Appendix D: Landscape Unit Conditions

Appendix D includes detailed results from the assessment of the Upper Cowlitz Cispus watershed. Landscape units (LUs) are first summarized here describing Hillslope and Valley Bottom characteristics in the Upper Cowlitz and Cispus Basin. Following that, individual LUs are described in detail.

Landscape Unit Summary

1 Hillslope Landscape Units Summary

The three hillslope LUs are Highlands, Mid-Elevation Hillslopes, and Lower Hillslopes. These represent the land areas above the broad mainstem valley bottoms that primarily influence the habitat within valley bottom LUs via their contributing processes, including sediment delivery (e.g., sediment transported down to valley bottoms), hydrology (e.g., amount and timing of surface water or groundwater runoff), and wood inputs. These processes are impacted by land use practices, such as timber harvest, as well as by natural processes, such as glacial melt and landslides.

The Lower Hillslopes LU is the area within the WDNR (2018) rain-dominated zone, and corresponds to elevations below approximately 500 meters (1,640 feet). Most of the private agricultural and rural residential land in foothills-type terrain is located within this LU. The Mid-Elevation Hillslopes LU encompasses what is generally considered the core ROS zone, which includes the WDNR peak rain-on-snow zone and the WDNR snow-dominated zone. Elevations range from approximately 500 to 1,200-1,300 meters (1,640 to 3,937-4,265 feet). The Highlands LU corresponds to the WDNR highlands zone, which are high-elevation areas where rain-on-snow events are less likely. This generally corresponds to elevations over 1,200 meters (3,937 feet) in the northern portion of the study area and above 1,300 meters (4,265 feet) in the southern portion, but varies depending on aspect and vegetation conditions. This zone covers the slopes of the high peaks located within the basin, including portions of Mount Rainier, the Goat Rocks, and Mount Adams. This area is almost all within federal ownership, much of it within Mount Rainier National Park and several wilderness areas.

2 Valley Bottom Landscape Units Summary

The valley bottom LUs were delineated to include the broad valley floors of the Cowlitz and lower Cispus rivers. They extend from Lake Scanewa at the downstream end to just above the Muddy Fork confluence on the Cowlitz and up to the Canyon Creek confluence on the Cispus. The valley bottom LUs generally contain the Tier 1 and 2 reaches from the Recovery Plan, representing some of the most important habitat for ESA-listed salmon and steelhead in the basin.

These LUs are characterized by relatively flat, valley floor gradients and they encompass the areas underlain by river alluvium and fluvially-worked glacial sediments. These are depositional "response" reaches with meandering or island braided channel types. The elevation range along the five Upper Cowlitz LUs is from 250 meters at Lake Scanewa to 400 meters at the upper end of the Upper Cowlitz-

Muddy Fork LU. The elevation range along the four Cispus LUs is from 250 meters at Lake Scanewa to 600 meters at the upper end of the Cispus – Upper LU. The area is rain-dominated, but receives upslope snow and glacial melt seasonally. The mainstem channels are large and low gradient with relatively frequent overbank flooding and channel migration. Flood events erode channel and floodplain sediments as well as glacial terraces in some locations. Cowlitz Falls Dam, which creates Lake Scanewa, has a strong influence on channel gradients at the downstream end of the study area; the backwater effect extends several miles up the mainstem Cowlitz and approximately 2 miles up the Cispus.

The valley bottom LUs have generally high human habitation, in particular throughout the Cowlitz River and in the Tower Rock section of the Cispus River. Private land use is primarily rural residential and agricultural. These land uses have various impacts on the valley bottom landscape, at times reducing channel migration with levees, riprap or other structures, and with effects to riparian vegetation.

Landscape Unit Descriptions

1 Highlands

1.1 Location Description

High elevation, snow-dominated terrain draining the high peaks and ridgelines.

1.2 Overview

This LU represents the "highlands" zone from the WA DNR rain-on-snow mapping. It roughly corresponds to areas above 1200 meters in elevation in the northern portion of the study area and above 1300 meters in elevation in the southern portion, but varies depending on aspect and vegetation conditions. It primarily consists of steep, snow-dominated subwatersheds, with some streams draining glaciers on Mt Rainier and Mt Adams. There are also important alpine and subalpine headwater meadows that help regulate hydrology in downstream channels. Most of the streams within the Highlands LU consist of steep source and transport reaches, many of which are subject to avalanches and debris flows. The LU is generally heavily forested with mature conifers except for above treeline. There is very little human development and nearly zero human habitation (<1% private ownership). The LU lies mostly within public lands, primarily within the Gifford Pinchot National Forest, but also with significant portions within highly protected public lands; this includes Mt Rainier National Park, as well as the Tatoosh Wilderness, the William O Douglas Wilderness, the Goat Rocks Wilderness, and the Mt Adams Wilderness, which are within the National Forest. Road density within the Highlands LU is the lowest of all LUs (0.8 mi/mi^2). This LU is almost entirely within federal forest lands (National Forest or National Park). With respect to federal forestland management within this LU (see Section 4.4 in the main report), the NWFP land use allocations comprise the following areas: CR/AW (i.e. little-to-no timber harvest) is 65%; LSR (very limited harvest) is 7%; and matrix (greater harvest) comprises

28%. Based on the status and trends monitoring by Miller et al. (2017) and described in Section 4.4 in the main report, the matrix lands are generally improving with respect to sediment, wood, riparian, and hydrologic condition, and the CR lands show a slight degrading trend; however, the authors stated that this is likely due to an elevated status within the CR zones and more degraded status within Matrix zones at the outset of monitoring efforts. Although some harvest does occur in the UCC basin in the AW and LSR designated areas of the NWFP (Ken Wieman, USFS, personal communication 2019), there is relatively little harvest in 72% of the land in this LU, and watershed process scores are improving based on AREMP monitoring. Watershed process conditions are likely to improve if kept under the same management regime.

1.3 Historical Conditions

Prior to Euro-American settlement of the basin, land cover consisted of late seral stage forests except for above timberline or in areas with recent fire, flood, or landslide disturbances. There would have been a range of forest vegetation types depending on slope, aspect, and elevation. Past timber harvest in the lower portions has been the primary driver of change. Climate change continues to alter hydrologic conditions, and is also likely impacting vegetation types (Beason et al., 2019). Glaciers on Mt Rainier and Mt Adams historically extended further downslope then today (Crandell & Miller, 1974, Beason et al., 2019).

Ecological Indicators – Highlands	
Indicator	**Description**
Natural vs. Human Disturbance	**Functional to Moderately Impaired** The potential for high-intensity stand replacing fires is higher due to decades of fire suppression, but fire return intervals would be expected to be long even under historical conditions. Mass wasting and flooding related to glacial retreat has likely increased disturbance to streams draining this LU as well as downstream LUs. Based on the NWFP land use allocations, timber harvest can still occur on 28% of the area of this LU, with the potential for harvest-related disturbance events (e.g. mass wasting, windthrow).
Hydrologic Alteration	**Functional** Increased glacial meltwater and slope failures related to glacial retreat has likely affected hydrologic processes to some degree. Timber harvest effects on hydrology are expected to be minor due to land use allocations (72% CR, AW, or LSR). IWA Ratings for subwatersheds in this LU are primarily rated as “Functional”, with a few areas of “Moderately Impaired” and no “Impaired” subwatersheds.

Sediment Processes	**Functional to Moderately Impaired** In some locations, forestry activities may have increased sediment from mass wasting events, however there are minimal existing roads (0.8mi/mi^2). Timber harvest effects on sediment delivery are expected to be minor due to land use allocations (72% CR, AW, or LSR). Glacial meltwater and slope failures related to glacial retreat has also likely affected sediment delivery processes. Sediment inputs related to forest fires are expected to be minimal under current conditions since there have been no significant fires affecting the Highlands LU (USFS GIS data 2019). IWA Ratings for subwatersheds in this LU are mostly rated as either "Functional" or "Moderately Impaired".
Large Wood Processes	**Functional** Headwater streams in this LU are expected to have generally high wood loading, and important contributions to downstream reaches through debris flows. Riparian reserves in the NWFP are expected to result in continued improvement in wood loading conditions into the future. Stream-adjacent forest roads and roads that interrupt debris flow paths are expected to have localized impacts to large wood availability and recruitment.
Channel Type and Form	**Functional** Channels are mainly steep source and transport reaches, many subjected to debris flows. There are some areas with high alpine meadows and slope wetlands.
Floodplain Connectivity	**Functional** There are not many well-developed floodplains in this LU due to the steep topography, but where they exist, they are assumed to be well-connected due to limited roads or other infrastructure along stream channels.
Lateral and Vertical Channel Dynamics	**Functional** Lateral and vertical channel dynamics are assumed to be relatively unchanged from historical conditions in this LU.
Off-Channel Habitat Connectivity and Refugia	**Functional** Off-channel habitat connectivity and refugia is assumed to be relatively unchanged from historical conditions in this LU due to limited roads or other infrastructure along stream channels.
Riparian Processes	**Functional** Many of the riparian areas in this LU have been impacted by past timber harvests, although some of them, such as in wilderness or National Park, have not. Previously harvested riparian areas are recovering due to riparian buffer protections in the NWFP and based on the results of status and trends monitoring (Miller et al., 2017). USFS stream temperature monitoring shows very few exceedances of the state

	criteria of 16°C for the 7-day moving average of the daily maximum (7-DADMax) for streams within the Highlands LU, suggesting no significant concerns with stream shading. IWA Ratings for subwatersheds in this LU are mostly rated as either "Functional" or "Moderately Impaired", with some of the highest rated conditions in the upper Clear Fork Cowlitz and Ohanapecosh drainages.

1.4 Contributing Process Drivers

These headwater systems are important sources for sediment, hydrology, and large wood inputs to downstream LUs. In general, they are functional with respect to these contributions.

1.5 Target Fish Use

These areas are not accessible to target salmon and steelhead species in the basin, and are not designated critical habitat for salmon or steelhead.

1.6 Habitat Patch Connectivity

These areas are important to keep in functional condition because of their influence on downstream LUs. Continued maturation of riparian forests will improve forest conditions over time. Existing protections, including public ownership and riparian buffer protections, are generally believed to be adequate for protection in this LU.

1.7 Management Plans, Past Studies, Projects

The lands within the Highlands LU are almost 100% public, and management is governed primarily by forest practice regulations and plans. These include the NWFP (see Section 4.4 in the main report) and other programs and policies of the Gifford Pinchot National Forest and Mount Rainier National Park.

1.8 Landownership

Land ownership is nearly 100% federal forest land within the Gifford Pinchot National Forest and Mt. Rainier National Park.

2 Mid-Elevation Hillslopes

2.1 Location Description

Mid-elevation rain-on-snow zone ranging from approximately 500 to 12-1300 meters in elevation.

2.2 Overview

This LU represents the "peak rain-on-snow" and "snow dominated" zones from the WA DNR rain-on-snow mapping. It roughly corresponds to elevations between 500 and 1200-1300 meters and varies depending on aspect and vegetation conditions. It primarily consists of lands within the Gifford Pinchot National Forest, with some protected wilderness lands in the upper drainages and some private commercial forest lands located in the western portion of the study area. Stream reaches range from source to response reaches but transport reaches are most common. There are impacts related to fine sediment delivery and hydrologic impairment due to past timber harvest and the forest road network, although road density is currently moderate, at 2.6 mi/ mi^2. This LU is almost entirely (94%) within federal forest lands (Gifford Pinchot National Forest and Mount Rainier National Park). With respect to federal forestland management within this LU (see Section 4.4 in the main report), the NWFP land use allocations comprise the following areas: CR/AW (i.e., little-to-no timber harvest) is 16%; LSR (very limited harvest) is 24%; and matrix (greater harvest) comprises 54%. Based on the status and trends monitoring by Miller et al. (2017) and described in Section 4.4 in the main report, the matrix lands are generally improving with respect to sediment, wood, riparian, and hydrologic condition, and the CR lands show a slight degrading trend; however, the authors stated that this is likely due to an elevated status within the CR zones and more degraded status within Matrix zones at the outset of monitoring efforts. Although some harvest does occur in the UCC basin in the AW and LSR designated areas of the NWFP (Ken Wieman, USFS, personal communication 2019), there is relatively little harvest in 40% of the land in this LU, and watershed process scores are improving based on AREMP monitoring. Watershed process conditions are likely to improve if kept under the same management regime.

2.3 Historical Conditions

These forests would have historically consisted of late-successional and late seral stage forests. Stream channels would have had significant large wood loading with a high influence on channel form, processes, and habitat. Streams would have had high habitat complexity with a high degree of connectivity to floodplains, CMZs, and off-channel habitat.

Ecological Indicators - Mid-Elevation Hillslopes	
Indicator	**Description**
Natural vs. Human Disturbance	**Functional to Moderately Impaired** The potential for high-intensity stand replacing fires is higher due to decades of fire suppression, but fire return intervals would be expected to be long even under historical conditions. There may also be an increased risk of forest diseases due to forestry activities and dense even-aged stands. Increased mass wasting and flooding related to slope and road failures has likely increased disturbance to streams draining this LU as well as downstream LUs. Based on the NWFP land use allocations, timber harvest can still occur on approximately 54% of the area of this LU, with the potential for harvest-related disturbance events (e.g. mass wasting, windthrow).
Hydrologic Alteration	**Functional to Moderately Impaired** Hydrologic alteration varies considerably across this LU. Impairment is primarily due to high forest road densities and past timber harvest. The higher elevation areas within the National Forest are in relatively good condition and the lower elevation private commercial forest lands are in a more impaired condition. Timber harvest effects on hydrology are expected to be moderate due to land use allocations (40% CR, AW, or LSR; 54% Matrix). IWA Ratings for subwatersheds in this LU are rated as mostly "Functional" in the headwaters contributing to the upper Cowlitz and Cispus mainstem, with "Moderately Impaired" ratings in the NF Cispus drainage and "Moderately Impaired" or "Impaired" ratings in tributary basins draining the private commercial timberlands to the west, including the Kiona, Davis, and Silver Creek drainages.
Sediment Processes	**Functional to Moderately Impaired** Sediment alteration varies considerably across this LU. Forestry activities, including timber harvest and road building, have likely increased the potential for fine sediment delivery to stream channels from mass wasting. Timber harvest effects on sediment delivery are expected to be moderate due to land use allocations (40% CR, AW, or LSR; 54% Matrix). Sediment inputs related to forest fires are expected to be minimal under current conditions. Two large fires occurred primarily in the Cispus Basin in 1902 (Cispus Fire) and 1918 (Hamilton Fire) (USFS GIS data 2019) but significant regrowth has occurred since then. IWA Ratings for subwatersheds in this LU are mostly rated as "Moderately Impaired", with some "Functional" ratings in higher elevation areas in the Upper Cowlitz and Cispus headwaters.
Large Wood Processes	**Functional to Moderately Impaired** Streams in this LU would be expected to have moderate or high wood loading, likely depending on the land use history. Most of the streams in this LU, either on private lands or in the National Forest, likely had significant reductions in large wood loading due to past timber harvests or even stream cleanouts. The wood loading is assumed to be recovering, particularly on the National Forest where there have been strong riparian protections in place since at least the mid-1990s after the beginning of the NWFP. Wood loading in the larger tributaries likely remains impaired because the wood that is available is not sufficient to serve as stable "key pieces" in the channel. Stream-adjacent forest roads and roads that interrupt debris flow paths are expected to have localized impacts to large wood availability and recruitment.
Channel Type and Form	**Functional** Given the range of headwater to low-gradient valley catchments, channel types would be expected to vary in this LU depending on slope and position within the catchment. Channel types are likely to range from steep source channels to low gradient response reaches. However, most channels would be expected to be transport reaches, confined within narrow valleys. There have not been significant

	impairments to channel form, except for where past timber harvests and road building have significantly reduced wood loading or have constrained floodplains and CMZs. However, these impacts are assumed to be fairly minimal given ownership and land-use allocations
Floodplain Connectivity	**Functional** Floodplains are not extensive due to the steep terrain, and where they exist, they are generally well-connected, with only isolated areas of impairment primarily related to forest roads.
Lateral and Vertical Channel Dynamics	**Functional** Lateral and vertical channel dynamics have not been significantly altered in this LU due to limited confinement due to roads and other infrastructure.
Off-Channel Habitat Connectivity and Refugia	**Functional** Off-channel habitat connectivity and refugia has not been significantly altered in this LU due to limited confinement due to roads and other infrastructure
Riparian Processes	**Functional to Moderately Impaired** Most riparian areas in this LU have been impacted by past timber harvests. Riparian areas are recovering due to riparian buffer protections, particularly in the National Forest where strong riparian buffer protections have been in place since the mid-1990s (beginning of the NWFP). USFS stream temperature monitoring shows some exceedances of the state criteria of 16°C for the 7-day moving average of the daily maximum (7-DADMax), including Cowlitz River tributaries Summit Creek, Ohanapecosh Creek, Skate Creek, and Willame Creek; and Cispus tributaries Walupt Creek, East Canyon Creek, Prospector Creek, Pumice Creek, and 1918 Creek (USFS unpublished data). These exceedances suggest there may be some impairment to canopy cover; however, the 7-DADMax rarely exceeded 18°C. IWA Ratings for subwatersheds in this LU are rated as either “Moderately Impaired” or “Functional”, with some of the highest rated conditions in the clear fork Cowlitz, Ohanapecosh, and Iron Creek drainages.

2.4 Contributing Process Drivers

These hillslopes have the greatest influence on hydrology and fine sediment washload in the mainstem rivers. Impairments in this LU have and will continue to impact downstream habitats.

2.5 Target Fish Use

Chinook salmon critical habitat is located in the lower elevation zones of this LU, particularly up Yellowjacket Creek and the North Fork Cispus River. Coho Salmon and steelhead critical habitat is nearly

identical in this LU, and is located at lower elevation areas, including Yellowjacket Creek, North Fork Cispus River, and Skate Creek.

The USFS has identified the NF Cispus in this LU as having good potential to support salmon and steelhead. Yellowjacket Creek has also been identified as a priority watershed (Ken Wieman, personal communication 2019).

2.6 Habitat Patch Connectivity

Stream habitats within this LU are relatively well connected to up- and downstream habitats and are important for supporting overall watershed health. Stream channels within this LU represent the transition from the relatively well functioning, more protected habitat in the Highlands LU, to the Lower Hillslopes and Valley Bottom LUs that have greater human influence and less habitat protection. Watershed conditions in this LU have a strong influence on the anadromous salmonid habitats in the larger downstream stream channels, and are therefore important for protection. Upland and riparian forests in this LU are recovering from past harvest and stream habitat conditions are likely on an improving trend, particularly with respect to wood loading and stream shade. Stream channels within this LU have the potential for offering important refugia habitats relatively well-protected from the human impacts that are more prevalent in downstream areas, particularly for steelhead and coho that make greater use of the smaller stream channels in this LU.

2.7 Management Plans, Past Studies, Projects

The Mid-Elevation Hillslopes LU is 94% public forest land and is managed according to the land use allocations in the NWFP as discussed in the main report in Section 4.

2.8 Landownership

This LU is 94% federal forest land, lying mostly within the Gifford Pinchot National Forest and a small portion within Mt. Rainier National Park in the northern part of the study area. The remaining 6% lies primarily within industrial forest land in the western portion of the study area (upper Lynx, upper Lake, and upper Kiona Creek basins).

3 Lower Hillslopes

3.1 Location Description

Low elevation rain-dominated zone below approximately 500 meters in elevation.

3.2 Overview

This LU represents the "rain dominated" zone from the WA DNR rain-on-snow mapping. It roughly corresponds to elevations below 500 meters, but varies depending on aspect and vegetation conditions. It primarily consists of rolling foothills and lower elevation peaks. It contains some of the larger tributary channels contributing to the mainstem Cowlitz and Cispus rivers, with channel types ranging from source to response but dominated by transport and response reaches. Some of the channels have broad floodplains on relatively flat slopes, such as Kiona, Silver, Siler, and Iron Creeks. Much of the eastern portion of this LU is National Forest and much of the western portion is private land with agriculture, rural residential, and forestry uses. Road density is relatively high, at 5.1 mi/mi2, reflecting greater human activity within this LU than the other upland LUs. This LU is about half within federal forest lands (Gifford Pinchot National Forest) and half within private lands. With respect to federal forestland management within this LU (see Section 4.4 in the main report), the NWFP land use allocations comprise the following proportion of the entire LU: CR/AW (i.e., little-to-no timber harvest) is 0%; LSR (very limited harvest) is 35%; and matrix (greater harvest) comprises 13%. Based on the status and trends monitoring by Miller et al. (2017) and described in Section 4.4 in the main report, the matrix lands are generally improving with respect to sediment, wood, riparian, and hydrologic condition, and the CR lands show a slight degrading trend; however, the authors stated that this is likely due to an elevated status within the CR zones and more degraded status within Matrix zones at the outset of monitoring efforts. Overall, 35% of the land is subjected to no or very limited timber harvest. The remainder is mostly within timber harvest areas, either federal Matrix lands or private timberlands. The Matrix lands may be improving as stated earlier. For private lands, clear-cut areas may be impaired with respect to hydrologic and sediment processes; however, riparian buffer protections on perennial streams would be expected to maintain good habitat conditions (see Section 4.4 in the main report for more info).

3.3 Historical Conditions

These forests would have historically consisted of late-successional and late seral stage forests. Stream channels would have had significant large wood loading with a high influence on channel form, processes, and habitat. Streams would have had high habitat complexity with a high degree of connectivity to floodplains, CMZs, and off-channel habitat.

Ecological Indicators – Lower Hillslopes	
Indicator	**Description**
Natural vs. Human Disturbance	**Functional to Moderately Impaired** The potential for high-intensity stand replacing fires is higher due to decades of fire suppression, but fire return intervals would be expected to be long even under historical conditions. There may also be an increased risk of forest diseases due to forest practices and dense even-aged stands. Increased mass wasting and flooding related to timber harvest and road building has likely increased disturbance to streams draining this LU as well as downstream LUs. Based on land ownership (about half is private land and half is federal forest land) and NWFP land use allocations, timber harvest can still occur on approximately 65% of the area of this LU, with the potential for harvest-related disturbance events (e.g., mass wasting, windthrow).
Hydrologic Alteration	**Moderately Impaired to Impaired** Hydrologic impairment is primarily due to high forest and non-forest road densities and past timber harvest, as well as some conversion to agriculture and rural residential development. Timber harvest effects on hydrology are expected to be moderate-to-impaired due to ownership (48% private) and NWFP land use allocations (0% CR/ AW; 35% LSR; and 13% Matrix). IWA Ratings for subwatersheds in this LU are mostly rated as either “Moderately Impaired” or “Impaired”.
Sediment Processes	**Moderately Impaired** Sediment alteration is related to forestry, agriculture, and rural residential development, which has likely increased the potential for fine sediment delivery to stream channels. Timber harvest effects on sediment delivery are expected to be moderate-to-impaired due to ownership (48% private) and NWFP land use allocations (0% CR/ AW; 35% LSR; and 13% Matrix). Sediment inputs related to forest fires are expected to be minimal under current conditions since there have been no significant fires affecting the Lower Hillslopes LU (USFS GIS data 2019). IWA Ratings for subwatersheds in this LU are rated as “Moderately Impaired”.
Large Wood Processes	**Moderately Impaired to Impaired** Wood loading in these streams is generally low due to past and on-going timber harvest, stream-adjacent roads, agricultural uses, and rural residential development. Riparian reserves on Matrix lands within the National Forest and DNR forest practices protections for riparian buffers for perennial and fish-bearing streams on private timber lands are expected to continue to improve large wood recruitment for fish.
Channel Type and Form	**Functional to Moderately Impaired** Channel types are mostly transport or response reaches, with only a few areas with source reaches, such as near Huffaker Mountain on the divide between the Cowlitz and Cispus. Overall, there has not been significant impairment to channel form, except for areas subjected to significant past timber harvests or where roads, agriculture, or rural residential development have significantly reduced wood loading or have constrained floodplains and CMZs. Kiona and Siler Creeks, in particular, have been impacted by rural residential development and agriculture, including major dredging and channelization.
Floodplain Connectivity	**Functional to Moderately Impaired** Overall, there has not been significant impairment to floodplain connectivity, except for areas subjected to significant past timber harvests or where roads, agriculture, or rural residential development have significantly reduced wood loading or have constrained floodplains and CMZs. Kiona and Siler Creeks, in particular, have been impacted by rural residential development and agriculture. Silver Creek has been leveed where it runs through the residential areas of Randle.

Lateral and Vertical Channel Dynamics	**Functional to Moderately Impaired** Overall, there has not been significant impairment to lateral and vertical channel dynamics, except for areas subjected to significant past timber harvests or where roads, agriculture, or rural residential development have significantly reduced wood loading or have constrained floodplains and CMZs. Kiona and Siler Creeks, in particular, have been impacted by rural residential development and agriculture. Silver Creek has been leveed where it runs through the residential areas of Randle.
Off-Channel Habitat Connectivity and Refugia	**Moderately Impaired** Off-channel habitat connectivity and refugia has been impaired by past timber harvests, or where roads, agriculture, or rural residential development have significantly reduced wood loading and have constrained floodplains and CMZs. Kiona and Siler Creeks, in particular, have been impacted by rural residential development and agriculture, reducing potential off-channel habitats. Silver Creek has been leveed where it runs through the residential areas of Randle. As channel migration and evolution is reduced, so is the generation of additional off channel habitats.
Riparian Processes	**Moderately Impaired** Most riparian areas in this LU have been impacted by past timber harvest or from agriculture, road building, or rural residential development. Riparian areas are recovering due to riparian buffer protections, particularly in the National Forest where strong riparian buffer protections have been in place since the mid-1990s (beginning of the NWFP). Riparian reserves on Matrix lands within the National Forest and DNR forest practices protections for riparian buffers for perennial and fish-bearing streams on private timber lands are expected to continue to improve riparian processes, including shade, bank stability, nutrient exchange, and large wood recruitment. USFS stream temperature monitoring shows some exceedances of the state criteria of 16°C for the 7-day moving average of the daily maximum (7-DADMax), including Cowlitz River tributaries Davis Creek, Silver Creek, Siler Creek, and Schooley Creek; and Cispus River tributaries Woods Creek, Greenhorn Creek, Iron Creek, and Quartz Creek (USFS unpublished data). These exceedances suggest there may be some impairment to canopy cover. Davis Creek, Siler Creek, and Woods Creek have exceeded 20°C on one or more occasions. IWA Ratings for subwatersheds in this LU are mostly rated as “Moderately Impaired”.

3.4 Contributing Process Drivers

Aquatic habitat in this LU is heavily influenced by watershed land use and management including forest practices (within this LU and upslope contributing LUs), agriculture, and rural residential development. These activities affect sediment delivery, hydrology, wood supply, and other processes. The condition of processes within this LU also contribute to downstream valley bottom LU habitats and are likely to affect the amount of fine sediment delivery, the amount of wood delivery, and water temperatures in downstream areas.

3.5 Target Fish Use

This LU contains small amounts of Chinook salmon critical habitat in Silver Creek, Muddy Fork, and mainstem Cowlitz River upstream of the Muddy Fork. Coho salmon and steelhead critical habitat is more widespread, including larger portions of tributaries such as Kiona Creek, Silver Creek, Johnson Creek, Skate

Creek, and Muddy Fork in the Upper Cowlitz basin, and Quartz Creek, Iron Creek, and Woods Creek in the Cispus basin. The USFS has identified lower Iron Creek and Woods Creek as having good potential to support salmon and steelhead (Ken Wieman, personal communication 2019).

3.6 Habitat Patch Connectivity

This LU represents a large portion of the fish-bearing tributary habitat in the study area, and therefore likely provides important spatial diversity for upper Cowlitz fish populations. Tributary habitat and processes within this LU also affect salmon and steelhead production in downstream areas. Conditions within this LU are therefore important for protection and restoration.

3.7 Management Plans, Past Studies, Projects

Federal forest lands, which make up approximately half of the LU, are managed according to the land use allocations in the NWFP. Much of the other half of the LU is private timber land, for which forest practices are governed by the WA DNR forest practices regulations (see Section 4.4 in the main report). There is very little agricultural use and only a small amount (<5%) of rural residential land in this LU. Streams and wetlands in the non-forest and non-agricultural areas are regulated through various existing management frameworks. These include protections for Waters of the US (would primarily be wetlands in this LU), administered through the WA Department of Ecology and US Army Corps of Engineers. For other shoreline areas, land use practices are governed by the Lewis County Shoreline Master Program, which regulates uses that affect riparian zones, wetlands, aquifer recharge areas, frequently flooded areas, wildlife habitat conservation areas, and geologically hazardous areas.

3.8 Landownership

The lands within the Lower Hillslopes LU are approximately half public ownership (51.6%) and half private ownership (48.4%). The lands within the Lower Hillslopes LU are approximately half public ownership (51.6%) and half private ownership (48.4%). Much of the eastern portion of this LU is National Forest and much of the western portion is private land with agriculture, rural residential, and forestry uses.

Figure 1. Representative images from the Lower Hillslopes LU. A: Private forest land adjacent to the Cowlitz River, B: Greenhorn Creek, a tributary to the Cispus River.

4 Upper Cowlitz – Muddy Fork Avulsion-Affected

4.1 Location Description

Cowlitz River Valley Bottom RM 132.5 – 128.2; previous (pre-2006) Muddy Fork confluence to grade break near Butter Creek confluence.

4.2 Overview

This area is affected by the high bedload generated from the 2006 Muddy Creek Avulsion and is still in a period of rapid adjustment. This LU is characterized by a relatively high road density (6.6 mi/ mi^2), but there also appears to be considerable upland restoration (i.e., road decommissioning, thinning, etc.) that may be addressing these limitations.

4.3 Historical Conditions

This LU, located just downstream of an alluvial fan and the confluence of the Muddy Fork Cowlitz and the Clear Fork Cowlitz likely has always been a dynamic area. There have been periodic changes in this area, however, based on the recent air photo record, in the decades prior to the 2006 avulsion, this area was less dynamic. Past lahars and other large mass wasting events originating from the slopes and glaciers of Mount Rainier have periodically affected this area since the last ice age, most originating from the Muddy Fork. Large in-channel wood would have provided structure to support island braided planform, and would have increased instream habitat complexity.

Ecological Indicators – Upper Cowlitz Muddy Fork	
Indicator	**Description**
Natural vs. Human Disturbance	**Functional to Moderately Impaired** Natural flood, bedload, and debris flood pulse disturbance originating primarily from the Muddy Fork related to glacial meltwater and moraine collapse events from Mount Rainier (Cowlitz and Ingraham Glaciers). Primary human disturbance is related to flood protection (levees, bank armoring, large wood removal)
Hydrologic Alteration	**Functional to Moderately Impaired** Minor impacts primarily related to flow diversion out of Lake Creek (Packwood Hydro diversion from Packwood Lake) that reduces flow in Lake Creek. Climate change impacts are likely to increase future flood events related to glacial melt and related moraine collapse on the mountain. IWA Rating "Functional" for upstream contributing area.

Sediment Processes	**Functional to Moderately Impaired** This area is affected by the high bedload generated from the 2006 Muddy Fork Avulsion. It is still in a period of adjustment. Significant aggradation occurred during and immediately following the avulsion. This avulsion and subsequent aggradation and lateral channel adjustment is believed to be mostly a natural process. Bank armoring limits recruitment of sediment from banks and therefore limits exchange of sediment and natural adjustment processes. IWA Rating "Moderately Impaired" for upstream contributing area.
Large Wood Processes	**Moderately Impaired to Impaired** Abundant recruitment of trees and development of log jams related to the Muddy Fork avulsion. However, many trees and jams were removed following this and other events. There is not much wood in the low flow channel. Most is high on the floodplain as well as on high in-channel bars. Historically, larger wood would have been more abundant and more stable and more engaged with the channel year-round
Channel Type and Form	**Moderately Impaired** Currently braided. Likely alternates from Island Braided to Braided depending on time since last flood/debris event from Mt Rainier. Beechie & Imaki (2014) predicted type is Island Braided. Currently it is mostly braided, with a few islands. Past timber harvest and smaller available wood and levees/armoring likely trends site to braided more than island braided.
Floodplain Connectivity	**Moderately Impaired** Connectivity is relatively high, due to aggradation of material sourced from the avulsion. The channel bed elevation is high overall in relation to the floodplain. However, floodplain connectivity has been reduced in many areas due to levees.
Lateral and Vertical Channel Dynamics	**Moderately Impaired** Aggradation and resulting lateral channel adjustment eroded out homes in the High Valley community following the 2006 avulsion. In the years since, it appears the channel has downcut into the aggraded coarse bedload at the upstream end, with material continuing to move downstream and creating continued channel adjustment downstream during floods. Armoring and levees in many areas, and past wood cleanouts limits lateral adjustment, which has resulted in the fair rating for this indicator.
Off-Channel Habitat Connectivity and Refugia	**Moderately Impaired** Multiple thread channel. But steep and high velocity overall. Not much for quiescent backwater-type habitat; although likely there is some present at moderately high flows that inundate downstream portions of high flow braids. There is likely limited availability of low velocity areas during large floods with all braids activated. Wall-based channels and backwater channels along margins would have historically provided more of this habitat. Armoring and development has cut off this type of habitat.

Riparian Processes	**Moderately Impaired to Impaired** Riparian areas were historically clear-cut, then developed for residential/vacation homes. In many areas, bank armoring degrades bank and riparian vegetation. No late seral stage vegetation is left in the area. Even where there is robust second growth timber, it is not of sufficient size to provide the large structure of standing and recruited trees that would have been provided historically, and would have had much more of an effect on channel form and habitat.

4.4 Contributing Process Drivers

From upstream – This LU is highly affected by flood/debris events from upstream LUs, in particular from Mount Rainier, and from avulsions around the confluence of the Muddy and Clear Forks, which will continue into the future. Inputs of large wood are contributed from upslope as well. Fine glacial sediments are contributed from the Muddy Fork.

To downstream – The coarse bedload pulse from the 2006 avulsion is continuing to move downstream. It is currently contributing smaller material (gravels/cobbles) to downstream LU, likely with coarser material and an increase in gradient moving downstream over time.

From tributaries – Flood and debris events from tributaries have been and will continue to be significant. Particularly from Coal Creek and Butter Creek, and less from Lake Creek due to the moderating influence of Packwood Lake. Wood and sediment recruitment needs are being considered in the new Packwood Hydroelectric Management Plan (Ken Wieman, USFS, personal communication 2019).

To tributaries – Aggradation of the mainstem bed will cause greater backwatering and therefore aggradation of lower portions of tributaries.

4.5 Target Fish Use

Within this LU, the mainstem Cowlitz River appears to be the primary area used by target species for spawning and rearing, based on EDT output (MBI, 1999). This highly dynamic reach is still recovering from the Muddy Fork avulsion. Relatively frequent and rapid vertical and lateral adjustments to the avulsion likely reduces suitability as spawning habitat. Additional potentially important zones for target species include lower reaches of numerous tributaries that were not included in EDT Tier 1 or Tier 2 reaches, such as Lake Creek and Hinkle Tinkle Creek. Coho salmon and steelhead may utilize lower reaches of these or other tributaries, where spawning gravels are able to aggrade and rearing habitat is more abundant, for spawning (McIntosh et al., 1990).

Chinook Salmon critical habitat in this LU is contained in the mainstem Cowlitz River and Muddy Fork. Coho Salmon and steelhead critical habitat is contained in those same mainstem areas, and also in lower tributary reaches such as Coal Creek, Hinkle Tinkle Creek, and Lake Creek.

4.6 Habitat Patch Connectivity

This LU is a transition zone, from steep headwater systems (Clear and Muddy Forks) to much flatter valley bottom areas. It will be important to maintain habitat in this LU at least as viable migration corridor to upper Clear Fork and Ohanapecosh system.

4.7 Management Plans, Past Studies, Projects

Given the recent debris flow and flooding generated from the 2006 avulsion, there have been various recent studies and projects in this LU. Recent studies have been prepared for Lewis County, including a flood hazard risk assessment (NRCS, 2009), a channel migration study (GeoEngineers, 2003 and 2009), and the July 2006 FEMA flood insurance study. The flooding related studies suggest that throughout this area there continues to be risk of additional flooding and bank erosion, including additional potentially catastrophic events. A further report (Cardno, 2014) provides recommendations for potential protection/preservation opportunities.

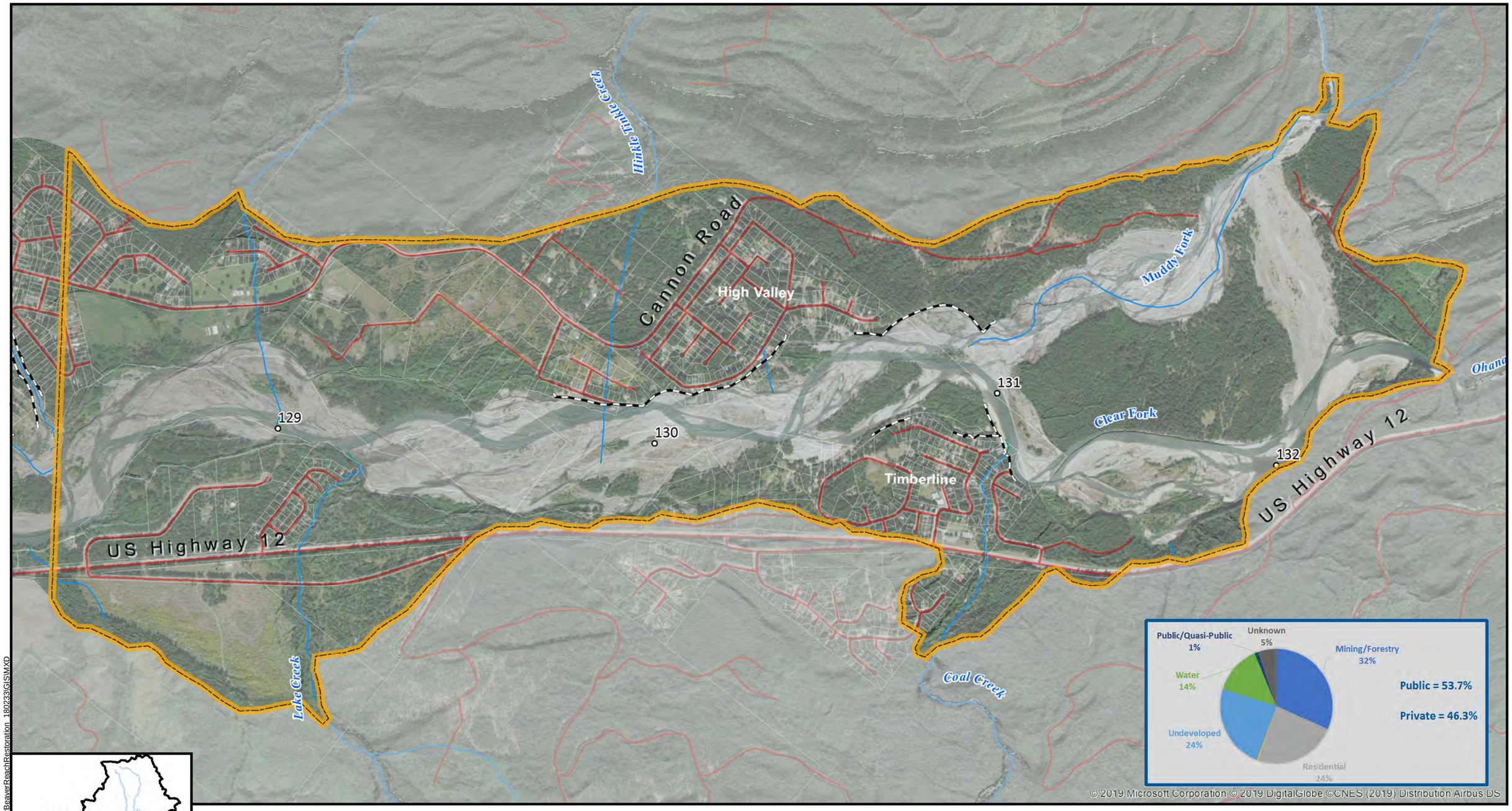
There have been several river projects in this LU, mostly related to flood hazard protection. These include armoring (e.g., riprap) in several locations, and some more fish-friendly armoring where large wood has been incorporated into armored banks (see Figure 2 for an example). NRCS (2009) documents flood protection projects constructed in the 1970s and the 1990s. Recent and ongoing revetment are working to protect existing structures.

Figure 2. Recent bank stabilization project with large wood and riprap at RM 131.5 (Timberline community).

4.8 Landownership

This LU is nearly 50% privately owned, including communities of Timberline and High Valley.

Figure 3. Representative images from the Cowlitz - Muddy Fork Avulsion-Affected LU. A = Upstream view of broad braid-plain from Muddy Fork avulsion. B = Long riprap along High Valley community. C = Example of abundant large cobble bars with large wood deposits. D = Example of well-connected floodplain forest with active recruitment of riparian trees.



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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 800 1,600 3,200 Feet

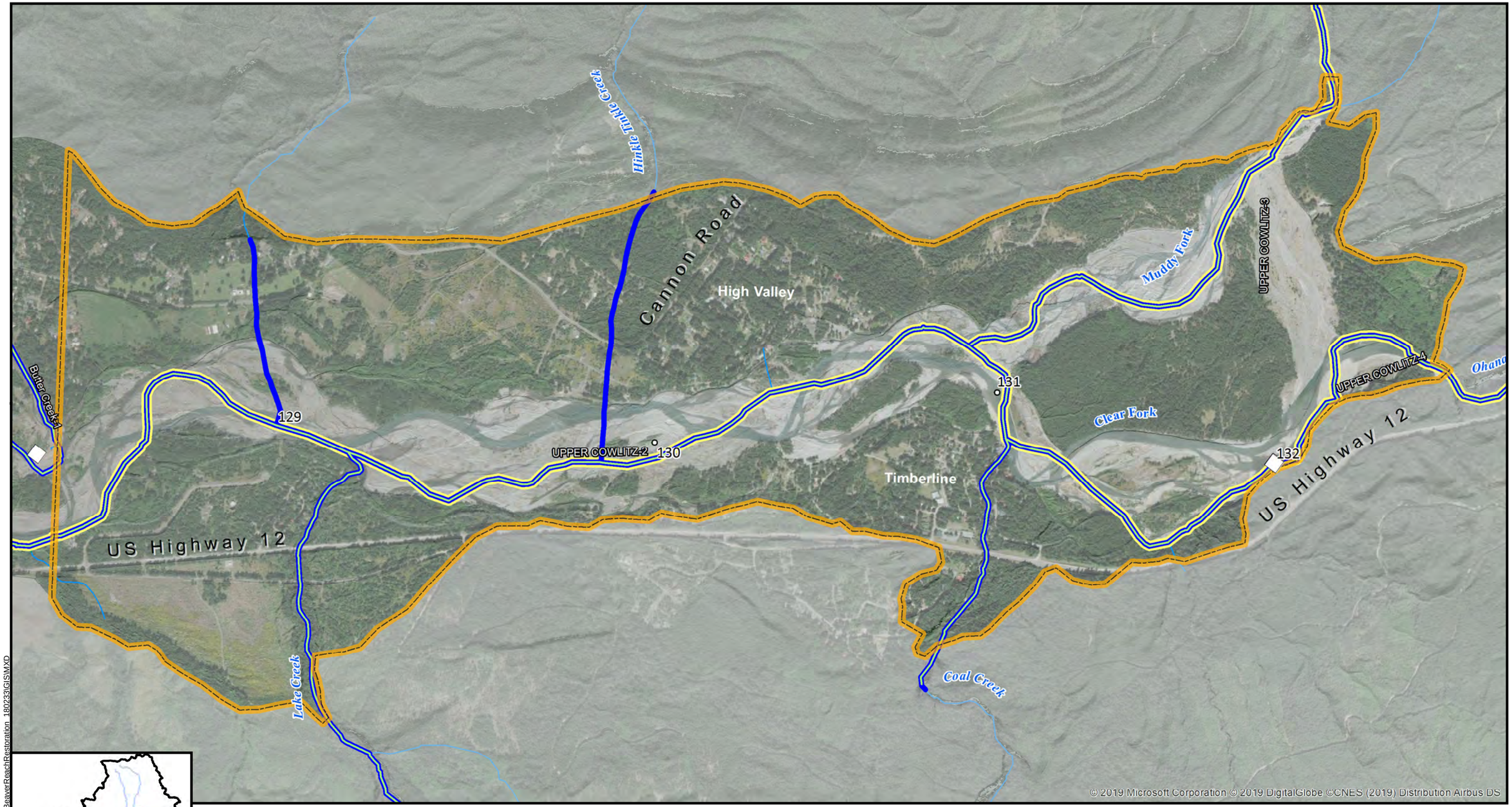
Landscape Unit Boundary
Parcel Boundaries
River Miles
Levee and/or Armoring
Roads

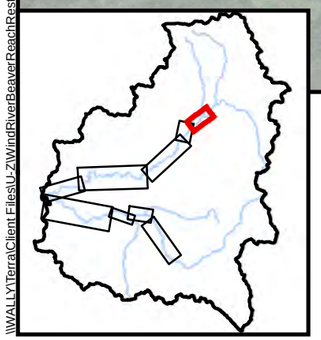
Landscape Unit Overview

Landscape Unit:

Upper Cowlitz - Muddy Fork

Upper Cowlitz-Cispus Community-based Habitat Strategy Development





*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 800 1,600 3,200 Feet

Landscape Unit Boundary
Recovery Plan Reach Breaks
River Miles

Species Distribution
Chinook Salmon
Coho Salmon
Steelhead Trout
Potential Barriers

Landscape Unit - Fish Distribution

Landscape Unit:

Upper Cowlitz - Muddy Fork

Upper Cowlitz-Cispus Community-based Habitat Strategy Development

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5 Upper Cowlitz – Packwood

5.1 Location Description

Cowlitz River Valley Bottom RM 128.2 – 125.5; grade break near Butter Creek confluence to Skate Creek.

5.2 Overview

This LU is flatter gradient than the upstream LU and not yet under as much influence by the coarse bedload aggraded from the 2006 Muddy Fork avulsion. There is a high degree of residential development in this segment, as it goes through the town of Packwood, which lies within the FEMA-designated 100-year floodplain. This high degree of habitation is reflected by the road density (7.2 mi/ mi^2), which is the greatest within the Upper Cowlitz. There are developed high glacial terraces (and some bedrock hillslope features) on the south/east side that are not at risk of flooding, but there are also low developed floodplain surfaces on both sides that are at risk. Substantial upland restoration projects have been completed that may benefit this LU. Floodplain development, flood protection projects (armoring/levees), and the Skate Creek Bridge affect processes and habitat. This LU includes lower Butter Creek and lower Skate Creek.

5.3 Historical Conditions

Historically this LU was likely island braided (Beechie & Imaki, 2014). Historical large forest stands and large in-stream wood would have provided high quality habitat and relative stability to island braided system, with changes occurring infrequently in response to pulse flood/debris disturbance. Abundant abandoned oxbows would have been accessible by fish for productive rearing and flood refuge.

Ecological Indicators – Upper Cowlitz Packwood	
Indicator	**Description**
Natural vs. Human Disturbance	**Moderately Impaired** Flooding impacts in the river corridor is moderated by revetments and human features.
Hydrologic Alteration	**Functional** Climate change is likely to increase flood and debris flow events related to glacial melt and related moraine collapse on the mountain. There is also the potential for larger late fall through early spring floods related to more precipitation falling as rain rather than snow. IWA Rating “Functional” for upstream contributing area.

Sediment Processes	**Moderately Impaired to Impaired** Sediment dynamics have been altered due to channel confinement in the mainstem and in the Butter Creek tributary. Sediment transports more readily through the reach now than historically due to these confinements. The Butter Creek fan has been truncated by confining levees on both sides. This channel now more readily transports coarse bedload into the reach and extends the fan further out into the mainstem, which may also reduce lateral channel dynamics on the mainstem as a result. Coarse bedload from upstream of the Muddy Fork avulsion will continue to work its way downstream from the upstream LU. IWA Rating "Functional" for upstream contributing area.
Large Wood Processes	**Impaired** There is a lot of wood but little is engaged with the channel except at high flows. Wood appears to be rapidly re-distributed with each high flow event; whereas historically jams comprised of very large pieces would have been expected to remain stable over longer periods. There are occasional areas with good margin wood where the stream is meandering into mature forests and recruiting wood pieces. However, this wood is second growth, and provides much less structure than it may have historically where channel migration would occasionally result in recruitment of very old and large trees.
Channel Type and Form	**Moderately Impaired to Impaired** Channel type is braided. Beechie & Imaki (2014) predicts island braided, and it has likely changed from historically island braided to more braided. Island braided form would have been supported by large apex jams that protect sediments and allow for forest growth. Now there is less forested margin habitat.
Floodplain Connectivity	**Impaired** Floodplain connectivity is affected by development and levees/armoring, particularly on river-right RM 127.5 – 128. Channel incision related to armoring and to the Skate Creek Road Bridge also reduces floodplain connectivity. The town of Packwood and surrounding areas are within the FEMA-delineated 100-year floodplain, potentially leading to future armoring and reductions in connectivity and/or impacts to existing landowners.
Lateral and Vertical Channel Dynamics	**Impaired** Lateral connectivity is affected by a levee near RM 128 and development on the low floodplain surface on the river-right near RM 127.5, which prevents re-occupation of channel into large abandoned oxbow. Although the Skate Creek Bridge is located in an area of relatively more natural confinement compared to other areas in the LU, the bridge and upstream and downstream armoring nevertheless fixes the channel in place, causing channel incision and reduction in lateral dynamics. There are old secondary channels that have been cut off by the bridge approach fill.
Off-Channel Habitat Connectivity and Refugia	**Moderately Impaired to Impaired** Some off-channel habitat is available in this LU but it is limited by human features. There is an abandoned oxbow where Butter Creek now enters, an oxbow downstream on river right near RM 127.5. Additional, smaller off-channel features exist, but are affected by development, bank armoring, and levees to various degrees. Skate Creek Bridge reduces future creation and connectivity to lateral habitats.

Riparian Processes	**Moderately Impaired to Impaired** Riparian areas were historically clear-cut, then developed for residential homes. In some areas, bank armoring degrades bank and riparian vegetation. No late seral stage vegetation is left in this LU. Even where there is robust second growth timber, it is not of the size to provide the large structure of standing and recruited trees that would have been provided historically. These larger trees would have had much more of an effect on channel form and habitat.

5.4 Contributing Process Drivers

From upstream – The pulse of coarse bedload coming from upstream LU derived from 2006 Muddy Fork avulsion is present in this LU and impacting physical processes. Fine, glacial meltwater sediment is contributed from upstream which increases turbidity.

To downstream – Incision related to Skate Creek Bridge has upstream and downstream effects on vertical and lateral channel dynamics.

From tributaries – There are contributions of coarse bedload from Butter Creek to the mainstem, which may extend this tributary fan farther into mainstem.

To tributaries – Butter Creek now flows into an abandoned oxbow, providing potential off-channel habitat fed by clear-water source. Tributaries that enter abandoned oxbows have less connectivity to mainstem than they would have historically due to less connectivity to these oxbow features.

5.5 Target Fish Use

Within this LU, the mainstem Cowlitz River appears to contain important high flow refuge rearing habitat—although habitat capacity is likely lower than historical conditions due to human alterations—plus some spawning habitat. In addition, tributaries such as Butter Creek, Skate Creek and the upper reaches of Hall Creek within this LU historically supported steelhead and coho salmon spawning and rearing, with the highest quality rearing habitat in the downstream alluvial sections where floodplain habitats and pools are more frequent (McIntosh et al., 1990). Upper Skate Creek appears to offer potential for high quality habitat for all three target species, and substantial restoration has been completed in this zone.

Chinook Salmon critical habitat in this LU is contained only in the mainstem Cowlitz River. Coho Salmon and steelhead critical habitat is contained in the mainstem Cowlitz as well as Skate Creek, Butter Creek, and upper Hall Creek.

5.6 Habitat Patch Connectivity

As with the downstream LU, there is good potential to restore an island braided system. Achieving this here in combination with downstream LU would provide a significant portion of restoration of river form and process that would support a complex array of aquatic habitat throughout the upper valley. Restoring this reach would also support potential restoration of the lower portions of two primary tributaries, Butter Creek and Skate Creek.

5.7 Management Plans, Past Studies, Projects

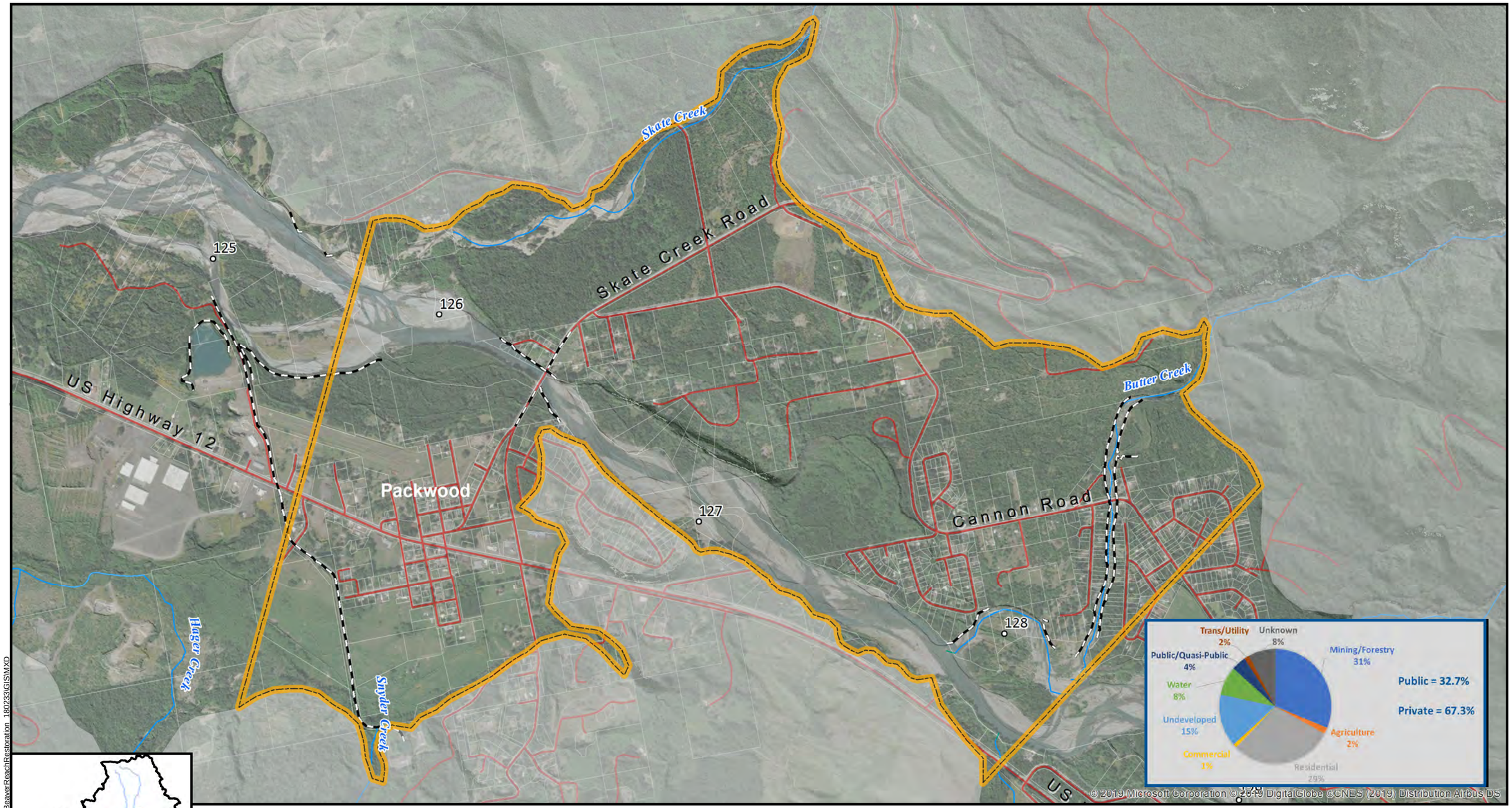
The studies developed for Lewis County after the Muddy Fork avulsion include this LU. The NRCS (2009) report describes potential risk to the Skate Creek Bridge from racked large wood. The GeoEngineers (2003 and 2009) reports describe the CMZ in this region, including an observation of bank recession from 1999-2007 (approximately at RM 127). This LU corresponds to "Cowlitz 10" reach for protection recommendations (Cardno, 2014).

Various river projects have occurred in this LU, primarily connected to bank armoring. Some actions include pieces of large wood to provide some edge fish habitat benefit.

5.8 Landownership

This LU is 67% privately owned, with a relatively high degree of residential development (nearly 30%, the greatest of any LU), as it goes through the town of Packwood. The town of Packwood and surrounding areas are within the FEMA-delineated 100-year floodplain, and significant flood risk still exists, particularly to neighborhood in floodplain river-right RM 127.

Figure 4. Representative images from the Cowlitz-Packwood LU. A = typical broad flat gravel and cobble bar. B = houses high on south bluff in Packwood area. C = Riprap and large wood bank protection structure on south bank upstream of Skate Creek Bridge. D = Skate Creek Bridge and riprap extending up- and downstream.



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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

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0 900 1,800 3,600 Feet

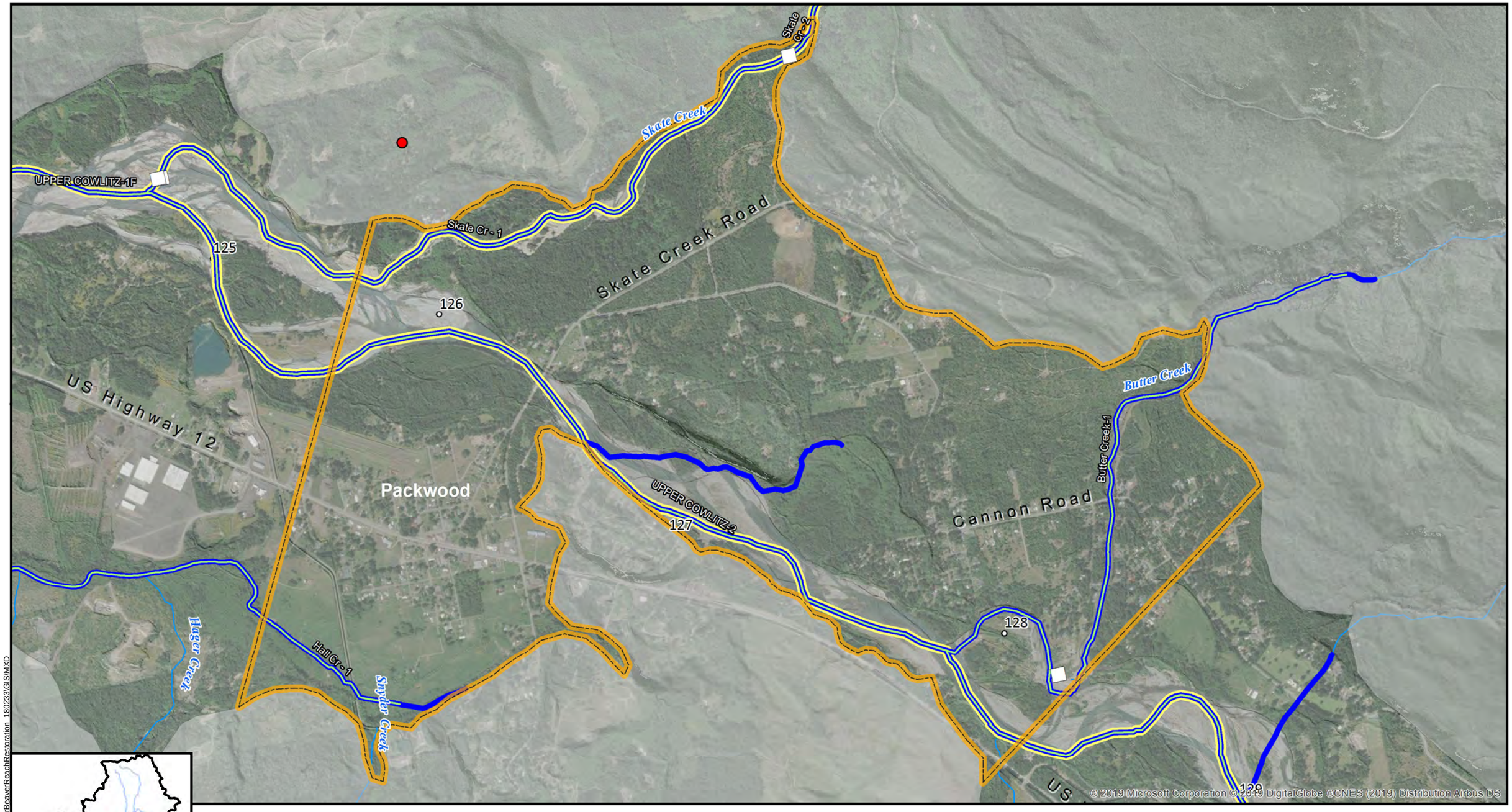
Landscape Unit Boundary
Parcel Boundaries
River Miles
Levee and/or Armoring
Roads

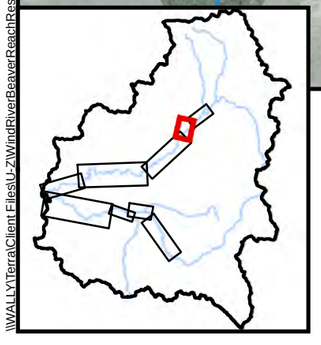
Landscape Unit Overview

Landscape Unit:

Upper Cowlitz - Packwood

Upper Cowlitz-Cispus Community-based Habitat Strategy Development





*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

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Landscape Unit Boundary

Recovery Plan Reach Breaks

River Miles

Species Distribution

Chinook Salmon

Coho Salmon

Steelhead Trout

Potential Barriers

Landscape Unit - Fish Distribution

Landscape Unit:

Upper Cowlitz - Packwood

Upper Cowlitz-Cispus Community-based Habitat Strategy Development

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6 Upper Cowlitz – Mid-Valley

6.1 Location Description

Cowlitz River Valley Bottom RM 125.5 – 116.4; Skate Creek to Cora Bridge (Hwy 12).

6.2 Overview

Sparsely developed broad alluvial valley. Occasional impairments related to houses and human confinement features, including a moderate road density (3.9 mi/ mi^2). Naturally confined short segment halfway through LU near Johnson Creek confluence. Includes lower Johnson Creek, lower Hall Creek, and lower Wilhelm Creek.

6.3 Historical Conditions

Historical photos, landscape features, and Beechie & Imaki (2014) modeling suggest this segment historically was likely a complex island braided system with multiple channels, abundant abandoned oxbows/wetlands, and large log jams. Floodplain and riparian areas were heavily forested prior to clearing for agriculture.

Ecological Indicators – Upper Cowlitz Mid-Valley	
Indicator	**Description**
Natural vs. Human Disturbance	**Moderately Impaired** Flooding impacts in the river corridor is moderated by revetments and human features.
Hydrologic Alteration	**Functional** There is a minor alteration related to return flow from the Packwood Lake Hydroelectric Project diversion, which enters at river-left at upstream end of LU. Future climate change impacts are likely to increase flood events. IWA Rating “Functional” for upstream contributing area.

Sediment Processes	**Functional to Moderately Impaired** There is a high bedload supply from upstream, which is dominated by gravels and cobbles. Banks are composed primarily of coarse alluvium. Bedload supply is expected to continue to be high as pulse of coarse bedload continues to move down from upstream LUs from the Muddy Creek avulsion and the associated lateral adjustment. There is a lack of instream structure from large wood jams that likely historically served to help aggrade bedload and allow for the growth of forested island complexes. IWA Rating "Functional" for upstream contributing area, suggesting low fine sediment inputs from the catchment.
Large Wood Processes	**Impaired** There is wood in many areas but not much of it is engaged with the channel except at high flows. Wood appears to be rapidly re-distributed with each high flow event; whereas historically jams comprised of very large pieces would remain stable over longer periods. There are occasional areas with good margin wood where the river is meandering into mature forests, but this recruited wood is second growth and provides much less structure than it may have historically where channel migration would occasionally result in recruitment of very old and large trees from the banks.
Channel Type and Form	**Impaired** Currently the channel is braided and single thread. Historical photos, landscape features, and Beechie & Imaki (2014) modeling suggest this segment was likely a complex Island Braided system with multiple channels. It has likely changed from historically Island Braided to more braided and single thread due to past clearing, reduction of large wood structure (standing riparian and in-stream), and human constraints on valley width. Island braided form would have been supported by large apex jams that protect sediments and allow for forest growth. Now there is less forested margin habitat.
Floodplain Connectivity	**Moderately Impaired** Floodplain connectivity is only occasionally affected by development and levees/armoring. There is likely incision at the downstream end related to the Cora Bridge.
Lateral and Vertical Channel Dynamics	**Functional to Moderately Impaired** There is natural confinement in the middle of the LU where the Johnson Creek fan and Skyo Mountain converge on the mainstem. There are few human confining features. There is the airstrip and nearby pond and the Packwood Lake Hydroelectric Project return flow ditch river-left near RM 125. There are a couple of houses with bank armoring river-right near RM 125. There is old armoring/levee river-left RM 120. There is a washed-out road and houses river-left RM 118.5. There is armoring associated with Cora Bridge at downstream end. There is armoring along lower Johnson Creek.

Off-Channel Habitat Connectivity and Refugia	**Functional to Moderately Impaired** There is good existing off-channel habitat but it likely pales in comparison to historically abundant floodplain oxbows, wetlands, and spring-fed wall-based systems. There are many opportunities to improve existing habitat and reconnect lateral habitats would potentially include temperature refuge for juvenile salmonids during the summer.
Riparian Processes	**Moderately Impaired to Impaired** Riparian areas were historically clear-cut and many floodplain areas are still in commercial timber production. Some areas have been developed for rural residential homes. In some areas, bank armoring degrades bank and riparian vegetation. No late seral stage stands are left in the LU. Even where there is robust second growth timber, it is not of the size to provide the large structure of standing and recruited trees that would have been provided historically, and would have had much more of an effect on channel form and habitat.

6.4 Contributing Process Drivers

From upstream – Coarse bedload will continue to work downstream from upstream avulsions and flood/debris pulses, but this reach is in relatively good equilibrium with its sediment supply.

To downstream – Incision of downstream LU, combined with past channel clearing of large wood, and confinement in this LU, has possibly extended higher slope and coarser bedload transport downstream into downstream LU.

From tributaries – Hall Creek provides clear water. Johnson Creek provides coarse bedload. Johnson, Wilhelm, and possibly others provide occasional debris flow inputs. Hall Creek provides non-glacial but tannin-heavy water. Hall Creek water quality may be impaired downstream of rural residential areas within the valley bottom.

To tributaries –Channel bed elevation is being maintained in the mainstem via high bedload supply. This supports habitat and connectivity in lower portions of tributaries.

6.5 Target Fish Use

Historically, this reach would have had greater complexity and off-channel habitat availability to support juvenile rearing, as suggested by Beechie & Imaki (2014) modeling efforts. In addition to mainstem habitat, numerous non-EDT Tier 1 or 2 tributaries appear to support target salmonids. For example, Willame Creek contains spawning gravels in the lower portion within the flat Cowlitz River valley, although accessible habitat ends at several falls a short distance upstream. Johnson Creek similarly has the highest potential to support target species spawning and rearing in lower reaches, as the upper creek is in a deep canyon (McIntosh et al., 1990). In addition, Garret, Burton, Dry, and Smith Creeks all appear to support anadromous salmonid production, as evidenced by observations documented within the WDFW SalmonScape database.

Chinook salmon critical habitat in this LU is contained in the mainstem Cowlitz River. Coho salmon and steelhead critical habitat is contained in the mainstem Cowlitz River, and several tributaries such as Hall Creek, Johnson Creek, Smith Creek, Willame Creek, and Burton Creek.

6.6 Habitat Patch Connectivity

This is a transition zone from higher gradient braided/island braided system to lower gradient highly sinuous system. This LU has the greatest potential to re-create island braided type habitat, and so should be viewed as an important linkage between upstream and downstream units.

6.7 Management Plans, Past Studies, Projects

The Lewis County channel migration study (GeoEngineers, 2003 and 2009) describes this area as "braided river section" and notes areas of localized erosion, but does not identify any major additional hazards in this area. The Cardno (2014) protection report includes the following reaches within this LU: Cowlitz 9 (Skate Creek), Cowlitz 8, Cowlitz 7a and 7b (Smith Creek), Cowlitz 6, and Cowlitz 5. Bank revetments have been installed in this area.

6.8 Landownership

Landownership in this LU is greater than 75% privately owned. This area includes less development than the two upstream LUs, however there are residential and agricultural land uses throughout the area.

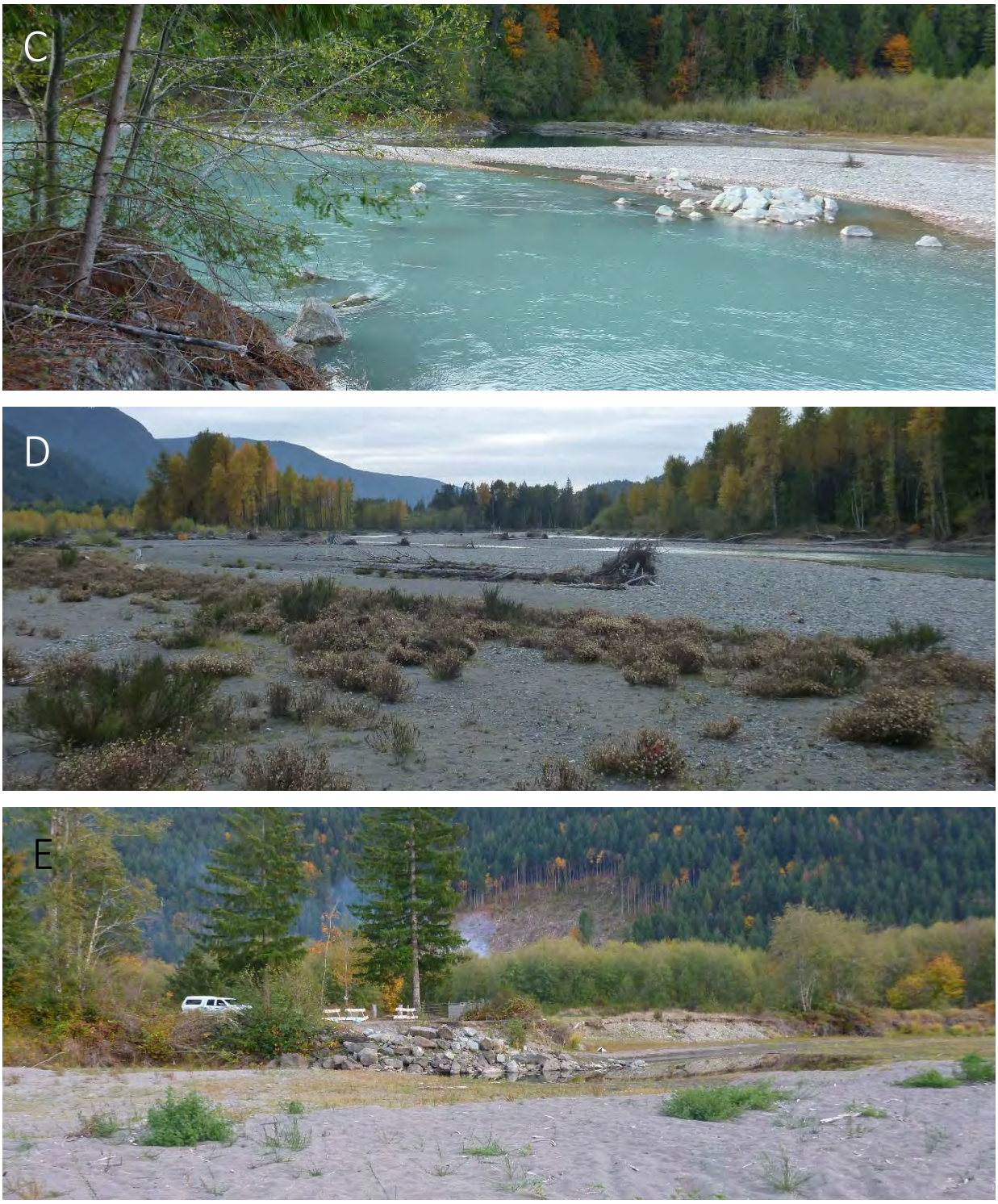
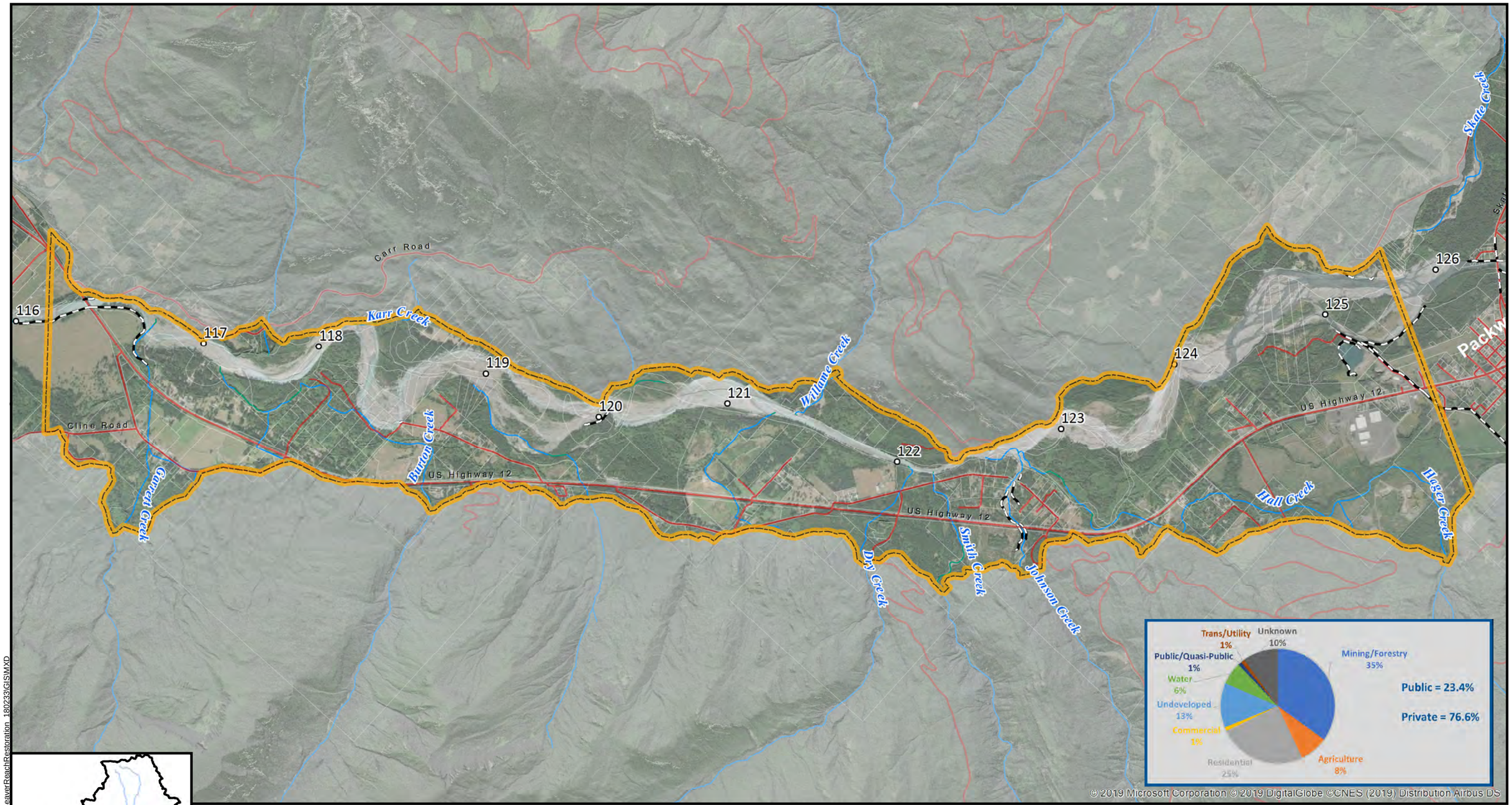


Figure 5. Representative images from the Cowlitz-Mid-Valley LU. A = riprap bank protecting houses river-right near RM. B = broad braid-plain typical of this reach (near RM 123). C = riprap failing into channel near RM 120. D = Elements of island-braided system downstream of RM 120. E = road washout (and now rock barb protection) river-left near RM 118.5.



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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 1,750 3,500 7,000 Feet

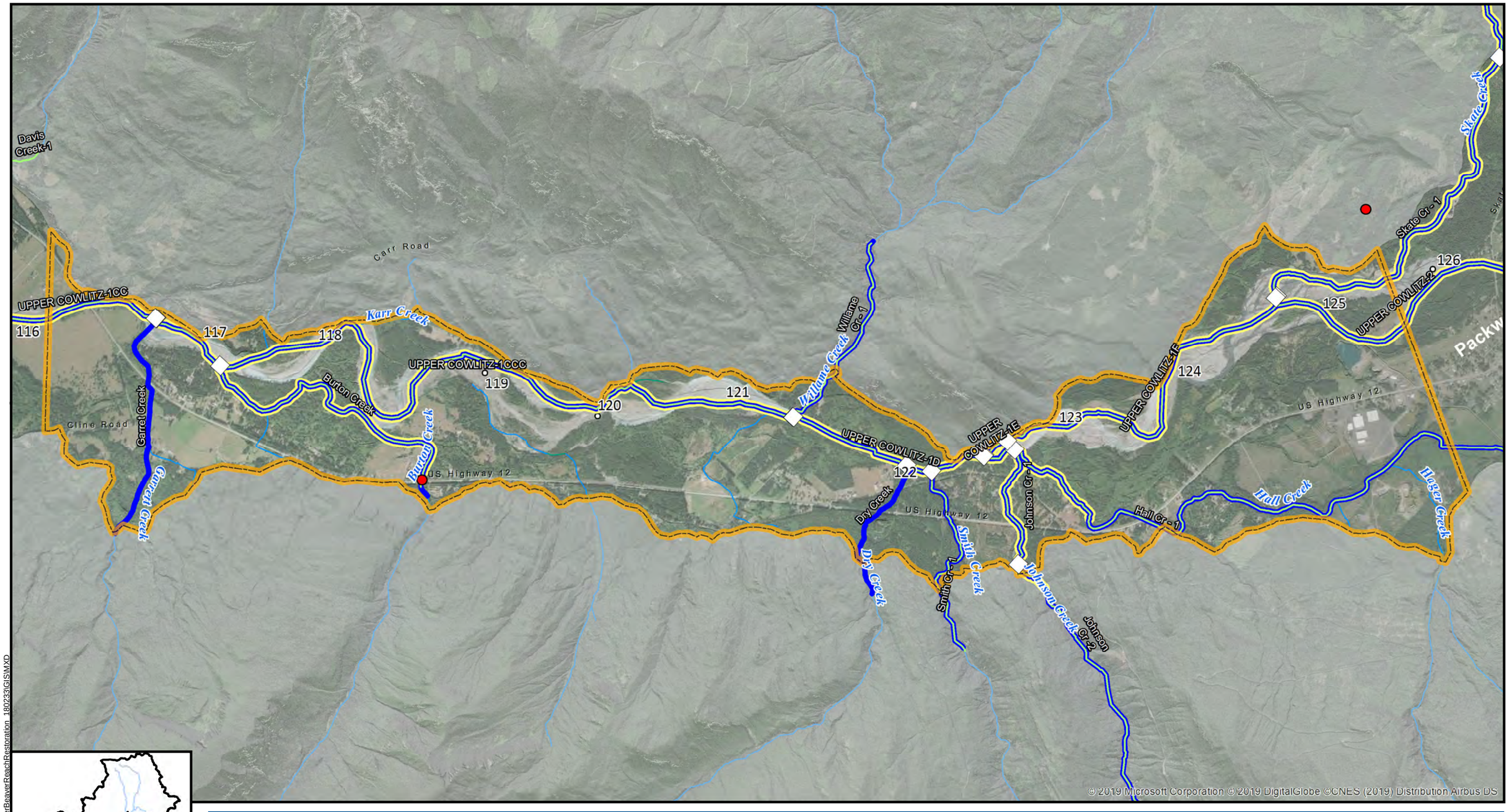
Landscape Unit Boundary
Parcel Boundaries
River Miles
Levee and/or Armoring
Roads

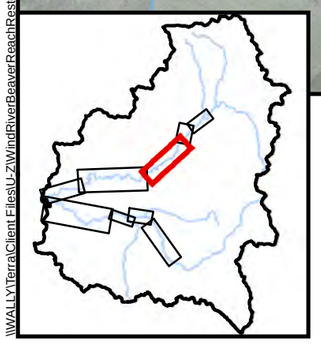
Landscape Unit Overview

Landscape Unit:

Upper Cowlitz - Mid-Valley

Upper Cowlitz-Cispus Community-based Habitat Strategy Development





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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 1,750 3,500 7,000 Feet

- Landscape Unit Boundary
- Recovery Plan Reach Breaks
- River Miles

Species Distribution

- Chinook Salmon
- Coho Salmon
- Steelhead Trout
- Potential Barriers

Landscape Unit - Fish Distribution

Landscape Unit:

Upper Cowlitz - Mid-Valley

Upper Cowlitz-Cispus Community-based Habitat Strategy Development

7 Upper Cowlitz – Randle

7.1 Location Description

Cowlitz River Valley Bottom RM 116.4 – 97.7; Cora Bridge (Hwy 12) to Scanewa Backwater.

7.2 Overview

This area is characterized by a low gradient meandering channel that has cut down through glaciofluvial sediments. There have been substantial changes from historical conditions where much of the valley bottom would have regularly flooded. Widespread agricultural development, bank armoring, bridges, instream wood removal, riparian clearing, flood protection have all impacted instream habitat. This LU is characterized by moderate road density (4.8 mi/ mi^2).

7.3 Historical Conditions

Historically, this LU would have had a low gradient highly sinuous planform with tortuous meanders, flow splits and side channels, and abundant abandoned oxbows and floodplain wetlands. The channel planform would have adjusted slowly over time or rapidly as avulsions during large, infrequent floods. Large portions of floodplain would have likely flooded annually during spring run-off, and nearly all of valley bottom would have flooded during large infrequent floods. There would have been a broad age range of riparian and floodplain forests, ranging from new deciduous growth on newly formed bar surfaces to patches of late seral stage conifer forest. In the channel there would have been large, relatively stable log jams supported by very large key pieces.

Ecological Indicators – Upper Cowlitz Randle	
Indicator	**Description**
Natural vs. Human Disturbance	**Moderately Impaired to Impaired** Flood disturbance is now expressed differently on the landscape than under "natural" conditions. There are now more interactions of floodwaters (and associated erosion) with human property and infrastructure. These impacts, and the human responses to them, have altered this disturbance process; and generally results in an impairment of natural river processes and habitat as a result.
Hydrologic Alteration	**Functional** No significant withdrawals, regulation, or inputs. Future climate change impacts are likely to increase flood events. IWA Rating "Functional" for upstream contributing area.

Sediment Processes	**Impaired** Valley bottom is comprised of glaciofluvial sediments. Banks are high (5-12 feet). Bank stratigraphy is consistent throughout the LU, with the bottom quarter to half comprised of coarse bedload (gravels and cobbles) and topped with mostly fines, some small gravels, and some ash layers. In many areas, old buried logs and jams are being exhumed via bank erosion. Channel bedload is gravels and cobbles. Past vegetation clearing on banks and floodplain areas is speeding bank erosion and recruitment of bank material, which is high in fines. Sediment dynamics (scour, transport, deposition) is likely more active than it was historically. IWA Rating "Moderately Impaired" for upstream contributing area.
Large Wood Processes	**Moderately Impaired to Impaired** There are some very large accumulations of wood in this LU, both from recently transported wood and wood being exhumed from eroding banks. More wood is interacting with the low flow channel compared to upstream reaches, likely due to the exhumed wood on banks that is partially in the channel but that remains stabilized by partial burial. Observation of occasional large old pieces and stumps suggests that very large key pieces derived from late seral stage forests were once present and likely abundant. These likely served to stabilize large jams that would influence channel complexity, dynamics, and would help maintain high sinuosity and low gradient (e.g. Figure 7).
Channel Type and Form	**Moderately Impaired to Impaired** The channel type in this LU has likely been transformed from highly sinuous, multi-thread meandering to mostly single-thread, less sinuous meandering, with some braided channel features within the active channel. Beechie & Imaki (2014) modeling suggests that the upper half would have been island braided and lower half would have been meandering. Based on landscape features and historical maps and aerials, it is more likely that all of it was once highly sinuous meandering but with multiple channels.
Floodplain Connectivity	**Impaired** There is less floodplain connectivity in this LU than there was historically. Historically, floodplain inundation likely occurred annually during spring run-off, when large portions of the valley bottom would be inundated regularly, with nearly the entire valley bottom inundated during large, infrequent floods. Currently, annual floods are mostly contained within the active channel, with floodplain inundation occurring only during large floods, and with the entire valley bottom almost never inundated. This shift is likely related to channel incision, and possibly widening of the now active channel. These are in turn related to meander cut-offs and reduction in sinuosity as a result of widespread agricultural development of the valley bottom, channel confinement, channel armoring, and possibly stream cleanouts. Floodplain fill and development, including elevated roadways, has also cut off large portions of floodplain.

Lateral and Vertical Channel Dynamics	**Impaired** The channel is laterally active, with erosion now happening at a greater rate than historically, likely related to vegetation clearing and increased gradient (and lower sinuosity), which increases erosive energy. Channel is incised, and may be in a renewed period of aggradation following past incision, but this is difficult to quantify.
Off-Channel Habitat Connectivity and Refugia	**Moderately Impaired to Impaired** Well-connected off-channel habitats have been reduced from what were likely abundant off-channel features. There remain some connected side-channels, abandoned oxbows, and alcoves, but not much in the active low-flow channel. Flood refuge is likely available and possibly abundant, and would also be associated with some large wood complexes.
Riparian Processes	**Impaired** Most riparian areas in this LU were historically clear-cut, mostly to facilitate agricultural production and some likely for timber production. In some areas, bank armoring degrades bank and riparian vegetation. Very little to no late seral stage vegetation is left in the area. Even where there is robust second growth timber, it is not likely large enough to have the kinds of impacts to channel form and habitat that would have been seen with historical late seral stage wood.

Figure 6. Deeply buried wood being exhumed from river bank due to bank erosion near RM 110.

Figure 7. Large stump in channel near RM 113.

7.4 Contributing Process Drivers

From upstream – Possibly more coarse bedload is being delivered to the upper end of the LU from upstream compared to historically. This is due to channel incision increasing gradient at the upstream end of the LU, and rapid erosion of banks upstream and confinement at Cora Bridge.

To downstream – More fines and bedload are being delivered downstream due to more lateral erosion. There is currently less floodplain storage than historically, which likely affects the downstream LU by transporting more sediment to it.

From tributaries – The lower tributaries are affected by road crossings, development, and agriculture. Alluvial fans have been disconnected. There is likely more coarse bedload delivery, and greater fines delivery than historically. There may be water quality issues from agricultural practices, rural development, and urban development in and near Randle.

To tributaries – Incision likely has reduced channel bed elevations, potentially as much as 5-10 feet. Tributaries that enter abandoned oxbows have less connectivity to mainstem than they would have historically due to less connectivity to these oxbow features.

7.5 Target Fish Use

The mainstem Cowlitz River in this area historically would have provided abundant high-flow refugia areas in off-channel wetland, oxbows, and side channels. The mainstem Cowlitz within this area is likely still utilized by juvenile salmonids during high flows, however the capacity is likely reduced from historical conditions as the mainstem is incised from the floodplain. Numerous tributaries that may represent important—if small—pockets of spawning and rearing habitat, many of which are Tier 3 and 4 in EDT.

These include sections of Siler, Kiona, Hampton, Silver, Cunningham, and Davis Creeks, plus a few others. Notably, Kiona Creek historically contained high quality spawning habitat up-valley, with low gradient and abundant wetlands downgradient within the Cowlitz River valley that would have provided high-quality coho rearing habitat. Silver Creek appears to still contain high quality spawning and rearing habitat near the mouth (McIntosh et al., 1990); the approximate length of anadromy is 5 miles (Ken Wieman, USFS, personal communication 2019). while falls, roughly 3 miles from the mouth, limit fish migration into upstream reaches. Numerous additional tributaries (e.g., Surrey Creek, Owens Creek) likely historically contributed spawning and rearing habitat in their lower reaches, although their current capacity to support spawning and rearing appears reduced.

Chinook salmon critical habitat in this LU is contained in the mainstem Cowlitz River and Silver Creek. Coho salmon and steelhead critical habitat is contained in those same areas, and several tributaries including Kiona Creek, Davis Creek, Siler Creek, Peters Creek, and Oliver Creek.

7.6 Habitat Patch Connectivity

There are important patches within this segment that have relatively intact forested conditions. These are highlighted in the Cardno protection report (2014). Linking these patches with other high-quality habitat may be beneficial by increasing the connectivity of high-quality habitat.

7.7 Management Plans, Past Studies, Projects

The Lewis County channel migration study (GeoEngineers, 2003 and 2009) describes this as the "meander bend section". The most dramatic channel evolution in this reach has been at the River Ranch area just downstream of the Cora Bridge (at the upstream portion of this LU). In several places the CMZ includes portions of Highway 12. The proposed protection reaches Cowlitz 4, Cowlitz 3, Cowlitz 2 and Cowlitz 1 are included in this LU (Cardno, 2014). Bank stabilization projects have occurred in this reach, including the work along Highway 12 (Figure 8).

Figure 8. Bank stabilization adjacent to Highway 12 with barbs.

7.8 Landownership

The Randle LU is more than 85% privately owned, the second greatest proportion of private ownership of any LU. Land use is agricultural and rural residential, with concentrated developed areas near the town of Randle.


A


B

C

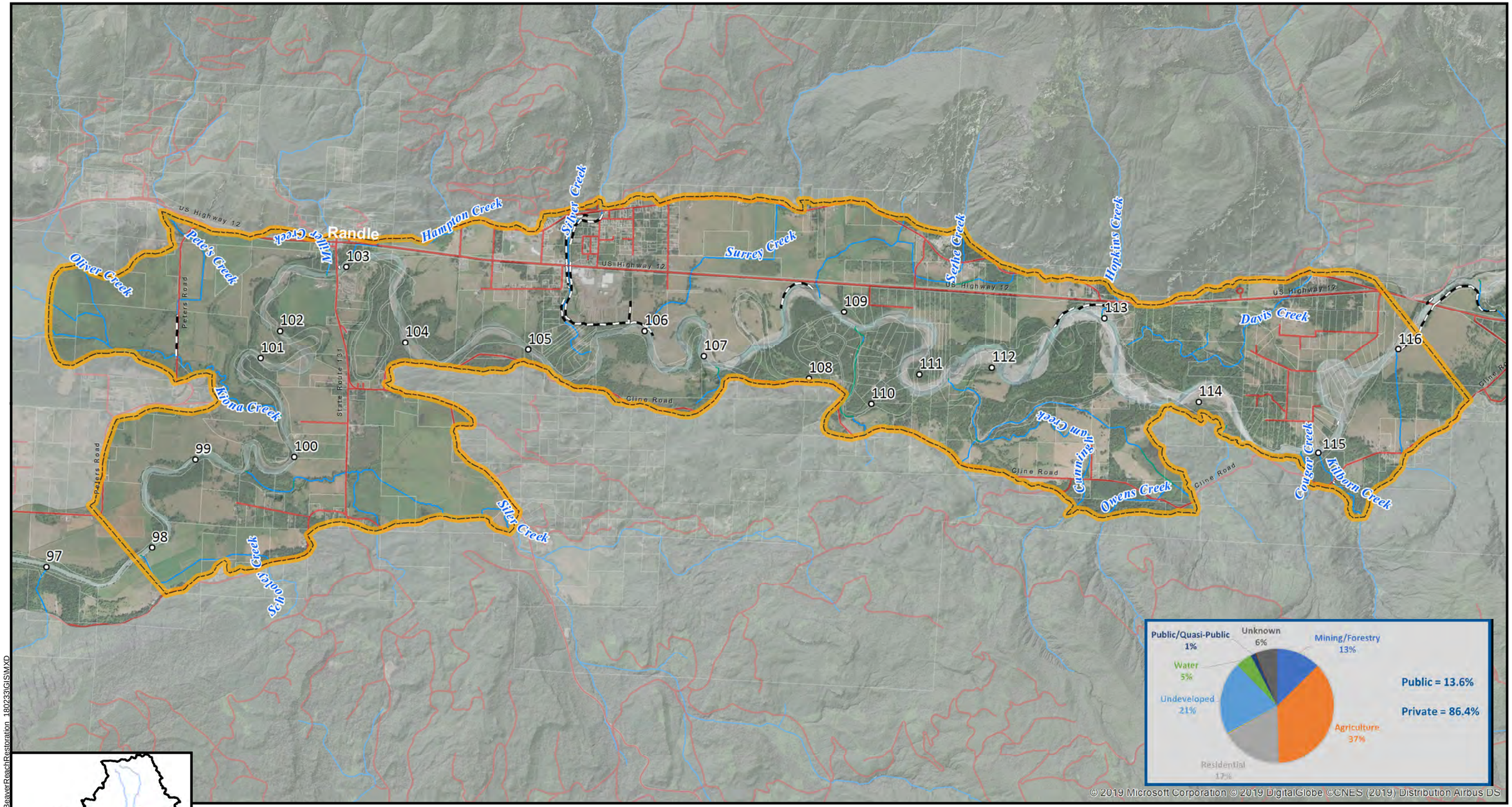
D


E


F


G

Figure 9. Representative images from the Cowlitz-Randle LU. A = old levee river-left downstream of Cora Bridge. B = typical of the high banks in the LU (near RM 115). C1 = Example of bank stratigraphy. C2 = close up of ash and charcoal layer. C3 = close up of tephra layer that is persistent throughout LU and believed to be from the St. Helens eruption in 1479. C4 = close up of charcoal layer that underlies the tephra layer in upstream portion of LU. D = giant log jam near RM 112. E = bank barbs for bank protection along highway near RM 108.5. F = recruited maple creating large jam near RM 107. G = riprap river-right upstream of mill. H = Siler Creek. I = across from Kiona Creek mouth.



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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 2,300 4,600 9,200 Feet

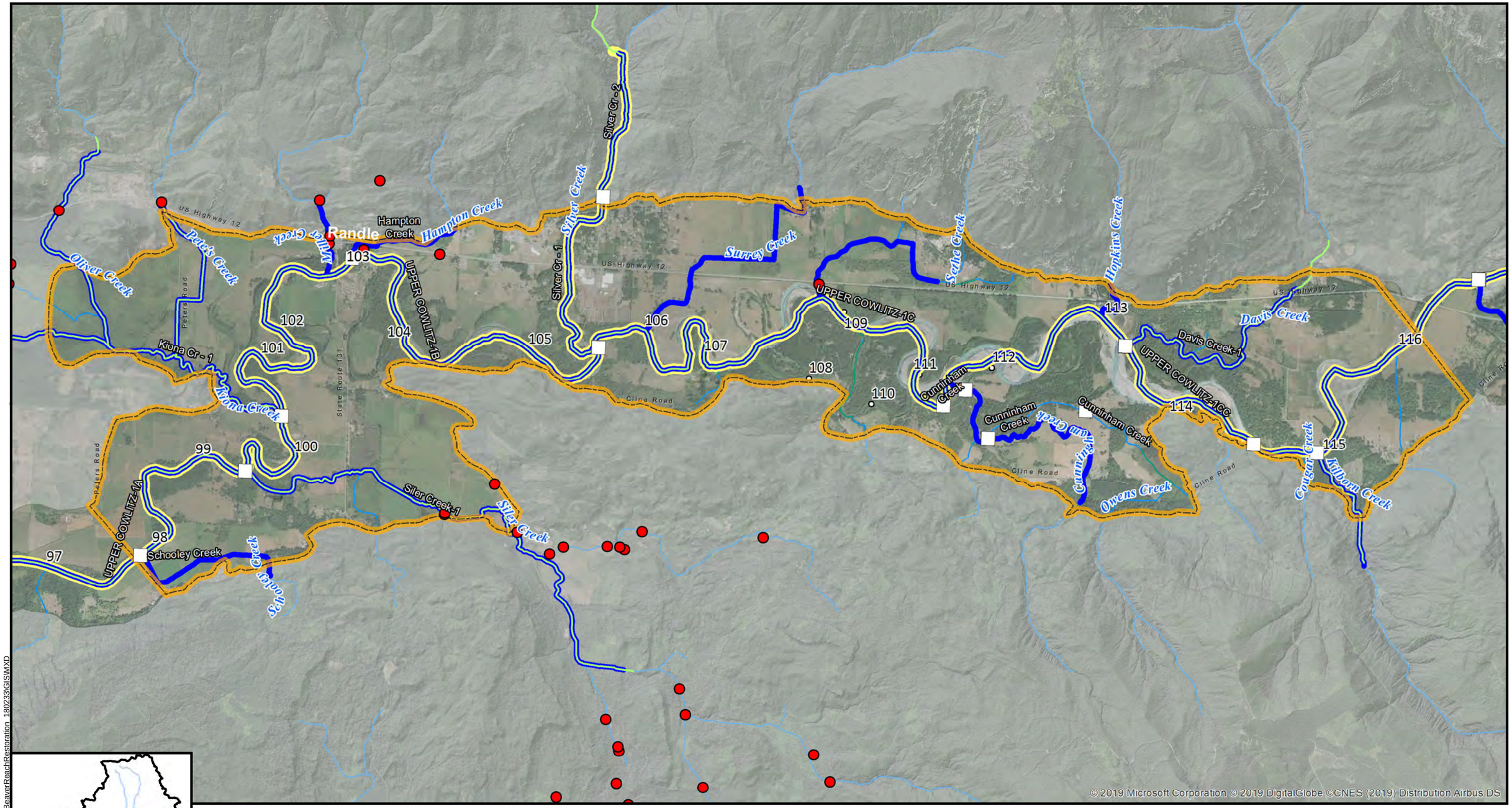
Landscape Unit Boundary
Parcel Boundaries
River Miles
Levee and/or Armoring
Roads

Landscape Unit Overview

Landscape Unit:

Upper Cowlitz - Randle

Upper Cowlitz-Cispus Community-based Habitat Strategy Development



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*Imagery from Bing Maps

0 2,300 4,600 9,200 Feet

Landscape Unit Boundary

Recovery Plan Reach Breaks

River Miles

Species Distribution

Chinook Salmon

Coho Salmon

Steelhead Trout

Potential Barriers

Landscape Unit - Fish Distribution

Landscape Unit:

Upper Cowlitz - Randle

Upper Cowlitz-Cispus Community-based Habitat Strategy Development

8 Upper Cowlitz – Scanewa

8.1 Location Description

Cowlitz River Valley Bottom RM 97.7 -90; Scanewa Backwater to Lake Scanewa.

8.2 Overview

This LU lies within the backwater influence of Lake Scanewa. It is partially confined by glacial terraces and landslide deposits. This LU is characterized by the lowest road density of the valley bottom LUs (3.0 mi/ mi^2).

8.3 Historical Conditions

Historically, the upper portion of this LU was similar to the upstream LU and the remainder was partially confined by glacial terraces and from landslide deposits off of the western ridge of Huffaker Mountain. But in-channel habitat was much more suitable to salmon and steelhead use compared to the backwater-influenced condition present today. The channel had pool-riffle habitat, abundant bar-forms, wood jams, and other complexity that is currently missing.

Ecological Indicators – Upper Cowlitz Scanewa	
Indicator	**Description**
Natural vs. Human Disturbance	**Impaired** Lake Scanewa backwater reduces natural fluvial disturbance and adjustment processes.
Hydrologic Alteration	**Impaired** The hydro-regulation effects (backwater) from Cowlitz Falls Dam and Lake Scanewa are significant in this LU. IWA Rating "Functional" for upstream contributing area.
Sediment Processes	**Impaired** Sediment dynamics in this LU are highly altered by backwater effects. Historically, the channel segment would have been a transport and response reach, with temporary storage of upstream and locally delivered material, followed by mobilization downstream. It is now fully a response reach, with all of the coarse bedload and much of the fine load deposited in Lake Scanewa. IWA Rating "Moderately Impaired" for upstream contributing area.

Large Wood Processes	**Impaired** Large wood processes are highly altered. Wood that enters this reach either locally or from upstream now floats down into Lake Scanewa and collects there or is removed from the dam forebay. Large wood likely provides little impact on fish habitat in this segment
Channel Type and Form	**Impaired** Backwater effect has changed this system from a pool-riffle channel, possibly island braided in some areas, to a lake.
Floodplain Connectivity	**Impaired** The backwater effect has partially or fully inundated low floodplain surfaces in some areas and has reduced the important flood pulse channel-floodplain processes that occur in natural systems. There are some areas where high flows inundate old channel scars and create floodplain wetlands. These areas likely provide good potential foraging habitat for juvenile salmonids, but they are limited and of unknown value, particularly with respect to flood refuge, which would not be expected to be limiting in this segment.
Lateral and Vertical Channel Dynamics	**Impaired** The backwater effect has reduced the gradient and energy needed for natural lateral adjustment processes. Channel bed is vertically aggrading as bedload material collects in Lake Scanewa.
Off-Channel Habitat Connectivity and Refugia	**Moderately Impaired to Impaired** There appear to be some off-channel wetlands available and accessible, particularly at the downstream end of the LU just above the lake; however, their use by salmon and steelhead is unknown.
Riparian Processes	**Moderately Impaired to Impaired** Many segments of the riparian areas and floodplains in this LU are vegetated, but stand age is young. Regardless, riparian vegetation is unable to interact with the system as it would have historically prior to hydro-regulation. Its effect on bank stability, temperature (via shade), and large wood recruitment has been degraded.

8.4 Contributing Process Drivers

From upstream – Bedload is delivered this reach and aggrades in Lake Scanewa. Large wood from upstream floats through and either eventually sinks in the lake or is removed from the dam forebay. The backwater/dam provides base-level control to the upstream LU.

To downstream – Hydro-regulation of this LU has significant impacts to the downstream areas outside the study area.

From tributaries– There are no significant tributary inputs to this LU.

To tributaries – There are no significant tributary inputs to this LU. However, the backwater may actually increase fish passage connectivity to lower Schooley Creek, which is located at the upstream end of the LU.

8.5 Target Fish Use

Under current conditions, the mainstem Cowlitz within this LU likely is predominantly used for adult and juvenile migration. Salmon and steelhead released upstream of Cowlitz Falls Dam as part of the truck-and-haul program commonly pass through Lake Scanewa on the way to spawning grounds in the Upper Cowlitz or Cispus Rivers (Kock et al., 2016). All juveniles produced in the basin must pass through this reach during outmigration. The backwater effect from Cowlitz Falls Dam reduces water velocities and makes the area unsuitable for spawning. Residence times of salmon and steelhead in this LU are likely low but relatively unknown.

Of note, Lambert Creek may offer potential coho and steelhead spawning and rearing habitat. Lambert Creek was omitted from the prior EDT analysis, likely due to inaccessibility associated with a box culvert near the mouth. However, it appears that a PCSRF project sponsored by Lewis County removed this culvert in 2006, opening up nearly 5 km of habitat.

Chinook salmon, coho salmon, and steelhead critical habitat in this LU is contained in the mainstem Cowlitz River.

8.6 Habitat Patch Connectivity

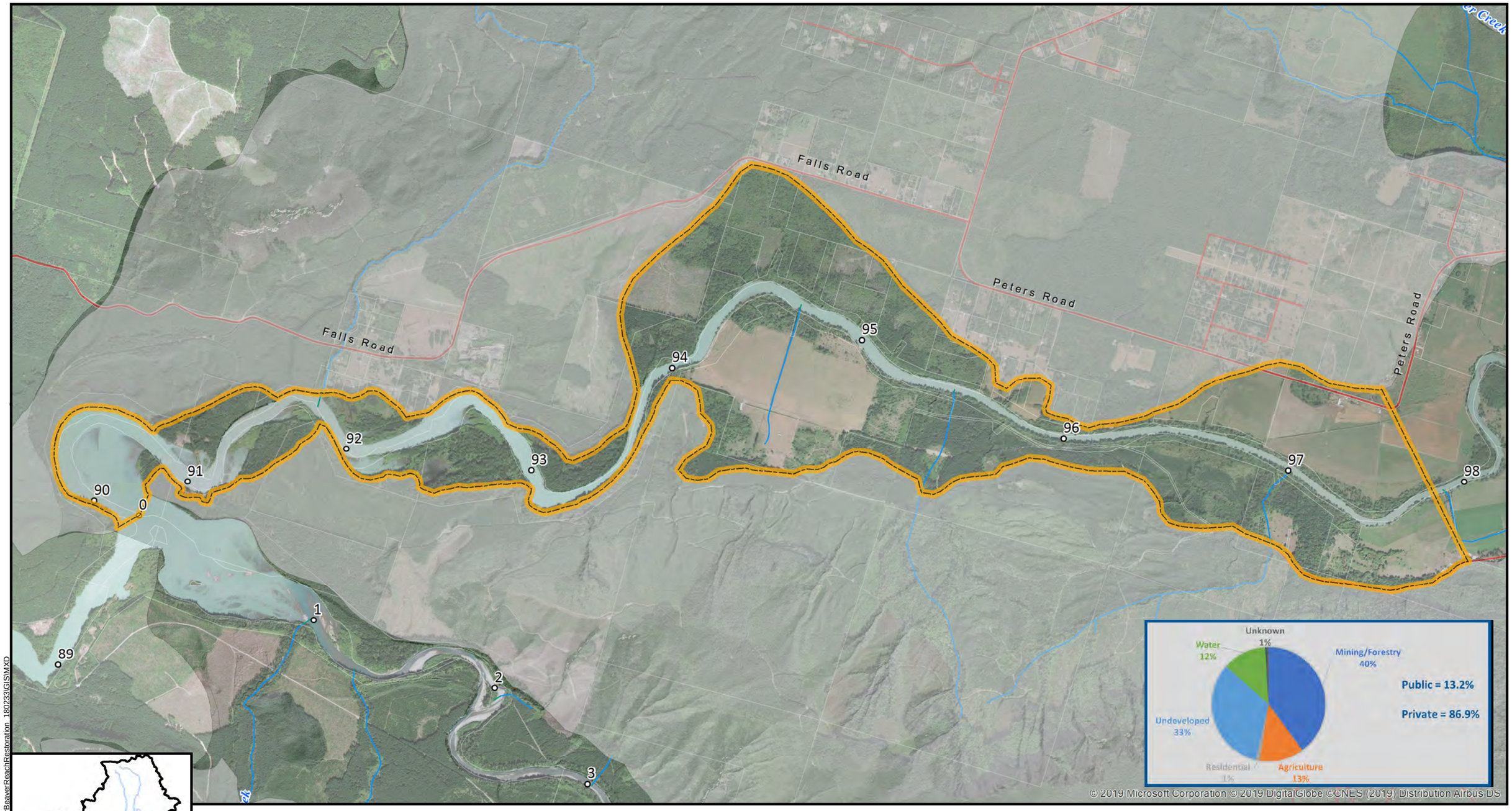
This is the upper end of the Cowlitz River hydrosystem, which has significant impacts to fish passage and river ecological processes in the Cowlitz Basin. Addressing this large impediment would connect important patches of better functioning habitat up- and downstream, but this is outside the scope of this effort.

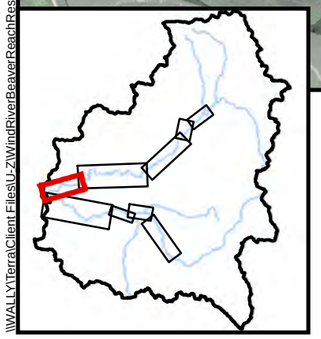
8.7 Management Plans, Past Studies, Projects

Dam operations predominantly control the conditions in this LU and are regulated through Tacoma Power's FERC license.

8.8 Landownership

The landownership in this LU is almost entirely privately owned (the greatest proportion private of any LU), with the primary land use as agricultural.





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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 1,400 2,800 5,600 Feet

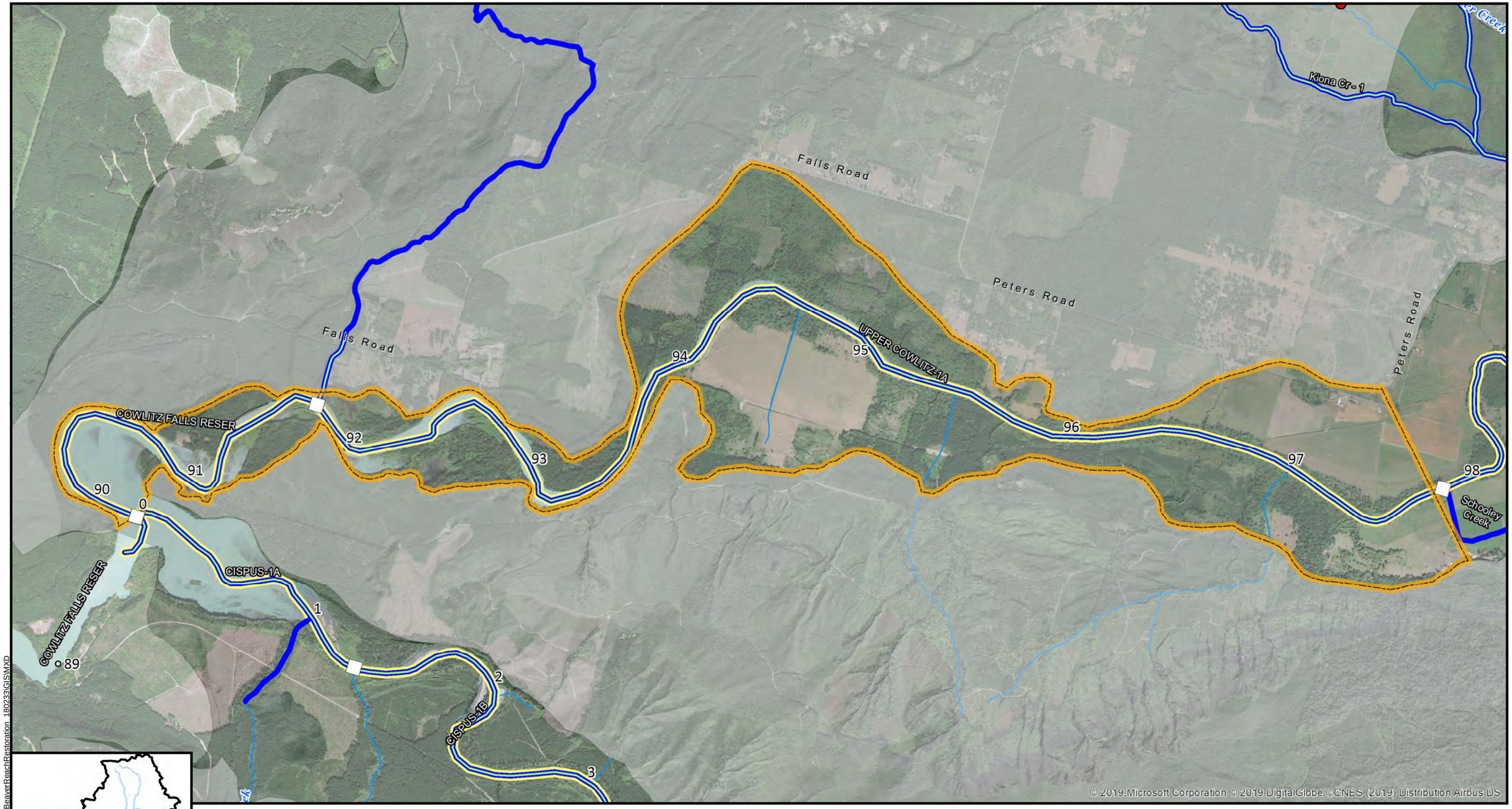
Landscape Unit Boundary
Parcel Boundaries
River Miles
Levee and/or Armoring
Roads

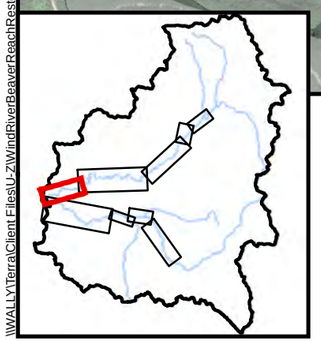
Landscape Unit Overview

Landscape Unit:

Upper Cowlitz - Scanewa

Upper Cowlitz-Cispus Community-based Habitat Strategy Development





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*Imagery from Bing Maps

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0 1,400 2,800 5,600 Feet

Landscape Unit Boundary
Recovery Plan Reach Breaks
River Miles

Species Distribution
Chinook Salmon
Coho Salmon
Steelhead Trout
Potential Barriers

Landscape Unit - Fish Distribution

Landscape Unit:

Upper Cowlitz - Scanewa

Upper Cowlitz-Cispus Community-based Habitat Strategy Development

9 Cispus – Upper

9.1 Location Description

Cispus River Valley Bottom RM 30.7 to 21.7; Canyon Creek confluence to valley widening near RM 21.7.

9.2 Overview

This upper segment of the Cispus River study area is confined in the upstream portion and partially confined in the downstream portion. There are pockets of forested islands present in this LU. The riparian area of this channel segment is heavily vegetated with mature forest and possibly some patches of late seral stage forest. There is abundant large wood in the channel except in the confined reaches. The LU lies entirely within the Gifford Pinchot National Forest and is mostly isolated from roadway or other impacts, although LU road density is moderate (5.6 mi/ mi^2).

9.3 Historical Conditions

Historical conditions would not have been substantially different from today except for the presence of late seral stage riparian stands and very large and relatively stable log jams in the channel. This riparian and in-channel structure would have reduced the frequency of channel adjustment and would have increased hydraulic and habitat complexity. Portions of this LU would have had island braided planform (Beechie & Imaki, 2014), more than exists today, with relatively stable secondary or co-dominant channel formation that would persist for many years until large, infrequent floods would cause adjustments.

Ecological Indicators – Cispus Upper	
Indicator	**Description**
Natural vs. Human Disturbance	**Functional to Moderately Impaired** Large catastrophic fires are probably more likely now due to fire suppression and younger, denser forest stands. Because of the steep, directly contributing hillslopes, fire in this area would contribute significant sediment and debris that would affect this LU and downstream LUs. Stream system is likely less resilient to flood and debris flow disturbance due to smaller riparian trees and smaller in-channel large wood.
Hydrologic Alteration	**Functional** There are no withdrawals, regulation, or artificial inputs. Future climate change impacts are likely to increase flood events. IWA Rating "Functional" for upstream contributing area.
Sediment Processes	**Functional** There are no major impacts on sediment sources, sinks, or processes. It's possible there is more active erosion of bank sediment due to past timber harvests and younger trees, leading to potentially less storage of sediments than would have occurred with large log jams. But these impacts are not particularly significant and are on a trend towards recovery.

	IWA Rating "Functional" for upstream contributing area.
Large Wood Processes	**Functional to Moderately Impaired** Abundant wood except for in upstream confined sediments. Wood is likely of smaller size than historically, where very large late seral stage trees would have provided stable key pieces. Many current pieces are nevertheless large and do form large jams that can persist for years. Because of the partial confinement, wood is not large enough, in many cases, to persist in the low flow channel; whereas historically the very large pieces would persist even in the active channel. A few locations, however, do have channel spanning jams.
Channel Type and Form	**Functional** Channel type is partially or mostly confined pool-riffle channel, with a few pockets of island braided planform. There are a few straight, plane-bed sections. The presence of island braided conditions may have been reduced somewhat from historical conditions, and there may also have been a reduction in wood-forced pool morphology; but overall there is not a significant change.
Floodplain Connectivity	**Functional** Where they naturally exist, floodplains are well-connected.
Lateral and Vertical Channel Dynamics	**Functional** Where there is a wider unconfined valley, the river moves around or is characterized by split flows around forested island complexes. Lateral dynamics may be slightly greater under current conditions due to younger forests and smaller in-channel wood, but this relatively minor and is on an improving trend as the forest matures. Possibly slight channel incision due to less abundance of large stable jams, causing some disconnection of floodplain channels.
Off-Channel Habitat Connectivity and Refugia	**Functional** Where it exists, there is connectivity to off-channel habitat.
Riparian Processes	**Functional** Trees are mostly second growth, but there are some patches of what appear to be late seral stage stands. The riparian forest is protected under current USFS policy and is maturing. USFS stream temperature monitoring shows some exceedances of the state criteria of 16°C for the 7-day moving average of the daily maximum (7-DADMax) on the mainstem Cispus River (USFS unpublished data). These exceedances suggest there may be some impairment to canopy cover.

9.4 Contributing Process Drivers

From upstream and tributaries – There are high bedload and wood inputs from headwater systems. Most of this material is transported through the LU.

To downstream – Most upstream and locally generated wood and bedload is transported to the lower gradient and less confined LUs downstream, to the broad, laterally active, alluvial Cispus Valley.

9.5 Target Fish Use

This LU provides adult migration, spawning, and juvenile rearing and migration habitat for target species, primarily within the mainstem Cispus, and also potentially in the lower reaches of some tributaries. Rearing habitat value may be naturally limited within the mainstem during higher flows due to relatively high gradient relative to reaches downstream.

Chinook salmon critical habitat in this LU is contained in the mainstem Cispus River, while coho salmon and steelhead critical habitat also includes lower Twin Creek.

The USFS has identified the mainstem Cispus in this LU as having good potential to support salmon and steelhead (Ken Wieman, personal communication 2019).

9.6 Habitat Patch Connectivity

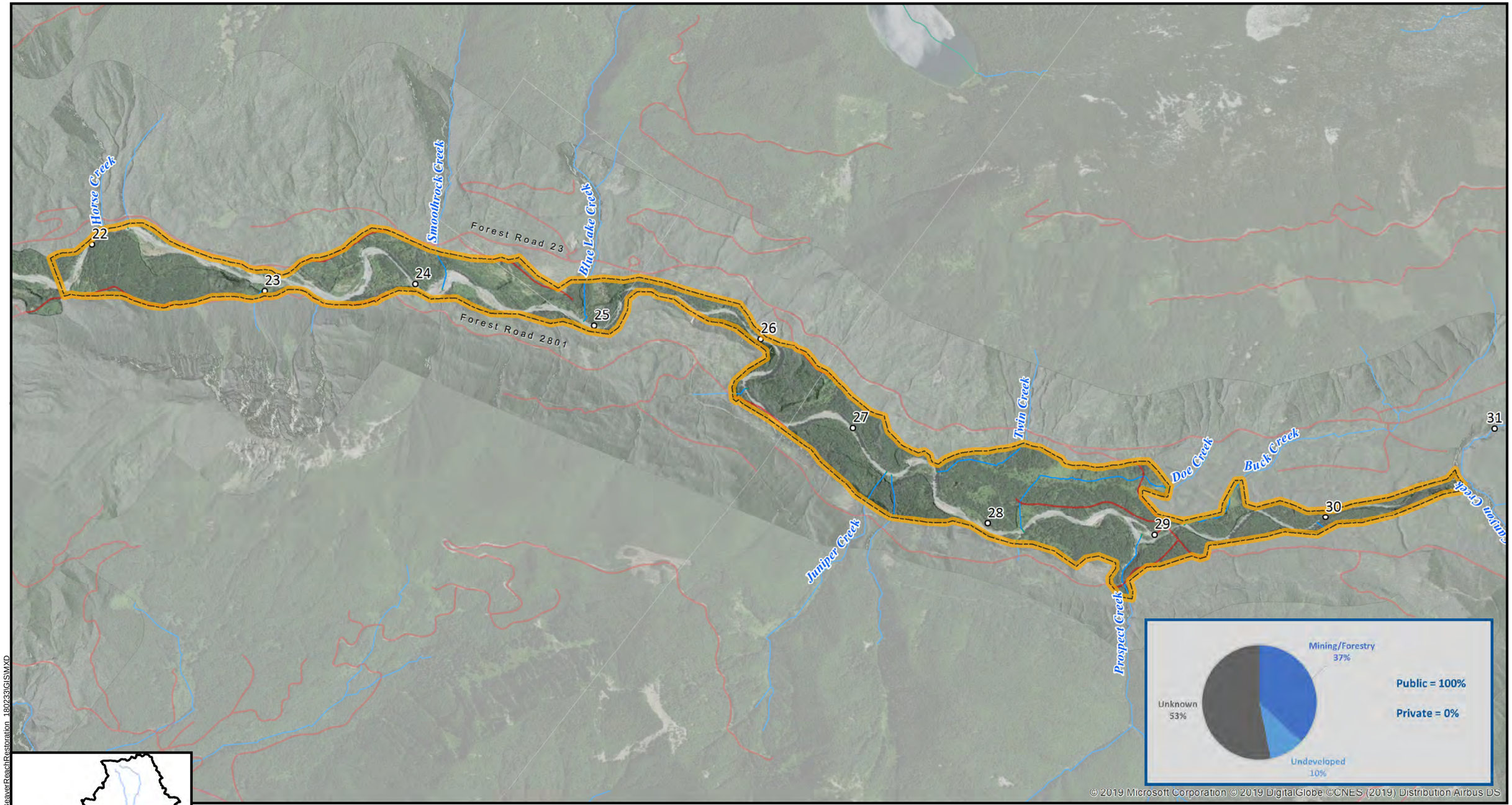
This LU represents an important transition zone from flatter downstream alluvial valley to headwater systems. It is currently functioning properly in that capacity and is well-protected.

9.7 Management Plans, Past Studies, Projects

The LU is within the Gifford Pinchot National Park and is governed by the Northwest Forest Plan and the WA DNR Forest Practices Act.

9.8 Landownership

The LU lies entirely within the Gifford Pinchot National Forest.



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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 1,550 3,100 6,200 Feet

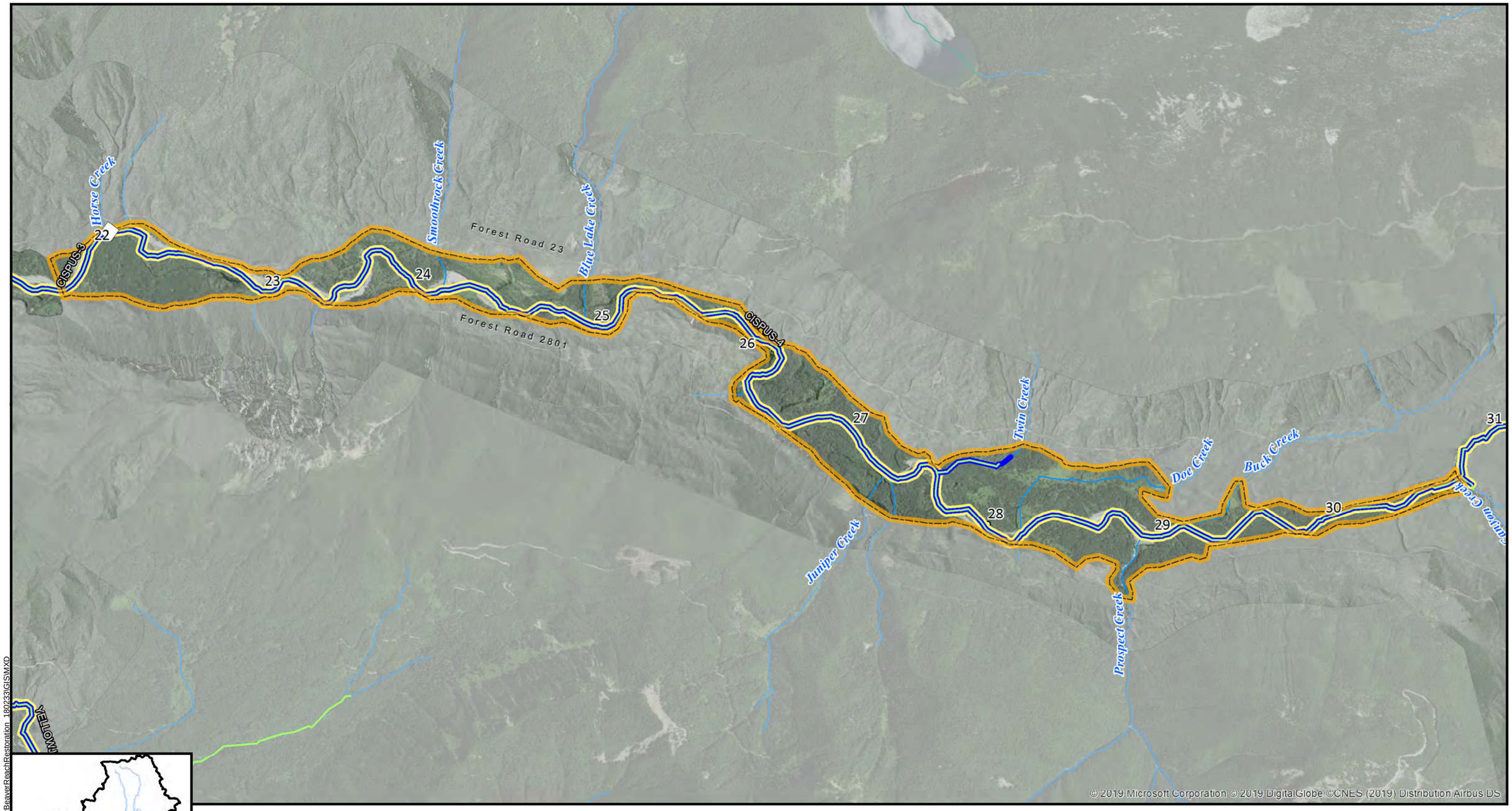
- Landscape Unit Boundary
- Parcel Boundaries
- River Miles
- Levee and/or Armoring
- Roads

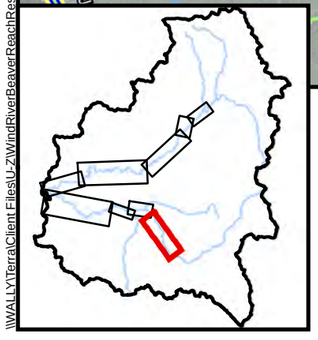
Landscape Unit Overview

Landscape Unit:

Cispus - Upper

Upper Cowlitz-Cispus Community-based Habitat Strategy Development





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0 1,550 3,100 6,200 Feet

Landscape Unit Boundary
Recovery Plan Reach Breaks
River Miles

Species Distribution
Chinook Salmon
Coho Salmon
Steelhead Trout
Potential Barriers

Landscape Unit - Fish Distribution

Landscape Unit:

Cispus - Upper

Upper Cowlitz-Cispus Community-based Habitat Strategy Development

10 Cispus – Mid-Valley

10.1 Location Description

Cispus River Valley Bottom RM 21.7 – 17.5; Valley widening near RM 21.7 to Cispus Road Bridge.

10.2 Overview

This LU includes a highly dynamic braided channel, with some vestiges of island braided character. There is high bedload, multi-thread channels, high large wood loading and jams, high complexity, and multiple age-classes of young to very mature forests. There is some bank protection/restoration project history in this LU, most recently with riprap protection of FS Road 23 at the upstream end (2018 project). There are also older engineered log jams along FS 23 in now-abandoned oxbows. Incision and channel simplification at downstream end of this LU is observed, related to Cispus Road Bridge and approach fill. The North Fork Cispus enters this segment and has push-up levees along the lower portion that disconnects the tributary from its historical fan. This LU is characterized by moderately high road density (6.4 mi/ mi^2)

10.3 Historical Conditions

Dynamic island braided system, with multiple side channels and co-dominant channels separated by forested islands. Multiple age-classes of riparian and floodplain vegetation from newly established to late seral stage. Massive relatively stable log jams that span channel, force planform changes, and meter flow into side channels and off-channel areas. Abundant and well-connected off-channel features including abandoned oxbows and floodplain wetlands.

Ecological Indicators – Cispus Mid-Valley	
Indicator	**Description**
Natural vs. Human Disturbance	**Functional** The stream system is less resilient to flood and debris flow disturbance due to smaller riparian trees and smaller in-channel large wood assumed to be a result of historical forest management practices.
Hydrologic Alteration	**Functional** No withdrawals, regulation, or artificial inputs. Future climate change impacts are likely to increase flood events. IWA Rating "Functional" for upstream contributing area.

Sediment Processes	**Functional** There are no major impacts on sediment sources, sinks, or processes. There may be more active erosion of bank sediment due to past timber harvests and younger trees. And compared to historical conditions, there is possibly less storage of sediments in the channel due to a lack of large log jams that would have helped to further protect mid-channel bars and to support forested island development. But these impacts are not particularly significant and are on a trend towards recovery. There have been some localized increases in sediment inputs from past road washouts, especially at the FS 23 Road washout near RM 21, but these are relatively small inputs overall and in the case of the RM 21 washout have been halted with bank armoring. Upriver road washouts have also contributed sediment to this reach and since the 1996 flood, the channel has been very dynamic due to excess sediment (Ken Wieman, USFS, personal communication 2019). IWA Rating "Functional" for upstream contributing area.
Large Wood Processes	**Functional to Moderately Impaired** There is abundant wood, much of it interacting with the low flow channel, and also abundant in secondary channels, floodplain overflow channels, and throughout the floodplain. Wood is likely of smaller size than historically, where very large late seral stage trees would provide stable key pieces. Many current pieces are nevertheless large and do form occasional large jams that can persist for 2-5 years based on observations from the recent historical air photo record. Stream-adjacent roads including the 23 and 2801 roads affect large wood availability and recruitment in some locations. There is a lack of large wood input in the upper NF Cispus (Ken Wieman, USFS, personal communication 2019).
Channel Type and Form	**Functional to Moderately Impaired** Historically, this LU was likely an island braided system. This conclusion is supported by the Beechie & Imaki (2014) predictions as well as site observations. It has transitioned to a more braided morphology, likely due to past timber harvest and related reduction in riparian stand size and in-channel wood size, and possibly from greater delivery of coarse bedload from upstream for similar reasons. Channel form appears to be trending back towards island braided as the forest matures. The incision related to the Cispus Road Bridge will limit this trend from happening at the downstream end of the LU.
Floodplain Connectivity	**Functional to Moderately Impaired** This LU has mostly good floodplain connectivity, with abandoned oxbows and much of the other floodplain areas regularly wetted during annual high flows, based on site observations. The incision and cross-valley levee related to the Cispus Road Bridge and fill limits floodplain connectivity at the downstream end of the LU. The lower North Fork Cispus is confined by push up levees and has severely reduced floodplain connectivity.
Lateral and Vertical Channel Dynamics	**Moderately Impaired** Much of the LU is in good condition with respect to vertical and lateral dynamics. There is a push-up levee that was constructed as part of the FS 23 riprap at upstream end (RM 21). Levee is located opposite the armor (and associated engineered log jam) and serves to fix the river in place at this

	location. It will likely eventually wash out during large floods but could persist for years depending on the hydrology. There is new riprap armoring on river-right at the upstream end of the LU (RM 21) to protect FS 23, but the road is at the toe of the hillslope so this is not a major lateral constriction. There is riprap river-right along an abandoned oxbow and along a portion of the active mainstem (RM 19-19.7). The riprap is intermittent and failing, but nevertheless is limiting lateral channel migration and margin habitat in this area. The Cispus Road Bridge at the downstream end has caused channel incision and has reduced lateral dynamics. However, during very large floods, the bridge may provide a constriction that results in upstream bedload deposition and a lateral response. Evidence for this response can be seen in the abandoned oxbow river-right upstream of the bridge, which possibly developed during the 1996 flood. The lower North Fork Cispus is confined by push up levees and has severely reduced lateral connectivity.
Off-Channel Habitat Connectivity and Refugia	**Functional to Moderately Impaired** There is generally high connectivity to off-channel habitats including abandoned oxbows, floodplain wetlands, and alcoves along channel margins. The riprap river-right from RM 19-19.7 limits the development and connectivity to off-channel habitat in that area. The incision related to the Cispus Road Bridge limits connectivity to off-channel habitats at the downstream end. Push up levees on the lower North Fork Cispus limit off-channel and distributary fan channel habitat availability.
Riparian Processes	**Functional** Trees are mostly second growth, but there are some patches of what appear to be late seral stage stands. The riparian forest is protected under current US Forest Service policy and is maturing. Riparian conditions are impaired at the FS 23 riprap bank, at the upstream end, and at downstream end around the Cispus Road Bridge. USFS stream temperature monitoring shows some exceedances of the state criteria of 16°C for the 7-day moving average of the daily maximum (7-DADMax) on Camp Creek and the mainstem Cispus River (USFS unpublished data). These exceedances suggest there may be some impairment to canopy cover.

10.4 Contributing Process Drivers

From upstream – This reach is more of a response reach than the upstream LU and represents a break in valley grade and width where material delivered from upstream aggrades. Large wood generated from abundant upstream sources also deposits in this reach.

To downstream – Material (bedload and wood) is delivered to downstream LUs but this LU is mostly a sink for much of this material.

From tributaries – Coarse bedload from the North Fork Cispus is more readily transmitted to this reach due to artificial confinement of the lower North Fork.

To tributaries – Conditions in the mainstem generally lead to high connectivity to tributaries through this reach.

10.5 Target Fish Use

This LU includes the lowermost reaches of Camp Creek and the North Fork Cispus and high floodplain connectivity contains good floodplain and off-channel habitat that is likely used by juvenile salmonids during high-flow periods for rearing. The mainstem within this LU is complex and appears to contain high quality spawning habitat. The North Fork historically contained a healthy run of coho salmon and provided juvenile rearing habitat as well (McIntosh et al., 1990).

Chinook salmon critical habitat in this LU is contained in the mainstem and North Fork Cispus River, while coho salmon and steelhead critical habitat also includes lower Camp Creek.

The USFS has identified the lower NF Cispus and the mainstem Cispus in this LU as having good potential to support salmon and steelhead (Ken Wieman, personal communication 2019).

10.6 Habitat Patch Connectivity

This LU represents an important valley bottom segment that is of relatively high quality and needs to be maintained.

10.7 Management Plans, Past Studies, Projects

The LU is within the Gifford Pinchot National Park and is governed by the Northwest Forest Plan and the WA DNR Forest Practices Act. There have been multiple US Forest Service projects in Cispus mainstem, mainly associated with FS Road 23 protection (Figure 10). A couple of the older projects are now within abandoned oxbows.

Figure 10. Large engineered log jam at upstream of FS Road 23 repair near RM 21.

Figure 11. Older engineered log jam placed along FS Road 23 near RM 19 (now in abandoned oxbow).

10.8 Landownership

This LU comprises public forest land, almost exclusively.


A


B


C


D

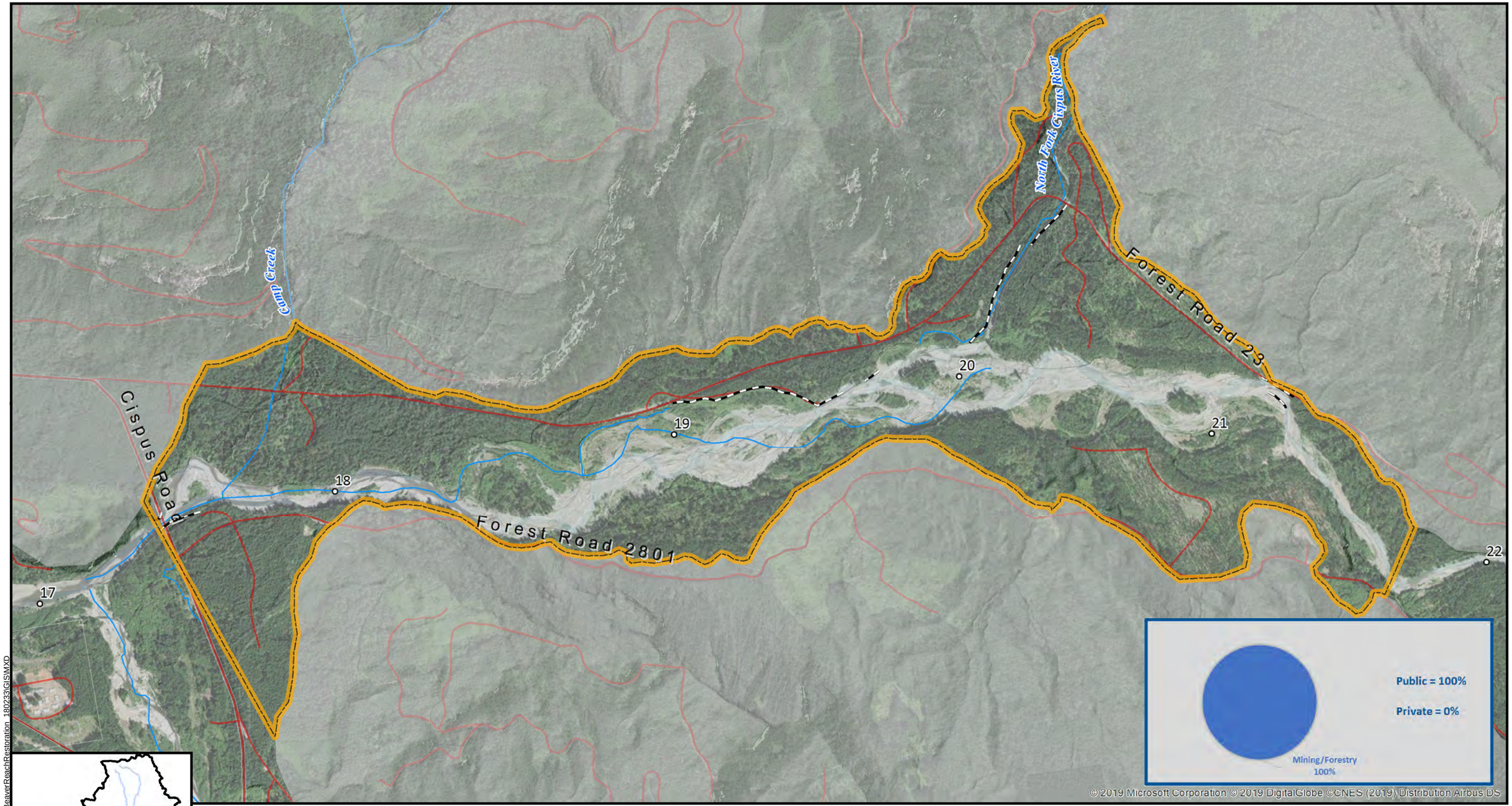

E

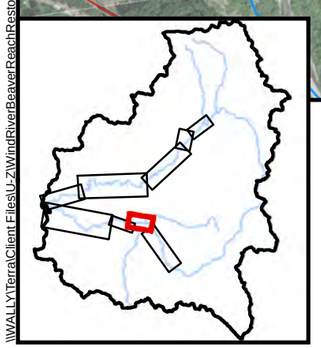

F


G


H

Figure 12. Representative images from the Cispus-Mid-Valley LU. A = USFS Road 23 repair near RM 21. B = large ELJ at upstream end of USFS Road 23 repair. C = push-up levee created across from USFS Road 23 repair. D = large wood complexity typical of this reach. E = high terrace being eroded into near RM 20. F = riprap bank along spur road along oxbow near RM 19.5. G = failing riprap bank near RM 19.5. H = large wood complexity typical of this LU. I = Channel incision through aggraded bed material upstream of Cispus Road Bridge.





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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 850 1,700 3,400 Feet

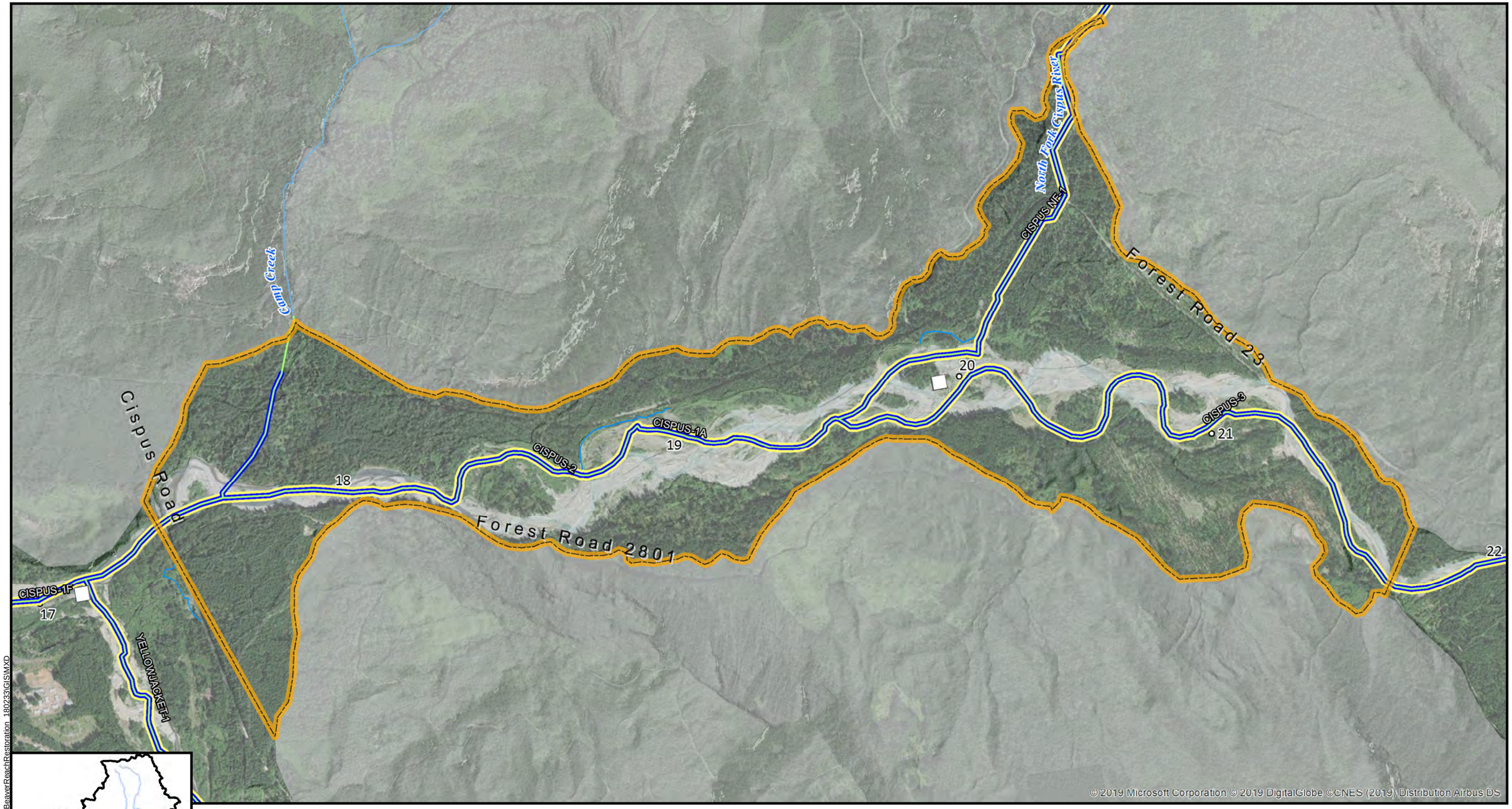
- Landscape Unit Boundary
- Parcel Boundaries
- River Miles
- Levee and/or Armoring
- Roads

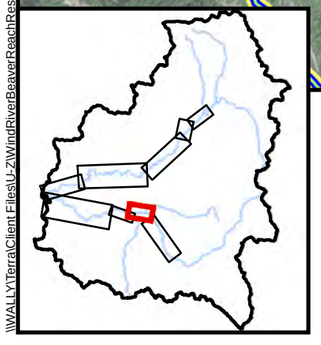
Landscape Unit Overview

Landscape Unit:

Cispus - Mid-Valley

Upper Cowlitz-Cispus Community-based Habitat Strategy Development





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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 850 1,700 3,400 Feet

Landscape Unit Boundary
Recovery Plan Reach Breaks
River Miles

Species Distribution
Chinook Salmon
Coho Salmon
Steelhead Trout
Potential Barriers

Landscape Unit - Fish Distribution

Landscape Unit:

Cispus - Mid-Valley

Upper Cowlitz-Cispus Community-based Habitat Strategy Development

11 Cispus – Tower Rock

11.1 Location Description

Cispus River Valley Bottom RM 17.5 – 13.5; Cispus Road Bridge to start of channel confinement.

11.2 Overview

This LU has a dynamic braided and island-braided channel type. It has low sinuosity compared to historical conditions. There is some in-channel wood, but much of it is perched on bar surfaces. There are young to middle-aged riparian forest stands, many dominated by alder with Himalayan blackberry undergrowth. Private development and US Forest Service campground impair and disconnect floodplains and lateral channel migration. This LU includes lower Yellowjacket Creek, a major tributary, which has a complex and dynamic lower end but is incised with floodplain and CMZ disconnection due to the Cispus Road Bridge crossing 0.75 miles up from the confluence with the Cispus River. This LU is characterized by the second highest road density of any LU within the study sub-basin (7.3 mi/ mi^2).

11.3 Historical Conditions

Historically, this LU was likely a dynamic island braided system, with multiple side channels and co-dominant channels separated by forested islands (Beechie & Imaki 2014). It would have included multiple age-classes of riparian and floodplain vegetation from newly established to late seral stage. There would have been massive, relatively stable log jams that spanned the channel, forced planform changes, and metered flow into side channels and off-channel areas. There were abundant and well-connected off-channel features including abandoned oxbows and floodplain wetlands.

Ecological Indicators – Cispus Tower Rock	
Indicator	**Description**
Natural vs. Human Disturbance	**Functional to Moderately Impaired** Compared to natural conditions, the stream system is now less resilient to flood and debris flow disturbance due to past timber harvests resulting in much smaller riparian trees and smaller and less abundant in-channel large wood. There have also been channel and floodplain encroachment, including from the road and campground.
Hydrologic Alteration	**Functional** No withdrawals, regulation, or artificial inputs. Future climate change impacts are likely to increase flood events. IWA Rating "Functional" for upstream contributing area.

Sediment Processes	**Functional to Moderately Impaired** There is currently more active erosion of bank sediment due to past timber harvests and younger trees, which in some cases is contributing fines to the channel. Compared to historical conditions, there is likely considerably less storage of sediments/bedload in the channel due to a lack of large log jams that would have helped to protect mid-channel bars and to support forested island development. The frequency and magnitude of erosion of the channel bed has likely increased due to channel straightening and a reduction in jog jams, which increases stream energy. This has likely shifted the regime more towards transport, although it is still very much a response reach overall. IWA Rating "Moderately Impaired" for upstream contributing area.
Large Wood Processes	**Moderately Impaired** There is less wood in this LU compared to upstream. Most of the wood is atop bars and does not interact with low flow channel. The channel is eroding into forested stands and recruiting wood in some locations, with some bank-attached trees providing good margin habitat; but the stands are either alder or young conifers, and are ultimately not recruiting material large enough to serve as key pieces in the active channel.
Channel Type and Form	**Moderately Impaired** The historical channel type was likely either highly sinuous meandering or island-braided. Beechie & Imaki (2014) modeling predicts island braided. Now it is braided and single-thread wandering. Sinuosity has been sharply reduced through meander cut-offs. Channel form would have been historically highly influenced by large log jams that would help stabilize forested islands and create side channel and multiple co-dominant channels. There is currently less margin habitat than would have occurred historically.
Floodplain Connectivity	**Moderately Impaired** The broad, historically active floodplain has been disconnected by floodplain development and confining features, and also by channel straightening and likely a bit of related incision. Floodplain connectivity has been decreased due to the Cispus Road Bridge at the upstream end of the LU, as described for that LU. There is also armoring and a remnant road/levee on river-left near the old road crossing near RM 15.8. There are numerous residences (mostly vacation cabins) and the US Forest Service Tower Rock Campground that lie within the river-left floodplain. Floodplain connectivity on the Yellowjacket Creek fan is disconnected by the Cispus Road that forms a levee across the east end of the fan. The floodplain of Yellowjacket Creek is disconnected by the Cispus Road Bridge (over Yellowjacket Creek) and eastern approach fill; the disconnection is being worsened by the bridge-related channel incision.
Lateral and Vertical Channel Dynamics	**Moderately Impaired** There is a high glacial terrace bordering the river-right side in the downstream half of the LU, and a bedrock outcrop river-right RM 16.1. There is an old bridge abutment river-left RM 15.7 as well as an old segment of levee/armoring on the old south bridge approach that may be preventing migration to the south. The levee is close to the Tower Rock Campground and may be providing protection to this area. There is riprap river-left at downstream end associated with cabins in the Tower Rock community. The Yellowjacket Creek fan is laterally constrained by the Cispus Road that forms a levee across the east end of the fan. The upper fan/floodplain is constrained by the Cispus Road Bridge over Yellowjacket Creek, creating channel incision.

Off-Channel Habitat Connectivity and Refugia	**Moderately Impaired** Off-channel habitat availability and quality has been reduced from historical conditions due to changes in channel type, lateral dynamics, and floodplain connectivity. There does exist off-channel rearing and refuge habitat at higher flows, but not much connected at lower or average flows and much less available habitat than historically, where side channels, well-connected abandoned oxbows, and connected floodplain wetlands would have been abundant. There is off-channel habitat in Yellowjacket Creek, primarily in the east distributary channel scar, that is wetted and mostly accessible to fish from the downstream end. This has also been the location of habitat improvements. Off-channel habitat in other areas of Yellowjacket Creek, particularly in the vicinity of the bridge and upstream, has been reduced due to channel incision from the bridge.
Riparian Processes	**Moderately Impaired** This LU has younger forest stands compared to the upstream LUs. There is also a much greater presence of invasive species – primarily Himalayan blackberry and Scotch Broom. In some cases, dense blackberry within alder stands is limiting natural succession by preventing conifer undergrowth. There are older forests on the steep hillslopes at the downstream end providing some wood inputs. And in many cases, there is good new willow growth occurring on newly formed gravel bars. USFS stream temperature monitoring shows some exceedances of the state criteria of 16°C for the 7-day moving average of the daily maximum (7-DADMax) on Yellowjacket Creek and the mainstem Cispus River (USFS unpublished data). Yellowjacket Creek shows at least one exceedance of 20°C for the 7-DADMax. These exceedances suggest there may be some impairment to canopy cover.

11.4 Contributing Process Drivers

From upstream – This LU has less wood and coarse sediment loading compared to upstream LUs. Some of this material may be working its way down to this area. The backwater effect of Cispus Road Bridge during large floods may be limiting some of the continuity between the reaches.

To downstream – The downstream constriction point, where natural confinement increases, helps to hold and control grade of this LU. Most bedload and wood that is transported out of this reach is readily transported down through the downstream ("Cispus River Valley - Lower") LU to Lake Scanewa.

From tributaries – Yellowjacket Creek is a major tributary that enters the Cispus River in this LU. Confinement from the bridge, and the Cispus Road that forms a levee across the eastern portion of the fan, has reduced connectivity across the entire historical fan surface, and likely results in a greater contribution of coarse bedload and wood to the mainstem as a result.

To tributaries – Nearby tributaries appear to be accessible to fish. Tributaries appear to have mostly adjusted to the minor incision that has occurred in the mainstem.

11.5 Target Fish Use

The Cispus River in this LU is relatively low gradient and less confined compared to upstream reaches, and contains suitable spawning gravels for salmon and steelhead. The mainstem Cispus River between Iron Creek and the North Fork Cispus historically contained the best spawning habitat in the Cispus subbasin

(McIntosh et al., 1990). Yellowjacket Creek contains relatively good habitats for rearing and migration, but complexity is reduced by floodplain encroachment and infrastructure.

Chinook salmon critical habitat in this LU is contained in the mainstem Cispus River and Yellowjacket Creek. Coho salmon critical habitat includes those areas and Dry Creek and Covell. Steelhead critical habitat includes the mainstem Cispus River, Yellowjacket Creek, and Covell Creek.

The USFS has identified the mainstem Cispus in this LU as having good potential to support salmon and steelhead. Yellowjacket Creek has also been identified as a priority watershed (Ken Wieman, personal communication 2019).

11.6 Habitat Patch Connectivity

This is a very important valley bottom segment that links to the upstream LU that has high potential for improvement. Improving this link would create a long well-functioning segment of the middle alluvial Cispus Valley.

11.7 Management Plans, Past Studies, Projects

Reaches identified for protection include Cispus 4 and Cispus 3 (Cardno, 2014). An Erosion Hazard Study was completed for Lewis County in response to channel migration after the 1996 flooding (Harrera, 2004). Subreaches 1, 2 and 3 from this study are contained within this LU. This document provides valuable synthesis information about channel evolution in this area, and also identifies channel migration and avulsion hazards in the area. Multiple US Forest Service projects have been completed in Yellowjacket Creek.

11.8 Landownership

Landownership in this LU is split almost equally between private ownership and public ownership. The area is within the Gifford Pinchot National Forest, but also includes a small residential community.

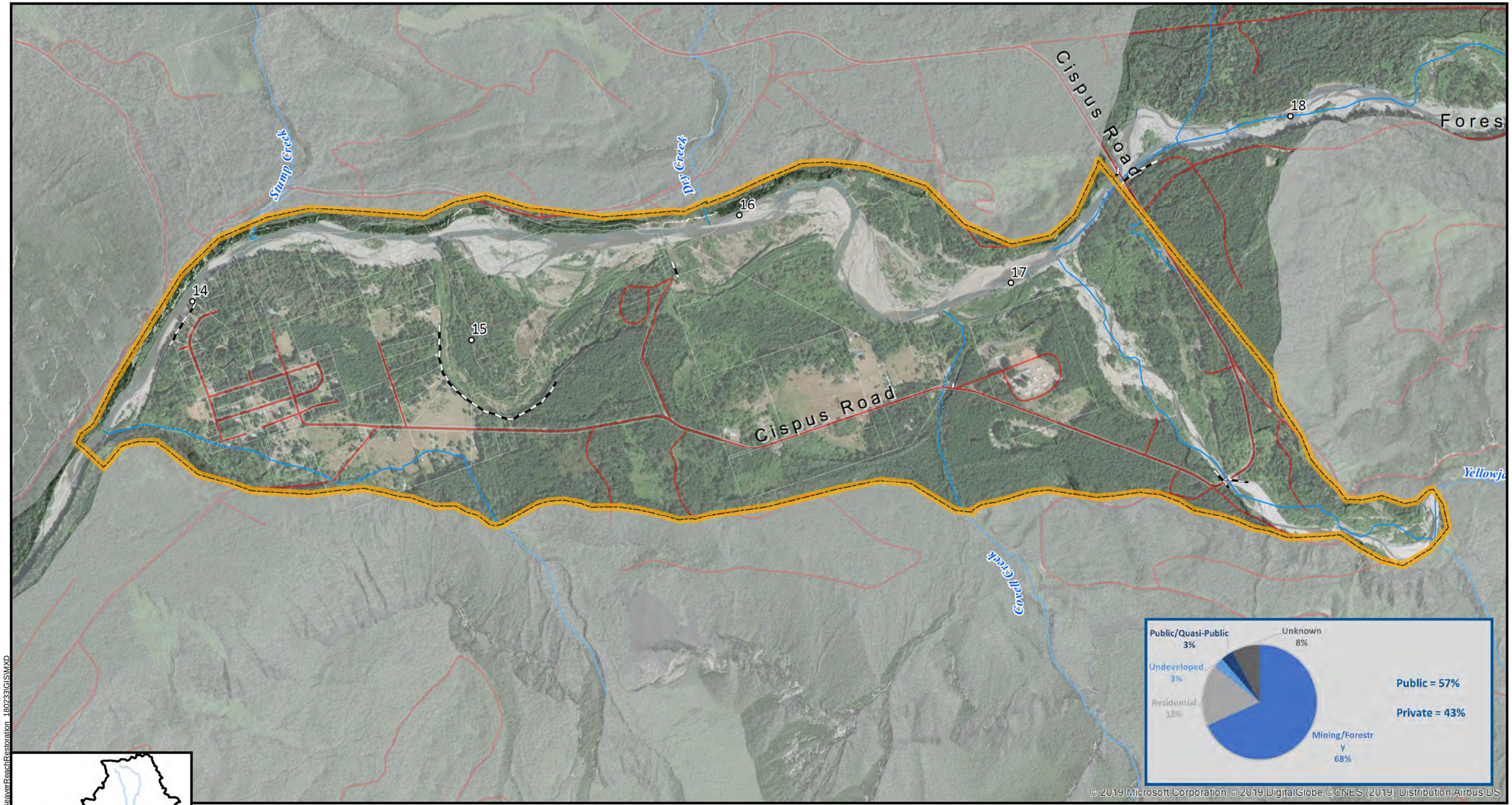
Figure 13. Yellowjacket Creek projects with large wood

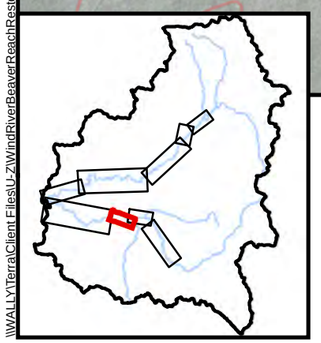

A


B


C

Figure 14. Representative images from the Cispus-Tower Rock LU. A=Looking downstream near confluence with Yellowjacket Creek. B=Washed out bridge. C=within historical alignment. D=riprap protecting Tower Rock community (RM14). E=wood accumulation on Yellowjacket Creek.





*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 800 1,600 3,200 Feet

Landscape Unit Boundary
Parcel Boundaries
River Miles
Levee and/or Armoring
Roads

Landscape Unit Overview

Landscape Unit:

Cispus - Tower Rock

Upper Cowlitz-Cispus Community-based Habitat Strategy Development

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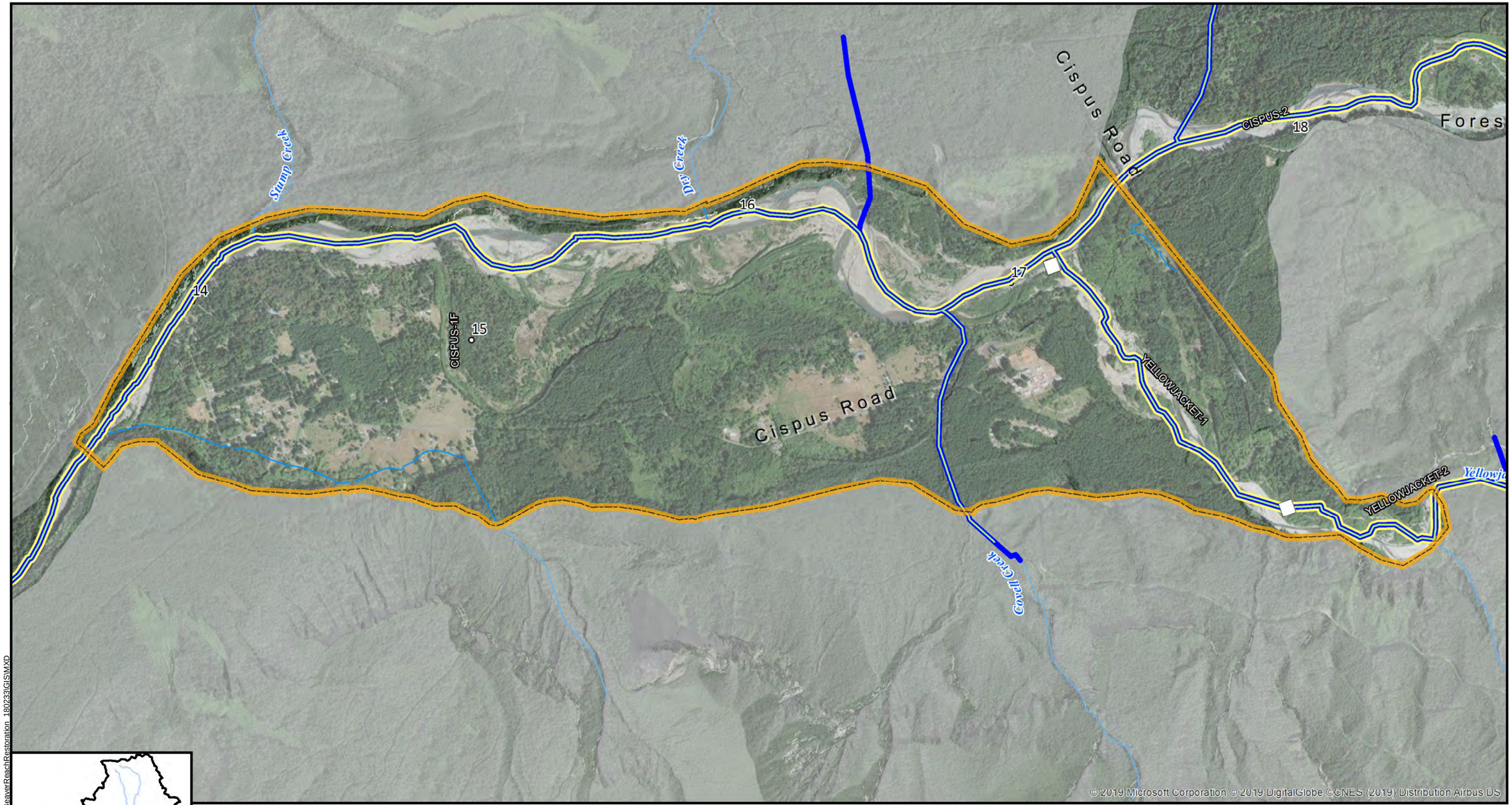

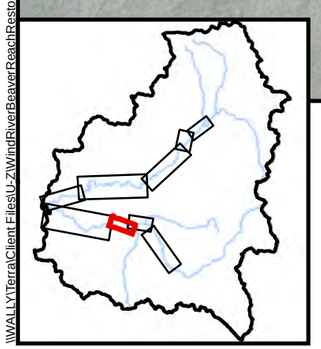

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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 800 1,600 3,200 Feet

Landscape Unit Boundary
Recovery Plan Reach Breaks
River Miles

Species Distribution
Chinook Salmon
Coho Salmon
Steelhead Trout
Potential Barriers

Landscape Unit - Fish Distribution

Landscape Unit:

Cispus - Tower Rock

Upper Cowlitz-Cispus Community-based Habitat Strategy Development

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12 Cispus – Lower

12.1 Location Description

Cispus River Valley Bottom RM 13.5; Start of channel confinement to Lake Scanewa.

12.2 Overview

This is a confined and partially confined channel, bordered by glacial terraces and bedrock hillslopes, with steep gradient and alternating pool-riffle and plane bed channel segments. Forests are mostly second growth, but mature. In-channel wood abundance is relatively low. There is very little human development or direct impacts to the LU, except for the backwater effect of Lake Scanewa at the downstream end. The upper portion is within the National Forest and the lower portion is commercial timber land. This LU is characterized by the greatest road density of any LU within the sub-basin (7.4 mi/ mi^2).

12.3 Historical Conditions

Historical channel planform would have been similar to today due to natural confinement. However, late seral stage riparian stands and large in-channel wood delivered from upstream would have created large jams in some locations, particularly in pockets of valley widening and split flow areas. Bank-attached fallen trees would also have provided important key pieces for jam development as well as complex channel margin habitat.

Ecological Indicators – Cispus Lower	
Indicator	**Description**
Natural vs. Human Disturbance	**Functional to Moderately Impaired** The primary change in disturbance regime is the backwater effect of Lake Scanewa at the downstream end, but this only really affects the very downstream end of the LU due to the high gradient channel.
Hydrologic Alteration	**Functional to Moderately Impaired** Lake Scanewa backwater affects channel conditions at the downstream end of the LU. Future climate change impacts are likely to increase flood events. IWA Rating "Functional" for upstream contributing area.
Sediment Processes	**Functional to Moderately Impaired** There is likely less bedload stored in this segment compared to historical conditions due to loss of in-stream wood. Otherwise, sediment processes are likely fairly unaltered. IWA Rating "Moderately Impaired" for upstream contributing area.

Large Wood Processes	**Moderately Impaired** In-channel wood abundance is relatively low because everything except large late seral stage trees have trouble self-stabilizing in this channel. There are occasional bank-attached fallen trees that remain along margins, but these do not persist for long. There is also wood that racks up on the upstream sides of islands or that is perched on the occasional bar features or on bedrock shelfs, but not much is engaged with the low flow channel.
Channel Type and Form	**Functional** There has been no major alteration because the channel is naturally confined. There likely has been a reduction in scour pools and backwater pools that would have been created by large jams, historically.
Floodplain Connectivity	**Functional** There has been no major alteration because the channel is naturally confined.
Lateral and Vertical Channel Dynamics	**Functional** There has been no major alteration because the channel is naturally confined. Lake Scanewa backwater likely has created aggradation of bedload material at the downstream end of the LU.
Off-Channel Habitat Connectivity and Refugia	**Functional** There has been no major alteration because the channel is naturally confined.
Riparian Processes	**Functional to Moderately Impaired** The upper portion of the LU in the National Forest has well-forested riparian zones and connected upland forests. Riparian forests are generally mature second growth, with some older stands. The lower portion, within private timber lands, generally has a forested 200-foot buffer of second growth forest, with connected upland forests ranging from recently clear-cut to mature second growth. USFS stream temperature monitoring shows some exceedances of the state criteria of 16°C for the 7-day moving average of the daily maximum (7-DADMax) on lower Greenhorn Creek, lower Iron Creek, lower Woods Creek, and the mainstem Cispus (USFS unpublished data). These exceedances suggest there may be some impairment to canopy cover.

12.4 Contributing Process Drivers

From upstream – There is coarse bedload and wood delivered to this LU from upstream, low gradient alluvial segments.

To downstream – Most material delivered to this LU channel segment is transported through to Lake Scanewa.

From tributaries – Major tributaries include Quartz, Woods, Iron, and Greenhorn. Quartz, Iron, and Greenhorn drain the southern range extending south towards Mount St Helens and are fairly steep, high bedload cobble and boulder systems as they enter the Cispus. These tributaries have flood signatures from the 2006 and/or the 1996 events based on the age of alder colonization on bars, indicating debris flow activity during at least the 1996 event. Woods Creek is lower gradient and drains more gentle topography between the Cispus and Cowlitz, with abundant headwater wetlands.

To tributaries – No significant influence.

12.5 Target Fish Use

The Cispus River in this LU has relatively lower gradient compared to upstream reaches and contains suitable spawning gravels for all species. The mainstem Cispus River between Iron Creek and the North Fork Cispus historically contained the best spawning habitat in the Cispus subbasin (McIntosh et al., 1990). Floodplain and off-channel habitats are limited as a result of natural valley confinement.

Historical and current fish use of tributaries within this LU is limited by gradient and barrier falls. Quartz Creek fish passage is limited by a barrier falls, and steelhead historically spawned up to the falls. Crystal Creek is steep and fish use is likely limited to downstream areas. Woods Creek historically had very low baseflow (1 cfs) and is too small and rough to provide salmonid habitat. Greenhorn Creek contains limited spawning habitat and has a barrier falls limiting fish passage upstream. Iron Creek supports steelhead and coho salmon spawning and rearing, and historical observations showed that fish were abundant up to the falls (McIntosh et al., 1990).

Chinook salmon critical habitat in this LU is contained in the mainstem Cispus River, while coho salmon and steelhead critical habitat also includes Quartz Creek, Iron Creek, Greenhorn Creek, and Woods Creek lower Twin Creek. Steelhead critical habitat also includes Crystal Creek.

The USFS has identified lower Iron Creek, Woods Creek, and the mainstem Cispus upstream of Iron Creek in this LU as having good potential to support salmon and steelhead (Ken Wieman, personal communication 2019).

12.6 Habitat Patch Connectivity

This channel segment is primarily an important migration corridor, with adult holding and likely steelhead parr rearing. Although it is not a critically important or threatened link between upstream and downstream segments, it does need to have at least some occasional holding pools and velocity refuge for juveniles during high flows.

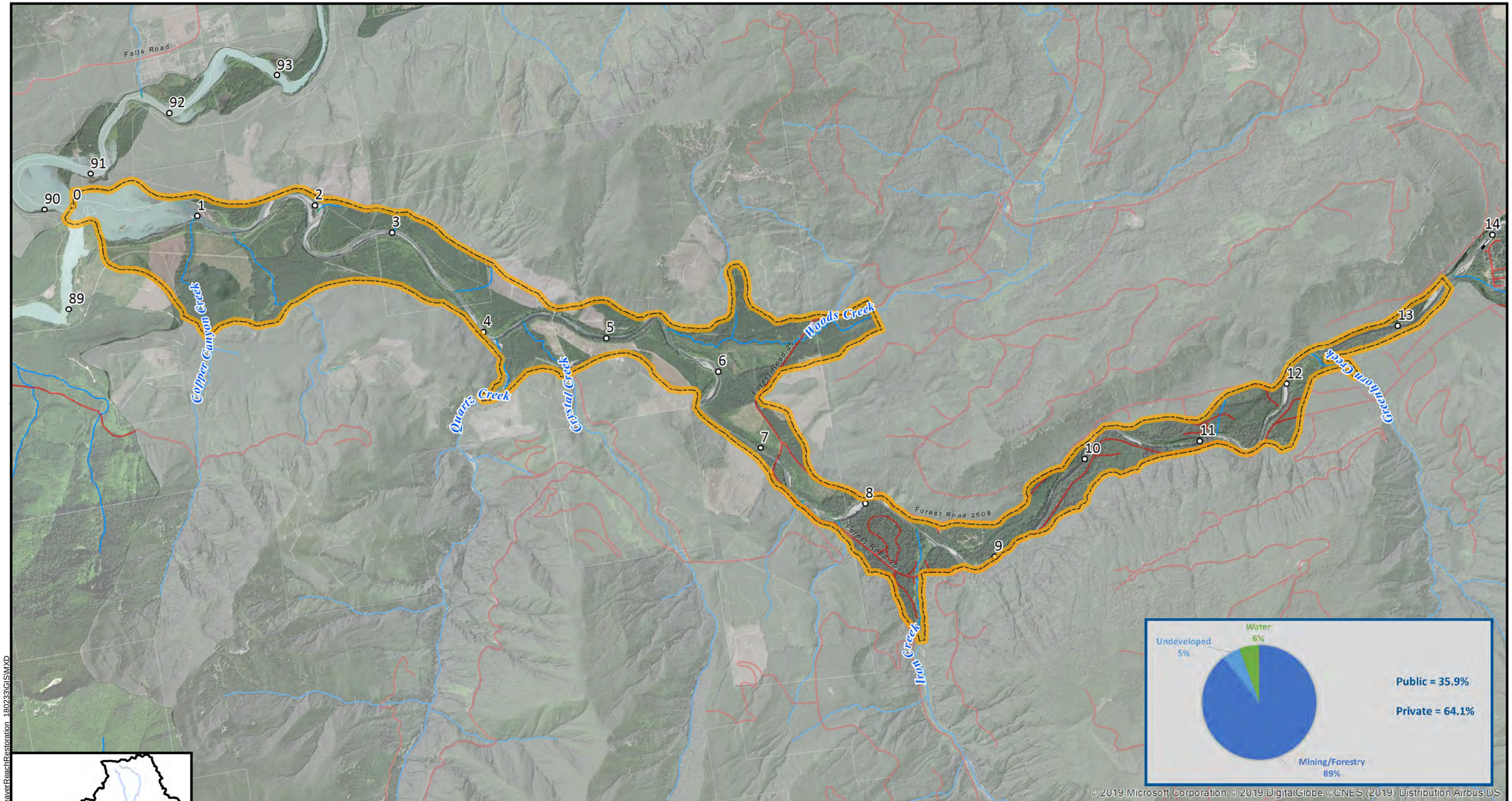
12.7 Management Plans, Past Studies, Projects

The upper section of this LU, above Greenhorn Creek, is included in the CMZ study (Herrera, 2004). The study identifying reaches for protection includes Cispus 1 (Quartz Creek) and Cispus 2 in this LU. Approximately 30% of this LU is within the Gifford Pinchot National Park and is guided by the Northwest Forest Plan and the WA DNR Forest Practices Act.

12.8 Landownership

Landownership in this LU is predominantly private, with forestry being the primary land use.

Figure 15. Representative images from the Cispus-Lower LU. A= looking downstream at RM7 at bridge. B=Iron Creek. C: RM 9, boulders and minimal in-channel wood.



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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 2,300 4,600 9,200 Feet

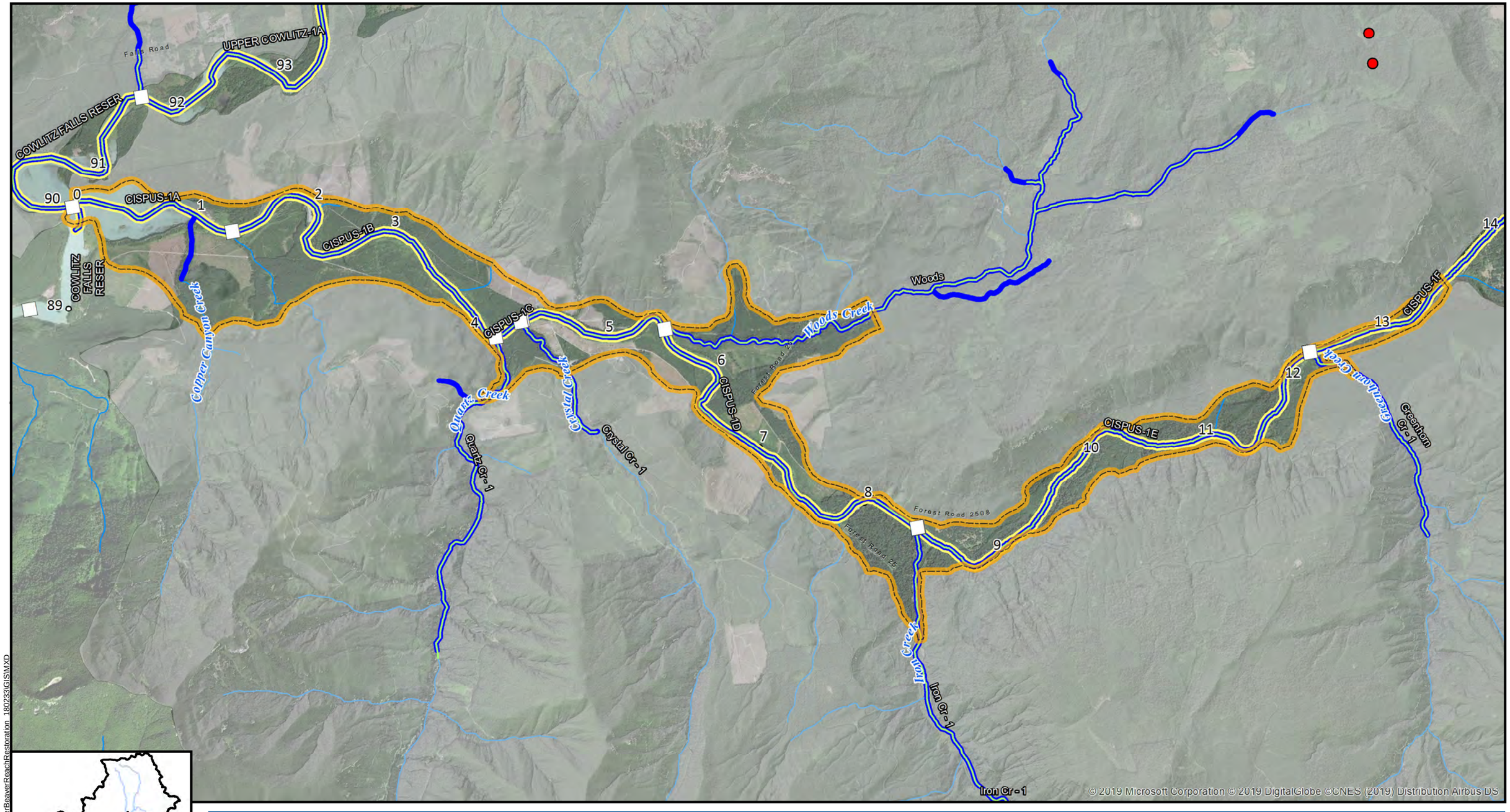
Landscape Unit Boundary
Parcel Boundaries
River Miles
Levee and/or Armoring
Roads

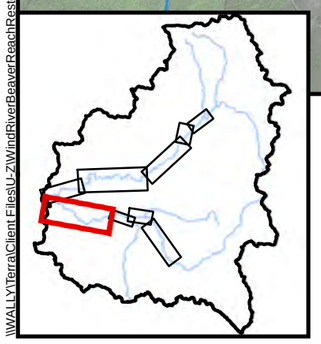
Landscape Unit Overview

Landscape Unit:

Cispus - Lower

Upper Cowlitz-Cispus Community-based Habitat Strategy Development





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*Underlying hillshade calclulated from multiple LiDAR datasets

*Imagery from Bing Maps

0 2,300 4,600 9,200 Feet

Landscape Unit Boundary
Recovery Plan Reach Breaks
River Miles

Species Distribution
Chinook Salmon
Coho Salmon
Steelhead Trout
Potential Barriers

Landscape Unit - Fish Distribution

Landscape Unit:

Cispus - Lower

Upper Cowlitz-Cispus Community-based Habitat Strategy Development

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