REACH-SCALE PLAN: SOUTH FORK NOOKSACK RIVER

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1.0 Introduction

This plan is being prepared as a deliverable pursuant to the Nooksack Indian Tribe’s approved work plan under grant SEANEP-2015-NookIT-00024 as administered by the Washington Department of Ecology. The intent of the approved work plan is to develop a “reach-scale” plan for the protection and restoration of the riparian zone of the South Fork Nooksack River (SFNR) in agricultural areas from its confluence with the North Fork Nooksack River at river mile (RM) 0.0 upstream to the confluence with Skookum Creek, at RM 14.3. This reach-scale plan presents, at a conceptual scale, 1) a description of the geographical setting of the SFNR watershed, 2) legacy impacts, 3) impacts of projected climate change on aquatic resources, 4) an inventory of riparian areas and their condition along the river, 5) opportunities for riparian protection and restoration, and 6) identification of land areas (while maintaining confidentiality) that may qualify for funding for protection and restoration activities on lands along the river and/or its tributaries.

This reach-scale plan, Phase 1 of this grant, is intended to provide a basis for more detailed analysis and planning on land parcels where there is substantive opportunity for the protection and restoration of riparian areas and that have owners who are willing to participate in funding for Phase 2, riparian protection and restoration implementation. This reach-scale plan also provides watershed-wide information that has been excerpted from the Draft Watershed Conservation Plan (NIT 2017) prepared by the Nooksack Indian Tribe for the SFNR. The Watershed Conservation Plan is based upon several years of research and analysis of watershed conditions, and aims to provide information and recommendations for protecting and restoring water resources specifically and natural resources in general. The Watershed Conservation Plan provides detailed information on the SFNR watershed that relates to the specifics of this reach-scale plan.

Water quality and water quantity are major concerns in the SFNR watershed. The South Fork Nooksack River does not meet federal and state Clean Water Acts (CWA) standards, and as such, the river is listed as on the CWA Section 303(d) as an impaired water body for high temperatures and excessive fine sediment. The Watershed Conservation Plan addresses these concerns in general by presenting pertinent detail on watershed characteristics, including the legacy impacts of past land use and continued climate change, and offering recommendations on actions that could reduce the severity of these impacts.

2.0 Watershed Characteristics

2.1 Geographic Setting

The SFNR is one of three forks that form the Nooksack River (geographic Hydrologic Unit Code (HUC) 17110004). Figure 1 shows the location of the SFNR watershed within Water Resources Inventory Area (WRIA) 1, which includes the Nooksack River, Sumas River and several independent drainages to the Strait of Georgia. The SFNR originates on the east side of the snow-dominated Twin Sisters Mountain Range, the west and south margins of Loomis Mountain and the west side of Dock Butte, and drains about 164 square miles of watershed area before joining the North Fork Nooksack River to form the mainstem Nooksack River at river mile 36.6. Elevation ranges from approximately 7,000 feet on the Twin Sisters Range to approximately 236 feet at the confluence with the North Fork Nooksack River. There are no longer active glaciers on the Sisters
Range and other areas of the upper watershed; however, vestigial ice with a total area of 0.42 square miles remains. The river has an average annual flow of 1,104 cubic feet per second (cfs) measured at the USGS gage at Saxon Road Bridge (Site Number 12210000). Base flow during the summer is supported by a small amount of melting ice but predominantly groundwater inflow. Late fall, winter, and spring flows are provided by rainfall and snowmelt.

2.2 South Fork Nooksack River Reaches

The mainstem South Fork Nooksack River can be divided into five reaches based on river miles: RM 0–14.3 (floodplain; impaired TMDL reach); RM 14.3–18.5 (canyon); RM 18.5–25.4 (core Chinook spawning); RM 25.4-31 (confined areas); and RM >31 (mostly U.S. Department of Agriculture [USDA] and U.S. Forest Service [USFS] administered lands). The contributing watershed can be divided into seven subbasins based on these reach breaks and the contribution of larger tributaries. Figure 2 shows how the South Fork Nooksack River can divided for the descriptive purposes.

Reach #1 - RM 0-14.3: TMDL Impaired Reach

The lowest reach of the SFNR flows through a broad alluvial valley that is dominated by agricultural land use. This reach is the subject and primary focus of this reach-scale plan. Historically, this unconfined valley was the area where wood and sediment delivered to the channel upstream was deposited, forming a branching river system with abundant logjams and a well-connected floodplain with extensive wetlands. This section of the river was the first to be impacted by land use changes, beginning with land clearing in the 1860s for agriculture and shingle bolts. The floodplain was almost entirely cleared and burned by the early 1900s and logjams removed from the channel to allow for wood transport down the river. The loss of logjams
and vegetation from the banks of the river and increased sediment loading led to rapid channel migration and widening by the 1930s, and subsequent bank armoring to protect eroding farmlands.

Cumulatively the effects of land clearing, channel cleaning, bank armoring, and increased sediment loading since the 1930's have led to channel incision and floodplain abandonment through much of the lower 14.3 miles of the river. Although incision has led to channel deepening, the wide active channel area still exists, thereby reducing the effectiveness of riparian shading.

Some of the likely impacts on hydrology and water quality as a result include increased water temperature, increased sediment delivery to the channel, increased sediment transport rate, stream incision, and general loss of the natural streamflow regime (faster runoff times, higher peak flows, lower low flows). In addition to legacy impacts, climate change will impact the watershed further, especially RM 0-14, by increasing water temperatures, decreasing baseflows, increasing peak flows, and altering sediment dynamics with a likely increase in sediment loading and transport. To protect riparian and floodplain habitat and facilitate habitat restoration, land acquisition has been a high priority in the lower SFNR valley. The acquisition has allowed for wetland creation, floodplain channel restoration, and extensive riparian planting, while making substantial portions of the floodplain available for floodwater storage.
Reach #2 - RM 14.3-18.5: Canyons

The segment of the South Fork Nooksack River from RM 14-18.5 has a more confined morphology dictated by bedrock valley walls and erosion-resistant terraces. Channel migration has been very low through the historic period in this reach. Most of this segment is in its natural condition with ample riparian cover and serves as a conduit for sediment. There are no barriers, roads, or rip rap that interfere with flow. Currently much of this reach is industrial forest land and managed under the forest practices rules, which require site-potential buffers along the river. Property acquisition to provide long-term protection for the reach has been the focus of restoration activities. Habitat restoration opportunities are limited by poor construction access.

Reach #3 - RM 18.5 – 25.4: Chinook Core Spawning

The unconfined sections of the river in this section represent the core spawning areas for South Fork Nooksack spring Chinook and have been the focus of instream habitat restoration since the 1990s. This reach of the river is bordered by a mix of industrial forest lands and conservation property. Riparian zones are recovering from past forest practice activities that harvested the majority of the riparian zone of the SFNR. Several large deep-seated landslides occur along the channel in this reach, episodically contributing large amounts of fine sediment to the river. Four engineered logjam projects have been completed and design is ongoing for several more projects. The focus of the restoration has been on creating high quality holding habitat for adults, with a newer focus on trying to reverse the trend of channel incision in the reach. Extensive sediment reduction work has been completed by forest landowners and restoration partners in this reach. Riparian restoration has been ongoing for approximately 15 years and is expected to continue.

Reach #4 - RM 25.4 – 31: Confined Reaches

A partial passage barrier marks the break between this reach and the downstream core spawning area. In the early 1990s, Seattle City Light acquired a corridor along the South Fork Nooksack River from RM 25 to the USFS border, near RM 33. The channel is sinuous and intermittently anastomosing in some reaches with occasional large gravel bars. Erosion resistant terraces of fluvial and glacial deposits slow the channel migration rate through much of the reach. Deep-seated landslides occur in glacial deposits that line the channel and the upland portions of the watershed, as well as a large bedrock landslide at RM 31 along the right bank of the channel. Past land use activities have likely exacerbated the glacial deep-seated landslides, as groundwater recharge areas were not protected by the forest practices rules until the last decade. In addition to the deep-seated landslides, there are abundant shallow-rapid landslides that have delivered sediment to the channel. These slides generally occur on steep, convergent slopes and are often related to land use activities, such as timber harvest or road construction.

Reach #5 - Upstream of RM 31: USDA-Forest Service

This section of the river lies above the anadromous barrier at RM 31. Much of the watershed above RM 31 lies within land administered by the USFS and is currently protected by the North West Forest Plan. Forest roads are limited on USFS property, but a lack of funding for maintenance has led to several places where road failures have impacted aquatic resources. The South Fork Nooksack River downstream of the USFS boundary is bordered by property acquired and preserved by Seattle City Light as mitigation for dams on the Skagit River. These areas have been a focus for forest road abandonment, infrastructure removal, restoration, and riparian planting. Beyond the mitigation property, lands are managed for industrial forestry and are subject to the Forest Practices rules, which require buffering of all fish-bearing streams and portions of non-fish
bearing streams. A substantial number of higher hazard forest roads have been abandoned by the landowner in this reach of the river. While no instream habitat projects have been completed or are planned in this section of the river, efforts focused on watershed and riparian restoration and sediment reduction are expected to continue.

2.3 Land Use

The South Fork Nooksack River watershed has been subjected to a variety of land uses and management schemes. Figure 3 shows approximate areas of the various land uses. Logging has historically been the most significant and widespread land use and commercial activity in the SFNR watershed since European settlement in the 1880s (Whatcom County 1990). Timber was originally transported down the river until a railroad system was constructed (Royer 1982). Rails were eventually replaced by forest roads throughout the watershed. By the 1930s, much of the forest and wetland areas on the lowlands had been cleared and drained for agricultural production, resulting in rapid channel migration and expansion of the unvegetated channel area around the river. Subsequent channel erosion led to installation of bank stabilization infrastructure (i.e. riprap) that eventually led to narrowing of the active channel width. Channel straightening has resulted in a loss of about 3,500 feet, or about 5% of channel length, reduced access of the river to its floodplain, and reduction in effective shade and hyporheic exchange in the channel (Collins and Sheikh, 2004). Current land use in the SFNR watershed is dominated by forestry in the uplands, with agricultural use restricted to the valley floor. The U.S. Forest Service manages the headwaters of the watershed downstream to approximately river mile (RM) 33. Between RM 33 and RM 25, Seattle City Light purchased the river-adjacent property for conservation as mitigation for hydroelectric dams on the Skagit River.

Present-day watershed function is the result of both current land uses and legacy impacts that have altered the forests on the hillslopes of the watershed and in the riparian zones of the tributary network. These forest changes affect the upland water cycle, sediment transport, and in-channel river processes. In particular, land use has reduced upland water storage, and the export of water from the watershed has been accelerated relative to natural conditions, leading to lower summer streamflows and warmer stream temperatures (Dickerson-Lange 2017). Climate warming will exacerbate these conditions with less snowpack and earlier melt, resulting in further reductions in summer streamflow and increases in stream temperature (Mote and Salathe’, 2010; Elsner et al, 2010; Mantua et al., 2010). Upland watershed function affects the health of both terrestrial and aquatic ecosystems. In addition to a warming climate over the past 100 years, human-caused impacts such as forest harvest, road-building, fire, beaver trapping, and in-channel wood removal reduce the amount of water stored or accelerate the export of water from the watershed (Jones and Greant, 1996; Rice, 1995; Bowling and Lettenmaier, 2001; Soicher et al., 2006). Thus, opportunities exist to adapt management practices and restore watershed function in order to buffer projected climate change impacts. Restoration of these river systems will increase sediment and water storage and slow the export of water from the network. Together these restorative changes can have a considerable impact on peak flow, base flow, and groundwater resources.
2.4 Hydrology

The Nooksack basin lies within a convergence zone with sub-Arctic weather from the northwest, and Pacific weather systems from the south and west (U.S. Forest Service 1995). In the summer months, the Pacific systems dominate with mild, clear weather and low levels of precipitation. In the winter, cold Pacific and sub-Arctic systems move into the area bringing storms, high levels of precipitation, and occasionally very low temperatures. The hydrograph of the South Fork Nooksack River is bimodal and reflects rain, spring snowmelt, and occasional rain-on-snow events (Figure 4). This means that the period of lowest flow also corresponds with the warm summer months, often leading to high stream temperatures and water quality impairment in the river. The hydrograph reflects regional climate patterns, with nearly 50% of the annual precipitation occurring between November and January and snowmelt occurring in April through June.

The SFNR watershed is considered a transient watershed with snow-driven hydrology in the higher elevations and rain-driven hydrology in the lower elevations. Transient watersheds are the most sensitive to climate change impacts because small changes in temperature can substantially affect snow accumulation and snow covered area (Mote and Salathé 2010). Further, inter-annual variability in climate and weather can result in a large variability of snowpack, rain, temperature, and hydrology from year to year (Hamlet et al., 2005). In addition to climate variables, watershed characteristics that affect the timing and routing of peak flow include differences in elevation, slope, aspect, soils, and vegetation cover.

Monitoring of river flow in the South Fork Nooksack River at Saxon Bridge has shown that the summer low flow period has lengthened and the annual minimum baseflow discharge has slightly decreased since 2009. Since 2009, the number of days between the onset of baseflow and the minimum baseflow has increased as well as the total number of days of the baseflow period. The WY 2015 hydrograph is similar to the projected shape of the SFNR hydrograph under future climate change scenarios, where less snowfall will result in a reduction of the spring snowmelt peak and lower summer baseflow conditions.
The variability in the timing and magnitude of peak flows and baseflows is likely due to differences in the inter-annual variability of the El Niño- Southern Oscillation (ENSO) or the occurrence of atmospheric rivers in the winter time (e.g. “Pineapple Express”). In addition, the amount of snowpack, rain-on-snow events, and intensity of rainfall can all affect the timing and magnitude of winter flows and onset and duration of baseflow.

The interaction between the surface water and subsurface water is particularly evident during the baseflow period. Seepage run studies (comparing flows between upper and lower stations of a river reach) during the baseflow period suggest spatial variability in the exchange of groundwater with surface water in the SFNR and its tributaries (Gendasczek, 2014). Generally, the upper SFNR valley consistently gains streamflow, whereas the lower SFNR below Skookum Creek is more likely to lose streamflow to groundwater storage. However, discrete cold-water anomalies with low diurnal temperature variability were recorded at two locations along the SFNR river miles 10 and 11.3, suggesting groundwater influx to the mainstem SFNR. These cold-water anomalies were associated with both bank and streambed seepage of groundwater as well as thermal stratification within pools associated with log jams. Continuously monitored groundwater levels in riparian wetlands and water surface stage of the SFNR suggest that some wetlands are dynamically linked to the river whereas other wetlands are perched on low-permeability floodplain sediments and receive their recharge from direct precipitation (Gendaszek, 2014).

Taken together, these data provide the foundation for a future groundwater-flow model of the SFNR basin that may be used to investigate the potential effects of future climate change, land use, and groundwater pumping on water resources in the study area. In addition to domestic, agricultural, and commercial uses of groundwater within the SFNR basin, groundwater has the potential to provide ecological benefits by maintaining late-summer streamflows and buffering stream temperatures. Cold-water refugia, created and maintained in part by groundwater inflow and groundwater exchange within the channel bed, can be key elements to restore the health and viability of threatened salmonids in the SFNR.
2.5 Sediment

Turbidity and suspended sediment transport in the Nooksack River watershed are dynamic, multifaceted, and complex—both temporally and spatially, as well as having a stochastic or random nature. The SFNR is on the Clean Water Act (CWA) 303 (d) list for fine sediment that exceed the Washington State CWA criteria. Watershed hydrology, land use, weather, and geology are the main drivers of baseline suspended sediment output; however, stochastic events (i.e. landslides, bank erosion, and rain on snow events) occasionally occur that can significantly increase that output. Because there is a minimal current glacial melt component to hydrology in the SFNR, high sediment transport generally only occurs during peak flows in the rainy winter months. Spikes in turbidity generally mirror peaks in discharge due to the SFNR’s predominantly rain-dominated watershed. Snowpack in the uplands or prolonged periods of drought stall or reduce sediment transport. In the SFNR, turbidity and SSL generally decrease downstream from Saxon Road to Potter Road (NNR, 2017). The decrease in turbidity and increase in discharge from upstream to downstream likely indicates that most of the sediment sources to the SFNR are above the Saxon Road site. In addition, the lower SSL at Potter Road would suggest that fine sediment is being stored in the lower SFNR reach. It is interesting to note that sediment transport in the SFNR is seasonally opposite of the MFNR or NFNR, which are driven by summer glacial ice melt that provides increased sediment loading.

Natural processes and human activities affect the volume, distribution and frequency of sediment delivery to stream channels. In general, erosion rates in forested mountain watersheds are highly variable and depend on differences in slopes, soils, geology, vegetation, and climate (Rice et al. 1972). While sediment transport processes are episodic over some time scale, channel response to sediment depends on the channel’s ability to transport and store material relative to the amount of sediment supplied. When the sediment supply is greater than the ability to transport sediment, channel responses such as aggradation, channel widening, substrate fining, pool filling and channel braiding can occur. Conversely, a reduction in sediment load can lead to channel incision and bedload coarsening. Either of these changes can negatively affect the quality of instream habitat.

Glacial deposits, including short-lived lake deposits, overlay the bedrock through much of the SFNR watershed. These deposits vary in composition from thinly bedded clay, silt and sand to boulder-laden glacial till. These deposits are also largely associated with the numerous stream-adjacent failures that line the South Fork Nooksack River from its headwaters to below Lyman Pass (River Mile 18). These landslides have a substantial impact on water quality (Section 2.4.3). There have been 875 shallow-rapid landslides mapped in the watershed upstream of Saxon Bridge over the 55-year photo record (Watts 1996, Kirtland 1995, Cascade Environmental Services 1993, Peak Northwest 1986). Of the characterized landslides, 62% (483 of 779) were associated with land use activities and 80% (465 of 580) delivered sediment to a stream. The most common land use associated with shallow rapid failures was recent timber harvest. A more recent reconnaissance mapping of 101 landslides in the SFNR Watershed following the 2009 storm found that the percentage related to land use had been greatly reduced to 11% associated with roads and 28% with a harvest unit or young forest (Powell et al. 2010).

Elevated turbidity, which is a measure of water clarity and can be used as a proxy for fine sediment. Turbidity can directly affect the growth, survival, reproduction and ecological integrity of aquatic life in multiple ways. Turbidity grab sampling efforts in 1998, 1999 and 2012 have shown that turbidity in the mountain tributaries to the SFNR valley was heavily influenced by
forest practices, particularly road fill failures in the Todd Creek watershed (Soicher 2000). Many sampling locations exceeded the 1-hour “Slight Impairment” threshold of 38 NTU at least half of the time sampled, which can cause behavioral effects to fish such as disorientation and altered feeding. Some of the locations also surpassed the 1-hour threshold for “Significant Effects” (160 NTU), which can cause more permanent changes to growth and habitat. A more recent study by the Nooksack Indian Tribe that uses continuous turbidity records in the SFNR indicates that turbidity at both Saxon Rd. and Potter Rd. exceeds the 24-hour “Slight Impairment” criteria nearly 50% of a water year on average. Both locations exceed the 10 month “Significant Effects” criteria (3 NTU) for most of a given water year (NNR, 2017).

2.6 Stream Temperature

The SFNR is listed on the Clean Water Act (CWA) 303(d) list for excessive temperatures, so a Total Maximum Daily Load (TMDL) is under development to assess heat allocations for the river and develop an implementation plan to voluntarily address water temperature (Department of Ecology 2017). The Environmental Protection Agency (EPA), Washington State Department of Ecology (DOE), and the Nooksack Indian Tribe are cooperating on the development of this effort. In addition to this regulatory objective, EPA Region 10 has partnered with EPA’s Office of Research and Development (ORD), Office of Water (OW) and Nooksack Indian Tribe (NIT) together initiated a Pilot Research Project to consider how projected climate change impacts for the SFNR could be incorporated into the TMDL and influence salmon habitat restoration plans that address legacy and current impacts of land management and that are robust in the face of climate change. Two EPA publications that resulted from this project includes: 1) Quantitative Assessment of Temperature Sensitivity of the SFNR under Future Climates using QUAL2Kw (Butcher et al. 2016) and 2) Qualitative Assessment: Evaluating the Impacts of Climate Change on Endangered Species Act Recovery Actions for the South Fork Nooksack River (EPA et al. 2016).

High water temperatures during summer represent an important limiting factor for Nooksack early Chinook salmon and other salmonids in the Nooksack River watershed, especially in the SFNR. High water temperatures in the SFNR regularly exceed optimal temperature ranges and approach lethal limits for salmonids. Figure 5 shows instantaneous temperature at Saxon Road and Potter Road bridges. In 2015, the 7-day average of the daily maximum in the SFNR was nearly 23°C, well in excess of the temperature ranges considered optimal for Chinook Salmon incubation (11-15°C) and juvenile rearing (14.2°C-16.8°C) (Coe and Cline 2009; NNR 2012, 2013, and 2015, unpublished). High temperatures in the lower SFNR stress holding and spawning fish and increase susceptibility to disease, which can cause prespawning mortalities or otherwise reduce reproductive success. Although increases in average temperature over time may seem small, salmonids and other aquatic life are very sensitive to these small changes. As much as 0.5° C (0.9° F) can alter life stage timing and duration thereby affecting feeding behavior and growth. Water year 2015 for the SFNR was indicative of what is projected for the future with climate change with regards to low streamflow and high temperatures: higher temperatures and lower streamflow in the summer, and higher temperatures, less snowpack, and more flooding in the winter. Discrete temperature measurements at both Saxon Rd and Potter Rd. indicate a general trend of warming since 2009, where both locations frequently exceed beneficial use criteria during summer months (Figure 5). These trends could be indicative of decadal variability as the period of record is not long enough for longer-term analysis.
Temperature is directly affected by the removal of riparian zone vegetation, which increases solar radiation reaching the stream surface. Additional land uses, such as forest practices, in the Nooksack River watershed have likely contributed to elevated stream temperatures. In a recent study performed by Pollock et al. (2009) in forest lands of western Washington, harvest in upland areas explained approximately 39 percent of the variation in stream temperatures, while harvest within the riparian areas explained 33 percent. This study suggests that commercial forestry, primarily roads, on upland areas of a watershed have similar or more impact on stream temperatures than forestry activities in riparian areas adjacent to the stream. Further, many tributaries that are non-fish bearing perennial, intermittent, and ephemeral alike, are not afforded protective buffers under the Washington State forest practice rules which likely further exacerbates temperature loading of the river. These processes need to be considered when identifying appropriate best management practices for temperature modulation in the Nooksack River watershed. Channel restrictions by flood control levees, hard armoring, transportation structures, and disconnection of the channel from its floodplain, coupled with draining of floodplain wetlands have also likely contributed to increasing temperatures, especially in the lower SFNR.

2.7 Riparian Conditions

Riparian conditions along the SFNR and its tributaries vary widely across the watershed. An inventory of riparian conditions on fish-bearing streams throughout the Nooksack watershed found that wood recruitment and shading potential were related to land use, as represented by zoning classification, in the following order from highest function to lowest: national park, national forest, commercial forest, rural forest, rural, urban and agriculture (Duck Creek Associates 2000, Coe 2001). While substantial riparian restoration efforts have occurred across the floodplain subsequent to this inventory, the SFNR Valley is still the critical focus area for protecting and improving riparian conditions. The goal for the SFNR is to have mature, coniferous-
dominated riparian zones of at least 200-300 feet wide to maximize shading and wood
recruitment potential to the river. There have been extensive efforts made to establish riparian
buffers and under-plant deciduous stands along the streams with coniferous seedlings to speed
the forest along the successional pathway toward climax forest conditions.

Shade modeling of the SFNR under current and site potential vegetation was accomplished as a
part of the South Fork Nooksack River temperature TMDL (Department of Ecology 2015 Draft).
The site potential conditions for the riparian stands were assumed to be a 150’ wide buffer of
mature (>100-year old) conifer stands averaging 166’ tall. A second sensitivity model run for
historic conditions based on scientific input from the Tribe included modeling a wider (218’) and
taller (290’) buffer (Butcher et al. 2016). This model run was thought to more accurately represent
“natural conditions” or “conditions that occurred prior to the pollution problem.” The modeling
of existing and site-potential shade showed a dramatic gap, likely due to the on-going and legacy
impacts of land use on the riparian conditions.

The riparian zone of the river and its floodplain tributaries is impacted by a variety of existing
infrastructure. For the mainstem SFNR, extensive riprap boulder bank armoring is the greatest
impact to riparian function. Transportation infrastructure (roads, railroad) also limits the
development of riparian stands within 300’ of the river. In addition, agriculture and residential
development eliminate large areas of forested land that would otherwise be available for
recruitment to the river. The following directly impact riparian function in the SFNR watershed:

- 9.25 miles of bank armoring along SFNR
- 2.1 miles of road in the riparian zone of SFNR
- 31% of SFNR buffer and 16% of tributary buffers are actively farmed
- 11% of SFNR and 8% of tributary buffers impacted by residential development

2.8 Channel Processes

For much of the length of the channel, the width of the channel migration zone is only slightly
larger than the current active channel width. This slow migration allows mature conifers to
dominate the streamside forest. This improves the shading potential for the river, but limits the
amount of large wood recruited to the channel. Channel migration rates naturally vary along the
SFNR due to variation in channel confinement, bank resistance, valley slope, flow, sediment load
and vegetation characteristics. In the upper reaches of the watershed, long sections of the river
have shown essentially no migration through the historic period, while in the SFNR Valley there is
topographic evidence of migration across the width of the broad floodplain. Changes in land use
can influence this balance, causing the river to adapt to the changing conditions. Mapping by the
General Land Office (GLO) in the 1890s showed a markedly different river through the SFNR Valley
than can be seen even in the earliest aerial photographs (Figure 6) (Collins and Sheikh, 2004). The
channel was narrower, more sinuous and contained more side channel length (channels split from
the main channel by forested islands) than can be seen today. These changes through time from
a stable multithread channel to a rapidly migrating sinuous to braided channel have impacted
habitat and private property throughout the SFNR Valley.
Figure 6. Comparison of the GLO survey map from the 1890’s and the 2013 aerial photo and showing the loss of sinuosity and secondary channels.

The current reduction in sinuosity together with the loss of wood debris may have serious long-term impacts on channel incision and entrenchment. This entrenchment is thought to have an adverse impact on habitat quality by increasing shear stress through the reach resulting in reduced floodplain-channel interaction, increased red scour, increased sediment transport and the abandonment of many floodplain tributaries (GeoEngineers, 2002). Channel incision can isolate the channel from numerous secondary channels and its floodplain, and reduce the water stored in the uplands and in the riparian zone that contribute to critical in-stream flows for fish during lower flow (Wigmosta et al. 2015).

Legacy impacts on channel morphology and streamflow routing also affect the magnitude of baseflow. Where riparian forests and in-channel wood have been removed, stream channels have cut down into the sediment, leading to reduced flooding of the floodplain and earlier depletion of water stored as shallow groundwater (Pollock et al. 2014). Where channels are incised, the increased gradient between the shallow groundwater elevation and the in-channel water surface elevation results in a lowering of the shallow groundwater elevation, less water available to riparian vegetation, and early dewatering of the stream (Pollock et al. 2014, Beechie et al. 2008, Emmons 2013).
2.9 Salmonids

2.9.1 Occurrence

The lower SFNR provides habitat for all Pacific salmonid species, including spring and fall Chinook salmon, coho salmon, pink salmon, chum salmon, sockeye salmon, steelhead, bull trout, and cutthroat trout. South Fork early chinook is an independent population of the threatened Puget Sound Chinook Evolutionarily Significant Unit (ESU) that is essential for recovery. Chinook spawn upstream to the anadromous barrier at RM 31, although Sylvester’s Falls at RM 25 constitutes a partial blockage, and in larger tributaries to the South Fork Nooksack River. The abundance of both early Chinook salmon populations (North Fork/Middle Fork early Chinook salmon, South Fork Nooksack early Chinook salmon) is critically low, on the order of dozens to a few hundred natural-origin spawners for each population. A report by the US Commission of Fish and Fisheries on Fisheries of the West Coast that includes 1895 Nooksack River catch data estimates that nearly 25,000 Chinook inhabited the Nooksack River at that time. Abundances of salmonid populations in Puget Sound have diminished to less than 10% of levels relative to the late 19th century (Lackey, 2000).

The populations comprise two of 22 independent populations in the Puget Sound Chinook Salmon Evolutionarily Significant Units (ESU), which are listed as threatened under the Endangered Species Act (ESA). Nooksack early chinook (including both the SFNR and the North/Middle Fork populations) is the highest priority species, although restoration of Chinook habitat is expected to yield collateral benefits to other species. Nooksack spring Chinook salmon hold great cultural and subsistence importance to the Nooksack Tribe and Lummi Nation.

A significant proportion (38%) of returning SF Nooksack early chinook spawners sampled from 1999 to 2013 had out-migrated as yearlings, indicating the importance of freshwater holding and rearing habitat in the SFNR, floodplain tributaries and connected wetlands (Nooksack salmon co-managers, unpublished data). Habitat degradation is considered the leading cause for the decline of salmonid populations in the Nooksack watershed. High temperatures and low habitat diversity are the most significant factors limiting SF Nooksack early chinook in the lower SFNR, followed by high fine sediment load, lack of key habitats, low flows, and human disturbance (WRIA 1 SRB 2005). Some of the major impacts include:

- Low proportion and frequency of pool habitat.
- Reduction in availability of complex edge and floodplain habitats.
- Lack of instream wood and other forms of cover.
- Frequent high water temperatures that exceed optimal ranges or reach lethal limits.
- High proportion of fine sediment in spawning substrates.
- Decreased summer flows and higher peak flows.
- Degraded water quality (i.e. dissolved oxygen, pH, turbidity, nutrients).

Salmonids are particularly vulnerable to climate change because of their ectothermic (cold-blooded) physiologies and anadromous (living in both freshwater and marine water) life histories that require migration through linear stream networks that are easily fragmented (Isaak et al. 2010). Climate change impacts on temperature, flow and sediment regimes could profoundly affect physiology, behavior, and growth of individuals; phenology, growth, dynamics and distribution of populations; structure of communities, and; functioning of whole ecosystems.
(multiple authors, cited in Rieman and Isaak 2010), with increasing complexity and thus difficulty predicting impact at higher levels (Rieman and Isaak 2010). Climate change impacts to salmonids as a result of increased temperature can cause lowered dissolved oxygen, changes in growth of juveniles, changes in timing of emergence and migration, creation of thermal barriers to migration, disturbance to community structure, and increased occurrence of pathogens (i.e. Columnaris) or filamentous algae. The impacts of climate change due to changes in timing and magnitude of discharge may result in reduced habitat availability, reduced access to floodplain or side-channel habitats, or changes in timing or length of life history stages. Projected increased sediment with climate change may result in reduced egg-fry survival, changes in feeding behavior, biophysical injuries, or avoidance of habitats completely.

It is important to consider the pace of climate change and the ability of salmonids to adapt to that change. Salmonids do have the capacity to rapidly colonize new habitats, so to the extent that climate change will affect the distribution and availability of critical habitats, salmonids may be able to exploit what emerges, assuming such habitat is suitable and accessible (multiple authors cited in Rieman and Isaak 2010). Salmonids may also adapt over time through natural selection—evidence indicates evolution can occur within 10 to 20 generations (40-80 years; multiple authors, cited in Rieman and Isaak 2010) — although there is uncertainty about climate change outpacing evolution rates. Climate change impacts will affect every life stage of Chinook salmon, increasing the difficulty of adaptation (Figure 7).

**Holding:**

Adult salmonids returning to their natal streams must reach spawning grounds at the proper time and with sufficient energy reserves to complete their life cycles. Flow, water temperature and water quality must be suitable during their migration season and the physical habitat must provide sufficient space and cover for the returning populations. In the SFNR, habitat modeling indicates that upstream migration and holding habitat quantity and diversity is limiting the spring chinook population (Mobrand Biometrics 2004). The lack of deep pools with complex cover (i.e. pools associated with log jams) limits holding by all species, but especially early chinook, summer steelhead and bull trout. Holding habitat has been degraded due to loss of habitat complexity, including bedform variation and woody debris cover, coupled with low flows and high water temperatures which together can stress the fish and render them vulnerable to disease, predation and poaching (Doughty 1987).

Adult Chinook migrate and hold through the warm summer months when elevated water temperatures can impact their reproductive success. Pools can provide thermal refuge areas for adult chinook by intercepting groundwater or storing water cooled at night for a longer period of the day, since structural elements and substantial pool depth are two important factors that can promote seep development and thermal stratification in pools. Recent monitoring of thermal refuge areas in the South Fork Nooksack River has shown that many logjams are associated with water that is cooler than the adjacent average temperature of the river (Nooksack Natural Resources unpublished data). While thermal stratification of pools has dominated in backwater areas, generally the deep main channel pools have been well-mixed, emphasizing the importance of a diverse array of pool locations to meet different life history stage needs.
### Life Stage:

<table>
<thead>
<tr>
<th>Life Stage</th>
<th>Jan</th>
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</table>

### Climate risk:

- Increased Winter Peak Flows and sediment loads
- Loss of Spring Snowmelt Reducing Discharge
- Increased Summer Temperatures
- Decreased Summer Low Flows and Increased Temperatures
- Respective Life Stage Periodicities

**Figure 7. Spring Chinook Life Stage Periodicity in the South Fork Nooksack River and Vulnerability to Legacy and Climate Change Impacts.**

### Spawning:

Substrate composition, local cover, water quality and flow are important habitat elements before and during spawning. The number of spawning fish that can be accommodated is a function of the area of suitable habitat, the size of redds constructed by the species, and the behavior of the fish. The main habitat impacts to spawning Chinook that have been identified in the SFNR watershed are increased fine sediment in spawning gravel and loss of eggs due to channel migration or bed scour (WRIA 1 Salmon Recovery Board 2005). Both of these likely affect the SF early Chinook population to some degree.

Research from Hyatt and Rabang (2003) suggests that redd loss is expected to be higher in mainstem channels than in side channels, floodplain tributaries and sloughs. In the North Fork Nooksack, the opportunity to create and maintain these more scour resistant habitat types has been the focus of recent habitat restoration activities. Since the majority of the South Fork Nooksack early chinook population spawns in the low flow channel of the main river channel, the opportunities for improving side channels and tributary habitat is likely limited and reducing the impacts of flow depth on the channel is likely the best approach to improving incubation survival.

### Juvenile Rearing:

Spring chinook have diverse freshwater rearing habitat requirements due to the three life history stages they display during the rearing phase. Chinook can migrate as fry, as fingerlings, or as yearlings. In the South Fork Nooksack River, juvenile fish surveys have found rearing Chinook during the winter and early spring in the mainstem channel, as well as floodplain tributaries and...
sloughs, such as Landingstrip and Hutchinson creeks (Naef 2002). Recent fish inventories in the SFNR have found that most (76%) of the juvenile Chinook enumerated during a snorkel survey of the upper Acme-Saxon reach were associated with wood cover, including 51% with complex cover of multiple logs (Ecotrust, unpublished data). Most chinook were found in pools (49% of total), followed by flat-water glides (29%), braids (18%), and main channel riffles (4%) (Coe 2005). The Chinook habitat preference for pools and woody cover emphasizes the importance of stable wood accumulations for juvenile rearing habitat.

**2.9.2 Salmon Habitat Restoration Projects**

Substantial efforts to restore habitat in the South Fork Nooksack River watershed have been undertaken since the 1990s. Project partners identified 166 habitat improvement projects that were implemented between 1998 and 2003 in the SFNR including sediment reduction, fish passage, habitat acquisition, instream restoration and habitat assessment (Nooksack Recovery Team 2009). Extensive voluntary riparian planting has been accomplished in the South Fork Nooksack River watershed by landowners either as part of an incentive program, such as the Conservation Reserve Enhancement Program (CREP), or through grant funding, such as the Centennial Clean Water fund. These projects include establishing riparian vegetation in places where no buffer exists, treating invasive species that can compete with native trees, and interplanting conifers to speed forest succession toward a mature conifer forest. The majority of these projects were focused on improving near-channel watershed processes, rather than improving instream habitat for Chinook, which necessitates working in the challenging environment of the main channel of the SFNR. Additional voluntary restoration actions in the upper watershed need to be implemented to further reduce temperature and sediment exceedances and reduce impacts to salmonids.

Beginning in 2001, engineered logjam projects were implemented in the main channel to more directly improve the habitat for Chinook salmon. The first of these projects, and one of the first engineered logjam projects in the Pacific Northwest, was built by the Lummi Nation near Larson’s Bridge (River Mile 19) on the South Fork Nooksack River. Initial monitoring of the project showed that it was successful at creating deep pools with wood cover and protecting an active landslide from erosion (Lummi Natural Resources 2002, Southerland and Reckendorf 2010, Maudlin and Coe 2012). After 5 years of assessment and design, the second engineered logjam project was located at the confluence of the South Fork Nooksack River and Hutchinson Creek, an important cool water tributary of the SFNR. This project was completed in 2006 and included the installation of six engineered logjams with the removal and set-back of approximately 450 feet of armored levee. Monitoring results showed improved low-flow connectivity of Hutchinson Creek and the development of deep scour pools with wood at the logjams along the river (Lummi Natural Resources 2007, Maudlin and Coe 2012). Following construction of the Lower Hutchison project in 2006, 13 projects have been implemented in the SFNR over the last 10 years (Table 1).
Table 1. Logjam project location, number of structures, sponsor and year completed.

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Location (River Mile)</th>
<th>Structures</th>
<th>Lead Sponsor</th>
<th>Year Completed</th>
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3.0 Climate Change Impacts on the South Fork Nooksack River

3.1 General Impacts

As previously described, legacy impacts have resulted in elevated stream temperatures and increased sediment transport in the SFNR. The focus of this reach-scale plan is to address the impacts of water quality exceedances on fish and fish habitat and identify specific opportunities to protect and restore riparian conditions that ameliorate these conditions. Climate change will continue to occur and into the future, at a higher rate. A protection and restoration project should not just address conditions related to legacy impacts, but also address the cumulative impact of legacy impacts and climate change impacts in order to be more comprehensively effective in regard to the recovery of salmon. As such, it is important to have a basic understanding of the likely impacts of climate change on the aquatic ecosystem of the SFNR.

Modeling of future climate indicates a shift in both air temperature and precipitation patterns for the South Fork Nooksack River (Butcher et al 2016). Annual average air temperature has already increased in this region by 1.1°C over the last 100 years, according to the longest meteorological record at Clearbrook (Figure 8). While the annual precipitation will stay about the same, summer precipitation is expected to decrease and winter precipitation will likely increase, with the percent falling as snow decreasing, and the amount falling as rain increasing. The reduced snowpack and summer rainfall are expected to lead to a reduction in summer flow in the river, while the increase in winter precipitation falling as rain is expected to increase mean peak flow. Modeling of a moderately severe climate projection shows increases in mean annual stream temperatures,
which are expected to be most pronounced during the summer low flow period, pushing the maximum summer water temperature from 18.4°C to 25.1°C by 2080 (Butcher et al. 2016). Climate change projections are thoroughly discussed in Sections 2.3.1 and 2.4.2 of the SFNR Watershed Conservation Plan and outlined below:

- Increased winter precipitation and decreased summer precipitation
- Increased summer air temperature by 2080’s of 2.81 °C to 6.31 °C (or about 5 to 11 °F)
- Increased winter air temperature by 2080’s of 2.44 to 4.28 °C (or about 4 to 8 °F)
- Increased August stream temperature by 2080’s of up to 6 °C (11 °C)
- Reduced snowpack and earlier snow melt
- Changes in timing and magnitude of flow (earlier snowmelt peak, greater peak flood events, longer baseflow periods)
- Increased sediment transport rates of 200-400%

3.2 Snow Accumulation and Melt

Snow accumulation and melt dynamics will likely be impacted by climate change. The most significant impact of climate change will be increased atmospheric temperature. Increased atmospheric temperature will cause the average snow level to increase, thereby reducing the area of snow accumulation in the watershed. Similarly, the depth of snow in the accumulation area will be subjected to more melt and rain on snow events. Rainfall will occur over a larger portion of the watershed and the rainfall will occur with higher intensities that exceed the water storage capacity of the snowpack causing more runoff. These factors combined will result in an overall

Figure 8. Change in annual average air temperature at Clearbrook, WA from 1905 to 2015.
decrease in snow water equivalent in the watershed from approximately 0.7 m under historical conditions to less than 0.1 m by 2075 as shown in Figure 9. The reduction in snow water equivalent with climate change will obviously affect the hydrology of the SFNR.

3.3 Stream Flow

Climate warming is projected to affect both the timing and magnitude of streamflow in the SFNR (Dickerson-Lange and Mitchell 2014, Elsner et al. 2010, Murphy 2016 cited from Dickerson-Lange 2017). In particular, warming temperatures will raise the rain-snow transition elevation which will result in diminished seasonal snowpack (both area and depth), earlier snowmelt, and a shift in the timing of the spring streamflow peak (i.e., the freshet) to earlier in the year. Associated with these key hydrologic changes are numerous impacts to humans and ecosystems, which include increased flood magnitude, reduced summer water availability, and increased summer stream temperatures (Beechie et al. 2012). Murphy (2016) applied the Distributed Hydrology Soil Vegetation Model (DHSVM) with the coupled dynamic glacier model to project the impacts of climate change on streamflows within the Nooksack River watershed. Table 2 summarizes the projected changes in flow as a percentage deviation from the historical period (1950-2010). Figures 9, 10, and 11 illustrate the likely changes in snow water equivalent and hydrology of the SFNR due to climate change (Murphy 2016). Streamflows are projected to increase in the SFNR in the period of November through March by as much as 112 percent due to greater precipitation amounts in the form of rain over a shorter high precipitation period, reduced area of snow accumulation, and warmer temperatures. In contrast, streamflows are projected to decrease from April through October by as much as 76 percent due to reduced precipitation over this period, reduced snowmelt, and higher temperatures.

As indicated previously, projected climate change will likely alter the SFNR hydrograph. As shown in Figures 9 and 10, the shape of the hydrograph will transform from the current bimodal shape to more of a unimodal shape. The base of the hydrograph will likely narrow, low summer flows will occur earlier and end later, there will be a nominal snowmelt signature to the hydrograph, and peakflows will be higher and occur longer during the fall through early spring period.

These potential changes to the hydrograph could have great implications to water availability. For instance, minimum instream flow as mandated by WAC 173-501 for the summer period is 300 cfs as shown in Figure 12. The recurrence interval for that flow is approximately one or more times in two years. With climate change, the recurrence interval for that flow could be one or more times in 20 years depending on the climate change scenario. This shift in recurrence interval with assumed climate change suggests that minimum instream flows will occur more infrequently (less often) and that junior water right holders would likely have less frequent access to water. This also indicates that important flows in the late summer will continue to diminish with climate change and further impact fish.
Figure 9. The effect of climate change on Snow Water Equivalent and Hydrology of the South Fork Nooksack River (Taken from Murphy 2016).
Table 2. Projected changes in streamflow under various time horizons and representative carbon pathways (RCP) for the South Fork Nooksack River. (From Murphy 2016).

<table>
<thead>
<tr>
<th>Month</th>
<th>RCP 4.5</th>
<th>RCP 8.5</th>
<th>RCP 4.5</th>
<th>RCP 8.5</th>
<th>RCP 4.5</th>
<th>RCP 8.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2025</td>
<td>2050</td>
<td>2075</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>October</td>
<td>-13%</td>
<td>-11%</td>
<td>-9%</td>
<td>-17%</td>
<td>-9%</td>
<td>-7%</td>
</tr>
<tr>
<td>November</td>
<td>17%</td>
<td>16%</td>
<td>20%</td>
<td>26%</td>
<td>32%</td>
<td>37%</td>
</tr>
<tr>
<td>December</td>
<td>14%</td>
<td>16%</td>
<td>42%</td>
<td>41%</td>
<td>42%</td>
<td>69%</td>
</tr>
<tr>
<td>January</td>
<td>45%</td>
<td>62%</td>
<td>72%</td>
<td>83%</td>
<td>82%</td>
<td>112%</td>
</tr>
<tr>
<td>February</td>
<td>16%</td>
<td>25%</td>
<td>28%</td>
<td>35%</td>
<td>44%</td>
<td>61%</td>
</tr>
<tr>
<td>March</td>
<td>24%</td>
<td>23%</td>
<td>29%</td>
<td>31%</td>
<td>30%</td>
<td>33%</td>
</tr>
<tr>
<td>April</td>
<td>0%</td>
<td>-3%</td>
<td>-7%</td>
<td>-3%</td>
<td>-11%</td>
<td>-23%</td>
</tr>
<tr>
<td>May</td>
<td>-25%</td>
<td>-28%</td>
<td>-39%</td>
<td>-41%</td>
<td>-50%</td>
<td>-62%</td>
</tr>
<tr>
<td>June</td>
<td>-41%</td>
<td>-42%</td>
<td>-54%</td>
<td>-57%</td>
<td>-65%</td>
<td>-75%</td>
</tr>
<tr>
<td>July</td>
<td>-40%</td>
<td>-42%</td>
<td>-59%</td>
<td>-66%</td>
<td>-65%</td>
<td>-76%</td>
</tr>
<tr>
<td>August</td>
<td>-40%</td>
<td>-41%</td>
<td>-51%</td>
<td>-56%</td>
<td>-57%</td>
<td>-65%</td>
</tr>
<tr>
<td>September</td>
<td>-39%</td>
<td>-43%</td>
<td>-47%</td>
<td>-53%</td>
<td>-57%</td>
<td>-64%</td>
</tr>
</tbody>
</table>
Figure 10. Forecasted Streamflow Response to Future Climate Change in the South Fork Nooksack River (Mitchell 2017).

Figure 11. Change in Magnitude of Peak Flows and Timing of Flows Due to Climate Change (Taken from Grah 2016).
3.4 Stream Temperature

Tetra Tech, Inc. was contracted by EPA-ORD to model the impacts of continued climate change on stream temperatures in the SFNR. The basis of the climate change assessment is a common set of simulations using 21 global climate models (GCMs) from the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report and Coupled Model Intercomparison Project 3 (CMIP3). Tetra Tech, Inc. (2015) developed a quantitative assessment of climate change impacts on the SFNR. The quantitative analysis therefore selected three climate models that are anticipated to produce the least warming of air temperature (model low-impact scenario), medium warming (medium-impact scenario), and highest warming (high-impact scenario). These were evaluated at three time horizons through the 2080s.

The climate models predict a trend of increasing air temperature over the 21st century. By the 2080s, the average summer air temperature across the SFNR watershed is projected to rise by 2.81 °C to 6.31 °C (or about 5 to 11 °F), while the average winter air temperature is projected to rise by 2.44 to 4.28 °C (or about 4 to 8 °F).

Tetra Tech’s modeling predicts that average water temperatures in August could increase up to 6 °C by the 2080s under the high impact scenario if no actions are taken to mitigate the impacts. Coupled with the air temperature changes, the climate models suggest a decrease in precipitation and an increase in dew point temperature during the critical summer period. The combined effects of changes in climate and changes in summer low flow on summer water temperatures was evaluated through application of the QUAL2Kw model (Ecology 2003) that was calibrated for
application to the South Fork as part of the TMDL effort. QUAL2Kw is a quasi-steady state model and is Ecology’s preferred tool for TMDLs. The model simulates hourly temperature and heat budget with hourly variations in input parameters and boundary conditions.

Large increases in the 7DADMax water temperature are predicted by 2080 if stream shading is left at current levels, with temperatures increasing to above 23 °C throughout much of the length of the river (Figure 20). Restoration of system potential vegetation (tree heights associated with the 100-year site index) dampens the increase by about 2 °C in the TMDL scenario. There could be additional mitigation of water temperature increases through effective buffering on all tributaries to the South Fork, as was investigated in additional natural conditions scenarios summarized below in Table 3. The Tribe believed that the TMDL (WADOE undated) did not utilize a realistic assumption of natural conditions. The Tribe provided Tetra Tech (WADOE undated) with what the Tribe considered be more realistic natural conditions. If system potential vegetation was in place it would be projected to protect against increases in 7Q10 temperature through the 2020s, but increases on the order of 2 °C are still expected by the 2080s. It should be noted that the “combined natural parameters variations” scenario (referred to as “natural/restored”) suggested a 15.5 percent reduction in stream temperatures for the South Fork overall relative to the TMDL scenario. The majority of this reduction was due to using climax tree height (290 feet) as compared to the assumed 100-year site index tree height (160 feet). The sensitivity analysis suggested that under climax conditions, the SFNR would have likely just met the numerical standards for temperature, which is a different conclusion reached by the TMDL.

3.5 Sediment Dynamics

Sediment loads are likely to increase under climate change due to loss of soil-protecting snowpack, increased saturation of soils on steep slopes, increased frequency and magnitude of over-steepened slopes associated with valley glacier recession, increased entrainment and transport of sediment within the channels, and increasing intensity of precipitation events yielding more extreme peak flows. Flow and sediment modeling on the Skagit River has shown a possible six-fold increase in sediment load during the winter high-flow period by the 2080s. While the Skagit watershed is larger, more heavily glaciated, and contains multiple dams, the physical drivers in the Nooksack watershed are similar and it will likely experience a similar or greater response to climate change. Increased sediment flux in the Nooksack will likely come as a result of several processes: increased streambank erosion, increased mass wasting, and increased surface erosion.

The channel shape and plan-form of the South Fork and its tributaries are expected to respond to increases in winter peak flow and more frequent high-flow events. Changes in channel width, depth, slope, grain size, bedforms, sinuosity and bed scour depth are all possible responses to increased frequency, magnitude and duration of flow. In the lower-gradient alluvial valleys of the South Fork and its tributaries, these changes will likely lead to an increase in bed and bank erosion. A partial sediment budget for the upper South Fork found that streambank erosion and undercutting of stream-adjacent unstable landforms was a dominant source (59 percent) of sediment to the river between 1967 and 1991 (Kirtland 1995).
### Table 3. Summary of Sensitivity Analysis for Natural Conditions Estimate using Current Climate.

<table>
<thead>
<tr>
<th>Scenario/Variation</th>
<th>River Reach</th>
<th>Water Quality Criteria (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Headwaters to RM 18</td>
<td>RM18 to Confluence</td>
</tr>
<tr>
<td>TMDL Original System Potential, Scenario 5</td>
<td>17.8</td>
<td>19.6</td>
</tr>
<tr>
<td>Cooler Headwater Tributaries (20 percent cooler)</td>
<td>16.9</td>
<td>19.0</td>
</tr>
<tr>
<td>Reduced Natural Channel Width</td>
<td>17.2</td>
<td>18.9</td>
</tr>
<tr>
<td>Increased Riparian Climax Tree Height and 80 percent Effective Buffer Width</td>
<td>16.7</td>
<td>18.2</td>
</tr>
<tr>
<td>Enhanced Hyporheic Exchange</td>
<td>17.8</td>
<td>19.3</td>
</tr>
<tr>
<td>Combined Natural Parameter Variations</td>
<td>15.1</td>
<td>16.4</td>
</tr>
<tr>
<td>% Change in Temperature with Combined Natural Parameter Variations</td>
<td>-15.2%</td>
<td>-16.3%</td>
</tr>
</tbody>
</table>

These projected changes highlight the important function of upland hydrologic processes to store water and sediment in-situ and to slowly release water to the stream network. These projections give credence to the need to plan and implement adaptation strategies now in advance of a future with continued climate change.

#### 3.6 Spatial Distribution of Impacts

The effects of climate change are expected to vary across the SFNR watershed. While climate modeling was not conducted at a scale that allows for evaluation of the effects at the subbasin scale, the watershed can be evaluated for the potential to respond to the expected changes in climate (Figures 13-16; Table 4). For example, reduced spring snowmelt was evaluated by the proportion of the watershed that is currently snow dominated or highland that could become part of the transient snow zone as a result of climate change. The most heavily impacted areas lie in the higher elevation zones in the upper SFNR and Skookum Creek. Results from the loss of winter snow pack will be felt most severely in the upper reaches of the main stem where the majority of the watershed area lies above the transient snow zone.

Summer low-flow temperature modeling shows that the greatest impacts of increased air temperature on water temperature occur in the lower three reaches of the South Fork. These areas either currently exceed the 7-DAD Maximum lethal limit of 22 °C or will be expected to exceed this limit under the under the medium-impact climate change scenario (Butcher et al., 2016).
Figure 13. Maximum Stream Temperature by River Mile for Existing 7Q10 flows, 90th Percentile Meteorology, and Current Shade; 2080 Conditions (High GCM, Medium GCM, and Low GCM) with Current Shade; and 2080 Conditions with Natural/Restored Conditions (adapted from Butcher et al. 2016).
Figure 14. Change in Spatially Averaged Maximum Water Temperature in the South Fork Mainstem at Critical Conditions for Future Climate Scenarios with System Potential Vegetation Compared to Current Climate and Vegetation (from Butcher et al. 2016).

Figure 15. Maximum Stream Temperature by Reach for 7Q2 flows and 50th Percentile Maximum Air Temperature with 100-yr System Potential Shade for 2080 High GCM, 2080 Medium GCM, and 2080 Low GCM.
Figure 16. QUAL 2Kw model nodes of the Maximum Stream Temperatures (7Q10 flows) along the mainstem South Fork Nooksack River for 2040 (using a medium GCM), along with current snow-dominated precipitation zones based on elevation, climate, latitude and vegetation (DNR 1991). Not shown are the lower elevation “rain-dominated” and “rain-on-snow” zones in the watershed.

While no modeling has been completed for tributary streams, the greatest impact on water temperature is expected in the Hutchinson and lower SFNR subbasins, due to their lower elevation. Similarly, the impacts of potential lower summer flow is expected to have the greatest impact on attaining water temperature criteria in the lower elevation portion of the watershed. The mainstem SFNR through much of the Acme Valley (reach 1) loses surface water to groundwater recharge (Cox et al. 2005), further reducing low flows.

Increased winter peak flow is expected to be more strongly effected in reaches of the SFNR that have been impacted by artificial confinement to prevent erosion. Much of the valley has also incised into its floodplain during the historic period, further abandoning the floodplain surfaces. Sediment flux is expected to reflect the increase in peak flow, as sediment transport increases. Increases in bank erosion and potentially an increase in mass wasting could deliver more sediment to the channel in the steeper areas of the upper watershed and subbasins.
Table 4. Distribution and severity of climate change impacts through the South Fork Reaches and Subbasins.

<table>
<thead>
<tr>
<th>Reach or Subbasin</th>
<th>Climate Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Reduced Spring Snowfall (percent of basin)</td>
</tr>
<tr>
<td>Machias</td>
<td>Moderate (&lt;5 percent of basin)</td>
</tr>
<tr>
<td>1 (RM 0-14.3)</td>
<td>High (80 percent of basin)</td>
</tr>
<tr>
<td></td>
<td>High (88 percent of basin)</td>
</tr>
<tr>
<td>3 (RM 18.5-25.4)</td>
<td>High (73 percent of basin)</td>
</tr>
<tr>
<td>4 (RM 25.4-31)</td>
<td>High (77 percent of basin)</td>
</tr>
<tr>
<td>5 (Upstream of RM 31)</td>
<td>High (77 percent of basin)</td>
</tr>
</tbody>
</table>

4.0 South Fork Nooksack River Watershed Community Engagement

4.1 Background

Incorporating community values was identified as a critical component of SFNR watershed conservation plan development early in the process. An initial planning team was formed in 2014 to conceptualize SFNR watershed planning and comprised of interested and informed individuals of government staff, non-governmental organizations, and interested informed publics. The planning team developed a conceptual project framework and developed a plan for public outreach and stakeholder engagement. The Tribe obtained grant seed money for the planning effort from the Bureau of Indian Affairs and Environmental Protection Agency, among other grantors. A comprehensive public outreach and stakeholder engagement program was implemented beginning in 2015. The hope was that any planning efforts in the watershed would be well-informed about the interests of the people who care about this place.
4.2 Methods and Results

The approach to community engagement was based on an innovative method called “Strategic Systems Mapping.” The method is based on two concepts: 1) creating a common understanding of the facts and 2) building relationships. Information was made widely available through an interactive website (https://www.sfnooksack.com/).

The first part of the process was to gather together Interest Groups with people who had common issues, so that they could talk among themselves about issues, concerns, and opportunities. The Planning Team identified seven different interest groups: Agency and Tribal, Fish, Agriculture, Transportation and Utilities, Large Forest Landowners, Small Forest Landowners, and Recreation-Small Businesses. Following the Interest Group meetings, a community meeting was held and a community survey was conducted.

In early 2017, a Watershed Group was formed, for the following purposes:

A. To bring forward what had been learned from the Interest Groups, Community Meeting, and Survey, and identify areas of common ground.
B. To create a framework for dialogue about watershed conditions, goals, and strategies.
C. To provide feedback on the Nooksack Indian Tribe’s Watershed Conservation Plan.
D. To determine, after a facilitated series of four meetings, whether the Watershed Group would want to continue, and perhaps eventually develop a more comprehensive Community Watershed Plan to address other issues of concern to residents and landowners.

Forty-four residents and landowner representatives signed up to participate in the Watershed Group. An additional 353 people asked to be kept informed of the process and received regular updates. All of the meeting notes, input worksheets, agendas, and presentations were uploaded onto the website, and meetings were recorded and aired by the local low-power FM radio station, 102.5 KAVZ.

In addition to learning about the issues facing our watershed, the Watershed Group also worked to identify long-term goals and principles that could serve as a foundation for the Group moving forward, and to inform any agencies or other entities engaged in planning in the South Fork Nooksack River watershed. The group used a consensus-seeking process to identify Long-Term Community Goals and Planning Principles, as follows:
Long-Term Community Goals

Although we have a wide range of perspectives and interests in the South Fork Nooksack River Valley, we are looking for win-win solutions to protect our water resources for:

- Our Families: Keep the rural way of life and protect it for our children.
- Our Farms: Maintain and protect productive agricultural lands and promote long-term agricultural economic viability.
- Our Forests: Maintain and protect the forestland base and promote a sustainable forest industry with a skilled and steady local workforce.
- Our Fish: Improve the South Fork ecosystem to increase and support the salmon population.
- Our Recreation: Ensure through public regulation, education, and community engagement that recreational activities in the Valley contribute positively to the health and safety of our Watershed and protect property rights and community values.

Watershed Planning Principles

In order for us to achieve our long-range goals, we need:

- Communication, transparency, and trust between landowners, residents, agencies, and other stakeholders in the Watershed.
- Voluntary agreements between landowners and community partners, with incentives for landowner’s efforts to improve watershed conditions.
- Shared understanding and open dialogue around data, science, resource management, and the changing climate conditions that affect our watershed.
- Public education around how farmers, foresters, fishers, and other businesses are continually improving their practices to protect and improve water quality.
- Consideration of the knowledge of local residents relevant to wise management of land and water resources.

4.3 Next Steps

By May 2017, the SFNR Watershed Group had met five times and had provided feedback on the Nooksack Indian Tribe’s Watershed Conservation Plan. While the future of the group is still being determined, there is broad support for continued meetings, education, and dialogue, and a planning team of volunteers from the group has been formed to determine and lead the next steps. Interests of Watershed Group members included:

- To pursue funding opportunities and resources to support landowner voluntary efforts
- To learn about and discuss watershed issues
- To give feedback on various agency plans and projects
- To develop a comprehensive Community Watershed Plan
- To provide public education opportunities on watershed issues
5.0 Recommended Actions for Watershed Restoration and Conservation

A riparian protection and restoration project should not just address conditions related to legacy impacts, but also address the cumulative impact of legacy impacts and climate change impacts in order to be more comprehensively effective in regard to the recovery of salmon. The Watershed Conservation Plan (NIT 2017) identified recommendations to facilitate the development, planning, and implementation of voluntary actions in the SFNR that are consistent with community goals and values and also would serve to:

- Support recovery of South Fork Nooksack early chinook and other salmonids;
- Help achieve compliance with Washington State Water Quality Standards for temperature, dissolved oxygen, and turbidity;
- Help meet instream flows; and
- Build ecosystem resilience to climate change.

Towards these ends, nine actions are recommended for discussion and consideration:

- Floodplain Reconnection
- Stream Flow Regimes
- Erosion and Sediment Delivery
- Riparian Restoration
- Instream Rehabilitation
- Acquisition and Easements
- Fish Passage Barrier Removal
- Community Engagement and Outreach
- Planning
- Data Gaps

These recommendations are made in general for the SFNR watershed; however, they provide context and support for the proposed actions presented in the reach-scale plan below. The reach-scale plan acts on these recommendations where relevant and appropriate.

5.1 Floodplain Reconnection

Floodplain reconnection can restore river-floodplain dynamics that create diverse habitats and/or restore fish access to floodplain habitats. Reconnecting floodplains (including restoring vertical connectivity) can help ameliorate increased peak flows by increasing flood storage and reducing flood peaks, and ameliorate the effects of increased temperature and decreased base flow by increasing the length of hyporheic flow paths and restoring floodplain aquifer storage (Beechie et al. 2013). Temperature modeling indicates that enhanced hyporheic exchange in the South Fork Nooksack River mainstem lowers critical condition stream temperatures, although effects of restoring meander-scale hyporheic exchange were not modeled. The action can also potentially ameliorate increased sediment by allowing fines to settle in floodplain areas, thereby reducing sediment load in the main channel. These benefits may increase resilience of salmon populations to climate change impacts (Beechie et al. 2013). Actions include reconnecting floodplain channels, removing or setting back levees and bank hardening, or promoting aggradation through log jams. Floodplain and off-channel habitat reconnection is considered to have immediate and long-lasting benefits and a high probability of success.
5.1.1 Objective

The objective of floodplain reconnection is to restore the connectivity of the South Fork Nooksack River to its historic channel migration zone and floodplain to allow for natural habitat-forming processes (bank erosion, formation and maintenance of floodplain channels) and flood routing.

5.1.2 Challenges and Opportunities

Opportunity for floodplain reconnection depends on existing land ownership, use and development. The lower SFNR valley is prime agricultural land. Agricultural landowners often recognize the beneficial aspects of flooding to soil productivity, although post-flood cleanup of debris can be costly and time-consuming. Bank erosion is a greater concern, because, while an important habitat-forming process, it also may take away valuable agricultural land important to maintain economic viability. Floodplain reconnection must also avoid affecting existing development (buildings, other infrastructure).

There is approximately 9 miles of bank hardening in the lower South Fork Nooksack River, although much of it lies at the outer edge of the historic migration zone and protects working farms. The highest priority for restoring channel migration is the historic migration zone; approximately 310 acres of the historic migration zone has been isolated from the current channel by bank hardening. Reconnecting such areas will obviously require landowners willing to allow channel migration and sufficient funding to compensate them.

Flood control levees are not common in the South Fork Nooksack River, although infrastructure such as the railroad embankment, City of Bellingham pipeline crossing, several County roads and Highway 9, all act as levees at certain flow levels. Relocating such critical infrastructure outside the floodplain is expensive, but may be possible over the long-term as the infrastructure is maintained or replaced. For example, when the structurally deficient Potter Rd. bridge over the SFNR was replaced (2015-2016), the new bridge was designed with considerably wider spans to better convey floods.

Placing engineered log jams in the river channel can help reconnect floodplains by promoting aggradation in areas where landowners are willing to allow increases in flood elevation. Design of engineered log jam projects includes extensive analysis to ensure that project will be effective at meeting habitat objectives while avoiding negative impacts to adjacent landowners.

Geomorphic assessment helps proponents and stakeholders understand how the channel will respond to restoration, while hydraulic modeling informs how the project will affect flooding. As a condition of obtaining the floodplain development permit from the County, restoration proponents are required to show that project will not cause any increase in flooding (1% flood) at insurable structures. If a project is expected to increase flooding, approval from the landowner is required. Reconnecting floodplains is currently most feasible on lands in conservation ownership (e.g. Whatcom Land Trust). Community support for floodplain reconnection is more likely where it can be shown that it will benefit the community by reducing flood risk. As such, floodplain reconnection projects should integrate both salmon habitat and flood risk reduction into the design process. The Floodplains by Design grant program, administered by the Department of Ecology, provides funding for such integrated projects.
5.1.3 Actions

- Provide public education about the benefits of floodplain reconnection in maintaining soil productivity, reducing flood risk downstream, and improving water availability.
- Work with landowners, Whatcom County River and Flood, Acme/Van Zandt Flood Subzone, and the broader SFNR community to design and implement integrated floodplain reconnection projects that reduce flood risk while meeting salmon habitat objectives.
- Continue to develop and implement restoration project designs that reconnect floodplains (setback/remove infrastructure, reconnect floodplain channels and promote aggradation) to the extent feasible given landowner willingness.
- Work with infrastructure owners to develop plans to set back infrastructure (railroads, roads, pipelines, bridges/bridge footings) in the floodplain to the extent possible as infrastructure is repaired or replaced, especially infrastructure that currently function as levees and/or requires bank hardening but also that which may be threatened under climate change scenarios.

5.2 Stream Flow Regimes

5.2.1 Description

Protecting and restoring stream flow regimes entails reducing water withdrawals, road or stormwater drainage input, avoiding increases in impervious surfaces, reconnecting floodplains and restoring floodplain wetlands. Recently, strategies suggested to buffer the hydrologic impacts of climate change include maximizing snowpack retention through spatially variable forest thinning or retention and maximizing soil water storage through forest thinning and uneven-age forest management suggest, or restoring upland hydrology by increasing soil moisture.

Actions to reduce upland surface water drainage include reducing length of road network, disconnecting road network from stream network, and reducing impervious areas. Impervious surfaces causes greater peak flood flows while decreasing infiltration potential and water storage in soils. This in turn causes lower summer baseflows without the input of cooler groundwater that can potentially ameliorate high summer stream temperatures.

Potential wetland restoration actions include removing drainage tile, filling drainage ditches, re-establishing direct connection of tributaries to the river, reforesting historically forested wetlands, revegetating scrub and herbaceous wetlands, and/or reintroducing beaver. Beaver ponds can have profound impacts on a watershed’s potential for water retention. Active dams retain water in the dry season, metering it out downstream through gaps in the semi-permeable dam wall. Beaver dams can substantially reduce stream temperatures, trap sediment, and provide habitat for salmon.

Silvicultural practices can be used to optimize snow storage duration and maximize soil moisture. Practices include retaining and protecting forests in wind-exposed areas, gap cutting or thinning, and extending harvest rotations to allow maturation of selected stands. Developing management plans and implementing these recommendations would require explicit consideration of
topographic (elevation, slope, and aspect), meteorological (snowpack characteristics, wind speeds, cloud cover), and landcover (forest) characteristics.

5.2.2 Objective

The objective of this action is to reduce impacts (wetland modification, road networks) to the hydrologic regime, increase instream flows during summer low-flow and reduce peak flows, and build ecosystem resilience to climate change.

5.2.3 Challenges and Solutions

Restoring instream flow must be balanced with the need for water for irrigation, livestock watering, and domestic/municipal use. There may be some potential for landowners to reduce irrigation and utilize water banking. Opportunities for wetland restoration and beaver reintroduction in the SFNR valley will most likely be more viable in forested areas and less viable where there is high agricultural value. Foresters, farmers, and ranchers are often willing to support watershed conservation and restoration efforts, as long as those efforts do not negatively impact their economic viability.

5.2.4 Actions

- Incentivize and increase water conservation in the lower South Fork Nooksack River valley to the extent possible.
- Building on wetland assessment, work with willing landowners to protect and restore high priority wetlands along the lower South Fork Nooksack River, with the goal of maximizing temperature maintenance, baseflow maintenance, and sediment retention.
- Build on water rights assessment by reaching out to water right holders to explore opportunities for water banking to restore instream flow.
- Develop a groundwater-flow model coupled with a watershed model for the South Fork Nooksack River basin to quantify contribution of wetlands to SFNR hydrology and evaluate potential wetland restoration scenarios.
- Building on the beaver assessment (Ingram 2016) ground-truth beaver habitat model and work with landowners to identify locations where beaver can be reintroduced and work with federal, state, and County governments to enable beaver reintroduction where landowners are willing.
- Build on conceptual plan to restore upland hydrology by working with landowners to explore the feasibility of and model the hydrologic impacts of silvicultural practices that optimize snow storage duration and maximize soil moisture.

5.3 Erosion and Sediment Delivery

5.3.1 Description

With increased extreme precipitation events and subsequent increased peak flows projected for the region with climate change, erosion and sediment flux will also likely increase. Large amounts of sediment in a river system can have multiple adverse effects on aquatic habitat that can include widening and/or incision of the channel and aggradation of large pools, thereby increasing stream temperatures. Actions that could reduce sediment delivery to the South Fork Nooksack River
include road resurfacing and landslide hazard reduction. Such actions have long-term benefits, but take 5-20 years to achieve those benefits. The projects are considered highly likely to achieve their goals.

5.3.2 Objective

The objective of this category of actions is to minimize sources of sediment and to incorporate understanding of current and future sediment regime into conservation and restoration project and program planning.

5.3.3 Challenges and Solutions

The greatest challenge is the lack of information on relative sediment sources and uncertainty about future climate impacts. The Nooksack Tribe is working with US Geological Survey and Western Washington University researchers to monitor baseline sediment conditions and estimate how future climate will affect sediment regime.

5.3.4 Actions

- Develop a relative sediment budget to identify priorities for source control (road surface, bank erosion, mass wasting) and to provide a basis for modeling future climate scenarios.
- Continue to refine sediment transport estimates and monitor sediment dynamics over the long term.
- When designing restoration in a project reach of the SFNR, continue to evaluate feasibility of reducing sediment inputs from any stream adjacent landslides in the reach.
- Work with USFS to evaluate, prioritize, and address road network deficiencies.
- Assess potential for orphaned roads to deliver sediment and prioritize and implement orphaned road abandonment projects.
- Map deep-seated landslides throughout the SFNR and monitor them over time.
- Model risk of shallow rapid landslides in the SFNR.

5.4 Riparian Restoration

5.4.1 Description

Restoring the riparian zone of the South Fork Nooksack River and subbasins would substantially ameliorate high stream temperatures due to climate change and has been a major focus of restoration activities in the watershed. Examples of this action include removing invasive plant species that inhibit the growth of native species, planting or interplanting native plant species, and controlling livestock grazing or other riparian zone disturbance. Not only does riparian vegetation provide direct shade, but forested riparian areas also deliver large wood to the channel that creates deep pools for thermal refugia. Riparian restoration is currently considered a moderate salmon recovery priority (WRIA 1 SRB 2016), because WRIA 1 SRFB/PSAR funding decisions prioritize projects that provide immediate benefit to chinook abundance and productivity, and there are alternative funding sources for riparian restoration (e.g. Department of Ecology Centennial Clean Water Fund, EPA section 319 funding, NRCS Conservation Reserve Enhancement Program). Riparian restoration is considered to have long–term benefits, but it can
take decades to realize the benefits. Actions such as conifer interplanting have a high variability of success and low to moderate certainty of success.

5.4.2 Objective

The objective of this action is to restore mature riparian along and within 300 feet of the South Fork Nooksack River channel migration zone, as well as sufficient riparian buffers along tributaries to restore hydrologic and temperature regimes. The site potential buffer widths used in the TMDL “system potential vegetation” scenario was 150’.

5.4.3 Challenges and Solutions

Economic considerations limit landowners’ ability and/or willingness to protect and restore riparian buffers on productive agricultural or forestlands beyond regulatory requirements. The Conservation Reserve Enhancement Program for agricultural land and the Forestry Riparian Easement Program for small forest landowners can compensate landowners for the loss of land. While there is no publicly available information on enrollment in the Conservation Reserve Enhancement Program (CREP) or the Environmental Quality Incentives Program (EQIP), it is evident from the aerial photo analysis that a great number of agricultural landowners are participating in conservation programs in the South Fork Nooksack River Watershed. Based on the available information approximately 10% of the 340 landowners in the assessment area appeared to be participating in a riparian conservation program. Much of this work was in the Black Slough floodplain area, where land is likely less suitable for agriculture than areas along the lower SFNR, where about 31% of the riparian area is actively farmed.

5.4.4 Actions

- Purchase riparian easements and/or continue to implement and expand CREP program through the lower South Fork Nooksack River, with willing landowners.
- Work with forest landowners to voluntarily provide wider buffers on tributary streams.
- Control non-native invasive vegetation that outcompete native vegetation to accelerate trajectory to recovery in riparian areas along the SFNR and tributaries (especially Hutchinson Creek).
- Conduct riparian stand assessments and develop a riparian restoration plan for the South Fork Nooksack River watershed that identifies and prioritizes appropriate treatments by location.

5.5 Instream Rehabilitation

5.5.1 Description

Instream rehabilitation primarily involves the strategic placement of engineered log jams or other woody structures to encourage the formation of deep pools and coldwater refuges and increase habitat diversity and the availability of complex woody cover for hiding and resting. Instream restoration projects may ameliorate temperature increases by creating cold-water refuges through thermal stratification (Gendaszek 2014) or pool formation in areas of cool water input.
(Nooksack Indian Tribe, unpublished data), increasing hyporheic exchange (Parzych 2015), and narrowing active channel width, thereby increasing effective shade. Instream restoration can also ameliorate sediment inputs from large deep-seated landslides, as observed for the South Fork Nooksack River Larson’s Bridge project that was implemented by Lummi Natural Resources in 2001.

5.5.2 Objective

The objective of instream rehabilitation is to form deep pools and temperature refuges, increase habitat diversity (number of habitat units) and complex woody cover, and reduce the length of bank hardened with riprap.

5.5.3 Challenges and Solutions

There is broad awareness about the importance of log jams to salmon and habitat formation, especially among long-time residents of the valley who have witnessed the loss of log jams and associated deep pools over time. There is also concern over negative impacts, such as changes in channel alignment or flooding or increased risk to recreational users. In addition to recognizing the importance of wood, long-time residents of the valley understand that the river is dynamic and changes over time. Project proponents must also undertake a rigorous design and permitting process that includes explicit evaluation of channel and flooding response to restoration, and any public safety risk must be avoided or mitigated.

Opportunity for restoration among agricultural landowners could be increased by pursuing integrated habitat restoration and bank protection projects, especially at the outer edge of the historic migration zone to minimize constraints to channel migration. USDA National Resources Conservation Service’s Regional Conservation Partnership Program can fund such projects, although salmon recovery funding may be necessary to help defray the high design costs that are typical of engineered log jam projects.

5.5.4 Actions

- Continue instream restoration in high priority reaches of the South Fork Nooksack River that create coldwater refuges, increase effective shading, increase channel roughness to promote hyporheic exchange, reconnect floodplain channels, reduce redd scour, create flood refuge habitat, decrease shear stresses, and create hydraulic refuges.
- Share information and solicit input about proposed restoration projects in community forums.
- Work with landowners to develop, seek funding for, design and implement integrated habitat restoration/bank protection projects that provide mutual benefits to landowners and salmon habitat and replace riprap bank hardening with complex woody cover.
- Evaluate and communicate restoration project effectiveness to the SFNR community.
- Research mechanisms to maximize temperature refuge formation and maintenance (i.e. hyporheic, groundwater and surface flow dynamics that contribute cool water; pool
morphology or structural elements like wood that prevent immediate mixing of cool and warm water) and incorporate findings into restoration project designs.

- Improve habitat quality in cool-water tributaries, especially floodplain tributaries that provide important flood refuge and overwinter rearing habitat, by placing logs and log jams.

5.6 Acquisition and Easements

5.6.1 Description

This action includes acquisition of fee-simple title, conservation easements, and purchase of development rights from willing landowners.

5.6.2 Objective

The objectives of this action are to: (1) prevent watershed degradation through conversion of forest and agricultural land to development; and (2) to increase opportunity for riparian and floodplain restoration.

5.6.3 Challenges and Opportunities

The SFNR community values agriculture and forestry (see community long term goals), and support is strong for maintaining those land uses and avoiding conversion to development. In some cases, funding for easements or acquisition of less productive/income generative resource lands can help sustain active farm and forest operations while achieving restoration objectives.

5.6.4 Actions

- Implement purchase of development rights where landowners are willing, including
  - Quantify available development rights in the SFNR and prioritize acquisition.
  - Outreach to landowners of priority parcels to evaluate willingness
  - Develop strategy to secure sufficient funding to purchase development rights from willing landowners.
- Increase the opportunity for floodplain reconnection and riparian restoration by acquiring conservation easements or fee simple title to property in the floodplain from willing landowners, or otherwise working with landowners to support stewardship efforts. Look for opportunities to exchange river-adjacent land for property further from the river.

5.7 Fish Passage Barrier Removal

5.7.1 Description

Restoring longitudinal connectivity is intended to reestablish salmon migration to diverse habitats that have been lost through construction of artificial barriers. Reconnection often also restores downstream transport of sediment, wood or other organic matter, and flow. We have expanded the action beyond artificial fish passage barriers to also include evaluating improving passage at
natural fish passage barriers that prevent migration into the upper portions of the SFNR watershed, where summer stream temperatures are considerably cooler than the lower elevation portion of the watershed. Actions also address barriers in tributaries and floodplain channels that limit access to crucial rearing habitat and overall lower stream temperatures. Reconnecting habitat is considered to have immediate and long-lasting benefits and a high probability of success.

5.7.2 Objectives

The objectives of this category of actions are to restore fish passage at all artificial barriers and to evaluate improving passage at natural barriers (South Fork Nooksack River at RM 25 and RM 31, Skookum Creek at RM 0.5 and 2.4) to cooler upstream habitats.

5.7.3 Challenges and Solutions

While fish passage restoration projects may inconvenience landowners in the short-term during construction, the long-term impacts are typically neutral or, where associated with road improvements or upgrade of bridge load capacity, positive. Insufficient funding and lack of technical resources are the greatest barrier to fish passage restoration on private lands, but funding sources and project partners are available. Potential funding sources for fish passage barrier removal include Washington Department of Natural Resources’ Family Forest Fish Passage Program (private forestlands), U.S. Department of Agriculture Natural Resources Conservation Service’s Regional Conservation Partnership Program (agricultural lands), and Washington Department of Fish and Wildlife’s Fish Passage Barrier Removal Board. Local conservation partners who engage in fish passage barrier removal projects include Whatcom Conservation District and Nooksack Salmon Enhancement Association.

5.7.4 Actions

- Compile available data on fish passage barriers in the SFNR watershed and prioritize replacement according to length of habitat reconnected, salmonid species benefitted, and temperature of connecting waters. Make information publicly available.
- Outreach to landowners of priority barriers and connect landowners with funding sources and project sponsors.
- Increase use of cooler upstream habitats through release of hatchery-origin South Fork Nooksack River chinook smolts to such habitats.
- Evaluate feasibility of improving passage at natural barriers (SFNR at RM 25 and RM 31, Skookum Creek at RM 0.5 and 2.4) – and implement feasible projects.

5.8 Community Engagement and Outreach

5.8.1 Description

This action includes education and outreach and participating in community forums, such as the South Fork Watershed Group and Acme-Van Zandt Flood Subzone.
5.8.2 Objective

The objectives of this action are to build trust, raise awareness, and improve transparency to build community support for conservation and restoration efforts in the SFNR.

5.8.3 Challenges and Solutions

There is considerable interest among South Fork Watershed Group members in continuing to meet as a group. Group facilitation is helpful to identify areas of agreement and build consensus. The Nooksack Tribe provided funding for the initial series of meetings, but new sources of funding will likely be needed to sustain the effort as the Watershed Group moves forward as a self-organizing body, to provide for administration and communications.

5.8.4 Actions

- Encourage conservation partners to participate in community forums, such as South Fork Nooksack Watershed Group and Acme/Van Zandt Flood Subzone, to solicit input on conservation and restoration projects and programs.
- Develop targeted education and outreach materials to communicate importance of and build support for restoration and conservation projects and programs in the SFNR.
- Support education and outreach in community forums on topics of interest that relate to conservation and restoration projects and programs. South Fork Nooksack River Watershed Group members expressed interest in further conversations around the following topics:
  - Agriculture
  - Water Rights
  - Tubers/Water recreation
  - Strategy for public education & outreach
  - Forestry
  - Wildlife
  - Tribal Treaty Rights
  - Pioneer history & management techniques
  - Habitat Restoration
  - Flood Management
  - Water Quality (temperature, sediment)
  - In-stream restoration/log jams
  - Railroad/Highway impacts
  - Elk Habitat
  - Emergency Preparedness
  - Beaver re-introduction & re-location
5.9 Planning

5.9.1 Description

This action relates to planning of restoration and conservation programs and projects and supporting community efforts towards comprehensive watershed planning.

5.9.2 Objective

The objective of this action is to support long-term, holistic planning in the watershed and encourage community investment and participation in activities that advance watershed health for current and future generations.

5.9.3 Challenges and Solutions

Critics of conservation planning assert that it often lacks transparency and sufficient opportunity for public input. Continuing efforts to provide information and opportunities for meaningful community engagement in planning and project development is critical to success.

5.9.4 Actions

- Support the efforts of the Watershed Group to develop a comprehensive Community Watershed Plan, to advance long-term community watershed goals.
- Work with the SFNR community and the Acme/Van Zandt Subzone to re-evaluate the potential for integrated floodplain management planning, integrating flood risk reduction, agricultural protection, and salmon recovery needs.
- As a comprehensive water settlement approach develops to resolve conflicts at the broader Nooksack River watershed scale, work with the SFNR community to evaluate willingness to participate. Lummi Nation has proposed an approach that would integrate water quantity, water quality, and habitat restoration.
- Incorporate climate change information into updates to WRIA 1 Salmonid Recovery Plan and development and prioritization of projects for SRFB/PSAR funding.

5.10 Data Gaps

This section of the reach-scale plan has focused on existing knowledge on the South Fork Nooksack River. In addition, unique and contemporary research and investigation of water resources of the SFNR has been accomplished and summarized in this document. Review of this existing information as well as an outcome of the public outreach and stakeholder engagement program have identified gaps in data and knowledge that relate to existing conditions in the watershed and potential impacts of climate change on the functioning of the watershed. Although a comprehensive list of data gaps is not available at this time, one major area of research is needed that relates to more site-specific watershed modeling that resolves watershed functioning under natural conditions, with past and present land management, and under climate change scenarios. This work will require sophisticated computer modeling that is beyond the scope of and available budget of this planning effort to date. One of the potential functions of the Watershed Group, will be to continue to compile data gaps, determine what research needs to be accomplished that addresses the data gaps, and to seek funding to conduct such research.
6.0 Regulatory Framework

There are a variety of federal, state, and local land use regulations that apply to the proposed riparian protection and restoration actions. The proposed actions will need to comply with such regulations where relevant. Potential regulations that may apply by agency include the following:

6.1 US Environmental Protection Agency

The federal Clean Water Act (CWA) became law in October 1972, after both the US Senate and US House of Representatives overrode President Richard Nixon’s veto of the law. The Environmental Protection Agency (EPA) has overall regulatory authority over the federal CWA. Some sections of the CWA are delegated to the State of Washington, Department of Ecology (Ecology) depending on the state developing regulatory programs that meet the EPA’s interpretation of intent. The following sections of the CWA are relevant in the SFNR watershed.

- **Section 303(d) – Total Maximum Daily Load (TMDL).** This is a regulatory program established to bring an impaired water body back into compliance with the water quality standards. In the case of the SFNR, the river is 303(d) listed for excessive temperatures and fine sediment. The intent of the 303(d) program is that a TMDL must be prepared that addresses these sources of pollution, both natural and human-caused, and that brings the impaired water body back into compliance. Currently, EPA and Ecology are preparing a TMDL for high water temperatures for the SFNR.

- **Section 401 – Water Quality Certification.** Ecology has regulatory authority over this CWA program. All projects that involve exposure of soil and grading (excavation and deposition) such that eroded earth materials and/or other pollutants may be deposited in state or federal waters must receive water quality certification. Activities altering wetlands and streams may require permit authorization from WDOE per Section 401 of the federal Clean Water Act (CWA) as directed by the U.S. Environmental Protection Agency. WDOE has authority over discharge into all wetlands (including isolated wetlands) and streams; and may require permits if activities are conducted below the stream OHWM. Discharge may include de-leveling activities if material is moved within a wetland and creates an upland hummock. The WDOE reviews all CWA Section 404 permit applications received by the Corps for Water Quality Certification. WDOE requires an individual review of all wetland disturbances greater than 1/2 acre.

- **Section 402 – National Pollutant Discharge Elimination System (NPDES).** The CWA prohibits anybody from discharging "pollutants" through a "point source" into a "water of the United States and/or State water" unless they have an NPDES permit. The permit will contain limits on what you can discharge, monitoring and reporting requirements, and other provisions to ensure that the discharge does not impair water quality or people's health. In essence, the permit translates general requirements of the CWA into specific provisions tailored to the operations of each project discharging pollutants.

- **Section 404 – Discharge of dredged or fill material.** Section 404 of the CWA establishes a program to regulate the discharge of dredged or fill material into waters of the United States, including wetlands. Activities in waters of the United States regulated under this
program include fill for development, water resource projects (such as dams and levees), infrastructure development (such as highways and airports), mining projects, wetland and stream channel restoration projects. Section 404 requires a permit before dredged or fill material may be discharged into waters of the United States and/or State waters, unless the activity is exempt from Section 404 regulation (e.g., certain farming and forestry activities). The US Army Corps of Engineers (USACE) has been given the authority over this CWA section by the EPA as that agency routinely addresses discharge of dredged or fill material. USACE regulates the discharge of dredged or fill material into wetlands, streams, and other drainages that connect to Waters of the United States under Section 404 of the CWA. The USACE regulates structures and/or work in or affecting the course, condition, or capacity of navigable Waters of the United States under Section 10 of the Rivers and Harbors Act of 1899. The Corps requires notification for all disturbances to wetlands, streams, and potentially to other drainages (ditches), including restoration and enhancement activities. The Corps will automatically assert jurisdiction over some surface waters and will need to complete a significant nexus determination for others, depending on the degree of connection to other waters, the hydrologic classification of these associated waters, and their significance in the larger drainage basin. The USACE hydrologic classification is based on whether a surface water meets the definition of or is connected to a waterbody that meets the definition of a Traditional Navigable Water (TNW) or a Relatively Permanent Water (RPW). A TNW is a navigable water protected under Section 10 of the Rivers and Harbors Act of 1899 or other waters currently or historically used or susceptible to use in interstate or foreign commerce. An RPW is a surface stream or river that exhibits continuous flow of more than three months out of the year. Only the USACE has the authority to make jurisdictional determinations; however, the following is a description of the anticipated determinations. The SFNR is considered a TNW and the Corps would exert jurisdiction. Black Slough and other streams within the SFNR watershed likely qualify as waters adjacent or abutting a TWN and as RPWs. The majority of wetlands would likely also qualify as waters adjacent to an RPW and the USACE would likely exert jurisdiction. Activities in Waters of the United States that require USACE authorization may qualify for authorization under one of the general Nationwide Permits (NWPs) if the activities meet the criteria. For example, wetland and/or instream restoration in the SFNR would likely qualify for NWP 27. Individual Permits (IPs) are required when a project does not qualify for NWP authorization. As part of their permit review, the Corps must verify the project complies with Section 7 of the Endangered Species Act, the Magnuson-Stevens Fishery Conservation and Management Act, and Section 106 of the National Historic Preservation Act, (including archeological sites). Depending on activity, a CWA section 404 permit (NWP and/or IP) may be required.

6.2 US Fish and Wildlife Service/NOAA Fisheries Services

The federal Endangered Species Act (ESA) was passed in the 1973, and serves as the enacting legislation to carry out the provisions outlined in The Convention on International Trade in Endangered Species of Wild Fauna and Flora. Designed to protect critically imperiled species from
extinction as a "consequence of economic growth and development untempered by adequate concern and conservation", the ESA was signed into law on December 28, 1973. The U.S. Supreme Court found that "the plain intent of Congress in enacting" the ESA "was to halt and reverse the trend toward species extinction, whatever the cost." The Act is administered by two federal agencies, the United States Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration National Marine and Fisheries Service (NOAA-NMFS). Federally Threatened and Endangered species, including the Oregon Spotted Frog (*Rana pretiosa*), Puget Sound Chinook (*Oncorhynchus tshawytscha*), Puget Sound steelhead (*O. mykiss*) and bull trout (*Salvelinus confluentus*) have a documented or modeled presence within the SFNR. Restoration actions on sites with the potential presences of these species may require permits issued by the FWS and/or NMFS in accordance with Section 10 of the ESA. If projects qualify for NWP 27, with USACE informal consultation under section 7, they would be allowed by submitting a Specific Project Information Form in place of an HCP. Necessary permits may include Incidental “Take” permits and “Enhancement of Survival permits.” As part of such permits, a Habitat Conservation Plan (HCP) may be necessary to accompany an application for an Incidental Take permit.

### 6.3 US Forest Service

Federal lands in the watershed are managed under the Northwest Forest Plan, which allocates land among seven categories. Timber harvesting is limited to thinning and salvage for all categories, except for the matrix. The matrix area is reserved for intensive timber management. Of 25719 acres of the SFNR watershed managed by USFS, 25% is congressional reserved, 44% is administratively withdrawn, 31% is late successional reserves, and 0.28% matrix; these numbers exclude riparian reserves.

- **Congressionally Reserved Areas** – Lands that have been reserved by an act of Congress. In the SFNR watershed, Mt. Baker Wilderness is in this category.
- **Late Successional Reserves** – Reserves that will maintain a functional, interactive, late-successional and old-growth forest ecosystem. They are designed to serves as habitat for late-seral and old-growth dependent species including the northern spotted owl.
- **Managed Late Successional Areas** – Lands are either mapped managed pair areas or unmapped protection buffers. Managed pair areas are delineated for known northern spotted owl activity centers. Protection buffers are designed to protect certain rare and locally endemic species.
- **Administratively Withdrawn Areas** – Includes recreational, visual areas, back country, and other areas not scheduled for timber harvest.
- **Riparian Reserves** – Riparian reserves are areas along streams, wetlands, ponds, lakes, and unstable or potentially unstable areas where the conservation of aquatic and riparian-dependent terrestrial resources is important. These reserves protect aquatic habitat and its dependent species, and provides greater connectivity to late-successional forest habitat.
- **Matrix** – Matrix is the federal land outside the categories listed above. It is the area in which most timber harvest and silvicultural activity takes place.
6.4 Federal Reserved Water Rights

Federal reserved water rights include those created when federal lands are withdrawn from the public domain (e.g. national parks, national forests) and tribal water rights. Federal reserved water rights are excepted from comprehensive state control of water resources. The legal context of Pacific Northwest tribal water rights was reviewed in Osborn (2013). Tribes of the Pacific Northwest hold two types of water rights: (1) traditional on-reservation water rights recognized in Winters v. United States (1908); and (2) Stevens Treaty water rights, habitat-based water rights that exist at traditional fishing areas and that derive from fishing rights reserved in treaties negotiated by Washington Territorial Governor Isaac Stevens. Tribal water rights have a date of “time immemorial” for uses that predate the reservation (e.g. fishing) and from the data of the reservation for uses that originated with the reservation (e.g. agriculture). Unlike state water rights, Winters water rights are not governed by principals of prior appropriation, are based on future needs rather than actual use, and cannot be lost for non-use. Water rights for specific tribes have most commonly been defined and quantified through general stream adjudications, proceedings initiated in state courts that joins all water claimants within a watershed to determine the validity, priority, and quantity of water rights. Negotiated settlements provide an alternative to the expense, long duration, and divisiveness of adjudications, providing a mechanism for the development of creative, mutually beneficial solutions (WRIA 1 WMP IFWG 2003). Both the Lummi Nation and the Nooksack Tribe claim federal reserved water right claims to water in WRIA 1 for both (1) the purposes of their reservations as permanent, economically viable homelands, and (2) instream flows sufficient to support a harvestable surplus of salmon (WRIA 1 WMP IFWG 2003). In addition, the U.S. Forest Service and National Park Service have federal reserved water rights claims for the purpose of their federal reservations (WRIA 1 WMP IFWG 2003).

6.5 Washington State Department of Ecology (WDOE)

State Clean Water Act:

The Washington Department of Ecology has regulatory authority for the state’s clean water act (WA CWA). The state’s clean water program must be consistent with the federal clean water act as regulated by the Environmental Protection Agency. WA Ecology generally has responsibility for water quality through the following programs relevant to this reach-scale plan:

- **Sections 303(d) and 305(b)** – Water quality assessments and Total Maximum Daily Load program. A temperature TMDL is underway for the SFNR. Only one point discharge was identified in the watershed for the Skookum Fish Hatchery. All other sources of temperature pollution were identified as non-point sources, and as such, are not subject to specific regulatory requirements or permits. Rather, voluntary actions are relied on to bring the SFNR into CWA compliance.

- **Section 401 - Water Quality Certification** – Most projects that involve clearing and grading the land over certain threshold areas require certification that the proposed activities will not result in pollutant discharge to waterbodies, including wetlands. The federal Clean Water Act allows states to approve, condition, or deny projects proposed in waters of the United States, including wetlands. Projects that may result in a discharge to these waters must first receive a permit or license from one of
several federal agencies. Issuance of a Section 401 Certification means that Ecology has reasonable assurance that the applicant's project will comply with state water quality standards and other aquatic resources protection requirements under Ecology's authority. The Section 401 Certification can cover both the construction and operation of a proposed project. Conditions of the Section 401 Certification become conditions of the Federal permit or license. For 404 permits the Corps has developed Nationwide Permits to streamline the process for specific activities. The Corps reviews a proposed project to determine if an individual 404 permit is required, or if the project can be authorized under a Nationwide Permit. The Nationwide Permits also need Section 401 Certification from Ecology. Ecology has already certified, certified subject to conditions, or denied specific Nationwide Permits. If certified, no further Section 401 Certification review by Ecology is required. If certified subject to conditions, an individual certification or Letter of Verification from Ecology is required. If denied, an individual certification is required for all activities under that Nationwide Permit. Issuance of a 401 Certification means that Ecology has reasonable assurance that the applicant's project will comply with state water quality standards and other aquatic resources protection requirements under Ecology's authority. The 401 Certification can cover both the constructions and operation of a proposed project. Conditions of the 401 Certification become conditions of the Federal permit or license.

- **403 – National Pollutant Discharge Elimination** - Construction Stormwater General Permit. Construction site operators are required to be covered by a Construction Stormwater General Permit if they are engaged in clearing, grading, and excavating activities that disturb one or more acres and discharge stormwater to surface waters of the state. The permit is also required if clearing, grading or excavating activities disturb an area smaller than 1 acre if it is part of a "larger common plan of development or sale" that will disturb 1 acre or more and discharge stormwater to surface waters of the state or a conveyance system that drains to surface waters of the state. "Surface waters of the state" are broadly defined by state law and includes storm drains, ditches, wetlands, creeks, rivers, ponds, lakes and marine waters to obtain permit coverage. In addition to these permit triggers, Ecology reserves the right to require permit coverage at a construction site of any size, if Ecology believes that the site may be a significant contributor of pollutants to waters of the State of Washington or reasonably expects the site to cause a violation of water quality standards.

**Shoreline Master Program:**

The Shoreline Management Act (SMA), RCW 90.58, provides a statewide framework for managing, accessing and protecting shorelines. Now more than 40 years old, the SMA reflects the strong interest of the public in our shorelines and waterways for recreation, protection of natural areas, aesthetics and commerce. The SMA applies to major water bodies and their adjacent shorelands throughout Washington State. The approximate 28,204 miles of shorelines in the State include:
• Marine waters – 3,447 miles.
• Streams over 20 cubic feet per second mean annual flow – 21,645 miles.
• Water areas and reservoirs 20 acres and greater – 3,112 miles.
• Upland areas called shorelands that are 200 feet landward of the Ordinary High Water Mark.
• All associated wetlands.

The South Fork Nooksack River has an average annual flow that exceeds 20 cfs. As such, development activities that are proposed within the 200-foot regulatory distance from the river are subject to these regulations. Most habitat restoration projects can obtain exemptions and/or given expedited permits if no adverse impacts occur to the protected waterbody. Whatcom County has developed the County’s shoreline mater program that acts on these regulations and is consistent with the state’s program regulations.

**Water rights:**

The Washington State Department of Ecology manages the state’s water resources and administers the permits for water rights for surface and groundwater withdrawals. Any surface water use that began after the state water code was enacted in 1917 and any groundwater withdrawal (with exceptions noted below) after the state groundwater code was enacted in 1945 require a water-right permit or certificate. A water right permit is the first step towards securing a water right; a water right is said to be perfected when all conditions of the permit are met. For water uses which predate the permitting system, water right claims were made; their validity can only be confirmed through judicial process. The Claims Registry is closed, and Ecology cannot accept new claims; pre-code water rights for which a claim was not filed are considered to have been relinquished.

The definition of a water right is “a right to a beneficial use of a reasonable quantity of public water for beneficial purpose during a certain period of time occurring at a certain place” (WRC 2009). Water rights specify diversion/withdrawal rate, total annual use, purpose of use, season of use, point of diversion or withdrawal, and place of use (WRC 2009). Maintaining water rights requires continued use, which refers to both the “measure and limit” of a water right and the purpose(s) for which water is used. All or part of a water right is subject to relinquishment if it is unused, without sufficient cause, for five or more consecutive years (WDOE 2013).

Washington Water Law follows the prior appropriation doctrine, common in western water law, which holds “first in time, first in right”, ensuring that junior rights cannot impair senior water rights (Pharris & McDonald 2000). Seniority is established by priority date, or the date an application was filed or, for claims and exempt groundwater withdrawals, the date the water was first put to beneficial use. Water use by junior water right holders can be interrupted if it impairs use by senior water right holders.

The exceptions to the state permit requirement for groundwater withdrawals (RCW 90.44.050) include:

- Providing water for livestock (no gallon per day limit)
- Watering a non-commercial lawn or garden one-half acre in size or less (no gallon limit per day, but limited to reasonable use)
- Providing water for a single home or groups of homes (limited to 5000 gallons per day)
• Providing water for industrial purposes, including irrigation (limited to 5000 gallons per day but no acre limit)

Ecology is required by state law to retain adequate amounts of water in streams to protect and preserve instream resources and uses, such as fish, wildlife, recreation, aesthetics, water quality and navigation. An instream flow rule is a stream flow regime (specifying stream flow amounts at specific locations by time of year) set in a state regulation. Instream flows for streams in Water Resource Inventory Area (WRIA) 1, the Nooksack Basin, including the South Fork Nooksack River watershed, were established in 1985 (173-501 WAC). An instream flow is a water right that has a priority date and is managed like other water rights. Water rights senior to the 1985 instream flows have priority, so the instream flows are not guaranteed instream flow levels but rather can interrupt water use for junior water right-holders.

**Determining Legal Water Availability:**

As described above, while certain groundwater withdrawals do not require a state water right permit, with the Hirst, Futurewise, et al v. Whatcom County (2016) decision, the Court ruled that Whatcom County has an independent obligation to ensure that new permit-exempt uses do not impair instream flows and closures when making water availability determinations, i.e. that legal water is available. To respond to the ruling, in October 2016, Whatcom County issued an emergency moratorium on permits for uses that rely on state-permit-exempt groundwater withdrawals for water supply on properties within closed or partially closed basins. The ordinance was replaced in December, 2016, with an interim ordinance that ended the moratorium but required the applicant to provide evidence of legal availability before building permit or other project permits could be issued. Evidence of legal availability can take the form of: (1) a water right permit from the WA Department of Ecology; (2) a letter from an approved water purveyor with sufficient water rights, stating the ability to provide water; or (3) documentation that water can be supplied by a rainwater catchment system. Any new permit-exempt groundwater withdrawal would have to provide evidence of legal availability in the form of: (1) documentation that the well site is not in a closed basin; (2) study prepared by a qualified hydrogeologist certifying that use would not impair a senior water right; or (3) a mitigation plan prepared by a qualified hydrogeologist. The interim ordinance was extended in March and in April; the ordinance in effect at the time of writing will be effective for not longer than 6 months from April 14, 2017, the date it was adopted.

**6.6 Washington State Department of Natural Resources (DNR)**

The Washington State Forest Practices Rules (Title 222 WAC) apply to private and state forest lands and establish standards for forest practices such as timber harvest, pre-commercial thinning, road construction, fertilization, and forest chemical application. In July 2001, Washington adopted new forest practice measures commonly referred to as the “Forests and Fish Rules.” The updated Rules grew out of the 1999 Forests and Fish Report (FFR), which was produced by a collaboration of tribes, forest landowners, local governments, environmental groups and others, and which identified four goals: (1) provide compliance with Endangered Species Act for aquatic and riparian-dependent species on state and private forestlands; (2) restore and maintain riparian habitat to support a harvestable supply of fish; (3) meet the requirements of the Clean Water Act for water quality; and (4) keep the Washington timber industry economically viable. The Salmon Recovery Act of 1999 directed the adoption of these goals into the Washington State Forest Practice Rules. In 2006, the Washington State Forest
Practices Habitat Conservation Plan (FPHCP) (also known as the Forest and Fish HCP) was approved in 2006 by U.S. Fish and Wildlife Service and NOAA Fisheries to meet the requirements of ESA as well as the CWA.

Salient details of the rules\(^1\) include:

- **Riparian Buffers**: Riparian management zones on both sides of fish-habitat streams are managed to provide near-maximum shade at levels that approach or exceed the amounts provided by mature conditions. West of the Cascade crest (Westside), Type S (Shorelines of the State) and Type F Waters (fish-bearing streams) are protected with buffers that extend up to a site-potential tree height from the outer edge of the bankfull width or channel migration zone, whichever is greatest. This distance is 90 to 200 feet, depending on the productivity of the land near the stream. Timber management within buffers is progressively more restrictive in the zones closer to the stream with a no-harvest zone of 50’ and a shade requirement to leave all available shade using the approved shade model out to 75’. Along Type Np waters (perennial channels upstream of Type S and Type F waters, characterized by headwater spring at its uppermost extent), 50-foot no-harvest buffers are required for up to 500’ upstream of its confluence with the connecting water\(^2\). Small forest landowners\(^3\) are required to comply with the buffer requirements, but can apply for the Forestry Riparian Easement program to be compensated for at least 50% of value for the timber they leave; the program has been generally underfunded, however.

- **Road Maintenance**: Forest Practices Rules require that all existing forest roads must be improved and maintained to provide fish passage to fish in all life stages, prevent landslides, limit delivery of sediment and surface runoff water to streams and avoid capture or redirection of surface or ground water. To accomplish these goals, industrial landowners are required to bring all of their forest roads into an approved road maintenance plan within five years and complete improvements within fifteen years; in 2011, the 2016 deadline for completion of improvements was extended to 2021 for landowners who applied in time. Small landowners are also required to complete road maintenance plan checklists and to maintain roads to avoid damage to public resources. Improvements on small landowner roads are required at the time of harvest to ensure that costs associated with road improvements can be offset by revenues from the harvests. The exception to that requirement is that, for fish passage barriers, small forest landowners only have to apply for the Family Forest Fish Passage Program at the time of harvest; projects are added to a prioritized list and completed as funding is available, reducing certainty that barriers will be fixed. The DNR is responsible for tracking landowner compliance with road maintenance planning requirements. Landowners must

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\(^1\) The following paragraphs are largely excerpted from the *WRIA 1 Salmonid Recovery Plan*, with updates and additional information provided.

\(^2\) 50-foot no-harvest buffers on Type Np waters are 500 ft (if Np length>1000 ft), 300 ft or 50% of length (if Np length is between 300 and 1000 ft), or entire length (if Np length is <300 ft).

\(^3\) Small forest landowners are defined as one who has harvested in the past 3 years (and does not expect to harvest for ten years) no more than an average timber volume of 2 million board feet per year for their own forest lands in Washington state.
also complete road repairs on a “worst first” basis (i.e. where roads create fish passage barriers, fish passage improvements are completed on streams that open the most habitat first). Standards, priorities and implementation guidelines are established in the rule. The Washington State Forest Practices Rules also include new road construction standards to meet water quality goals and, specifically, to reduce sediment inputs to the stream.

- **Unstable Slopes**: In addition to the forest practices rules for road maintenance and management practices outlined above, protections for unstable slopes and wetlands will help ensure that hydrologic regimes for surface and groundwater are maintained. The Forest Practices Rules require considerable improvements to permitting processes with the goal of preventing forest practices from causing an increased rate of landslide-related sediment delivery. Improved topographic and geologic mapping will provide landowners and the Department of Natural Resources (DNR) with more accurate tools to predict where landslides may occur. Detailed standards are being established to field-identify the most hazardous areas. Local slope stability issues are being identified through regional efforts. Resource professionals representing agencies, tribes, and landowners are being trained to recognize potentially unstable slopes and geologists are mapping hazard areas and assisting resource professionals in assessing slope stability issues on the ground.

### 6.7 WA State Trust Lands Habitat Conservation Plan

State trust lands within the watershed are covered by the State Trust Lands Habitat Conservation Plan (HCP), approved in 1997, an ecosystem-based 70-year forest management plan that helps DNR develop and protect habitat for at-risk species, including northern spotted owl, marbled murrelet, chinook salmon, steelhead, and bull trout. Relative to the State Forest Practices Rules, the State Trust Lands HCP provides more protective riparian and wildlife habitat protection measures. Riparian protections consist of an inner riparian buffer to protect salmonid habitat and an outer wind buffer to protect the riparian buffer.

Riparian buffers along types 4, 1, 2, and 3 S and F waters are equal to one site-potential-tree-height in a mature conifer stand or 100 feet, whichever is greater. Riparian buffers along type 4 waters are 100 feet. Buffers apply to both sides of stream and are measured from the outer margin of the 100-year floodplain. Buffer widths average about 150 feet for types 1 and 2 and 100 feet for types 3 and 4 waters. Activities within the buffer are restricted thus: (1) no timber harvest is allowed for the first 25 feet from the stream; (2) for the next 75 feet, minimal harvest is allowed provided there is no reduction in stream shading or the ability of the buffer to intercept sediment or contribute nutrients or wood; such harvest is likely to include only selective removal of single trees; (3) in the remaining buffer, low levels of harvest are allowed, e.g. selective removal of single trees, selective removal of groups of trees, thinning operations and salvage operations.

Wind buffers are applied to types 1, 2, and 3 waters in areas that are prone to windthrow. For types 1 and 2 waters, wind buffers are 100-foot along the windward side; for type 3 waters wider than 5 feet and with at least moderate potential for windthrow, buffers are 50 feet.

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4 In practice, Type 1 is equivalent to Type S, types 2 and 3 are equivalent to F-type, and type 4 is Np type.
The State Trust Lands HCP also requires maintenance of hydrologic maturity for two-thirds of DNR-managed forest lands in drainage basins (>1000 acre in size) in the significant rain-on-snow zone, although exceptions effectively limit its implementation.

6.8 WA State Aquatic Lands

State-owned aquatic lands include the marine waters and navigable rivers and lakes. Projects taking place on or over state-owned aquatic lands require use authorization from DNR. Authorization may take the form of a lease or license. Applicants are encouraged to work with DNR Aquatic Resources Program early in design process so that staff may evaluate whether the proposed use is appropriate and to avoid or minimize impacts to aquatic resources. Public safety is another important consideration: obtaining authorization for large wood restoration projects additionally completion of the “DNR Public Safety Checklist for Large Woody Debris Projects.”

6.9 Washington State Department of Fish and Wildlife (WDFW)

Construction projects or activities in or near state waters that will “use, divert, obstruct, or change the natural flow or bed” requires a Hydraulic Project Approval (HPA). WDFW administers the HPA program under the state Hydraulic Code (Chapter 77.55 RCW), which was specifically designed to protect fish life. WDFW may also regulate the on-site wetlands if modification effects downstream waters. WDFW offers expedited HPAs (issued within 15 days of request) for projects when normal processing time would result in significant hardship to the applicant, unacceptable damage to the environment, and when the situation meets the definition of “imminent danger”. Some fish enhancement projects are eligible for “streamlined processing”, which means that they do not require local environmental permits or proof of State Environmental Protection Act compliance but do require approval of the local government. Large-scale engineered log jams projects are typically not eligible for streamlined HPAs.

6.10 Whatcom County

**Land Disturbance:**

Per Whatcom County Code 20.80.734, any land disturbance activities including clearing vegetation and grading earth materials that exceed the established thresholds require a land disturbance permit. Land disturbance permits regulate clearing and removal or destruction of trees and other vegetation, excavation, filling, grading, deposition of organic debris or other debris, and earthwork construction within unincorporated Whatcom County. By minimizing stormwater impacts generated by the removal of vegetation and alteration of landforms, these regulations protect public health, safety, and welfare, as well as aquatic and wildlife habitat, water quality, neighboring property, and other goals and policies of the Whatcom County Comprehensive Plan. Activities associated with this plan may require a Land Disturbance Permit from Whatcom County.

**Critical Areas Ordinance:**

Whatcom or Skagit Counties regulates all development activities in designated Critical Areas. Critical Area designations in the Whatcom County Critical Areas Ordinance (Title 16.16) include habitat conservation areas, frequently flooded areas, wetlands, geologically hazardous areas, and
critical aquifer recharge areas. Of these, only wetlands, frequently flooded areas, and habitat conservation areas apply to this project.

A number of activities within the critical areas are allowed, including but not limited to, certain forestry practices, vegetation maintenance, some recreational activities, maintenance of already-established buildings, utilities, and the cutting of hazard trees. When a development is proposed that would impact a critical area, a critical areas assessment report is typically required, in which the developer proposes alternative mitigation and protective measures. The code states that complete avoidance of impacts is the highest priority, and, in order for some impact to be allowed, the applicant must demonstrate that all reasonable efforts to avoid impacts have been taken (i.e., “mitigation sequencing”). The critical areas assessment report contains an analysis of how critical area impacts or risks will be avoided or minimized and an analysis of the proposed measures to prevent or minimize impacts. When impacts cannot be avoided, the developer includes a mitigation plan for replacing critical area functions and values that would be altered by the development.

In both Whatcom County, existing agricultural operations are allowed to continue within critical areas with an approved farm conservation plan pursuant to the Conservation Program on Agricultural Lands (CPAL, Article 8, Whatcom County Critical Areas Ordinance). There are no existing agricultural within the watershed in Skagit County. Conservation plan requirements vary depending on the type of agricultural operation, land zoning, and are more extensive for operations classified as moderate to high impact. Among the standard conservation plan requirements, existing native vegetation within critical area buffers (which includes riparian areas) are required to be maintained to practical extent. Clearing activities cannot be authorized within critical areas unless the clearing would occur on existing agricultural land and is considered an essential part of the ongoing agricultural use. The conservation plans are subject to monitoring, adaptive management, and enforcement by the counties. While the provisions for agriculture in the code do not provide further restoration of critical areas per se, the conservation plans, if implemented and enforced successfully, provide protection of existing riparian vegetation and potential for increased shading in the future.

- **Habitat Conservation Areas** - areas identified as being of critical importance to the maintenance of certain fish, wildlife, and/or plant species, including:
  - Streams
  - Areas with which federally and/or state-listed species have a primary association.
  - State priority habitats and areas associated with state priority species
  - Naturally occurring ponds under 20 acres in size.
  - Naturally occurring lakes over 20 acres and other waters of the state, including marine waters, and waters planted with game fish by a government or tribal entity.
  - Natural area preserves and natural resource conservation areas.
  - Locally important species and habitats that have recreational, cultural, and/or economic value to citizens of Whatcom County, including those identified in WCC 16.16.710(C)(10).

Buffer width on streams varies from 150 feet for shoreline streams to 100 feet for fish-bearing streams to 50 feet for non-fish-bearing streams. In the Skagit County portion of the watershed,
buffer widths are similar, except for 200 foot buffer width on shorelines streams and 150 foot buffer width on fish-bearing streams greater than 5 feet wide. Wetland buffers range from 25 to 300 feet depending on the ecological function of the wetland, intensity of proposed activities, and wetland category.

- **Wetlands** – areas that are inundated or saturated by surface or ground water at frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas. Regulation of development activities in wetlands, including restoration activities, pursuant to the County’s critical areas ordinance must be consistent with both the federal and state regulatory program. The County imposes specific protective buffers on wetlands depending on quality, function, and size. Generally, restoration activities are exempt or have expedited approval so long as there are no detrimental impacts on water quality and other functions.

- **Frequently Flooded Areas** – areas located along major rivers, streams, and coastal areas where the depth, velocity, intensity and frequency of flood water during major events presents a risk to human life and property. Frequently flooded areas may also include other areas not associated with rivers, streams, lakes, and ponds that regularly flood due to runoff from upland areas. These areas are likely to be associated with internally drained wetlands and/or uplands that pond water and that may discharge into a habitat conservation area. A large portion of the SFNR valley bottom is a frequently flooded area. Development and restoration activities within frequently flooded areas associated with the SFNR must comply with NOAA’s Biological Opinion that addresses the impact of development and restoration activities in frequently flooded areas on ESA listed salmonids.

### 6.11 Shoreline Management Program

All streams with a mean average flow of at least 20 cubic feet per second, all lakes over 20 acres in size, all marine shorelines, and all associated wetlands and floodways are under the jurisdiction of Whatcom County’s Shoreline Management Program (SMP; WCC Title 23) jurisdiction. Jurisdiction extends over all surface water and landward for 200 foot from the Ordinary High Water Mark (OHWM) of the shoreline or within wetlands extending from this 200-foot boundary. A key environmental protection standard underlying the SMP is no net loss of ecological function. Areas in the SFNR watershed under SMP jurisdiction include the following designations: Resource lands (lower South Fork from below Potter Rd. bridge to Acme), Conservancy (South Fork from Acme to around Saxon Rd. bridge, plus Hutchinson, Skookum, and Cavanaugh Creeks), Natural (South Fork upstream of Saxon Rd. bridge). Permitted and conditional uses vary by designation.
6.12 National Flood Insurance Program

In 1968, Congress initiated the National Flood Insurance Program (NFIP), which provides affordable flood insurance to citizens of communities that adopt approved flood management regulations. The Federal Emergency Management Agency (FEMA) administers the NFIP, including the Community Rating System (CRS) program, wherein communities are afforded discounted flood insurance rates depending on how well their community NFIP is rated. Whatcom County administers the NFIP program within its jurisdiction through implementation of the Flood Damage Prevention Ordinance (Title 17), which sets development restrictions and requires floodplain development permits for all development proposals within the floodplain. Based on Whatcom County’s CRS rating, Whatcom County residents in unincorporated areas currently pay a 20% discount on flood insurance. Title 17 includes methods and provisions for:

- Restricting or prohibiting uses which are dangerous to health, safety, and property due to water or erosion hazards, or which result in damaging increases in erosion or in flood heights or velocities;
- Requiring that uses vulnerable to floods, including facilities which serve such uses, shall be protected against flood damage at the time of initial construction;
- Controlling the alteration of natural floodplains, stream channels, and natural protective barriers, which help accommodate or channel flood waters;
- Controlling filling, grading, dredging, and other development which may increase flood damage;
- Preventing or regulating the construction of flood barriers which will unnaturally divert flood waters or which may increase flood hazards in other areas.

A key restriction of Title 17 is that all encroachments or other developments are prohibited in a designated floodway unless a registered professional engineer or architect certifies that the encroachment will not result in any increase in flood levels during the base flood, or the flood that has a one-percent change of being equaled or exceeded in any given year (also called the “100-year flood”). Floodways means the channel of a river and adjacent land areas that must be reserved to discharge the base flood without cumulatively increasing the water surface elevation more than one foot. The floodway in the South Fork Nooksack River extends from the mouth to just upstream from Skookum Creek. In addition to complying with FEMA regulations, the County and other communities throughout Puget Sound are required to comply with NOAA National Marine Fisheries Service’s 2008 Biological Opinion that required changes to the implementation of NFIP to meet requirements of the ESA in the Puget Sound watershed.

7.0 Reach-Scale Plan

The summary of the South Fork Nooksack River Watershed Conservation Plan presented above is relevant to reach-scale planning pursuant to the Tribe’s Ecology-NEP grant. That summary provided a context of the geography of the watershed, existing conditions that relate to water quality and water quantity, impacts on fish, and climate change impacts on the hydrologic system. Watershed Planning is a continuous process, which leads to valuable interactions among the planners, scientists, residents, landowners, organizations and government entities. It creates
opportunities for innovation and collaboration to achieve common goals, and requires patience to understand and learn from differences. The South Fork Nooksack River Watershed Conservation Plan project would not have been possible without the dedication of many community members and allies who care about the SFNR watershed and are actively seeking to understand its history and intelligently shape its future. This section details the proposed actions on specific properties that have high priority for riparian protection, restoration, and wetlands restoration within the riparian zone and where owner willingness to participate in Phase 2 funding has preliminarily been established through direct communication with the owners.

7.1 Focus Reach

This Reach-Scale Plan focuses on the floodplain area of the SFNR Watershed, also commonly known as the Acme Valley. The reach is 10.6 miles in length, extending from the confluence of the SFNR and Skookum Creek at RM 14.3, downstream to the confluence of the SFNR and the North Fork Nooksack River (RM 0.0) (See Figure 17). The width of the Acme Valley ranges from 1.5 miles to 0.5 miles at its southern extent, and in total represents an area of approximately 14 square miles.

7.1.2 Geology of the Reach

As mentioned earlier, the headwaters of the SFNR lie on the eastern slopes of the Twin Sisters in Whatcom County. From River Mile (RM) 34.1 to 16.5, the SFNR flows south and west through Skagit County, before turning north and entering the Acme Valley in Whatcom County. The portion of the channel upstream of the Acme Valley is generally steeper and more confined, with glacial till, lacustrine and outwash deposits mantling the valley walls.

Downstream of the more confined reaches, the SFNR passes under the Saxon Bridge (RM13), the upstream extent of the assessment reach, and winds northwest to the community of Acme (RM 8.5). In the assessment reach, the elevation of the valley floor is approximately 300 feet, with steep flanking ridges approaching 3000 feet. Alluvial fans are present along the valley walls where steep tributaries deposit sediment onto the flat plain of the South Fork. At the upstream end of the reach, the SFNR exhibits a dramatic shift from a moderately confined channel to an unconfined channel, where the 100-year floodplain abruptly increases in width from .1 miles to between 1 and 1.3 miles (FEMA 1990).
This unconfined portion of the South Fork Valley between RM 13 and RM 1 is comprised of thick sequences of glacial outwash and Vashon glacial drift deposits overlain with river and lake deposits (Dragovich et al. 1997). Drilling near the town of Acme found recent river deposits to be 20-30 feet deep, with a maximum depth of 90 feet documented further downstream (W.D. Purnell and Associates 1988; Dragovich et al. 1997).

The change in physiography between the more confined valley above the Saxon Bridge and the Acme Valley is manifested in a change in channel morphology. The wide floodplain and low gradient make the planning reach an area of fine sediment deposition, channel migration and wood accumulation. The numerous channel-spanning logjams described in early accounts (Morse 1883) would likely have caused frequent channel jumping, or avulsions, among a series of channel configurations. Channel movement through avulsion, coupled with logjams that functioned as erosion resistant hard-points across the floodplain, would likely have yielded a patchwork mosaic of mature forest and immature forest, as has been described in similar reaches that have not been as heavily impacted by land use activities (Fetherston et al. 1995). Evidence of such river dynamics is present in the pre-historic South Fork channels that dissect the valley floor, some now occupied by floodplain tributaries such as the Landingstrip Creek area and lower Hutchinson Creek.

The floodplain connectivity of the channel changes as it flows through the Acme Valley. From the Saxon Bridge downstream to the town of Acme, the channel is incised into the floodplain, with the 100-year floodplain width the same as the historic channel occupation width.
Downstream of Acme to approximately RM 6.8, the elevation of the riverbed is roughly equal to that of the surrounding floodplain. As the channel approaches the area confined by the Van Zandt landslide, the riverbed elevations are higher than the adjacent floodplain (>3 feet at RM2.7). Collins and Sheikh (2004) hypothesize that the pinching effect of the Van Zandt Dike Landslide deposit may have induced deposition in the channel upstream from the landslide, thereby locally raising bed elevations relative to the elevation of the valley floor. The highly sinuous channel planform seen in the lower reaches of the GLO survey is consistent with a depositional area.

7.1.3 Legacy of Past Land Use

An early traveler on his way up to Mount Baker made the following observation as he passed the mouth of the South Fork Nooksack River:

“The south fork, which emerges from a sequestered leafy nook, looked very tempting. Its waters are gentle and limpid until they mingle with the turbulent main stream, and were suggestive of the peaceful current of youth before entering upon the toils and trials of manhood.” (E.T. Coleman 1869).

Euro-Americans began settling in the Whatcom County area in the 1850s, attracted by high quality timber coupled with an easy access to water transportation, and moved into the South Fork watershed in the 1880s (Whatcom County Planning and Development Services Dept. 1997). Early descriptions of the South Fork describe an impenetrable floodplain forest, vast wetlands and a channel choked with large wood, forcing early travelers to portage great distances. By the time of the General Land Office Surveys in the mid-1880s, much of the South Fork watershed was still undeveloped with small openings in the forest where homesteads were located. By the turn of the century, timber harvest had begun in earnest in the South Fork valley with large cedars cleared from local homesteads fueling the shingle mills in the Acme Valley (Figure 18).

Land clearing and subsequent agricultural development spread rapidly through the Acme Valley. By the earliest aerial photos in the 1930s, much of the forest and wetland area had been cleared and drained for agricultural production (Figure 19). Land clearing along the river led to rapid channel migration and an expansion of the unvegetated channel area of the main channel between the GLO surveys and the first aerial photographs in the 1930s. The erosion of recently cleared farmland spurred the installation of bank protection projects along the river, beginning with wooden piles and cabled wood along the banks and transitioning to riprap in the 1940s. The spread of bank armoring along the river began narrowing the active channel width. With the increase in bank protection, the riparian zone was isolated from channel migration, halting large wood recruitment and the formation of stable logjams. The reduced rate of recruitment meant that wood accumulations in bank-hardened areas were formed from wood transported from upstream sources, rather than from local wood. This can affect the channel position where wood accumulates, and the stability of the logjam. Because logjams have an impact on channel migration and channel avulsion in the reach (GeoEngineers, 2002), the loss of more stable jams likely had an impact on the variability of channel sinuosity, as well as channel length from secondary channels and ultimately habitat stability.
Management of the channel led to marked changes in the channel planform since the early historic period. As evident from GLO surveys (Figure 20, same as Figure 6), approximately 35% of the channel length downstream of Saxon bridge was multi-threaded. Such narrower secondary channels would have been separated from the mainstem by forested islands; effectively increasing the shaded channel area. The secondary channels are also associated with increased hyporheic exchange (e.g. Kasahara and Wondzell 2003) and potentially more groundwater cooling. The GLO surveys also indicate the channel lost about 3,500’ of main channel length in the Acme Valley due to channel straightening. This is a loss of ~5% of the channel length, which resulted in a stronger north-south orientation of the channel through the valley and likely a further reduction in effective shade and hyporheic exchange.

Forestry has historically been a dominant land use activity in the SFNR watershed. The first logging camp in the Acme Valley began operation in 1905 just downstream of the Saxon Bridge and wood was transported by rail from the valley (Royer 1982). The Bloedel-Donovan company was to eventually build over fifty miles of railroad in this Saxon-Nooksack river valley region between

Figure 18. Early 20th century forest in the South Fork Nooksack watershed (left); Cavanaugh Creek trestle (top right); channel-spanning logjam South Fork Nooksack (mid right); Emma Hamel dwarfed by stump (lower right).
7.1.4 Current Land Use in the Reach

As mentioned earlier, land use in the SFNR watershed continues to be dominated by forestry, with agricultural use restricted to the Acme Valley floor (Figure 21). The U.S. Forest Service manages the headwaters of the watershed downstream to approximately RM 33. Between RM 33 and RM 25, Seattle City Light purchased the river-adjacent property for conservation as mitigation for hydroelectric dams on the Skagit River. The mountainous western portion of the watershed has been managed for forestry by the State of Washington and several industrial forest landowners. Recent aerial photo interpretation for the Acme Valley found the unconfined portion of the floodplain dominated by agriculture, with forested patches present on the Van Zandt landslides and several of the larger alluvial fans (Figure 22).
Within the non-federal commercial forest areas of the watershed, timber harvest has been active (Figure 23). In the 16-year period between 1998 and 2014, 772 harvest applications were approved in the South Fork watershed covering approximately 21,800 acres, or 18.6% of the watershed (Department of Natural Resources 2015). Timber harvest on federal lands in the South Fork watershed has essentially been halted by the NW Forest Plan, although timber harvest in the lower elevation areas along the river and its tributaries was active until the plan was adopted in 1994 (Figure 24).

As discussed earlier, the SFNR does not meet federal and state Clean Water Acts (CWA) standards, and as such, the river is listed as on the CWA Section 303(d) as an impaired water body for high temperatures and excessive fine sediment. The South Fork Nooksack River Climate Change and TMDL Pilot project (US EPA 2015 Draft) identifies potential nonpoint sources within the watershed that specifically can result in warmer temperatures include the following:
7.1.5 Riparian Zone Conditions

For the purpose of this analysis, the riparian zone of the Acme Valley was defined as 100’ on each side of a stream centerline for floodplain tributaries, and 300’ from the historic river corridor area. Riparian habitat conditions are heavily impacted by agricultural uses, transportation uses, and related infrastructure.
Figure 22. Land cover in the Acme Valley (Collins and Sheikh 2004).
Figure 23. Forest practice applications in the South Fork Nooksack River 1998-2014.

Figure 24. Timber harvest on USFS lands in the South Fork watershed.
For the mainstem SFNR, extensive riprap boulder bank armoring is the greatest impact to riparian function. The Acme Valley has an estimated 9.25 miles of bank armoring along the channel. Some of the armoring dates back to the 1930s, although the majority was installed in the 1960s and 1970s. Recently, efforts have been made to remove unnecessary bank armoring or replace it as necessary with wood-based bank protection. These projects still limit large wood recruitment from the riparian zone, although the impact to instream habitat is greatly reduced. A lack of funding for maintenance will likely mean that there will be a reduction in armoring through time, with only the sites with public benefit seeing ongoing maintenance.

Transportation infrastructure in the riparian zone is significant. The Burlington Northern-Santa Fe railroad runs along the mainstem for over a mile and half of its length. Whatcom County transportation infrastructure has the greatest impact on the riparian zone with an estimated 2.1 miles of road within the riparian zone, including 0.7 miles of riparian habitat impacted by State Route 9.

Agricultural activities impact a substantial amount of the riparian buffer area. As of 2016, 31% of the South Fork buffer and 16% of the tributary buffer area was being actively farmed. Various development activities impacted an additional 11% of the South Fork buffer and 8% of the tributary buffers. Developed areas likely have a much greater impact on water quality and habitat because in many cases these areas cannot be recovered without a substantial investment in infrastructure relocation. In a few cases, infrastructure has been relocated away from the riparian zone for other reasons, such as instream habitat enhancement or public safety, and the riparian zone was restored as a component of a larger project. One example of this was the relocation of approximately 1300 feet of Saxon Road out of the riparian zone in 2009, initiated by the Lummi Nation as a part of a habitat enhancement project near their Skookum Creek fish hatchery. The current conditions of the riparian zone in the Acme Valley vary between the mainstem South Fork and the floodplain tributaries and by the adjacent land use. Currently 58% (582.8 acres) of the 300’ South Fork riparian zone and 73% (656.2 acres) of the 100’ tributary riparian zone are either forested or wetlands. Of this forested buffer area, much of is comprised of partial-width buffers and immature forest. Based on an analysis of tree height and buffer width, 154.1 acres (~15%) of the South Fork riparian area is dominated by trees greater than 50’ tall across the 300’ wide buffer. For the tributary riparian zones, the area dominated by 50’ trees across the 100’ buffer is 358.8 acres, or 40% of the buffer area. Table 5 and Table 6 show the predominant land uses that currently exist within the riparian corridors.

Temperature is directly affected by the removal of riparian zone vegetation, which increases solar radiation reaching the stream surface. Also, there is some evidence that even-age forest harvest away from tributaries may also increase surface and subsurface flows to streams with elevated temperatures (Pollock et al 2009). This reduction of riparian zone vegetation reduces the available shade, which increases sunlight to the stream surface and subsequently increases water temperature. Shade modeling of the mainstem SFNR for the temperature Total Maximum Daily Load (TMDL) indicated that the current conditions provide greatly reduced shade when compared with site potential vegetation conditions (see Figure 25).
Table 5. Land use in the 300’ South Fork Nooksack River corridor riparian buffer (2016).

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Acreage</th>
<th>Percent of Buffer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest/ Wetland</td>
<td>582.8</td>
<td>58%</td>
</tr>
<tr>
<td>Active Agriculture (2016)</td>
<td>312.3</td>
<td>31%</td>
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<td>Paved Roads</td>
<td>17.3</td>
<td>2%</td>
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<td>Field/ Forest Roads</td>
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<td>&lt;1%</td>
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<td>Railroad</td>
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<td>1%</td>
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<td>Developed</td>
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<td>7%</td>
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<tr>
<td>Fallow Agriculture</td>
<td>9.4</td>
<td>1%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1,005.5</td>
<td>100%</td>
</tr>
</tbody>
</table>

Table 6. Land use in the 100’ tributary riparian buffers.

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Acreage</th>
<th>Percent of Buffer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest/ Wetland</td>
<td>656.2</td>
<td>73%</td>
</tr>
<tr>
<td>Active Agriculture (2016)</td>
<td>142.6</td>
<td>16%</td>
</tr>
<tr>
<td>Paved Roads</td>
<td>14.3</td>
<td>2%</td>
</tr>
<tr>
<td>Field/ Forest Roads</td>
<td>6.8</td>
<td>&lt;1%</td>
</tr>
<tr>
<td>Railroad</td>
<td>8.5</td>
<td>1%</td>
</tr>
<tr>
<td>Developed</td>
<td>40.1</td>
<td>4%</td>
</tr>
<tr>
<td>Fallow Agriculture</td>
<td>31.1</td>
<td>3%</td>
</tr>
<tr>
<td>TOTAL</td>
<td>899.6</td>
<td>100%</td>
</tr>
</tbody>
</table>

7.1.6 Salmonid Populations

The lower SFNR provides habitat for all Pacific salmonid species, including Chinook salmon, coho salmon, pink salmon, chum salmon, sockeye salmon, steelhead, bull trout, and cutthroat trout. Both early- (summer) and late-timed chinook spawn in the SFNR. South Fork (SF) Nooksack early chinook is an independent population of the threatened Puget Sound Chinook Evolutionarily Significant Unit that is essential for recovery. Annual escapement estimates for the population have ranged from 7 to 116 in the past decade (Nooksack salmon co-managers, unpublished data), although these are considered minimum estimates since turbidity and the presence of abundant pink salmon spawning in odd years can obscure visibility of chinook redds, counts of which form the basis of escapement estimates. Due to high risk of extinction of the population, a captive brood hatchery program was established in 2007, and the program releases began to return to the Skookum hatchery (RM 14.3) in earnest in 2015 (~949 adults, ~12 females) and 2016 (~1661 adults, ~114 females). Chinook spawn upstream to the anadromous barrier at RM 31, although Sylvester’s Falls at RM 25 constitutes a partial blockage, and in larger tributaries to the South Fork.

A significant proportion (38%) of returning spawners sampled from 1999 to 2013 had out-migrated as yearlings, indicating the importance of freshwater rearing habitat result of the hatchery program, restoration of chinook holding habitat (deep pools with cover in areas of cooler water influence) in the lower South Fork has been a high priority in recent years.

5 As part of the South Fork Chinook Rebuilding Program, juvenile chinook were seized from the South Fork, held at Lummi’s Skookum hatchery until DNA analysis confirmed they were native South Fork chinook, then they were raised to adulthood in captivity at either NOAA’s Manchester hatchery in Hood Canal or WDFW’s Kendall hatchery. Once mature, they were transferred to the Skookum hatchery and spawned, and their progeny released as fingerlings to the South Fork.
Figure 25. Modeled effective shade (fraction of potential solar radiation blocked by topography and vegetation) for each of the key modeled scenarios: Existing Vegetation in 2007, 100-year system potential vegetation (SPV) with all land reaching 100-year system potential, and 100-year SPV with developed lands not reaching system potential. Unvegetated channel area (NSDZ) shown for comparison (US EPA 2015 Draft).

Two “demographically independent populations” of the Puget Sound Steelhead Distinct Population Segment, listed as threatened under the Endangered Species Act, spawn in the South Fork: Nooksack Winter Steelhead and South Fork summer steelhead. South Fork summer steelhead are one of only five summer steelhead populations in Puget Sound, and are considered to be a small but stable population. Summer steelhead migrate upstream between April and October (WRIA 1 SRB 2005), rendering them vulnerable to high temperatures and low flows in summer. Spawning occurs in February and March and likely into April in the upper South Fork upstream of RM 25, including upstream of the upstream limit of chinook distribution at RM 31, and in upper South Fork tributaries such as Wanlick Creek. At a minimum, this population uses the lower South Fork for upstream adult migration and holding, and for juvenile rearing. More abundant and migrating upstream later than summer steelhead, winter steelhead spawn primarily from mid-March to mid-June, with peak spawning in May (Myers et al. 2015). They spawn in the South Fork and moderate- to large-sized tributaries to RM 25. Hutchinson Creek (to RM 5.9) is an important spawning tributary, with the highest winter steelhead redd counts of any tributary in the Nooksack River watershed. Steelhead rear in freshwater for one to four years before smolting, although most rear for two years, underscoring the importance of rearing habitat. Steelhead have the potential to be iteroparous (spawn more than once).

The Nooksack River watershed is one of 20 extant and 25 historic core areas in the Coastal Recovery Unit for the Coterminous U.S. Population of Bull Trout, listed as threatened under the Endangered Species Act. Three of the ten local bull trout populations in the Nooksack core area occur in the South Fork watershed: Lower South Fork Nooksack River, Upper South Fork Nooksack
River, and Wanlick Creek. Bull trout spawn in the South Fork to RM 38 and upstream, as well as in cooler tributaries to the South Fork. The lower South Fork is used by sub-adults and adults for foraging, upstream and downstream migration, and overwintering. Resident populations of Dolly Varden, a morphologically similar but distinct species to bull trout, have been found in Pine and Bell Creeks in the upper South Fork watershed.

Pink salmon (native, wild) spawn between August and October in the South Fork in both odd and even years. Because pink salmon have an obligate two-year life history, even- and odd-year spawners are reproductively isolated and thus distinct populations. Odd-year pink salmon are considerably more numerous. They spawn in the SFNR up to RM 25 and in associated tributaries, including Hutchinson, Skookum, Cavanaugh, Deer, and Plumbago Creeks.

Small numbers of riverine sockeye (native, wild) also spawn between August and November in the South Fork to RM 25 and in major SFNR tributaries. The Nooksack and Skagit watersheds show the most persistent evidence of riverine sockeye spawning in Washington.

Nooksack coho is a mixed stock with composite production. Skookum Creek Hatchery began coho propagation in 1977. Although out-of-basin coho stocks were initially used as broodstock, all coho broodstock have been derived from hatchery returns since the late 1980s/early 1990s. Coho spawn between October and January in the South Fork and tributaries to RM 25.

In addition, both chum salmon and cutthroat trout use the South Fork watershed, with chum spawning upstream to RM 20 between October and February and cutthroat trout spawning upstream to RM 25 in winter and spring.

### 7.1.7 Salmonid Habitat Conditions

Habitat degradation is considered the leading cause for the decline of salmonid populations in the Nooksack watershed. High temperatures and low habitat diversity are the most significant factors limiting SF Nooksack early chinook in the lower SFNR, followed by high fine sediment load, lack of key habitats, low flows, and human disturbance (WRIA 1 SRB 2005).

There is a low proportion and frequency of pool habitat. Habitat surveys in the Acme-Saxon reach in 2000 indicated average primary (channel-spanning) pool spacing was 330m and 18% of low-flow surface area was in pools. Most pools are formed by riprap; these pools are long and, while deep, lack the complex cover and hydraulic complexity that adult and juvenile salmonids prefer.

There has been a reduction in availability of complex edge (e.g. undercut banks, backwaters) and floodplain habitats (side channels, sloughs, braids). There is substantial bank hardening through the lower South Fork, especially the lower 8 miles. In part due to the bank hardening, the South Fork has incised considerably since the 1930s, reducing floodplain connectivity.

Instream wood and other forms of cover are lacking. In 2000, only 10 of the 20 primary pools inventoried in the Acme-Saxon reach had wood cover, and in-water wood was comprised of primarily single pieces or small accumulations; only 1 log jam (16 pieces) was inventoried in the low-flow channel.
High water temperatures regularly exceed optimal temperature ranges and approach lethal limits for salmonids. The lower SFNR is on the 303(d) list for high temperatures. In 2013, maximum 7-day average of the daily maximum temperature was 21.9°C in the South Fork near Acme and 22.2°C downstream of the Potter Rd. bridge; 2014 temperatures were similar, at 21.6°C and 22.2°C at the two locations, respectively. High temperatures in the lower South Fork stress holding and spawning fish and increase susceptibility to disease, which can cause prespawn mortality or otherwise reduce reproductive success. In 2003, 2006, 2009, and 2013, numerous pre-spawning mortalities were observed among early chinook spawning in the SFNR (NNR, unpublished data); necropsies (NWIFC and WDFW pathologist reports) indicated that primary cause of death was Columnaris, which is associated with higher mortality at temperatures greater than 15°C (Spence et al. 1996). Corresponding maximum 7-day average of the daily maximum in the lower south Fork (RM 1.8-3.5) during those same years were 23.1°C (2003), 23.0°C (2006), 23.8°C (2009), and 22.1°C (2013; Ecology and Nooksack Tribe temperature monitoring data).

### 7.1.8 Salmon Recovery

As described above, the lower South Fork and associated tributaries provide habitat for three ESA-listed salmonid species. Nooksack early chinook (including both the SFNR and the North/Middle Fork populations) is the highest species priority, although restoration of chinook habitat is expected to yield collateral benefits to other species.

The lower South Fork represents 36% of the spawning distribution and 19% of the freshwater habitat and is the highest priority geographic area for restoration for South Fork Nooksack early chinook (WRIA 1 SRB 2005). Restoration of the lower SFNR is expected to have a very significant impact on recovery of the population’s abundance and productivity. Due to the critically low abundances of South Fork Nooksack early chinook, projects that improve chinook habitat in the near term are prioritized. The 2016 Nooksack River Forks Project Development Matrices (WRIA 1 Salmon Recovery Board 2016), which guide development and ranking of salmon habitat projects for Salmon Recovery Funding Board (SRFB) and Puget Sound Acquisition and Restoration (PSAR) funding in WRIA 1, list the following Tier 1 (highest priority) strategies for the lower South Fork: (1) log jams to form deep complex pools: cool-water inflow areas; (2) log jams to form deep complex pools: other areas; (3) setback or remove riprap embankments; (4) lower artificial levees to native bank elevations; (5) acquire properties necessary to facilitate restoration; and (6) acquire properties at risk of degradation to protect high quality habitat, habitat-forming processes. Tier 2 (moderate priority) strategies include: (1) replace riprap with wood bank structures; (2) reconnect and restore side-channels and restore historic channel pattern; (3) relocate river-adjacent infrastructure outside the 100-year erosion hazard area; (4) reforest historic channel migration zone and 300' buffer; (5) remove invasive species (knotweed and reed canary grass); (6) improve in-channel woody debris loading in floodplain channels; and (7) improve riparian conditions along floodplain channels (outside HMZ and 300'). Highest priority actions to ameliorate the impacts of climate change in the lower South Fork are floodplain reconnection (hydromodification removal/setback, log jams to promote aggradation and/or increase water surface elevation at floodplain channel inlets), restoration of stream flow regimes (reduce water withdrawals, restore floodplain wetlands), riparian restoration, and instream restoration (Nooksack Tribe et al., in press).
Most of the SRFB- and PSAR-funded salmon recovery projects in the lower SFNR valley have involved either placement of engineered log jams or Whatcom Land Trust land acquisition to increase opportunity for restoration and protect habitat (Figure 26). Additional instream habitat restoration is planned (Nesset Reach) or proposed (Black Slough, Fish Camp reaches) in the coming years. Riparian restoration is incorporated into these types of projects to the extent possible. Most riparian restoration in the valley, however, has been funded through the Conservation Reserve Enhancement Program (CREP), a voluntary program that incentivizes stewardship of riparian buffers on agricultural and rural lands through lease payments and compensation for planting and maintenance. The term of these leases is 15 years, which is renewable.

### 7.1.9 Reach-Scale Recovery Strategy

The twin goals of the reach planning process are to protect farmlands and improve habitat conditions in the SFNR and its floodplain tributaries. The Whatcom County Comprehensive Plan provides for no net loss of agricultural land, forestland, and critical areas, wetlands, habitat conservation areas, and protective buffers. Existing residential zoning acts to conserve NRCS agricultural soils from development through R5A and 10A zoning with cluster development restrictions in those areas. The potential loss of productive farmland is a central area of concern in agricultural communities in Whatcom County and it is essential that land acquisition for conservation and habitat restoration is approached in a way that aligns with the Planning Principles developed by the forty-four diverse landowners and residents who gathered together for this planning process as the South Fork Nooksack Watershed Group, in particular:

- **Voluntary agreements between landowners and community partners, with incentives for landowner’s efforts to improve watershed conditions.**

This Reach Scale recovery strategy also aligns with WRIA 1 Salmonid Recovery Plan and the South Fork Nooksack River Temperature Total Maximum Daily Load (TMDL) implementation plan. Both of these plans contain recommendations for restoring and protecting riparian stands in the South Fork Watershed. The Salmonid Recovery Plan recommends buffers greater than 150’ wide or the site potential tree height (whichever is greater) and dominated (>70%) by mature conifers, unless hardwoods were dominant historically. The site potential buffer widths used in the TMDL were also 150’. For the historic conditions scenario in the TMDL, the recommended buffer widths were 300’ wide based on the maximum potential tree heights expected in the valley. (Figure 27).

The priority areas for riparian preservation and restoration lie along the SFNR. The South Fork Nooksack River Climate Change and TMDL Pilot project (US EPA 2015 Draft) looked at the impacts of climate change on Endangered Species Act recovery actions in the SFNR watershed. The project modeled stream temperature under a variety of climate change and recovery strategies and found that restoration of the historic channel and riparian conditions could largely off-set the effects of climate change on stream temperature (Figure 28).
Figure 26. Salmon habitat protection and restoration in the Acme valley.
Critical Areas:

Riparian protection on non-forest lands is provided by the Whatcom County Critical Areas Ordinance. Several of the critical area categories relate to preserving existing vegetated land, the most relevant to this assessment being the “wetlands and fish and wildlife habitat conservation areas.” The code designates variable protective buffer widths for all state-classified streams which fall under the categories: shoreline streams (Class S), fish-bearing streams (Class F), and non-fish-bearing streams (Class N). The Whatcom County Critical Areas Code designates 150-ft buffers for Class S streams, 100-ft buffers for Class F streams, and 50-ft buffers for Class N streams. In the Skagit County portion of the watershed, designations are somewhat different with a 200-ft buffer for Class S. Also, Class F and N requirements are similar except for Class F streams greater than 5 feet in width: for those the buffer is 150-ft.

A number of activities within the critical areas are allowed, including but not limited to, certain forestry practices, vegetation maintenance, some recreational activities, maintenance of already-established buildings, utilities, and the cutting of hazard trees. When a development is proposed that would impact a critical area, a critical areas assessment report is typically required, in which the developer proposes alternative mitigation and protective measures. The code states that complete avoidance of impacts is the highest priority, and, in order for some impact to be allowed, the applicant must demonstrate that all reasonable efforts to avoid impacts have been taken. The
critical areas assessment report contains an analysis of how critical area impacts or risks will be avoided or minimized and an analysis of the proposed measures to prevent or minimize impacts. When impacts cannot be avoided, the developer includes a mitigation plan for replacing critical area functions and values that would be altered by the development.

In both Whatcom and Skagit Counties, existing agricultural operations are allowed to continue within critical areas with an approved conservation plan. Conservation plan requirements vary depending on the type of agricultural operation, land zoning, and are more extensive for operations classified as moderate to high impact. Among the standard conservation plan requirements, existing native vegetation within critical area buffers (which includes riparian areas) are required to be maintained to practical extent. Clearing activities cannot be authorized within critical areas unless the clearing would occur on existing agricultural land and is considered an essential part of the ongoing agricultural use. The conservation plans are subject to monitoring, adaptive management, and enforcement by the counties. While the provisions for agriculture in the code do not provide further restoration of critical areas per se, the conservation
plans, if implemented and enforced successfully, provide protection of existing riparian vegetation and potential for increased shading in the future.

**Voluntary Conservation Measures:**

The WRIA 1 Salmonid Recovery Plan emphasizes voluntary and incentive-based actions in salmon recovery efforts. These voluntary protection actions can include voluntary reforestation, conservation easements, or the transfer of development or water rights. While there is no publicly available information on enrollment in the Conservation Reserve Enhancement Program (CREP) or the Environmental Quality Incentives Program (EQIP), it is evident from the aerial photo analysis that a great number of agricultural landowners are participating in conservation programs in the South Fork Watershed. Based on the available information approximately 10% of the 340 landowners in the assessment area appeared to be participating in a riparian conservation program. Much of this work was in the Black Slough floodplain area, where land is likely less suitable for agriculture than areas along the mainstem SFNR. Both the Temperature TMDL and the Salmonid Recovery Plan emphasize the need for establishing and expanding the riparian buffers along the mainstem SFNR, where the impacts of agriculture on the riparian buffer are the greatest (~31% of the riparian area is actively farmed).

**Acquisition for Riparian Protection:**

There has been a substantial amount of acquisition in the South Fork valley by Whatcom County and the Whatcom Land Trust for habitat protection, flood risk reduction and recreational use. All of these areas have been the focus of voluntary riparian restoration by those agencies and their partners. As of 2016, the Whatcom Land Trust is the largest private landowner in the valley, owning ~10% of all private land in the analysis area and the bulk of these have been reforested within the riparian zone and are managed for habitat conservation.

In response to the concern about the loss of farmland, the Whatcom Land Trust has sought to engage agricultural landowners in efforts to trade high value farmland that is held in conservation for high value conservation lands that are being farmed. This would allow for the maintenance of the agricultural land base, while ensuring that important habitat areas are protected and restored.

**7.1.10 NEP Reach Plan Prioritization Methodology**

Each parcel within the riparian zone of the reach was systematically evaluated by a team of people with backgrounds in watershed science, geology, wetland assessment, restoration, and agricultural planning. 345 parcels were reviewed for cover type, condition, and quality, opportunity for riparian restoration /ecological uplift, and opportunity for riparian protection. Figure 29 and Figure 30 indicate the areas that were identified as priorities, as per this analysis. Landowners who had the highest priority parcels (@ 30) were contacted personally by telephone.
and/or in person to determine whether they would have interest in qualifying for NEP funded riparian protection and restoration grant funding. Many landowners with priority parcels were interested in the project. These parcels were then evaluated in greater detail, and a rough concept of a project was developed by a member of the Planning Team, a restoration contractor, in conversation with the landowner. As the NEP-Ecology grant project continues toward an implementation plan that would lead toward Phase 2 grant funding, individual follow-up with these landowners will occur, and additional land owners may become interested and want to participate in the project and receive funding under Phase 2.

Each parcel was evaluated for the amount of active agricultural land was within the riparian buffer area. The highest priority for buffering was given to the South Fork Nooksack (a temperature impaired waterbody). The South Fork parcels included two buffering approaches. The first evaluated the conditions of a 100’ buffer on the estimated Ordinary High Water line of the river.
The second buffer that was applied was a 300’ buffer on the channel occupation area (generally the historic channel migration zone, except where infrastructure was present within the channel area). Tributaries and drainage ditches that were once streams or wetlands that appeared to meet the physical criteria for fish-bearing waters (>2’ wide and <20% gradient) were given a 100’ buffer. Each parcel was prioritized according to the area of each type of buffer present. The South Fork 300’ area was weighted twice as heavily as the tributary area and any area within 100’ of the OHW of the river was added to the 300’ area- essentially increasing the priority for those parcels. The assessment used best professional judgment to also evaluate other opportunities for restoration, but these were not included in the riparian restoration scoring. A description of the criteria and weighting system for the restoration opportunity is given in Tables 7 through 9. The thirty highest priority riparian restoration parcels are given in Table 10. The thirty highest priority riparian protection parcels are given in Table 11. The top 10 parcels for wetlands restoration are shown in Table 12. Table 13 identifies the 14 highest priority parcels with willing landowners.
Table 7. Best professional judgment criteria of the secondary restoration opportunities.

<table>
<thead>
<tr>
<th>Category</th>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunity for Instream Restoration</td>
<td>0-25</td>
<td>10pts for pool formation, 6 for shade, 5 for cool water input, 2 for stable split flow, 2 for forested island or bar</td>
</tr>
<tr>
<td>Opportunity for Riparian Restoration</td>
<td>0-20</td>
<td>10- for establish riparian forest, 5 establishment of conifers on well-drained soils, 3 establishment of hardwoods on hydric soils, 2 understory planting</td>
</tr>
<tr>
<td>Opportunity for Riparian Protection</td>
<td>0-15</td>
<td>10- for high priority, 5 for low priority, 3 for partial, 2 for designed, 5 for completed</td>
</tr>
<tr>
<td>Adjacency to Channel</td>
<td>0-5</td>
<td>5- within site potential, 3 beyond site potential, 2 for a secondary channel</td>
</tr>
<tr>
<td>Groundwater Recharge Zone</td>
<td>0-2</td>
<td>2- Wetlands connected to the channel</td>
</tr>
<tr>
<td>Documented Salmon Spawning</td>
<td>0-2</td>
<td>2- Spawning fish are present</td>
</tr>
<tr>
<td>Documented Other Species of Interest</td>
<td>0-1</td>
<td>1- Other species of interest are present</td>
</tr>
</tbody>
</table>

**NEP Reach Plan Riparian Protection Prioritization:**

Similar to the riparian restoration prioritization, full-with riparian buffers that were already dominated by trees taller than 50’ were identified as important areas for protection. The priority was again given to stands along the mainstem South Fork Nooksack. The acreage of the stands within 300’ of the South Fork were weighted twice as heavily as the stands along fish-bearing tributaries. The thirty highest priority parcels were identified Table 11. This analysis did not include areas of young buffers, such as CREP, that might be good candidates for preservation because the species composition and the buffer width were on a trajectory toward recovery, but did not meet the 50’ threshold for tree height. Several parcels were identified as priority areas for preservation based on this.

**NEP Reach Plan Wetland Uplift Prioritization:**

Wetland areas were first prioritized using a coarse screening based on wetland area and opportunity for restoration or preservation. The top 10 parcels for wetlands were then reprioritized by wetland specialists based on more detailed assessment of the current condition, potential restoration activities, and existing level of protection. Under this model, wetlands that currently function at a low level and have no protection are scored the highest because there is the greatest room for improvement. Alternatively, high functioning wetlands that are already protected will score low because there is little opportunity for lift. The final prioritized list of wetlands is given in Table 12.

Based on these prioritizations, landowners were contacted to determine their interest in participating in conservation programs. If landowners had previously been contacted regarding conservation, then they were not contacted again for this process. The final list of high priority parcels with willing landowners is given in Table 12. A map showing the location of priority parcels is shown in Figure 31.
Table 8. Best professional judgment criteria of the wetland restoration and preservation opportunities.

<table>
<thead>
<tr>
<th>Category</th>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunity for Wetland Restoration</td>
<td>0-15</td>
<td>5- for reestablish veg, 5 for Class 1-2 wetland or beaver habitat, 3 for Class 3, 2 for Class 4 or previous conversion to agriculture</td>
</tr>
<tr>
<td>Opportunity for Wetland Restoration</td>
<td>0-10</td>
<td>5- majority vegetated, 3 opportunity for Conservation Easement, 2 opportunity for CREP</td>
</tr>
</tbody>
</table>

Table 9. Revised ranking criteria for highest priority wetland areas (NES 2017).

<table>
<thead>
<tr>
<th>Category</th>
<th>Scale</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Condition</td>
<td>0-9</td>
<td>3 for active agriculture, 2 for fallow agriculture or beaver activity on site, and 1 for recently planted with native trees/shrubs or forested</td>
</tr>
<tr>
<td>Potential Restoration Actions</td>
<td>0-12</td>
<td>5- hydrological restoration, 4 for creating impoundments, 2 for vegetation enhancement, 1 for vegetation augmentation</td>
</tr>
<tr>
<td>Existing Level of Protection</td>
<td>0-5</td>
<td>3- No protection, 2 for enrolled in CREP, 0 for in trust or permanently protected</td>
</tr>
</tbody>
</table>

7.2 Specific Project Opportunities

The Reach Scale Assessment has resulted in the identification of fourteen priority parcels. Each of these parcels offers key opportunities towards advancing recovery goals. Each of the parcels has a willing landowner, and has been evaluated on-site. Several of the parcels are located on the mainstem of the South Fork, and many are located in the area of the Black Slough, which is an important tributary to the lower SFNR. Black Slough is a high priority area for wetland restoration and a moderate priority for riparian protection. Black Slough discharges into the SFNR in a section of the river where a series of in-stream engineered logjams are proposed. As such, riparian protection and restoration on these parcels would ecologically support the planned in-stream restoration on the SFNR near the confluence with Black Slough. From a spring chinook recovery standpoint, it would support the instream work through enhancement of water quality by increasing shading of slough water resulting in a cool water refuge at the confluence with SFNR. It is already a cool water source but would be further enhanced. Protection and restoration of Black Slough, especially in light of several high-ranked project opportunities with multiple landowners, will provide significant ecological lift to the reach.

It should also be noted that at the time of submitting this Plan to the DOE, 15,000 acres of commercial forestland in the Reach, currently owned by North Cascades Timberlands LLC was put on the market. Over 15,000 acres of forest in the watershed, which includes critical habitat on both tributaries and along the mainstem of the SFNR will be pursued, and possibly NEP funding would be appropriate to assist with purchase of easements or fee simple for areas within the riparian zone. This sale offers a major opportunity for advancing habitat recovery goals, reducing water temperature, and addressing sediment and water retention issues related to upland management.
Table 10. Top 30 Riparian Restoration Priorities in the NEP Reach Assessment.

<table>
<thead>
<tr>
<th>Rank</th>
<th>Area (acres)</th>
<th>Zoning</th>
<th>Riparian Restoration Score</th>
<th>Active Agriculture within 300' of SFN (acres)</th>
<th>Active Agriculture within 100' of SF OHW (acres)</th>
<th>Active Agriculture within 100' of Type F Tributary (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70.2</td>
<td>AGRICULTURAL</td>
<td>45.80</td>
<td>21.27</td>
<td>3.27</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>31.27</td>
<td>RURAL FORESTRY</td>
<td>33.08</td>
<td>12.54</td>
<td>1.61</td>
<td>6.39</td>
</tr>
<tr>
<td>3</td>
<td>21.81</td>
<td>RURAL FORESTRY</td>
<td>28.23</td>
<td>13.45</td>
<td>1.33</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>87.93</td>
<td>AGRICULTURAL</td>
<td>26.93</td>
<td>10.96</td>
<td></td>
<td>5.00</td>
</tr>
<tr>
<td>5</td>
<td>94.87</td>
<td>AGRICULTURAL</td>
<td>26.72</td>
<td>10.85</td>
<td>3.12</td>
<td>1.90</td>
</tr>
<tr>
<td>6</td>
<td>66</td>
<td>AGRICULTURAL</td>
<td>22.08</td>
<td>10.98</td>
<td></td>
<td>0.11</td>
</tr>
<tr>
<td>7</td>
<td>16.36</td>
<td>AGRICULTURAL</td>
<td>20.82</td>
<td>8.90</td>
<td>3.02</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>59.75</td>
<td>RURAL 1DU/10AC</td>
<td>20.51</td>
<td>9.85</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>42.22</td>
<td>AGRICULTURAL</td>
<td>19.71</td>
<td>9.85</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>51.35</td>
<td>AGRICULTURAL</td>
<td>18.68</td>
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Table 11. Top 30 Riparian protection parcels in the NEP Reach Assessment.

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<tr>
<th>Rank</th>
<th>Area (acres)</th>
<th>Zoning</th>
<th>Riparian Protection Score</th>
<th>Forested Buffer within 300’ of SFN (acres)</th>
<th>Forested Buffer within 100’ of Type F Tributary (acres)</th>
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Table 12. Wetland priority parcels in the NEP reach assessment.

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<tr>
<th>Rank</th>
<th>Area (acres)</th>
<th>Riparian Establishment Acreage *Agg. score</th>
<th>Wetland Acreage *Agg score</th>
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<tr>
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Table 13. Highest priority willing landowners in the Phase 1 NEP assessment area.

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<tr>
<td>C</td>
<td>26</td>
<td>&gt;50</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
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<td>&gt;50</td>
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<tr>
<td>E</td>
<td>&gt;50</td>
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<td>32</td>
</tr>
<tr>
<td>F</td>
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<td>15</td>
</tr>
<tr>
<td>G</td>
<td>&gt;50</td>
<td>&gt;50</td>
<td>10</td>
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<tr>
<td>H</td>
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<td>CREP</td>
<td>&gt;50</td>
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<tr>
<td>I</td>
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<td>CREP</td>
<td>&gt;50</td>
</tr>
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<tr>
<td>N</td>
<td>&gt;50</td>
<td>CREP</td>
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Figure 31. Parcels that were rated in the top ten for wetland restoration, top 30 for riparian protection, and top 30 riparian restoration.

At each location, soil types were identified. Soil types include:

- **Puget**: This is a very deep, poorly drained, silt loam soil found on the flood plain. It has been artificially drained and formed in alluvium. Permeability of this soil is moderately slow and the available water capacity is high. The effective rooting depth is limited by a seasonally high water table, which is at a depth of 1 to 3 feet from November through May. Runoff is usually very slow, but the soil may be ponded during the winter. There is no hazard of erosion. In most areas, Puget soil is subject to brief periods of flooding from
November through April. Downstream from Lynden, however, it is subject to frequent periods of flooding from December through February. Puget soil is considered hydric. Red Alder is the main woodland indicator species.

- **Briscot**: This very deep, poorly drained, silt loam soil is on flood plains. It has been artificially drained and is formed in alluvium. Permeability is moderate and available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1 to 3 feet from November through April. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion. Briscot soils are hydric soils. Red Alder is the main woodland species. The potential tree height for Briscot soil is 75 feet.

- **Shalcar**: This very deep, very poorly drained, muck soil is in depressions on outwash terraces and on some till plains and stream terraces. It has been artificially drained. It formed in herbaceous and woody organic deposits. Permeability is moderate in the upper portion of soil and very rapid in the lower part. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of .5 to 1.5 feet from October through May. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion. Red alder is the main woodland species. The Shalcar soil is considered hydric.

- **Oridia**: This very deep, poorly drained, silt loam soil is found on flood plains. It has been artificially drained. It formed in alluvium. Permeability is moderate in the Oridia soil. Available water capacity is high. The effective rooting depth is limited by seasonal high water table, which is at a depth of 1 to 3 feet from November through April. Runoff usually is very slow, but the soil may be ponded during the winter. In most areas this soil is subject to occasional, brief periods of flooding from November through April. Downstream from Lynden, however, it is subject to frequent, brief periods of flooding from December through February. Red alder is the main woodland species. Oridia soils are considered hydric.

- **Pangborn**: This very deep, very poorly drained, muck soil is in depressions on outwash terraces and on some till plains and stream terraces. It has been artificially drained. It formed in herbaceous and woody organic deposits. Permeability is moderate in the Pangborn soil. Available water capacity is high. The effective rooting depth is limited by a seasonal high water table, which is at a depth of 1.5 to 2.5 feet from October through May. Runoff usually is very slow, but the soil may be ponded during the winter. There is no hazard of erosion. Red alder is the main woodland species. The Pangborn soil is considered hydric.

- **Hydric Soil**: A soil that is saturated, flooded, or ponded long enough during the growing season to develop anaerobic conditions that favor the growth and regeneration of hydrophytic vegetation (U.S. Department of Agriculture-Soil Conservation Service 1985). Hydric soils that occur in areas having positive indicators of hydrophytic vegetation and wetland hydrology, or developed under such conditions, are wetland soils.
In addition, the existing condition of the riparian zone and the approximate occurrence and distribution of wetlands, surface water hydrology, existing site limitations, project opportunities, and estimated budgets were assessed. Costs were approximately estimated based on riparian protection and restoration. Using Phase 2 funds used solely to purchase easements and ownership, and not restoration, was considered as future funding that would pay for restoration is uncertain. We feel that Phase 2 funding should go towards both purchase of easements and ownership of riparian areas as well as riparian restoration.

7.2.1 Parcel A

Summary:

Parcel A offers an opportunity to build on significant riparian and wetland restoration efforts on another unique parcel with a diversity of habitats. The landowner is interested in exploring a permanent conservation easement on the majority of the parcel, providing permanent conservation of strongholds for spawning and rearing Coho. It is a juncture point of a major tributary with an alluvial fan, connected to both the Black Slough and the mainstem of the South Fork.

Overview:

Parcel A consists of 8.03 acres of current agriculture clearing within 100 feet of the salmon bearing tributary and 19.9 acres of Mature Riparian Forest along both sides of the creek and two tributaries. 28.8 acres of previous pasture have been restored through the CREP program along creek and two of its tributaries. A total of 12,141 linear feet of stream buffer have been restored. The site also supports a well-established beaver habitat complex, including a large beaver dam, which may have been occupied since the 1970’s. This habitat is present in flooded portions of the creek and its main tributary.

Wetlands:

The parcel contains approximately 78.3 acres of wetland. The western portion of the parcel contains palustrine emergent (PEM) depressional wetlands. The central portion of the site contains a palustrine scrub-shrub (PSS) riverine wetland along the creek. The eastern portion of the parcel contains palustrine forested (PFO) depressional and riverine wetlands. Vegetation observed in the PEM wetlands was dominated by soft rush. The wetlands are heavily grazed. The wetlands experience seasonal saturation. Water from the wetlands outlets via the creek and a seasonal drainage located in the northwest portion of the parcel. The PSS portion has been planted with willow, dogwood, young conifers and other shrubby species. The understory is dominated by reed canarygrass. Beaver activity along has ponded the creek.

The PFO wetlands contained western red cedar, red alder, vine maple, reed canarygrass, and American skunk cabbage. The wetlands experience seasonal saturation and inundation. The wetlands contain large woody debris and snags as well as amphibian habitat. Multiple drainages flowing west are associated with the wetlands.
Hydrology:

Many small tributaries run off Van Zandt Dike to feed wetlands and streams in the drainage of creek. These then flow into the Black Slough and finally into the South Fork Nooksack River. Prior to entering the property, the creek has a high velocity and gradient. At the eastern property boundary, the gradient flattens out and the creek’s velocity slows down, characteristic of an alluvial plain. The creek meanders westerly a short distance through the forest and intersects with a tributary that runs north-south along the edge of the pasture. The creek then turns northward through a pastured area where it is choked with flows off the property through a culvert and enters Black Slough 1000 feet later.

A network of channels flow northwest through the forested portion of the property and into creek. The tributary of the creek runs westerly along the southern property boundary until the edge of the pasture, where it is joined by a fork from the south and turns northward. A high water table and retention of surface water in depressions have resulted in wetlands throughout the pasture area. The wetlands are hydrologically connected to the creek.

A fish accessible drainage ditch is located in the northwestern corner of the property, flowing north through the pasture, then turning west and running northward along the western property boundary. This drainage ditch flows beneath the road and then into the creek. Beaver are present in the area so the impoundment of water and destruction of vegetation from their activity should be expected.

Vegetation:

Parcel A is about half pasture and half forest. The pasture is a combination of forage grasses with a high component of reed canarygrass. Other dominant species include bent grass, fescue, and bull rush. Rose bushes and Himalayan blackberries are occasional. Cattle have historically grazed the grasses and horses are currently on site. There are a couple scattered willow trees along the creek. The forested half of the property is a diverse hardwood overstory composed of Red Alder, Black Cottonwood, Bitter Cherry, Pacific Crabapple, and Paper Birch. There are occasional Western Red-Cedar, Western Hemlock, and Sitka Spruce in the unit. Shrub species are mainly Salmonberry, Red Elderberry, Indian Plum, and Vine Maple. The herbaceous layer is dominated by reed canarygrass. Skunk cabbage is present throughout the forested area.

Soils:

According to the Natural Resource Conservation Service Soil Survey of the Whatcom County Area the project site includes the Puget and Briscot soil series.

Existing Site Limitations:

Wetland function near the PEM wetland is compromised by poor soil condition tied to soil compaction, drainage from ditches and limited native vegetation. The site appears to be grazed during the wet season and soils have been compacted. Removing cattle during the wet season would be beneficial. De-leveling within the PEM wetland could increase diversity in water regimes
and storage capacity. Channel modification to the ditched drainages could increase salmon habitat. Ditches on the western portion of the site appear to facilitate drainage, removal or blockage of the ditches would improve the hydroperiod duration within the main part of the wetland. It may be a candidate site to used beaver to restore functions. Restoration with native shrubs and trees would improve water quality (temp in particular) functions. However, this area is a documented breeding site for the Federally threatened Oregon Spotted Frog and restoration should only proceed under a Habitat Conservation Plan approved by the USFW Service.

**Project Opportunities:**

- A conservation easement purchase of 73.65 acres.
- Purchase of the property for permanent conservation easement.
- Restoration of approximately 10 acres of Riparian Forest along the creek by planting native trees and shrubs.
- The restoration of approximately 30 acres of wetlands includes active management of the beaver habitat, de-leveling, including the creation of small ponds for amphibians, and impoundment of water seasonally.
- Restoration of vegetation could include Mixed Forest, Shrub/Scrub, and Wetland Pastures.

**Estimated Budget:**

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</table>

**7.2.2 Parcel B**

**Summary:**

Parcel B provides diverse opportunities for restoration and ecological uplift. It is a dynamic area with South Fork riverfront, a large forested tributary and an alluvial fan including its confluence with the Nooksack. A second smaller tributary feeds a pond on its way to the Nooksack and has already been restored through volunteer planting.

**Overview:**

The Parcel consists of 10.85 acres of agriculture within 300’ of the South Fork Nooksack River. Additionally, 3.12 acres within the 10.85 are within 100’ of the S. Fork. This parcel also includes 1.90 acres within 100’ of a major tributary. The parcel contains 21.94 acres of mature riparian area around the tributary, which includes a large portion of the Alluvial Fan. There are approximately 5 acres of land on the Alluvial Fan reclaimed by recent evulsion and deposition.
Hydrology:

The South Fork of the Nooksack flows along the eastern boundary adjacent to the railway, which sits on an elevated levy. This stretch of river is also disconnected from floodplain by a large revetment/levy. The Alluvial Fan and confluence with the S. Fork makes up a large portion of the Eastern 1/3 of the property. The tributary is frequently flooded and subjugated to debris flows and deposition during winter flood flows. A small tributary flows off Stewart Mountain, and enters a pond before exiting to the North at a break in the levy and joining the Nooksack.

Project Opportunities:

- Potential riparian restoration of 13.97 acres along the South Fork Nooksack, mostly consisting of well drained soils. This will support the establishment of planted conifers.
- The riparian area along the North side of the parcel is within an old floodway. This floodway has been identified by the adjacent property owners and The Acme Flood Control Zone District as a potential site to reestablish flood flow by removal of fill along the train trestle.
- Potential riparian restoration of 1.9 acres within 100’ of the tributary and an additional 3 acres of recent flood deposition. The riparian area along the tributary is dominated by hardwoods. These are predominately Red Alder, Bigleaf Maple, and Black Cottonwood. Soils are heavy silt and hydric. Establishment of a mixed deciduous/conifer stand is a possibility.
- Instream restoration potential includes logjams along three outside meanders and bank roughening along long sections of glide. Reinforcement of the existing rock revetments with bank roughening in tandem with wood and logjam construction will increase flood protection along the railroad and trestle. Lowering revetment elevation may be possible on the northern boundary.

Estimated Budget:

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7.2.3 Parcel C

Summary:

Parcel C offer a unique opportunity to restore the riparian forest along one of the last non-forested stretches of the Black Slough. Most of the slough has been restored through various restoration efforts over the last 20 years. Riparian forest could also be established along a recently daylighted and excavated tributary to the creek. Three adjacent parcels make up this farm, which is currently used to produce feed for livestock, and has recently invested in seeding new pastures, soil improvements, and farm machinery for the production of round bales. The Farm is interested
in riparian protection and conservation along both tributaries and limited restoration of wetlands outside of cultivated ground.

**Overview:**

Parcel C consists of 19.73 acres of agriculture along a 100-foot reach of the Black Slough and a tributary. This parcel also includes over 137 acres wetlands located in the highest priority Wetland Focus Zone. Restoration of irregular topography and reduced drainage would benefit the wetland function. The wetland has been drained in part by ditches and leveling of topography. Restoration with native forest and shrub species would provide a functional lift to water quality and wildlife functions of this wetland. Additionally, the creek tributary and Black Slough are both deeply ditched. Water quality and salmon habitat may be increased with channel modifications.

**Wetlands:**

The site contains palustrine emergent (PEM) depressional wetland. The entire site is actively cultivated for hay. Wetland hydrology is currently dominated by seasonal saturation. Water from the wetlands likely outlets via the ditched tributary of the creek which runs through the central portion of the site. Site vegetation consists exclusively of seeded pasture grasses.

**Hydrology:**

Many small tributaries run off Van Zandt Dike to feed wetlands and streams in the drainage of the creek. These then flow into the Black Slough and finally into the South Fork Nooksack River. The northeastern corner of the parcel is forested with a seasonal tributary ditched along the property boundary. A tributary to the creek enters the property via a culvert underneath the road to the South. The channel was recently day lighted and excavated in its entirety until its exit from the property in the North. The Black Slough enters the property and is ditched along the entire southern boundary.

**Vegetation:**

The parcel is predominately pasture with a conifer-dominated forest in the southeastern corner. The pasture is a combination of forage grasses with a small component of reed canarygrass within the margins of streams. Other species include bent grass, fescue, and bull rush. The pastures have been historically farmed for hay and green chop, with new pasture seeding occurring within the last 5 years. There are a couple scattered willow trees along the mainstem of the Black Slough.

**Soils:**

According to the Natural Resource Conservation Service Soil Survey of the Whatcom County Area the project site includes the Puget and Briscot soil series, with Hydric Soil.
Project Opportunities:

- A conservation easement purchase of 19.73+ acres.
- The restoration of approximately 10 acres of wetlands through de-leveling activities and installation of native vegetation.
- Potential riparian restoration of 19.73 acres along the Black Slough and a tributary to creek, mostly consisting of hydric soils. These soils will support the establishment of a mixed hardwood/coniferous forest.
- Instream restoration potential includes small Logjams within the Black Slough and tributary, and gravel pads for spawning habitat and riffle creation.

Estimated Budget:

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7.3.4 Parcel D

Summary:

Parcel D focuses on restoration of Palustrine emergent wetlands including some quality native mixed rush, sedge, and grasslands. The wetlands flow into a reconstructed channel and discharge into the Black Slough. Wetland function on this site has been compromised by historical actions such as forest removal and ditching. Removal or blockages in ditches and deleveling could provide a functional lift by increasing the hydroperiod complexity of the site. Restoration with native shrubs and trees would be beneficial in areas. This site is a documented breeding site for the Federally Threatened Oregon Spotted Frog. Seasonal grazing may be beneficial to the management of the Oregon Spotted Frog. Any restoration should include a Habitat Conservation Plan for this species that is coordinated with the USFW Service.

Overview:

Parcel D covers 55.8 acres, which includes 5.02 acres of agriculture within 100 feet of the Black Slough. Wetlands cover approximately 36.75 acres of pasture; all are located in the highest priority Wetland Focus Zone for the project. A riparian CREP project covers 5.9 acres. The buffer is 35-40 feet wide along the tributaries and 100 feet wide along the Black Slough. 5,864 lineal feet of buffer was restored.

Wetlands:

The parcel contains an approximately 36.75 acres of wetland. The southern portion of the parcel has a palustrine emergent (PEM) depressional wetland. The central portion of the parcel contains a palustrine scrub-shrub (PSS) depressional and riverine wetland.
Vegetation observed in the PEM wetlands included woolly sedge, awlfruit sedge, cattail, American skunk cabbage, hares foot sedge, daggerleaf rush, soft rush, and birds-foot trefoil. The PSS portion has been planted with primarily willow species. The dominant hydroperiods within the wetland is seasonal saturation with localized shallow ponding. A seasonally flowing tributary to Black Slough is located in the central portion of the parcel and contains water depths of up to six inches.

**Hydrology:**

The Black Slough flows South to North across the western property border exiting the parcel through a railway trestle midway. This area has a seasonally high water table with periodic flooding. A tributary flowing off the Van Zandt Dike travels through a large wetland and then joins the slough as it exits the parcel. A second tributary flows off the mountain and along the southern property boundary and enters the slough. A high water table and retention of surface water in depressions have resulted in wetlands throughout the pasture area. The wetlands are hydrologically connected to The Black Slough.

**Vegetation:**

The riparian area along the southern property boundary has been replanted with Douglas Fir, Grand Fir, and Western Red Cedar in areas of well-draining soil. In a depressional wetland along the southeast corner, Pacific Willow, Sitka Willow, dogwood, and Red Osier are planted. The riparian forest along The Black Slough is a mixed Red Alder, Paper Birch, Western Red Cedar, Sitka Spruce, and Grand Fir. Twinberry, Nootka Rose, Red Osier dogwood, and Pacific Ninebark are scattered in the understory and hedge of the stream margin. The wetland tributary is dominated by Pacific Scoulers, Sitka Willow, Red Osier, dogwood, with an outer margin of Red Alder, Paper Birch, and Western Red Cedar. Cares, scorpius, and juncus are found in the channel and expand into depressions flowing out and across the pastures.

**Soils:**

According to the Natural Resource Conservation Service Soil Survey of the Whatcom County Area, the project site maps as the Orida, Shalcar, Laxton and Puget soil series.

**Project Opportunities:**

- A conservation easement purchase of 15 acres.
- Enhancement of approximately 10 acres of wetlands focusing on de-leveling, including creation of small ponds for amphibians, and enhancing the impoundment of water seasonally through ditch modification.
- Restoration of vegetation could include Mixed Forest, Shrub/Scrub, and Wetland Pastures.
### Estimated Budget:

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#### 7.3.5 Parcel E

**Summary:**

Parcel E is a combination of agricultural, forestry, riparian, and wetland characteristics. The property is used for agriculture and also contains a forested area that is managing according to a forest management plan. A majority of the riparian buffer areas have been enrolled in the Conservation Reserve Enhancement Program (CREP) and would be made permanent under a proposed permanent conservation easement. Areas on the North end of the main parcel are within the Black Slough and have been harvested for timber recently.

**Project Opportunities:**

- A conservation easement purchase of up to 100.03 acres that would remove future development potential and protect riparian buffers and wetlands onsite.
- The restoration of approximately 10 acres of wetlands includes active management of beaver habitat, de-leveling, including the creation of small ponds for amphibians, and impoundment of water seasonally.
- Restoration of vegetation could include Mixed Forest, Shrub/Scrub, and Wetland meadows within the North end of the main parcel.
- Expansion of existing CREP areas with additional riparian buffer enhancement.

**Estimated Budget:**

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Parcel E was developed as a pilot project to explore whether a Purchase of Development Rights program could be utilized in conjunction with DOE funding to achieve greater restoration benefit. The PDR includes the analysis of the larger parcel “before” easement encumbrance and “after” easement encumbrance, and distinguishes between the conservation value and the development value. The appraiser successfully developed a model for establishing an easement that would restrict additional residential development on the property, as well as non-agriculture activities into perpetuity, while establishing clear protections for conservation. The proposed easement will allow for continued agricultural use of the land outside of the riparian and riparian buffer...
areas through the PDR, but clearly establish that NEP funding would only be applied to meet the recovery objectives and requirements of NEP funding. This pilot shows great promise in furthering cost sharing between different entities for mutually compatible restoration goals and ag. land protection goals.

7.3.6 Parcel F

Summary:

Parcel F provides an opportunity to restore and permanently conserve a large wetland and enhance an existing riparian buffer on the Black Slough. On-site wetland function is limited by lack of water storage capacity and vegetation diversity. De-leveling and blocking the ditches within the wetland could increase water storage capacity. Vegetation enhancement would increase habitat diversity and increase shading of water entering Black Slough. Wetland function on the east side of the site is limited by an extensive cover of invasive reed canary grass. Control of this species is recommended through planting of native shrub and tree species.

Overview:

Parcel F consists of 2.8 acres of agriculture along a 100 foot reach of the Black Slough, 6.64 acres of mature riparian forest, and 37.72 acres wetlands, which are located in the highest priority Wetland Focus Zone. The CREP project on this parcel includes 8.0 acres along both sides of the Black Slough. The buffer is well established and functioning well, providing shade and woody debris recruitment.

Wetlands:

The parcel contains approximately 37.7 acres of wetland. The majority of the parcel is comprised of palustrine emergent (PEM) depressional wetland. Vegetation in the wetland is dominated by reed canarygrass and hayed pasture grasses. Additional species observed in the wetland included: soft rush, bentgrass, hardhack, Nootka rose, and hawthorn. The wetland experiences seasonal saturation and limited shallow temporary ponding. Multiple shallow ditches exist throughout the pasture which direct water towards Black Slough, in the northwestern portion of the site.

Hydrology:

The Black Slough flows South to North across the western third of the property. This area has a seasonally high water table with periodic flooding. There is a small pond and associated wetland just East of a footbridge. A high water table and retention of surface water in depressions have resulted in wetlands throughout the pasture area. The wetlands are hydrologically connected to the Black Slough.

Vegetation:

A diverse riparian forest planting of mixed hardwood/ coniferous forest covers the riparian area of Black Slough. The majority of the Stand is Red alder. Paper Birch, and Black Cottonwood with patches or an understory of Sitka Spruce, Western Red Cedar, Grand Fir, and smaller numbers of
Western Hemlock and Douglas Fir. An understory of native shrubs interspersed with some invasive species exists throughout the forest and concentrated in some floodways where restoration did not take hold or was browsed by beaver. Invasive species include Himalayan blackberry, reed canary grass, and morning glory. Some skunk cabbage and willow are present around the pond and along the active channel. The remaining wetland pastures contain large patches of reed canarygrass, bull rush, and tall and red fescue grasses with some thistle and blackberry.

**Soils:**

According to the Natural Resource Conservation Service Soil Survey of the Whatcom County Area the project site includes Puget soil.

**Project Opportunities:**

- A conservation easement purchase of 26.8 acres
- The restoration of approximately 2.8 acres of riparian forest along the Black Slough. This could involve some enhancement of 8.0 acres of riparian area already restored through CREP
- Restoration of approximately 30 acres of wetlands focusing on de-leveling, including creation of small ponds for amphibians, and enhancing the impoundment of water seasonally through ditch modification. Restoration of vegetation could include Mixed Forest, Shrub/Scrub, and Wetland Pastures.

**Estimated Budget:**

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**7.3.7 Parcel G**

**Summary:**

Parcel G is already on track to restore forest cover on over 19 acres of wetlands feeding a fish-bearing tributary to the Black Slough. An additional three to four acres of wetlands, which hold significant surface water into early summer, could be modified to enhance water storage through deleveling, excavation, grading, and vegetated (eliminating patches of reed canary grass currently occupying areas of standing water). The farmer has chosen to wrap up his livestock operation, and has enrolled the majority of pasture to wetland restoration through the CREP Program.
**Overview:**

Parcel G consists of 33.77 acres of Priority 1 wetlands ranging from class 2-4. An 11.75 acre wetland CREP buffer along wetland tributaries to Black Slough will be installed in the spring of 2017. A total of 4,592 lineal feet of wetland will be restored. This effort builds on a previous riparian CREP project totaling 7 acres. This project buffers a large impounded wetland and tributary complex in the northwestern corner of the property.

**Wetlands:**

The parcel contains an approximately 33.7 acres of wetland. The southern portion of the parcel contains palustrine emergent (PEM) depressional and slope wetlands. The northern portion of the parcel contains palustrine scrub-shrub (PSS) depressional and riverine wetlands. Vegetation in the PEM wetlands is dominated by reed canarygrass and hayed pasture grasses. Species observed in PSS wetlands included: Pacific willow, black cottonwood, black twinberry, salmonberry, small fruited bulrush, large leaf sedge, cattail, lady fern, and giant horsetail. The wetlands experience seasonal saturation and seasonal ponding with water depths of up to six inches in the PEM wetlands. To the north, the PSS wetlands contain pockets of deeper inundation with depths ranging from 6 to 12 inches. The wetlands appear to outlet via the black slough tributaries in the northwestern portion of the site.

**Hydrology:**

Two small tributaries run off Van Zandt Dike feeding wetlands and streams in the Black Slough drainage, which empties into the South Fork Nooksack River. An approximately 4 acre wetland in the northwestern corner of property including a flooded tributary to the Black Slough is part of a larger complex that spans two neighboring parcels, A high water table and retention of surface water in depressions have resulted in wetlands throughout the pasture area. The wetlands are hydrologically connected to the Black Slough.

**Soils:**

According to the Natural Resource Conservation Service Soil Survey of the Whatcom County Area, the project site maps as the Orida and Pangborn soil series. The parcel has hydric soil.

**Project Opportunities:**

- A conservation easement purchase of approximately 33 acres.
- The restoration of approximately 10 acres of wetlands includes active management of beaver habitat, de-leveling, including the creation of small ponds for amphibians, and impoundment of water seasonally. Coordination with USFWS and a HCP may be necessary as the property is part of a wetland with Oregon Spotted Frog breeding habitat.
- Possible reconstruction of fish bearing tributary channel to Black Slough including wood placement and gravel pads for spawning.
- Restoration of vegetation could include Mixed Forest, Shrub/Scrub, and Wetland meadows.
**Estimated Budget:**

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### 7.3.8 Parcels H, I, J

**Summary:**

These parcels offer the potential for significant wetland rehabilitation and restoration. The site is adjacent to the river and is actively farmed. The site contains wetlands and seasonal drainages. The wetlands and drainages could potentially be restored to increase water capacity and native vegetation.

**Overview:**

This parcel includes an approximate 61 acres of wetland located adjacent to the South Fork Nooksack River. Restoration of irregular topography and reduced drainage would benefit the wetland function. The wetlands have been drained in part by ditches and leveling of topography. Native forest vegetation has been removed by past agricultural activities and now is maintained as pasture. Restoration with native forest and shrub species would provide a functional lift to water quality and wildlife functions of this wetland.

**Wetlands:**

The site contains an approximate 61 acres wetland across three areas. Two of the potential wetland areas are palustrine emergent/palustrine forested (PEM/PFO) depressional wetlands associated with unnamed drainages mapped by the NRCS. The majority of the area within these wetlands is currently farmed and may have been effectively drained to some degree. Based on LiDAR interpretation, these wetlands appear to drain northwest towards the South Fork Nooksack River. One additional riverine forested (RFO) potential wetland is located in the floodplain terrace, directly adjacent to the South Fork Nooksack River. The potential wetland is situated along the bend of the river and may receive flood water during high flow events.

**Hydrology:**

The site appears to contain seasonal drainages. NRCS mapping indicates two drainages on site which flow south to the South Fork Nooksack River. However, based on LiDAR and aerial imagery interpretation, water on site appears to flow to the north. A drainage in the central portion of the site appears to be partially ditched and farmed. Based on historical aerial imagery, the drainage has been farmed, tilled, and redirected multiple times over the past five years. Water appears to flow to the northern parcel boundary and then west to the Nooksack River. The potential wetland
in the northeastern corner of the site appears to flow off site to the north towards another ditched tributary of the Nooksack River.

**Vegetation:**

The site is actively used for agriculture and hay production. Two forested patches containing deciduous trees are located within the interior of the site. The riparian area butting the South Fork Nooksack River along with the northern property boundary are also forested.

**Soils:**

According to the Natural Resource Conservation Service Soil Survey of the Whatcom County Area the project site includes the Puyallup and Briscot soil series. The site has hydric soil.

**Project Opportunities:**

- A conservation easement purchase of 4 acres of forested wetland in the central portion of the site.
- The restoration of approximately 35 acres of wetlands through de-leveling activities and installation of native vegetation.
- Potential riparian restoration along the farmed and ditched drainages.

**Estimated Budget:**

This project budget has not yet been estimated, but will be able to also utilize the PDR program as piloted in this project.

**7.3.9 Parcel K**

**Summary:**

Parcel K provides an opportunity to enhance an existing riparian restoration project on the S. fork mainstem and a tributary/back channel/ wetland complex feeding the main stem. It is adjacent to river with a backchannel and tributary. A small wetland associated with back channel could also be restored.

**Overview:**

Parcel K consists of 3.2 acres of agriculture within 300’ of the South Fork Nooksack River. Additionally, 2.42 acres within the Priority 9 Wetlands zone. This parcel also includes approximately 5 acres of Riparian buffer plantings adjacent to a back channel/tributary and Approx. 2 acres of riparian buffer planting acres 100’ of the S. fork Nooksack.

**Hydrology:**

The South Fork of the Nooksack flows along the boundary of the parcel. The river enters the parcel just as it flows under a bridge and travels along the left bank engaging an old revetment protecting
the length of the parcel riverfront. This stretch of river is also connected to the immediate
floodplain by a back channel wetland complex, which is fed by a wetland complex/seasonal
tributary draining a mountain basin. This small tributary flowing off the mountain enters a pond
and several wetland complexes before exiting to the North at a break in the revetment joining the
Nooksack.

**Soils:**

Soils are Wickersham Channery silt loam.

**Project Opportunities:**

- Potential riparian restoration of approx. 3.0 acres along the S. fork Nooksack within 300’
of river. The riparian area along the river is dominated by conifers these are
predominately Douglas-fir, Western Red Cedar, and Sitka Spruce. The potential riparian
restoration, mostly consisting of well-drained soils, will support the establishment of
conifers.
- The riparian area along the east side of the parcel is within an old back channel/floodway.
The adjacent property owners and The Acme Flood Control Zone District as a potential
site to reestablish flood flow.
- Permanent conservation through a conservation easement on approx. 10 Acres.
- Instream restoration potential includes logjams and bank roughening along long sections
of glide. Reinforcement of the existing rock revetments with bank roughening in tandem
with wood and logjam construction will increase flood protection along the Potter RD.
Bridge. Lowering revetment elevation may be possible on the northern boundary.

**Estimated Budget:**

This project budget has not yet been estimated.

**7.3.10 Parcel L, M, N**

**Summary:**

Parcels L, M, and N provide enhancement and active management of a beaver pond/wetlands
complex that spans the corners of three parcels. The project provides opportunity for riparian
and wetlands restoration, wetlands enhancement through deleveling, and pond creation, permanent
conservation through conservation easements, and stream channel restoration via establishing a
meandered channel through a currently ditched section of the Black Slough.

**Overview:**

The parcels which compose this project include 9.34 acres of current agriculture clearing within
100 feet of the salmon bearing tributary named Black Slough and 35.85 acres of priority one
wetlands. Approximately 38 acres of previous popular plantation has been recently enrolled
(2016) and restored through The CREP program along the Slough and a ditched tributary. The
Slough carries a high volume of water throughout the winter. The field ditch on the north property
line takes a 90 degree turn to the south approximately a third of the length from the road. This ditch connects to an old irrigation pond.

**Wetlands:**

The National Wetland Inventory identifies a portion of a larger wetland in the northwest corner of this site. It classifies as Palustrine, Persistent Forested, Seasonally Flooded, but can occasionally be dry during the summer.

The majority of the property are lower functioning palustrine emergent wetlands. The wetlands are located in the highest priority Wetland Focus Zone for the property. The site also supports a well-established beaver habitat complex, including a series of small beaver dam, which may have been occupied since the 1990’s. This habitat is present in flooded portions of Black slough and its ditched tributary.

The current CREP project consists of a riparian forest buffer totaling 20.08-acres along 6,189 lineal feet of stream received 9,700 seedlings and a marginal pasture wetland buffer totaling 18.98-acres along 9,013 lineal feet of wetland tributaries receiving 9,100 seedlings.

The second parcel contains 6.94 acres of mature cottonwood within 100’ of Black slough, and 36.74 acres of Priority 1 wetlands. The majority of the parcel contains Palustrine forested (PFO) depressional and riverine wetlands. The site also supports a well-established beaver habitat complex, including a series of small beaver dams which may have been occupied since the 1990’s. This habitat is present in flooded portions of Black slough and its ditched tributary.

The third parcel consists of 44.14 acres of Priority 1 Wetlands. The majority of the parcel contains palustrine emergent (PEM) depressional wetlands. The Northern boundary is palustrine forested (PFO) depressional and riverine wetlands, that have been enrolled in CREP along the Black slough. The site also supports a well-established beaver habitat complex, including a series of small beaver dams which may have been occupied since the 1990’s. This habitat is present in flooded portions of Black slough and its ditched tributary.

**Hydrology:**

The Black Slough flows south to North through Parcel L, exiting through a culvert under the road. This area has a seasonally high water table with periodic flooding. A tributary flowing off the Van Zandt Dike travels through a large wetland along the Southern boundary of one unit then joins the slough as it travels through and exits the next unit. A second tributary flows off the mountain and along the northern property boundary crosses the road and continues North through Parcel M then into the Black slough. A high water table and retention of surface water in depressions have resulted in wetlands throughout the pasture areas, which are hydrologically connected to The Black slough.

The Black Slough flows northerly through Parcel north along the east property line. Three lateral field ditches flow east into the Slough. Their connections are unobstructed open to fish passage. This area has a seasonally high water table with high levels of saturation for much of the year.
**Vegetation**

The project area of L, M, and N are primarily covered by reed canarygrass, and a few scattered trees and shrubs. Hybrid poplars were harvested sometime after 2013. Blackberries are present throughout and especially along the waterways. A few small trees and shrubs are present along the north ditch and the pond and include mostly red alder. The area surrounding the pond is depressional and seasonally wet. Here in addition to the other mentioned species are wetland graminoids like soft rush and small fruit bulrush. There is a large volume of woody debris left over from the harvest of the poplars.

**Soils:**

According to the Natural Resource Conservation Service Soil Survey of the Whatcom County Area, the project site maps as the Puget and Briscot soil series.

**Project Opportunities:**

- Establishment of permanent conservation through conservation easements
- Wetlands enhancement through de-leveling and pond creation
- Channel restoration via establishing a meandered channel through a currently ditched

**Estimated Budget:**

This project budget has not yet been estimated.

7.4 Next Steps

With the parcels identified above, more discussion with the landowners will occur to refine assessments, discuss opportunities, clarify incentives, and develop the protection and restoration details needed for Phase 2 funding. An additional ten landowners of second-tier priority parcels have been identified through the inventory of the reach, who may also be contacted to determine landowner willingness. These additional parcels will only be considered if the parcels where more detail is known and that have higher protection and restoration potential ultimately are not further considered for Phase 2 funding.

The next steps for implementation with Phase 2 funding will include:

1. Meeting with landowners of the seven prioritized parcels to refine opportunities and options.
2. Contact of ten additional landowners to ensure that other potential projects that may be considered for development and qualify for funding under Phase 2 of this NEP funding.
3. Initial determination of project feasibility, including areas and costs.
4. Ranking of projects to prepare a proposal for Phase 2 funding.
5. Development of refined project plans, instruments, and budgets.
6. Conduct more detailed site-specific studies where additional information is needed, such as wetland boundaries, to develop detailed implementation plans.
7. Confirmation of landowner willingness to proceed.
8. Confirmation of funding.
9. Record conservation easements and land purchase.
10. Implementation of the projects.
11. Maintenance and monitoring of easements and restoration projects until progress toward success is demonstrated.

8.0 Conclusion

This reach-scale plan is an integration of three planning efforts including 1) watershed-wide characterization of natural conditions, status, and climate change risk that provides a context for the more detailed assessment of restoration and protection opportunities along the South Fork Nooksack River, 2) public outreach and stakeholder engagement to identify issues, concerns, and opportunities identified by the SFNR community; and 3) specific restoration and protection opportunities within the riparian zone of the SFNR and tributaries in the Acme reach from the Skookum Creek confluence to the confluence with the North Fork Nooksack River. The primary focus of this effort was on water quality issues of the watershed and river including temperature fine sediment exceedances. The assessment focused on the impacts of legacy impacts and climate change on water quality, fish habitat, and fish. This reach-scale plan assessed all parcels that partially or totally fell within 300 feet of the river and 100 feet of tributaries for condition, function, protection potential, restoration potential, and owner willingness. Through this process, 14 parcels were identified that had a high priority for restoration and/or protection, in combination with landowner willingness to participate in Phase 2 funding. Conceptual assessment of protection and restoration opportunities was made for these parcels and approximate costs for acting on the opportunities were identified. Total costs for all 14 parcels likely exceed the amount of available Phase 2 funding. Once this Reach-scale plan is approved, we will develop more detailed plans for implementation some or all of the 14 parcels including the details of protection and restoration; maintenance, management, and monitoring; conservation easements; and possible land purchase.

9.0 Literature Cited


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