Forest Service Harvest (acres)	Past Private Harvest (acres)	Total ECA Area (acres)	Total ECA (%)	WDR**
Kelley Creek	2,331	149	0	656	805	35	Medium
Siwash Creek	5,848	338	358	278	974	17	Medium
St. Joe Face	2,432	57	0	0	57	2	Low
Therault Creek	252	18	0	59	77	31	Medium
Williams Creek	918	56	0	320	376	41	Medium

** WDR – Watershed Disturbance Rating based on ECA (Appendix D, Table 212, FP 2015)

This analysis considered the total acreage of disturbance from the existing county, private and forest service roads network and past timber harvest activities on private and federal lands within the Brebner Flat project area.

Beneficial Uses and Water Quality Status

Water quality refers to the physical, chemical, and biological composition of a given water body and how these components affect beneficial uses. The Idaho Department of Environmental Quality (IDEQ) requires beneficial uses to be protected for each water body in the state. Blue Grouse, Siwash, Kelley, Roundhouse Gulch, Theriault, and Williams's creeks have the following beneficial use designations:

- Cold water aquatic life
- Salmonid spawning
- Primary contact recreation

The following table summarizes the length of stream located within the Brebner Flat boundary, Rosgen stream type, and current IDEQ category and classification summarized in table 7.

Table 7. IDEQ classification for streams located within the Brebner Flat project area

Stream Name	Stream Type	Category	2014 and 2016 (draft) EPA/IDEQ
Blue Grouse Creek	A3/4	2	Fully Supporting (1)
Kelley Creek	B3/4	2	Fully Supporting (1)
Roundhouse Gulch	A	2	Fully Supporting (1)
Siwash Creek	B2/3	2	Fully Supporting (1)
Theriault Creek	A	2	Fully Supporting (1)
Williams Creek	A	2	Fully Supporting (1)

Based on the 2014 final and 2016 Integrated Report draft recommendations, no stream within the Brebner Flat boundary is 303(d) listed by the EPA or rated as "not supporting" beneficial use in the 305(b) integrated report. As such, no total maximum daily load (TMDL) monitoring is required for the streams located within the Brebner Flat project area.

Stream Temperatures

Currently, the St. Joe River starting at the confluence of the North Fork of the St. Joe (upstream from Williams Creek confluence) to St. Joe City is rated as "not supporting" cold water aquatic life due to water temperature exceedance in the 2014 IDEQ Integrated Report with a completed State TMDL.

Direct incoming solar radiation is the dominant energy input for increasing stream temperatures with shade being the single most important variable to reduce this heat input (Gravelle and Link 2007, Krauskopf et.al. 2010). Of the proposed actions, timber harvest is the only activity that could potentially increase the amount of solar radiation reaching the streams. Through the implementation of the INFS (USDA 1995) and the incorporation of RHCAs into the Brebner Flat project area, the proposed activities would not further degrade water quality with respect to temperature because RHCAs would retain the canopy cover that prevents solar inputs to the stream. Field reviews of project area streams documented dense, intact overstory and understory vegetation providing canopy cover. Gravelle and Link (2007), also found that the use of riparian buffers effectively negated the effects of timber harvest impacts on stream temperatures in the reaches directly below harvested areas.

To evaluate current stream channel stability, a modified Pfankuch (Rosgen, 1996, 2006b) surveys were conducted by the St. Joe District Hydrologist and Fish Biologist on Siwash and Blue Grouse (2nd order tributary to Siwash). The modified Pfankuch evaluates the upper banks, lower banks, and streambed conditions. Based on this criteria, the modified Pfankuch rating ranged from poor to good (Hydro project file documents PH_1 and PH_2). Both the lower reach of Siwash, below the confluence with Blue Grouse, and Blue Grouse received poor to fair scores for bank rock content, debris jams and subsequent bank cutting, sediment and bedload deposition, and bedload brightness indicating frequent scouring events. A Pfankuch survey on the upper reach of Siwash Creek, above the confluence with Blue Grouse, wasn't conducted but visual observations indicated a stable streambed, lower banks, and upper banks capable of handling increased peakflow events at the bankfull and flood stages.

During the Pfankuch field surveys, evidence of hillslope instability were observed by the St. Joe District Hydrologist including bank shear, hummocky lobes, and mass wasting (slump) along Blue Grouse Creek. The slump appeared to initiate mid-slope running to the stream and didn't appear to be associated with an existing or historic road cut.

Peakflow Analysis based on Equivalent Clearcut Area (ECA)

Approximately, 45 percent of the Brebner Timber Sale Project area is located between 3,000 to 4,500 feet elevation band which is considered the transient snow zone. This band is susceptible to rain-on-snow events. In transient snow zones, an ECA value exceeding 20 percent is considered a threshold for evaluating existing watershed conditions. For this analysis, the empirical ECA methodology (Grant et al., 2008) was utilized to evaluate potential changes to the frequency and intensity of peakflow events.

Introducing Sediment into Streams

For surface water quality, roads connected hydrologically to a stream channel by a stream crossing, drainage feature, or overland flow present two concerns:

1. Road derived sediments and contaminants transported to streams; and
2. Surface and subsurface water flow alteration (interception – ponding and/or redirection).

Road derived sediments, referred to as wash loads, are particles washed into the stream during runoff events, finer than particles located within the stream, and typically remain suspended great distances impacting the turbidity, temperature, and concentrations of pollutants in the form of dissolved and total solids within the stream channel. During rain events and seasonal snowmelt, if near surface infiltration rates are exceeded, especially on heavily compacted road surfaces, overland flow occurs resulting in surface flow patterns, rill, and gully formation. Given adequate depth and velocity, eroded surface materials consisting of coarse sand and larger, can be transported to stream channels impacting streambeds.

Natural surface and subsurface waterflow patterns are interrupted by the construction of roads in mountainous terrain. In a forested environment, the majority of water runoff is subsurface flow traveling in preferential flow paths, macropores, such as animal burrows and decayed root cavities. When these preferential flow paths are interrupted such as by a road cut, water collects upslope of the road surface leading to water ponding on road surface, accelerated erosion, and in instances with shallow depth of soil on an impermeable substrate, hillslope slumping and/or failure. Road construction on any hillslope will inevitably decrease the site stability by (1) adding weight to the slope in the embankment fill, (2) steepening the slope on both cut and fill surfaces, (3) removing support of the cut slope, and (4) rerouting and concentrating road drainage water. Poor drainage design (too few or no culverts) and plugged cross-drains on insloped roads can cause saturation of critical areas of the fill slope and can lead to failure of the fill. Drainage water routed into potential or inactive slump-earthflow areas downslope of roads will decrease their stability; drainage into slope depressions and other wet areas can also initiate shallow, rapid failures. The loss of root strength after clearcutting could significantly reduce the stability of shallow earthflows and could also permit increases in soil creep. In deep-seated (>10m) creep and flow failures, the influence of lateral and vertical anchoring by tree-root systems is minimal (Swanston and Swanson, 1976, as cited by Sidle, 1985).

As material is eroded from road surfaces, the formation of water flow patterns, rills, and gullies would be expected during storm events. The road network becomes a conduit, mimicking an ephemeral stream channel, collecting and transporting storm water runoff and suspended sediment long distances. If hydrologically connected to a stream, sediment is directly deposited into the stream channel since no buffer exists to allow deposition of suspended sediment. Road surveys were conducted by the Forest Hydrologist, Fish Biologist, Fishery technician, and Hydrologic technicians to evaluate current road surface conditions, drainage features, and active erosional processes to identify maintenance priorities and evaluate past mitigation.

Direct and Indirect Effects

Road Density

With the Proposed Action alternative, road density (refer to table 8) would increase from 3.1 to 3.5 which is an 11.4 percent increase for Forest Service roads within the Brebner Flat project area as summarized in table 8.

Table 8. Comparison of road miles and density for the No Action and Proposed Action alternatives

	No Action		Proposed Action	
Jurisdiction	Road Length (miles)	Road** Density (mi/mi^2)	Road Length (miles)	Road** Density (mi/mi^2)
USFS	56.2	3.1	65.2	3.5

** Based on Brebner Flat project area of $18.41 mi^2$

Stream Crossing Frequency

The stream crossing frequency remains unchanged from the No Action alternative since no additional road – stream crossings resulted from the 9.05 miles of roads added as part of the Proposed Action.

Equivalent Clearcut Acres (ECA)

When a drainage on the IPNF, approaches a 20 percent ECA, there is an increased risk for adverse effects to the stream channel geomorphology. Values less than 20 percent are below the detection threshold of the empirical relationship. Researchers have attempted to quantify the ECA method (or similar methodologies) in an attempt to evaluate watershed responses due to timber harvest. Thomas and Megahan (1998) summarized the ECA discussion well. "Given the complex nature of the effects of forest cutting and roads on streams, it is not surprising that the literature provides mixed messages about peak flow responses". Table 9 summarizes the range of expected peakflow increases, by watershed, as a result of the Proposed Action timber treatments.

Table 9. Summary of % peakflow increases, based on ECA, by drainage for Proposed Action

Drainage	Drainage Area (acres)	FS New (acres)	All Roads (acres)	ECA Total (acres)	ECA Total (%)	Peakflow Change (%)
Kelley Creek	2,331	481	160	672	28	12-24
Siwash Creek	5,848	738	338	1,076	18	<threshold
St. Joe Face	2,432	260	64	343	13	<threshold
Therault Creek	252	39	18	57	23	11-22
Williams	918	119	63	190	20	10-20

** ECA adjustment factors (based on the amount of crown cover removed) for treatments proposed for the Brebner Flat project are clearcutting (1.0), seed-tree harvest with reserves (0.98), irregular shelterwood/seed tree with reserves (0.92 and 0.98), and irregular shelterwood with reserves (0.92).

Based on ECA, the St. Joe Face and Siwash drainages are below the detectable threshold as such, no effects beyond historic variability, would be expected. Streams located within the Kelley Creek and Williams Creek drainages could experience increased frequency of bankfull runoff events. An increase in the occurrence of instantaneous bankfull stage peak flow events would result in an increase in the frequency of bedload scour and deposition (Olsen et al, 1997). Bankfull stage, also referred to as geomorphic effective stream discharge, is defined as the increment of stream discharge that transports the largest portion of the annual sediment load, including bed load. The effectiveness of stream flows above bankfull to move sediment and bedload are diminished as they overflow onto the floodplain which dissipates the energy of the water.

Road Sediment

Based on WEPP: Roads modeling results, table 10 summarizes the road surface length, average slope, sediments generated from the associated road treatment, and potential sediments leaving the road buffer, without any BMP or design feature influence, a worst case scenario.

Table 10. Annual sediment loads from the Proposed Action planned road activities

Description*	Usage	Design	Distance (mi)	Avg. Slope (%)	Road Sediment (tons)	Outside Buffer (tons)
New Construction	NH	OR	2.02	7.6	43	+14
Reconstruction	NH	OR	2.96	10	79	+40
Temporary	NH	OR	4.04	11.1	97	+48
Decommissioned**	NH	OR	1.3	12.7	-12	-7
Closed -> Stored	NL	OR	4.39	9.9	-30	-18

* Model inputs: Width – 16ft., Fill gradient – 45%, Fill Length – 16ft., Buffer gradient – 45%, Buffer length – 25ft., Rock fragment – 25%; Sediment values based on 200ft. modeled road lengths extrapolated to listed distance
** Modeled results based on pre-decommissioned conditions for comparison

With proper BMP implementation, generated road surface sediment should be captured within the road right-of-way or within the adjacent forest litter layer (Seyedbagheri 1996, IDEQ 2016, Edwards et al. 2016). Karwan et al, [2007] evaluated suspended sediment resulting from road construction and timber harvest on the Mica Creek experimental watershed near the St. Joe National Forest and reported variable impacts on streams from BMPs implemented during road construction and timber harvest. Based on results, the study concluded road construction and maintenance didn't result in a significant difference in suspended sediment but, clearcut harvesting resulted in in-stream suspended sediment increases immediately following the timber harvest. The increase in suspended sediment dissipated within a year of completion of the timber harvest.

Fire – Slash Treatments

The Proposed Action intends to broadcast burn slash on 1,136 acres and grapple pile/burn the slash from the remaining 583 acres. The immediate effect of fire is an increase in overland flow (surface runoff), an increase in water flow patterns, and a decrease in subsurface flow, due to reduced infiltration from a hydrophobic layer at the soil surface, and associated hillslope instability. Based on the Erosion Risk Management Tool (ERMiT) for a low burn severity, sediment delivery of 2.06 tons $acre^{-1}$ (2,340 tons) in year-one, 1.05 tons $acre^{-1}$ (1,192 tons) year-two, 0.8 tons $acre^{-1}$ (908 tons) year-three, 0.58 tons $acre^{-1}$ (658 tons) year-four, and 0.34 tons $acre^{-1}$ (386 tons) year-five following the burned slash treatment. For rain, rain-on-snow, and snowmelt runoff, 187 acre-feet per year (0.26 cfs) runoff increase was modeled by ERMiT. For hillslope instability, Rice and Osborn [1970] reported landslides contributed only 1 to 2 percent of the total erosion from recently burned watersheds. Rice [Rice, 1977 as cited by Sidle, 1985] concluded that although burning may initially reduce landsliding, as rooting systems decay and new vegetation restores infiltration (2 to 3 years), the burned areas became much more vulnerable to landsliding similar to clearcut forest.

Another form of erosion is dry ravel. Dry ravel involves the downslope movement of individual soil grains, aggregates, and coarse fragments due to gravity. Dry ravel erosion has been noted to be inversely proportional to vegetative cover immediately after burning and during revegetation. Gravelle et al [2009] reported substantial increases in $NO_3 + NO_2$ (nitrate + nitrite) below clearcut harvest units, becoming diluted downstream, and suggested that it may be a partial response to burning the slash.

Cumulative Effects

Road Density

For cumulative effects analysis, all the private, forest service, and county roads were included resulting in a 5.8 percent increase in road density for the St. Joe – Siwash watershed as summarized in table 11.

Table 11. Road miles and density comparison between the No Action and Proposed Action alternatives

	No Action		Proposed Action	
Jurisdiction	Road Length (miles)	Road** Density (mi/mi^2)	Road Length (miles)	Road** Density (mi/mi^2)
USFS, Private, and County	143.93	2.90	152.98	3.08

** Calculations are based on St. Joe – Siwash watershed area of 49.6 mi^2

Watershed Disturbance Rating (WDR)

To date, the USGS Watershed Boundary Dataset is complete for the United States to the 12-digit hydrologic unit. The 14 and 16-digit hydrologic units are optional and are not complete for the nation. To evaluate possible impacts to specific streams located within the St. Joe – Siwash HUC12 watershed, select drainages were delineated using USGS StreamStats (refer to table 2 and 12). For hydrologic impact analysis the standard methodology is to utilize a HUC-12 spatial scale. Based on Pfankuch survey results, ECA modeling was expanded to include these drainages to evaluate the potential for stream channel impacts due to increased frequency of bankfull events. To determine the cumulative effects WDR for the estimated drainages based on ECA, the total acres of clearcut area was determined by combining the proposed timber treatments, existing and proposed road treatments, and past private land timber treatments (refer to table 12).

Table 12. Watershed Disturbance Ranking for select drainages based on ECA for past, present, and proposed activities

Watershed	Drainage Area (acres)	All Roads (acres)	New FS Harvest (acres)	Past FS Harvest (acres)	Past Private Harvest (acres)	Total ECA Area (acres)	Total ECA (%)	WDR** Ranking
Kelley Creek	2,331	160	481	0	656	1,298	57	High
Siwash Creek	5,848	338	738	358	278	1,712	29	Medium
St. Joe Face	2,432	64	260	0	0	324	13	Low
Theriault Creek	252	18	39	0	59	116	46	Medium
Williams Creek	918	63	119	0	320	502	55	High

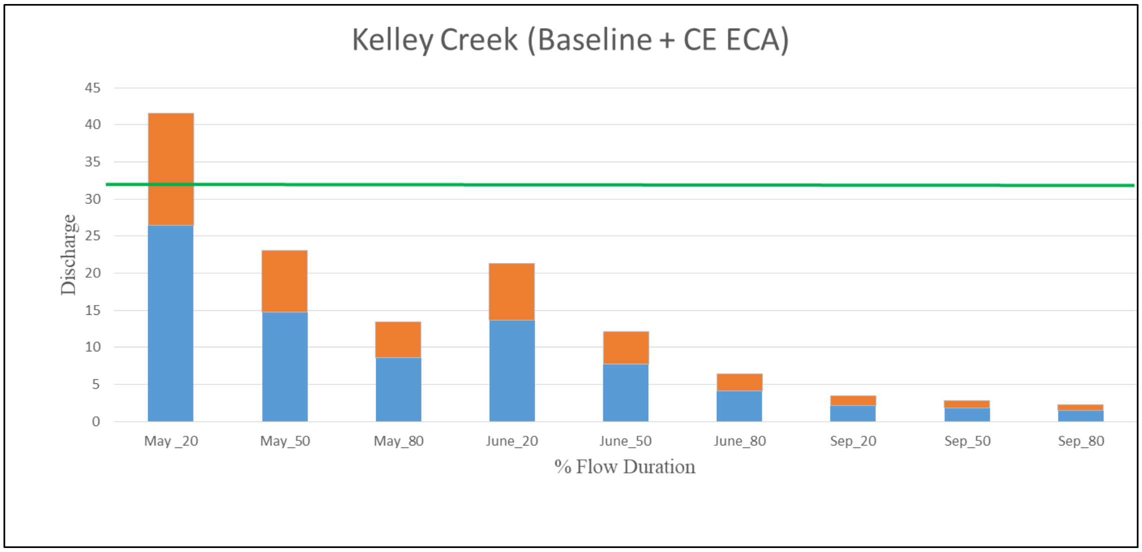
**WDR – Watershed Disturbance Rating based on ECA (Appendix D, Table 212, FP 2015)

With the incorporation of past activities, the WDR ranking remained the same for Siwash, St. Joe Face, and Therault but changed from a medium ranking to a high ranking for the Kelley Creek and Williams Creek drainages. For Kelley Creek, a peakflow increase of 16 to 33 percent could be expected and for Williams Creek 15 to 32 percent. As such, an increase in the frequency of bankfull events is likely within the Kelley Creek and Williams Creek drainages.

For Kelley Creek, based on field surveys, the streambed and streambanks of Kelley creek are considered stable with infrequent observation of bank erosion, streambed scour, and pool sediment deposition. With a potential increase in peak flows of 33 percent, additional bankfull stage events could be expected resulting in streambed scour, aggradation, and bank erosion impacting pool depth and streambed substrate. These effects would be expected to decrease incrementally to no effect within 20 years as post-disturbance vegetation is reestablished and pre-treatment interception, evapotranspiration, and infiltration rates are restored.

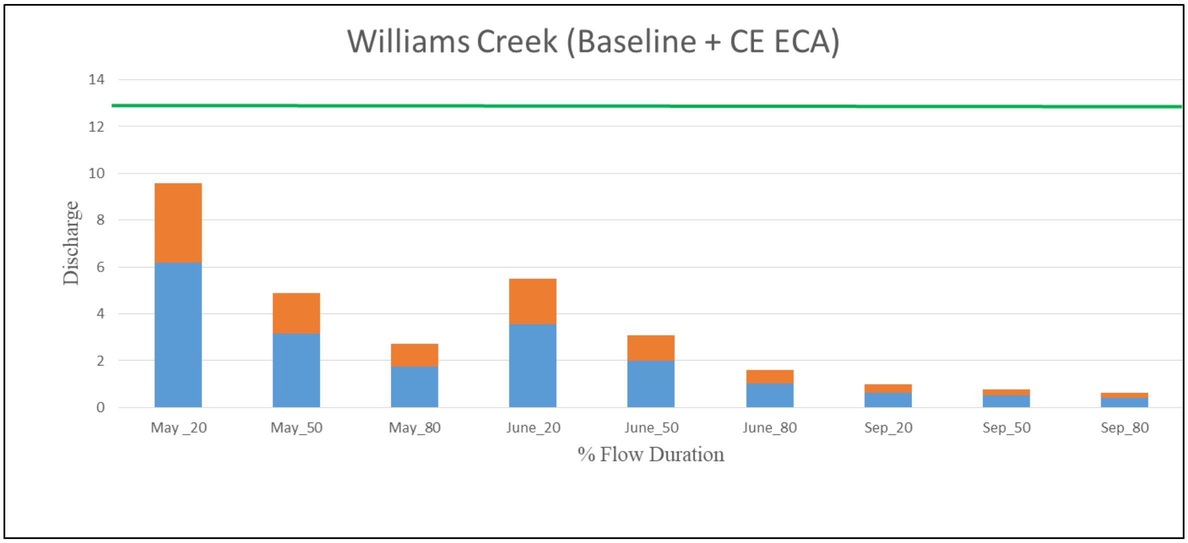
To evaluate the likelihood of bankfull events during the key periods of bull trout migration, the baseline discharge was adjusted by the modeled ECA increases (see figure 1). Based on this analysis, discharge from Kelley Creek could potentially exceed bankfull with a 20 percentile flow event during the month of May but not in June or September.

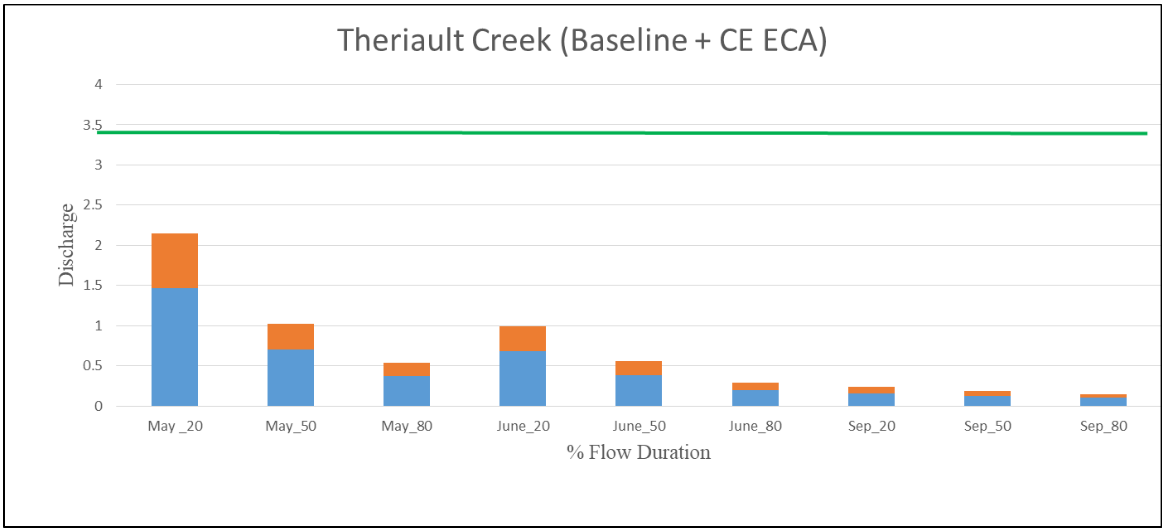
Figure 1. Kelley Creek bankfull discharge analysis (depicted by green line) during primary bull trout migration periods based on 20%, 50%, and 80% flow durations from StreamStats



Using modeled data (refer to table 12), Theriault and Williams's drainages, have similar possible increases in peak flows as Kelly Creek, which could have similar concerns with increased bankfull stage events impacting streambed and streambank stability; peaking within the first year of the proposed action and decreasing to no effect within 20 years. To evaluate the likelihood of bankfull events during the key periods of bull trout migration, the baseline discharge was adjusted by the modeled ECA increases (see figure 2). Based on this analysis, discharge from Williams Creek and Theriault Creek would be expected to remain below the bankfull levels in May, June, and September during the bull trout migration periods in the St. Joe River.

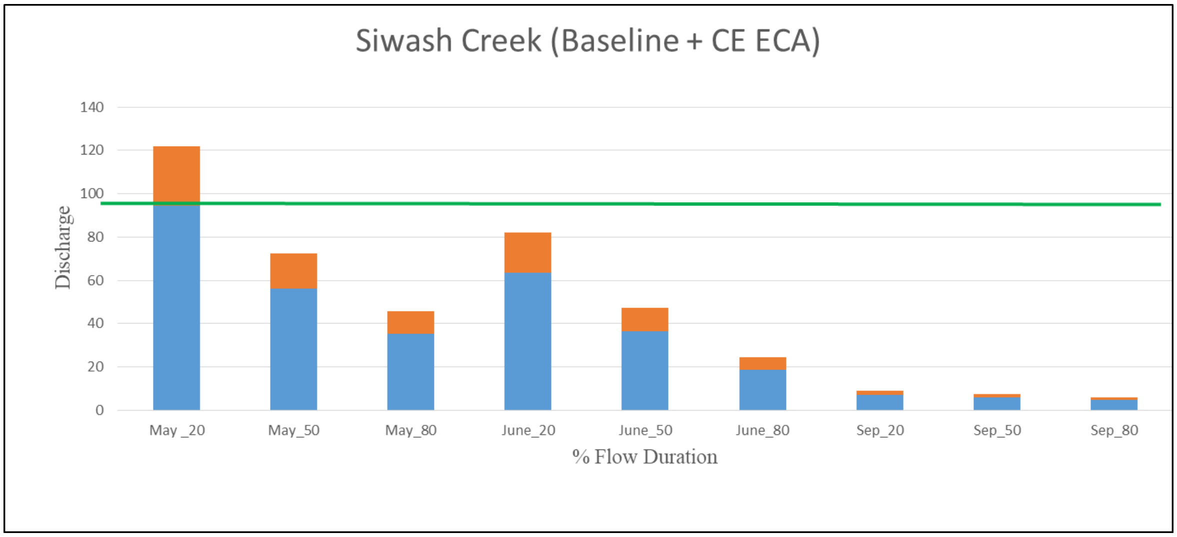
Figure 2. Williams and Theriault Creek bankfull discharge analysis (depicted by green line during primary bull trout migration periods based on 20%, 50%, and 80% flow durations from StreamStats





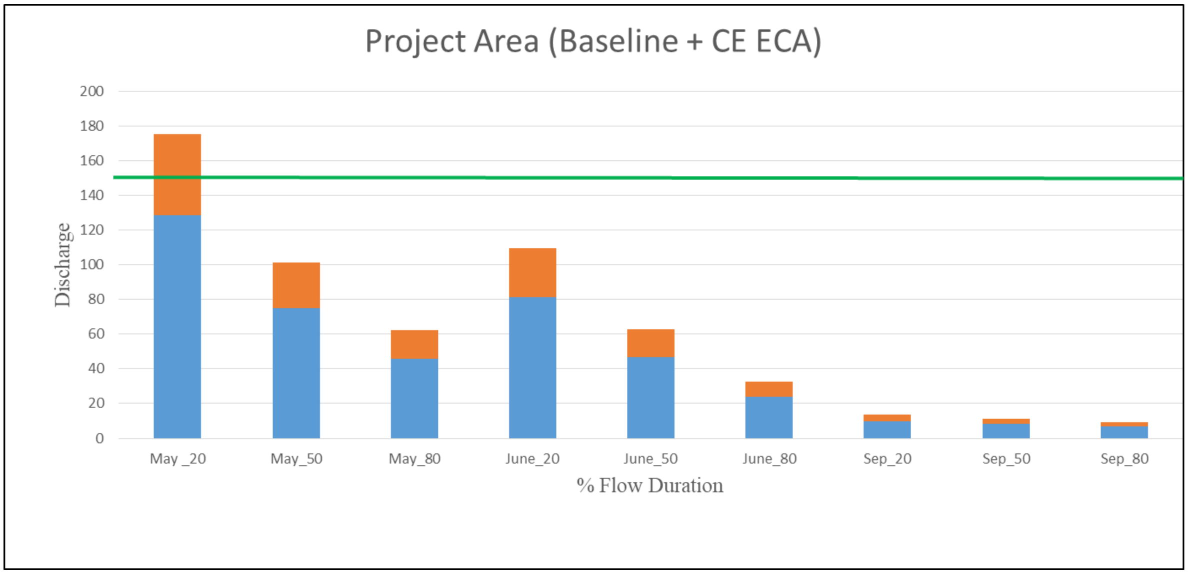
For Siwash Creek, the total ECA percentage is slightly above the detectable threshold for peakflow increases. Based on the stable stream conditions observed on the upper reach of Siwash, minimal impacts to the streambed, lower banks, or upper banks would be expected. For the lower reach, any minor peakflow increase would be mitigated as upper reach peakflows travel downstream into a larger stream channel. To evaluate the likelihood of bankfull events during the key periods of bull trout migration, the baseline discharge was adjusted by the modeled ECA increases (see figure 3). Based on this analysis, discharge from Siwash Creek could potentially exceed bankfull during a 20 percentile flow event during the month of May, but not in June or September.

Figure 3. Siwash Creek bankfull discharge during primary bull trout migration periods based on 20%, 50%, and 80% flow durations (USGS Streams Stats data)



Any increase in suspended sediment and bedload transport from these drainages could result in short-term surface water quality impacts in the St. Joe River due to potential fine sediments. To put this in perspective in-terms of dispersion by the St. Joe River, the combined bankfull discharges for Kelley Creek, Siwash Creek, Williams Creek, and Theriault Creek is 149cfs which is only 2.1% of the 7070cfs bankfull discharge for the St. Joe River at the confluence with Kelley Creek. Any sediment transport into the St. Joe River would be dispersed at a ratio of 47:1, only the 20 percentile flow duration in May (refer to table 4) would cross the bankfull threshold for total discharge from the Project Area.

Figure 4. Total PA bankfull discharge during primary bull trout migration periods based on 20%, 50%, and 80% flow durations (USGS StreamStats data**)**



Watershed Disturbance Ranking for Proposed Action

Based on the Forest Plan (Appendix D) Watershed Disturbance modelling approach, based on the St. Joe – Siwash watershed scale, the ranking for road density, stream crossing frequency, and modeled ECA remain unchanged at medium, low, and low, respectively (refer to table 13).

Table 13. Summary of WDR comparisons for road density, ECA, and stream crossing frequency for the No Action and Proposed Action alternatives

	No Action				Proposed Action			
	Ranking**	L	M	H	Ranking**	L	M	H
Road Density	2.90		●		3.05		●	
Stream Crossing Frequency	0.64	●			0.64	●		
ECA	7%	●			13%	●		

**WDR – watershed disturbance rating – refer to IPNF FP 2015, Appendix D, pp. 200 – 201

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