LIST OF PROJECT AREAS

Tier 1

Tier 2

Tier 3

ABBREVIATIONS

PA	Project Area
VM	valley mile
RM	river mile
cfs	cubic foot per second
mi	mile
ac/VM	acres per valley mile
FP	floodplain
ft	foot/feet
LiDAR	Light Detection and Ranging
NF	National Forest (road)
LWD	large woody debris
USFS	U.S. Forest Service
GIS	Geographical Information Systems

APPENDIX J.2
TIER 1: UNTREATED PROJECT AREAS

Project Area 2 Description

Project Area 2 begins at VM 43.10 at a bridge crossing for the NF-7 road and extends upstream to VM 43.66. The 2017 RM length is 0.64 mile, which is a relatively short reach. Field observations for this reach were conducted on October 11, 2018, when flow at the Starbuck gage was approximately 100 cfs.

The reach is near the upstream end of the Tucannon River reach assessment and includes characteristics that are typical of this part of the basin, such as little land use in the floodplain, steep average channel slopes, and generally narrower valley width.

Near the upstream end of PA 2, a spring is located in the right bank floodplain approximately 200 feet from the active channel. This spring continues in a surface channel for approximately 1,200 feet before joining with the main channel. At the time of field observations, flow from the spring was extremely low and went subsurface in multiple locations. Providing perennial connection between this spring and the main channel could provide off-channel habitat with a strong hyporheic connection and prevent stranding if the flows go subsurface during low-flow times.

The main channel is relatively well connected to the floodplain in the upper half of the reach. Several higher flow channels were observed with hyporheic or groundwater connection but no surface flow, indicating they are likely connected at higher

Project Area 2
Looking downstream at a single-thread, plane-bed channel. The single piece of wood is unlikely to stay in place for long.

Project Area 2 Reach Characteristics

VM Start (mi)	43.10
VM Length (mi)	0.56
Valley Slope	1.60%
RM Start (mi)	48.60
RM Length (mi)	0.64
Average Channel Slope	1.39%
Sinuosity	1.14
Connected FP (ac/VM)	9.87
Encroachment Removal (ac/VM)	2.22
Channel Aggradation (ac/VM)	2.85
Total FP Potential (ac/VM)	5.84
Encroaching Feature Length (ft)	71.10
Connected FP Rank	50

flows and would not require much effort to connect year-round. Near the middle of the reach, a 500-foot-long side channel exists on the right bank and seems to be maintained via a natural stable apex jam. Near this same area, the left bank has a large low-lying area that was inundated but not flowing at the time of the site visit. Just downstream of this area, several channel-spanning log jams were observed but did not appear to be stable. This reach also contains two rock "vortex" weirs, forcing large plunge pools. The downstream half of the reach is mostly a straight, plane-bed channel with a few mid-channel bars. During field observations, it was noted that this portion of the project area could benefit from the addition of instream wood for both habitat complexity and geomorphic process.

Throughout the reach, the large vegetation in the floodplain appeared to be mostly coniferous species set back into floodplain where there is likely less frequent inundation. The immediate riparian area contained mostly deciduous species that were much smaller in size (up to 15 feet high and 4 inches in diameter).

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows that PA 2 experienced very little geomorphic change. The GIS layer of highlighted areas shows two locations with minor bar building and channel migration (boxes 1 and 2). One additional location near the middle of the reach shows a minor channel avulsion and corresponds to the location of a stable apex log jam and side channel observed during field observations (box 3). It is possible that this instream wood will cause lasting geomorphic complexity in this area but it may also revert to the former plane-bed channel and disconnect from the side channel should the natural apex log jam wash away.

There are several factors that likely contribute to the lack of major geomorphic change within PA 2, other than the fact that no restoration work has been attempted in this reach to date. The reach has a lower average channel transport capacity, especially compared to other reaches in the upper basin. Additionally, while this reach has large, established vegetation in the floodplain, most of it is coniferous and set back from the immediate riparian area, making wood recruitment less likely and therefore causing less geomorphic change. This is supported by the fact that relatively little large wood was observed in the channel other than a few isolated log jams that may have washed in from upstream.

Geomorphic Characteristics and Restoration Strategies

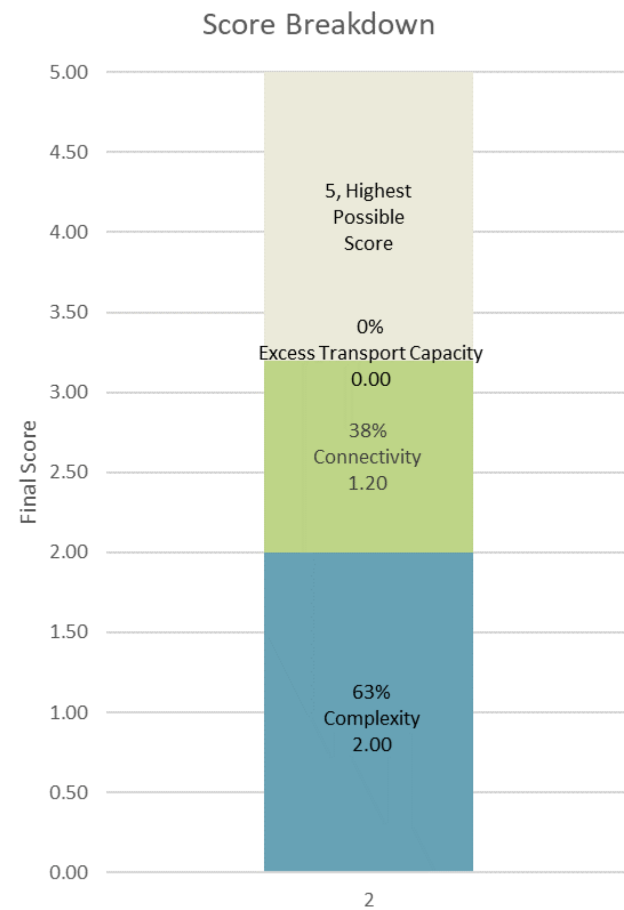
As shown in the following graphs and table, the Complexity metric makes up the majority of the score for PA 2, with a much smaller score for the Connectivity metric.

PA 2 scores in the 40th to 60th percentile for complexity, which is the range identified as having the most potential for complexity without being too confined to allow realistic projects to be completed. The existing complexity in this reach is driven mostly by one large side channel and several smaller split flows connected at the low-winter flow event. At the mean-winter and 1-year events, several more side channels are activated, but since most project areas in the assessment increase in complexity as flows increase, complexity for this project area is ranked evenly across all three flows for the Complexity analysis results.

Based on the 2-year floodplain inundation areas, and looking at the relative elevation map, there are multiple additional low-lying areas that could be activated as side channels. Excavating side channel blockages or raising water surface elevation should be the primary targets for restoration in this reach. These should be accomplished through the restoration strategies of cutting pilot channels, along with the strategic placement of instream wood to promote geomorphic change into these disconnected side channels.

Additionally, long stretches of PA 2 are a single-thread, plane-bed channel that, at a minimum, could be improved to have more in-channel complexity with split flows, mid-channel bars, and wood features. Channel dynamics in these stretches should be promoted through the addition of instream wood to the main channel, separate from pilot channel cuts. During field observations, bed material in this reach was noted to mostly consist of large cobbles and boulders. For this reason, as well as the desire to raise the bed elevation, gravel augmentation

PA 2 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

should also be considered a primary restoration strategy to promote aggradation, channel dynamics, and geomorphic changes in the project reach.

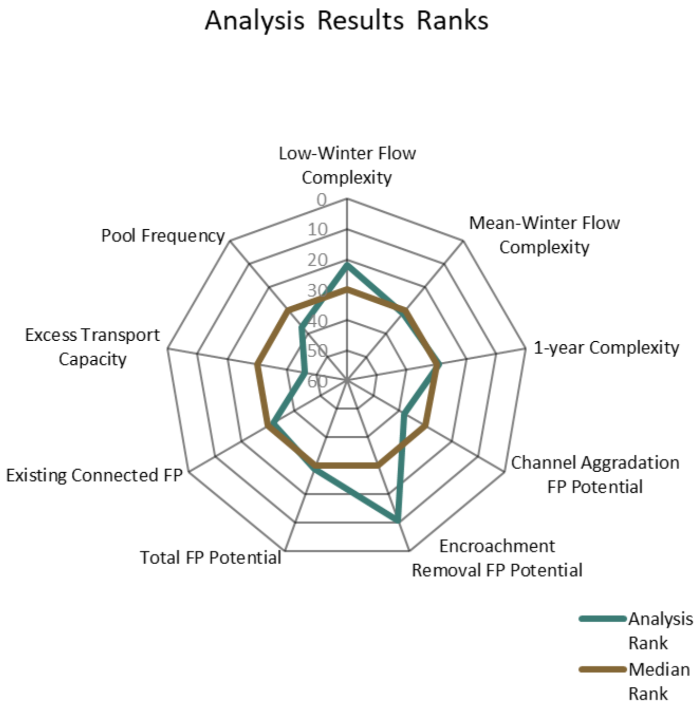
While not driven by a geomorphic metric analyzed in this assessment, PA 2 was noted during field observations to have some areas with sparse, mature vegetation in the immediate riparian area. Large woody material in the active channel is an essential part of the geomorphic process of this system; while artificially adding instream wood can jumpstart this process, in order for natural processes to be maintained long term, a supply of naturally growing wood in the accessible floodplain is essential. Riparian zone enhancement should be considered as a restoration strategy for this reach.

Finally, the pool frequency in this reach scores below average, which might reflect the fact that this reach has a very low supply of gravel material. Adding instream wood and gravel augmentation should promote the geomorphic processes that will promote and maintain pool frequency and depths throughout the reach.

Summary of Restoration Opportunities Identified

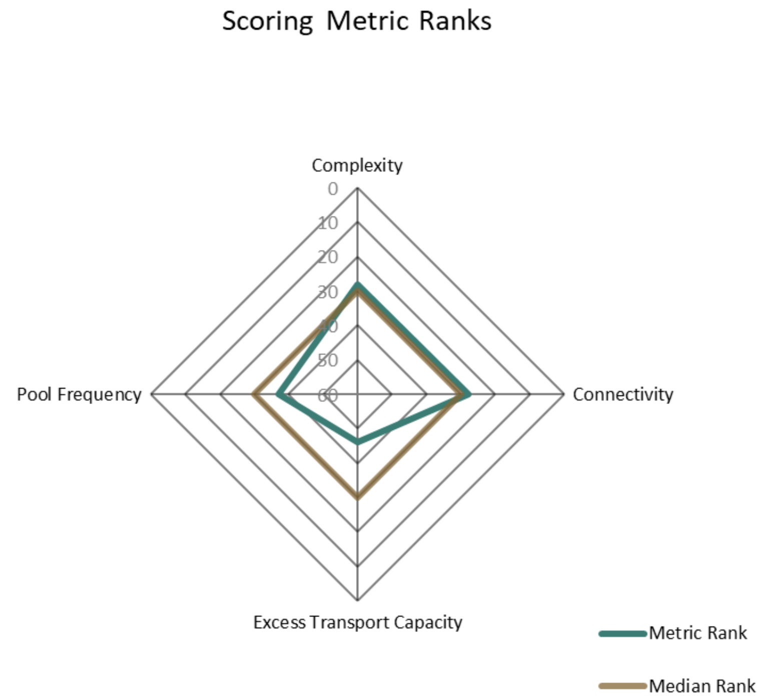
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)
- Riparian zone enhancement

PA 2 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

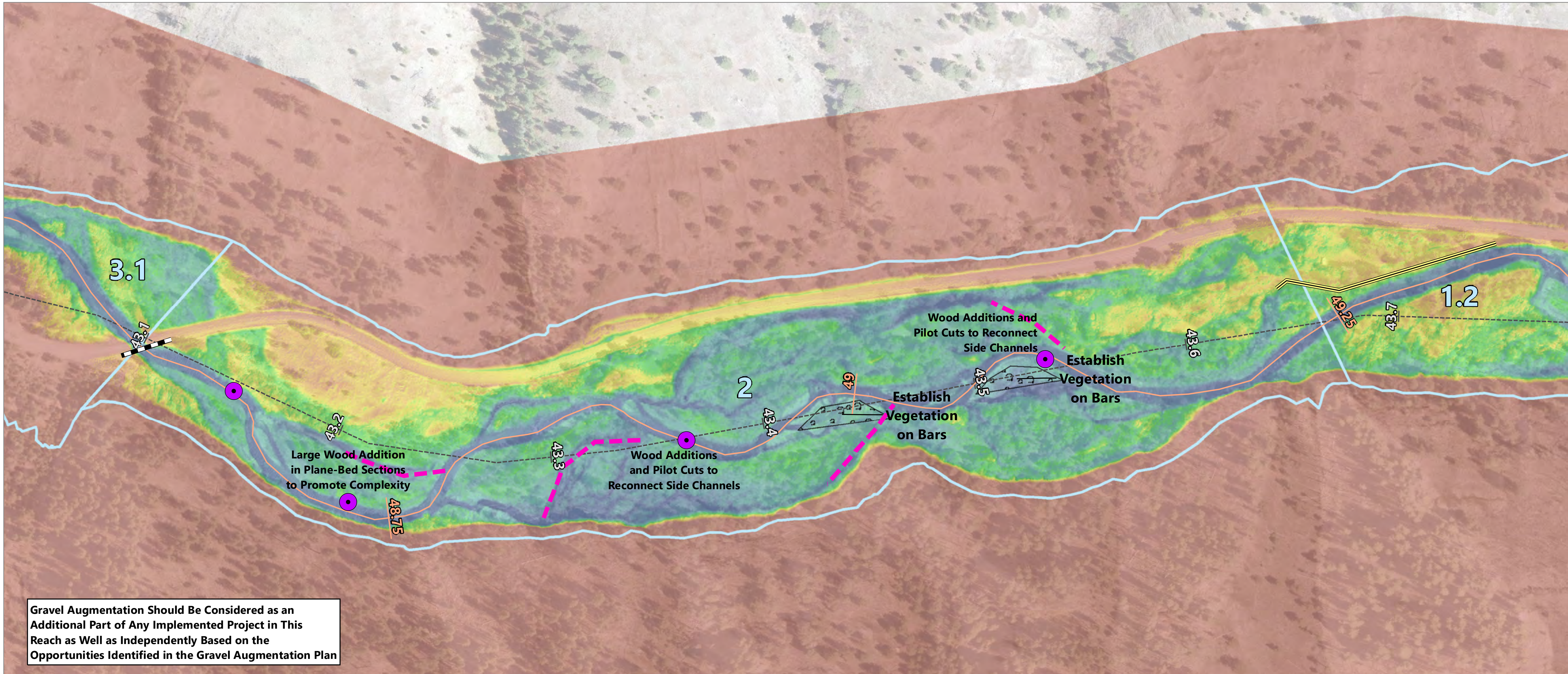
PA 2 Prioritization Scoring Summary

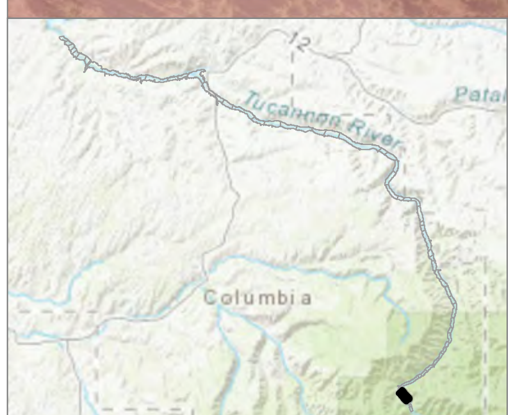


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 2 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.205	22	40%	Complexity	0.237	28	40% to 60%	3 of 5	5	40%	3.2	6	1	Untreated	5	1
Mean-Winter Flow Complexity	0.225	31	40%													
1-year Complexity	0.325	29	20%													
Channel Aggradation FP Potential	0.182	38	40%	Connectivity	0.203	28	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.141	11	40%													
Total FP Potential	0.372	29	20%													
Existing Connected FP	0.628	32	0%													
Excess Transport Capacity	-0.12	46	100%	Excess Transport Capacity	0.000	46	52% to 100%	4 of 4	0	20%						
Pool Frequency	9.33	37	100%	Pool Frequency	0.240	37	60% to 90%	4 of 5	1	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Riparian Enhancement

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 48.6
RIVER MILE END: 49.24
VALLEY MILE START: 43.1
VALLEY MILE END: 43.66

0 500
Feet

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ANCHOR QEA

Project Area 2
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 5 Description

Project Area 5 begins at the NF-160 bridge crossing for the USFS campground at VM 40.80 and extends upstream to VM 41.23. The 2017 RM length is 0.45 mile. Field observations for PA 5 were conducted on October 11, 2018, when flow at the Starbuck gage was approximately 100 cfs.

The upstream end of PA 5 begins at the end of a large levee in PA 4 for Camp Wooten. PA 5 itself is bounded on the left bank by the valley wall and Tucannon Road, and on the right bank by the road for Camp Wooten and the USFS campground.

For the majority of the reach, PA 5 is highly complex with multiple channel-spanning log jams forcing pools and side channels. A large amount of wood in PA-5 is the main contributor to this complexity throughout the entire reach. However, an abundance of easily transportable gravel material allows geomorphic change in this reach to happen easily as well.

On the right bank, the access road for Camp Wooten and the USFS campground prevent this complex reach from connecting to a large tributary and low swampy area along the valley wall. Removing the access road in its entirety may not be feasible, but at the downstream end there is some disconnected area past the USFS campground that could be reconnected.

On the left bank, several side channels or split flows come in contact with the valley wall and road prism where there is not

Project Area 5
Looking downstream at a large, natural, channel-spanning log jam forcing planform complexity, including an upstream pool and left bank high-flow path.

Project Area 5 Reach Characteristics

VM Start (mi)	40.80
VM Length (mi)	0.43
Valley Slope	1.51%
RM Start (mi)	46.09
RM Length (mi)	0.45
Average Channel Slope	1.39%
Sinuosity	1.06
Connected FP (ac/VM)	10.61
Encroachment Removal (ac/VM)	14.49
Channel Aggradation (ac/VM)	2.35
Total FP Potential (ac/VM)	21.79
Encroaching Feature Length (ft)	1,795.98
Connected FP Rank	44

much vegetation or overhanging cover, but in general riparian vegetation has large trees and good cover. In some areas of recent avulsions, gravel bars are bare but seem to be in the process of establishing vegetation.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows that a relatively large amount of geomorphic change has occurred in the last 7 years. Near the upstream end of the reach, a split flow has formed as the result of a log jam, and some minor erosion at the upstream end and deposition at the downstream end have also occurred (box 1).

Downstream, several more large, channel-spanning log jams have caused split flows, side channels, and excellent complexity. Deposition has occurred in the channel upstream of the channel-spanning log jam, and the channels downstream show signs of erosion and deposition causing more complexity and instream wood recruitment (box 2). Additional erosion and deposition as a result of another log jam has occurred just downstream of here (box 3).

Finally, at the downstream end of the reach, a large channel-spanning log jam has caused deposition in the channel and allowed flows into the floodplain, creating complex flow through this portion of the reach (box 4).

Multiple log jams and instream wood, along with an abundant supply of easily transportable material, has promoted geomorphic changes and good complexity throughout the reach.

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 5 receives the majority of its score from the Complexity and Connectivity metrics. PA 5 ranks in the 60th to 90th percentile of all project areas for complexity, indicating that while good complexity already exists in the reach, only a little more work is necessary to achieve the highest level of complexity in the basin. PA 5 ranks highly in all three complexity analysis results but slightly lower in the mean-winter and 1-year complexity analysis results. This indicates that some low-flow channels and split flows may be washed out during the higher flows. The complexity in this project area is driven by multiple natural log jams, and the primary restoration strategy for this reach should be to secure these log jams via piles or large rock. Additional instream wood should be considered as an additional restoration technique to ensure the complex split flows and side channels exist during all flow events.

PA 5 receives the highest possible score in the Connectivity metric, indicating it is within the highest percentile of project areas for floodplain potential. The Encroachment Removal analysis result ranks among the highest in the basin and is driven by the area behind the levee and road for Camp

Wooten. This large, low-lying area is associated with the tributary Hixon Creek and could provide a large amount of connected floodplain. Restoration opportunities to connect this would require moving the access for Camp Wooten possibly as a bridge upstream and partially inundating the nearby campground. While these restoration opportunities would be aggressive, they should be considered if the opportunity ever arises because the potential for floodplain reconnection is one of the highest in the watershed.

This project area receives no score in the Excess Transport Capacity metric, indicating that sediment material will likely be easily stored and maintained with the addition of instream wood. This reach has been a depositional reach over the past 7 years and has achieved good complexity as a result. Gravel augmentation likely is not necessary at this time; however, should geomorphic change begin to subside, gravel augmentation could be considered to maintain complexity.

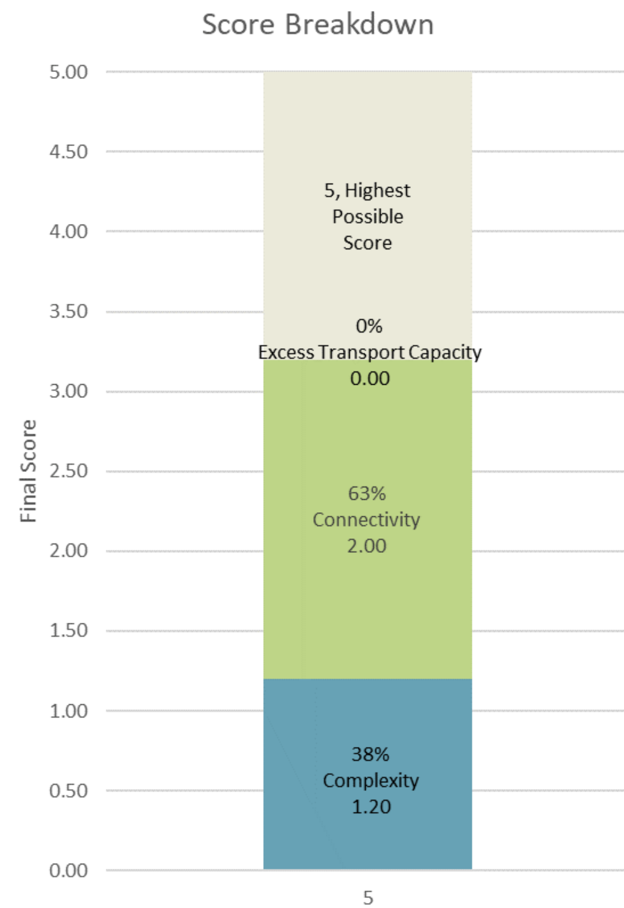
Summary of Restoration Opportunities Identified

- Remove levees and floodplain encroachments
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)

Long-Term Opportunities in this Project Area

- Relocate Camp Wooten access road to PA 4 and remove road and bridge in PA 5 for more floodplain connection and channel migration area.

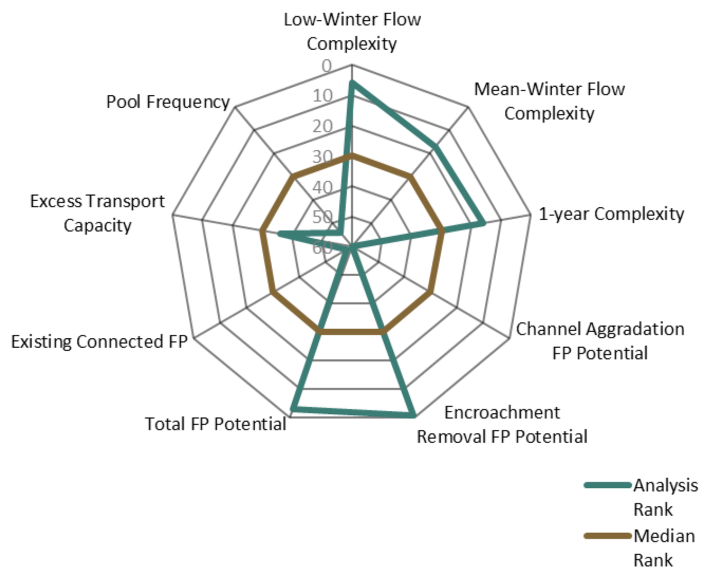
PA 5 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 5 Analysis Results Ranks

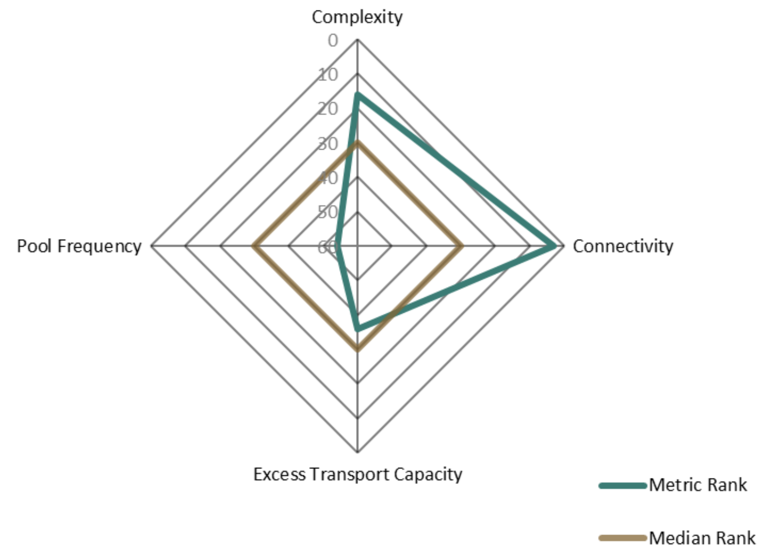
Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

PA 5 Scoring Metric Ranks

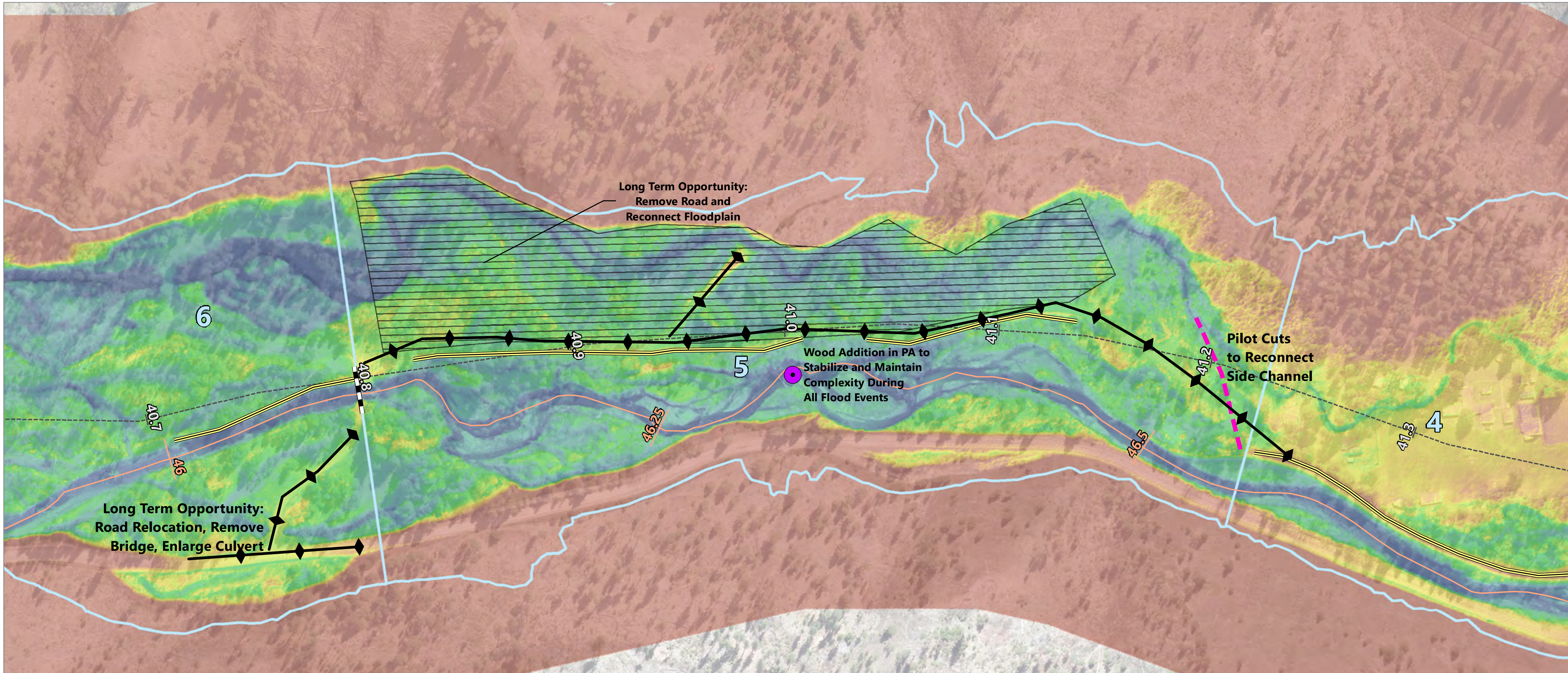
Scoring Metric Ranks

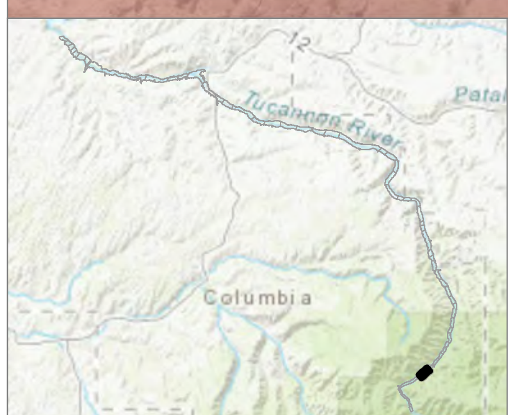


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 5 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.320	6	40%	Complexity	0.359	16	10% to 40%	2 of 5	3	40%	3.2	7	1	Untreated	6	1
Mean-Winter Flow Complexity	0.341	17	40%													
1-year Complexity	0.471	16	20%													
Channel Aggradation FP Potential	0.072	60	40%	Connectivity	0.342	3	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.447	1	40%													
Total FP Potential	0.672	3	20%													
Existing Connected FP	0.328	58	0%													
Excess Transport Capacity	-0.04	36	100%	Excess Transport Capacity	0.000	36	52% to 100%	4 of 4	0	20%						
Pool Frequency	4.41	54	100%	Pool Frequency	0.113	54	60% to 90%	4 of 5	1	0%						





LEGEND:
- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential
- Long Term: Relocate Road

Relative Elevation in Feet
High : 15
Low : -0

NOTES:
1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 46.09
RIVER MILE END: 46.55
VALLEY MILE START: 40.8
VALLEY MILE END: 41.23

0 500
Feet

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ANCHOR QEA

Project Area 5
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 14.3 Description

Project Area 14.3 begins at VM 33.0 and extends upstream to a bridge crossing for the Tucannon Road near Spring Lake at VM 33.64. The 2017 RM length is 0.72 mile. In 2014, the upper sections of this project area (PA 14.1 and PA 14.2) were the subject of a restoration project; however, the section of PA 14.3 below the bridge has remained untreated and was therefore separated for a distinct analysis. Field observations for PA 14.3 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization. The updated analysis performed for this assessment is described in detail as follows.

This reach is adjacent to the WFDW headquarters, and, while the channel is single thread and often plane-bed, it has well connected floodplain and was marked as "transitioning" into better habitat in 2011. During the previous assessment, channel migration, LWD recruitment, and development of instream and channel complexity were all observed through this area. In 2011, a higher amount of temporary sediment deposition and wider active channel were noted in this portion of the old PA 14.

In PA 14.3, riparian trees are mixed deciduous and conifers, dominated by alder, cottonwood, locust, and ponderosa pine. Some areas contain several snags, dying trees, or burnt mature trees. In 2011, this reach was populated by several very large mature cottonwoods, some of which were being actively

Project Area 14.3
Photograph taken from the 2011 prioritization showing wood recruitment in the channel.

Project Area 14.3 Reach Characteristics

VM Start (mi)	33.00
VM Length (mi)	0.64
Valley Slope	1.30%
RM Start (mi)	37.16
RM Length (mi)	0.72
Average Channel Slope	1.11%
Sinuosity	1.13
Connected FP (ac/VM)	13.69
Encroachment Removal (ac/VM)	2.89
Channel Aggradation (ac/VM)	7.16
Total FP Potential (ac/VM)	10.35
Encroaching Feature Length (ft)	978.96
Connected FP Rank	29

recruited to the channel. The understory was relatively dense with moderately diverse species in most areas. Some areas were dominated by invasive grasses or other weedy plants.

Geomorphic Changes

For a reach of less than 1 river mile, PA 14.3 has undergone a relatively large amount of change based on analysis of the difference between the 2010 and 2017 LiDAR data. Additionally, while not geomorphic change, the change analysis identified the removal of an old bridge embankment downstream of the current bridge on both banks (box 1). It is unclear what effect this removal has had on the remainder of the reach because this change is isolated from other change locations in the reach. Just downstream of the embankment removal, the channel appears to go through a major depositional zone for approximately 1,200 feet. Large sediment deposit areas have formed on the inside of four consecutive bends, with major corresponding bank erosion on the outsides of several of these bends. This lateral movement is likely resulting in the recruitment of floodplain wood and sediment as the river pushes into the floodplain and could be a source of more downstream deposition because the meander bend in this bow was cut off in 2018/2019 by cutting the high-flow channel leaving an alcove at the bottom of the meander (box 2).

Immediately downstream of the depositional reach, a large channel-spanning log jam is evident in the 2018 aerial imagery that corresponds to a major erosion area on the left bank. It is possible that the backwater from this log jam has resulted in lower transport capacity in the reach upstream, causing the deposition and lateral movement noted there. However, this debris jam could be unstable, and the geomorphic processes likely caused by it could be only temporary (box 3).

Downstream there is evidence of more outside bank erosion on both the left and right banks, with the more downstream location being additionally associated with deposition and bar building on the inside of the bend. This location is also associated with a high-flow channel that appears to have some minor deposition and erosion, likely formed during higher flows. If this erosion continues, it could open up a more frequently flowing side channel on the right bank (boxes 4 and 5).

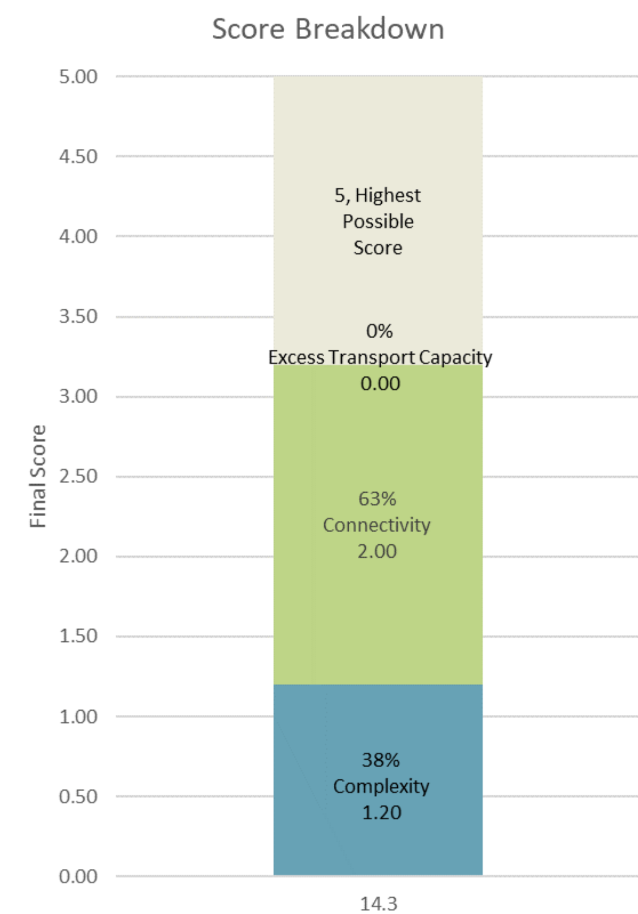
Finally, near the downstream end of the project area, a major channel migration is occurring towards the right bank with approximately 50 feet of lateral movement. This avulsion is likely the source of material found in the upper end of PA 15.1. This change occurs just upstream of a location where the channel makes a sharp bend to run along the valley wall on the left bank. Just downstream on the right bank there is a low swampy area that could be an old meander scar identified during field visits to PA 15.1. It is possible that this channel migration could eventually occupy this low elevation area, allowing flow to move away from the valley wall and possibly causing split flow. If this happens, the two channels would likely need to be stabilized and it is possible that a split flow could be accelerated with restoration work.

While this reach shows several major locations of geomorphic change and seems to be on a promising track towards recovering natural processes, it is evident that much of this change has been encouraged by a large amount of available sediment being deposited in the reach. The reaches immediately upstream were the target of restoration activities since the last assessment and it is possible that geomorphic change there could have allowed sediment stored in the floodplain to be mobilized. Regardless of the source, it is possible that much of this change is temporary in nature if the sediment supply is not continuous.

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 14.3 received the highest possible score in the Connectivity metric with the most potential in restoration strategies targeting channel aggradation. In addition, PA 14.3 receives a moderate score in the Complexity metric, which indicates that it ranks above average in the 60th to 90th percentile, a range that shows good existing complexity but does not place it in the top 10% of project areas, an objective that could be achieved with relatively little effort. For PA 14.3, the low-winter flow complexity analysis result ranked very poorly, falling in the bottom 10% of project areas, and is driven by one small island near the upstream end

PA 14.3 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

of the project area. However, at the mean-winter and 1-year flow events, complexity analysis results showed greater complexity, ranking in the top 10% at the 1-year flow. This change is primarily driven by the mean-winter flow activation of several long side channels in a low-lying area on the right bank floodplain near the middle of the reach. The islands formed by these side channels are further fractured by additional channels during the 1-year event, making this an extremely complex reach during higher flows. Restoration strategies targeting complexity in this reach should focus on allowing perennial flow to access the already existing high-flow channels so that the complexity seen at the 1-year flow is realized year-round.

The high Connectivity metric score is primarily driven by the channel aggradation potential, which scores in the top 25% among project areas. This high score is likely due to a large, low-lying area on the left bank near the end of the reach that is connected at the 5-year event but disconnected at the 2-year event. Currently, this area is disconnected by a high bank, but there appears to be several high-flow paths at the upstream end. Additionally, this area could be connected either by raising the water surface elevation via channel aggradation or by encroachment removal of the high bank, but there is more potential benefit in raising the water surface elevation in this area. There are some additional areas on the right bank near the upstream end of the project area that are disconnected at both the 5-year and 2-year events, but they are generally smaller and are disconnected by a larger distance, making reconnection more difficult.

Because channel aggradation would benefit both driving metrics of complexity and connectivity potential in this reach, restoration strategies should focus on storing and retaining sediment in this reach. Transport capacity was ranked just below average, which indicates that added sediment in this reach should be easily retained, and gravel augmentation should be a primary restoration strategy. Pilot channel cuts should also be considered as a restoration option to reconnect these disconnected flow paths.

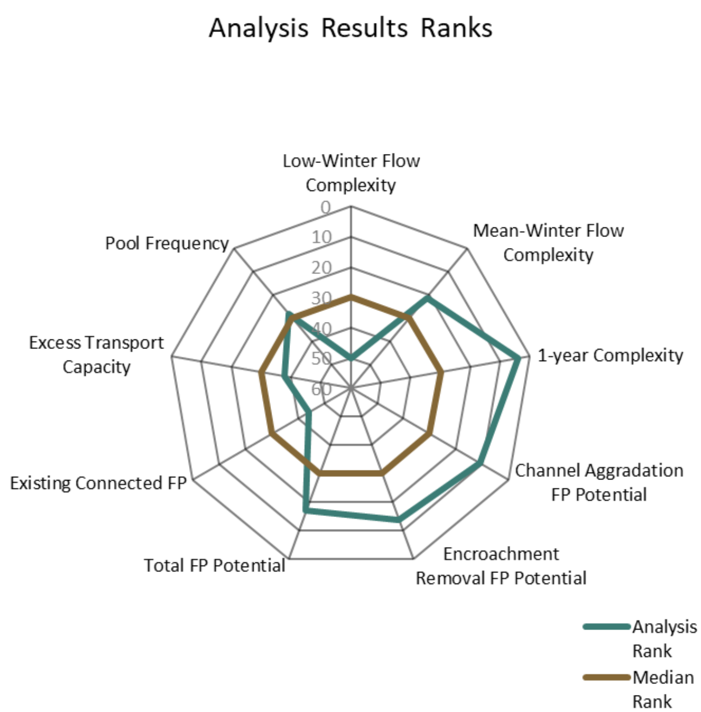
Restoration efforts should then focus on adding instream wood and floodplain structure to stabilize existing flow paths, retain sediment, and allow additional flow onto the floodplain, in addition to gravel augmentation. Because the 2018 aerials show several large log jams, instream and floodplain structure could be accomplished by either adding additional wood or securing natural recruits instream provided they are still in place.

Finally, PA 14.3 scores near the average for the assessment area in the Pool Frequency metric, indicating a moderate amount of already existing pools. The identified restoration strategies of pilot channel cuts, adding instream wood, and gravel augmentation should promote the natural processes that will encourage and maintain pool formation.

Summary of Restoration Opportunities Identified

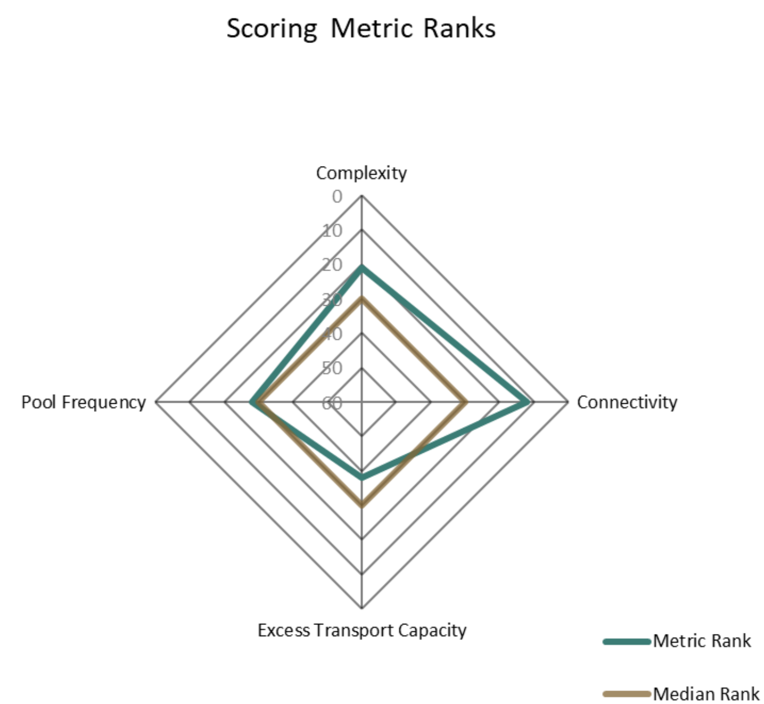
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)

PA 14.3 Analysis Results Summary s



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

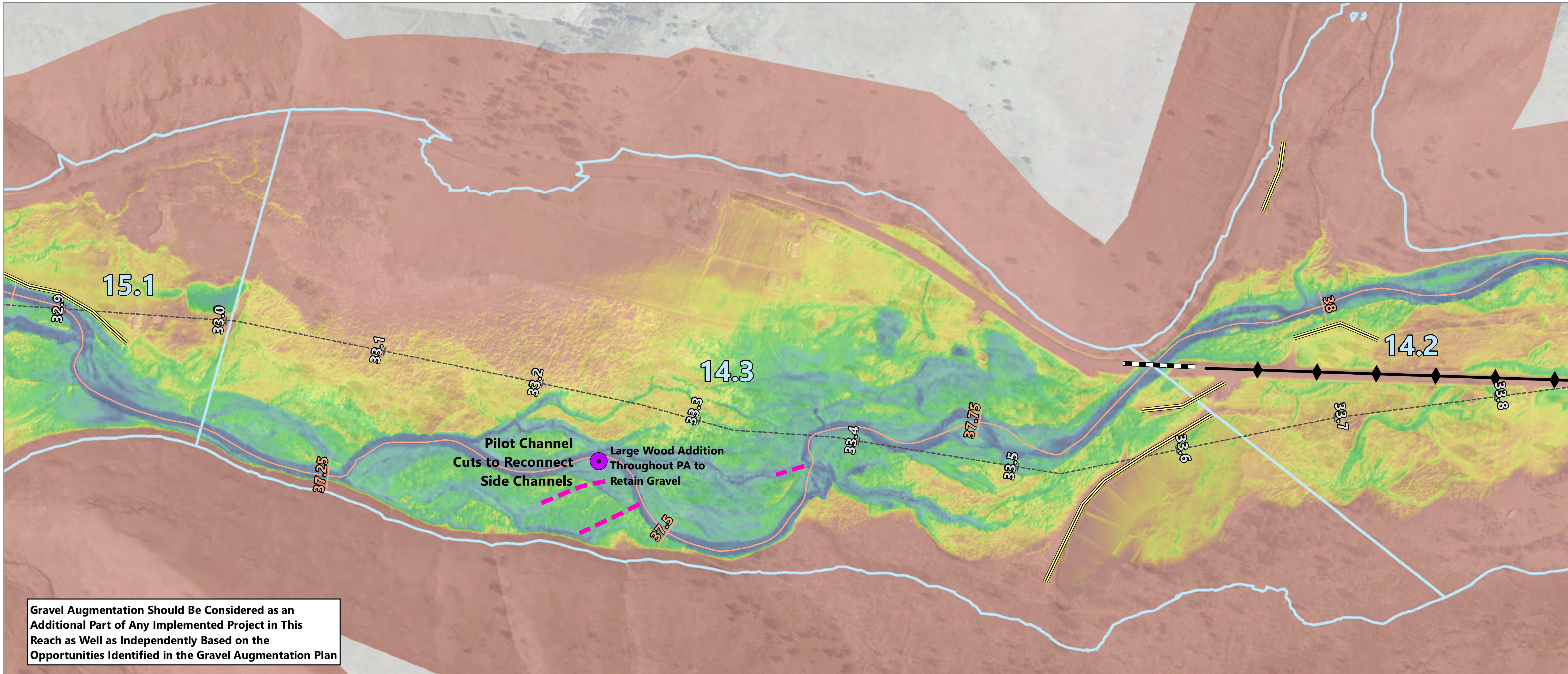
PA 14.3 Prioritization Scoring Summary

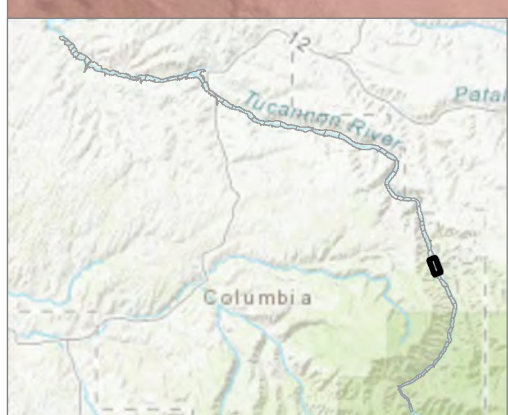


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 14.3 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.094	50	40%	Complexity	0.306	21	10% to 40%	2 of 5	3	40%	3.2	10	1	Untreated	7	1
Mean-Winter Flow Complexity	0.303	21	40%													
1-year Complexity	0.738	4	20%													
Channel Aggradation FP Potential	0.298	11	40%	Connectivity	0.253	12	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.120	14	40%													
Total FP Potential	0.431	17	20%													
Existing Connected FP	0.569	44	0%													
Excess Transport Capacity	-0.05	38	100%	Excess Transport Capacity	0.000	38	52% to 100%	4 of 4	0	20%						
Pool Frequency	11.11	28	100%	Pool Frequency	0.285	28	40% to 60%	3 of 5	5	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Long Term: Relocate Road

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 37.16
RIVER MILE END: 37.88
VALLEY MILE START: 33
VALLEY MILE END: 33.64

0 500
Feet

Publish Date: 2021/01/25, 3:46 PM | User: mgieschen
Filepath: \\orcas\gis\Jobs\TucannonRiver_1006\Maps\Conceptual Maps\Tucannon Untreated Project Areas_mg.mxd

ANCHOR QEA

Project Area 14.3
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 18.2 Description

Project Area 18.2 begins at VM 28.78 and extends upstream to a bridge crossing for the Tucannon Road near Hartsock Grade Road at VM 29.48. The 2017 RM length is 0.78 mile. Field observations for PA 18.2 were not conducted in 2018 as part of this assessment update. However, the upper section of PA 18.1 was part of a restoration project and was treated recently before data were collected in 2017. This has likely had an effect on PA 18.2, immediately downstream, that is not yet reflected in the data. The remainder of this site description was taken from the 2011 prioritization.

In 2011, no significant infrastructure was observed downstream of the bridge. Aggradation and channel expansion was observed throughout much of the project area, as evidenced by bank erosion, high volumes of sediment deposition, and multiple flow path development.

The complex instream hydraulic conditions created by the presence of large wood, the ability of the river to migrate, and the high volume and supply of bed load sediments create relatively good instream habitat conditions in a majority of the project area. Deep pools at recruited trees were providing ample holding areas for adults, and cover and refuge for juvenile fish. There were several side channels, particularly downstream of the bridge, that provided excellent off-channel rearing habitat.

Project Area 18.2
No site photograph available.

Project Area 18.2 Reach Characteristics

VM Start (mi)	28.78
VM Length (mi)	0.70
Valley Slope	1.21%
RM Start (mi)	32.46
RM Length (mi)	0.78
Average Channel Slope	1.06%
Sinuosity	1.11
Connected FP (ac/VM)	13.36
Encroachment Removal (ac/VM)	2.02
Channel Aggradation (ac/VM)	5.28
Total FP Potential (ac/VM)	8.80
Encroaching Feature Length (ft)	1,457.96
Connected FP Rank	30

The floodplain in this project area was relatively well-connected and contained a large quantity of low-lying floodplain. Small sections of remnant levees and spoils were located in a few places; however, the influence of these features to natural processes appeared to be insignificant.

Downstream of the bridge, the riparian zone was wider and contained a greater number of mature trees, better species diversity, and greater plant density. Riparian trees in the project area were primarily deciduous, dominated by cottonwoods, dogwoods, and alders, with few conifers.

The wetland on the downstream side of the bridge was ponded and perched above the river water surface elevation; the source of the water was unclear. The wetland on the right bank upstream of the bridge span was disconnected from the channel by a levee and did not appear to contain surface water.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows several major geomorphically induced changes in PA 18.2. At the upstream end of the reach, a large deposition of sediment is evident in the main channel for a stretch of several hundred feet. A side channel has formed on the right bank as a result and may eventually become an avulsion location, but as of the 2018 aerial imagery, flow was still present in the main channel. A large erosional reach just upstream in PA 18.1 could be the source of this sediment, although several other erosional locations are also noted in that reach (box 1).

Near the middle of the reach, a large avulsion into the right bank floodplain has occurred since 2010, with a depositional area at the head of the former main channel and erosion and channel downcutting in the new channel on the right bank floodplain. The 2018 aerial imagery shows some of the former channel is inundated, but it appears surface flow is cut off by the material deposition at the flow split. The 2018 aerial imagery also shows several large log jams in the new channel (box 2).

Just downstream of where the new channel returns to the former channel location, the channel goes through a sharp left meander bend that is scouring the right bank (box 3). It is possible that high flows are cutting off the next meander bend at this location; just downstream a side channel appears to be headcutting across the meander (box 4). It is likely these processes will cause the channel to cut off and possibly abandon this meander bend.

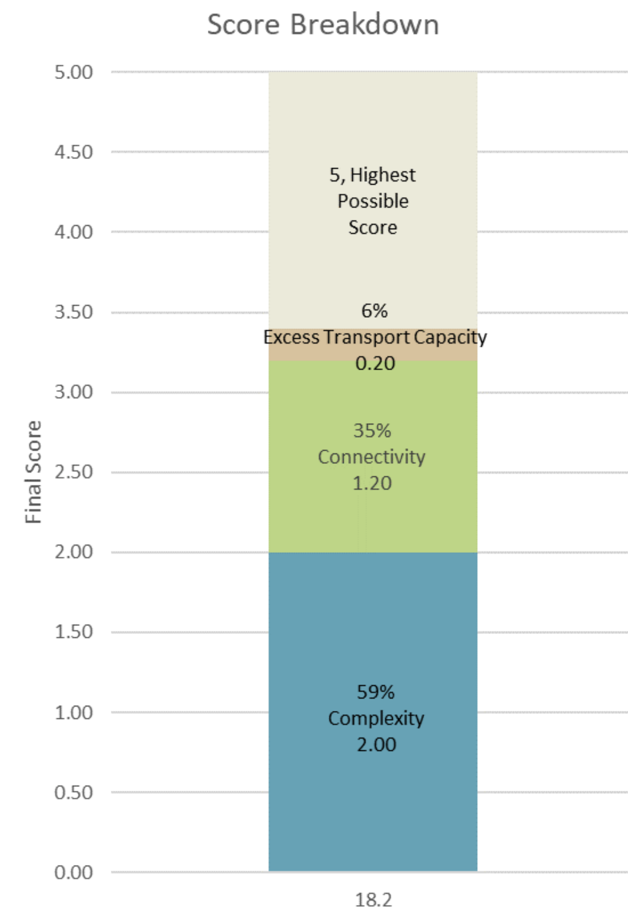
Finally, at the very downstream end of the reach, a small meander appears to have been blocked by a log jam and sediment deposition. The channel has avulsed a short distance into the left bank floodplain and now runs directly against the left bank valley wall, as it continues to do in the upper portion of PA 19 (box 5).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 18.2 receives the majority of its score from the Complexity prioritization metric. PA 18.2 ranks near average for Complexity in the 40th to 60th percentile, which is a range that has been identified as having the most potential for complexity restoration. The analysis results for complexity at all three flows are relatively average compared to the other project areas, with the low-winter flow being slightly below average and the high flow being slightly above average. At the low-winter flow, the complexity score is driven by two moderately sized side channels near the upstream end of the project area. At the mean-winter flow, these two areas become more complex with several secondary side channels splitting off and bisecting the resulting islands. However, the downstream portion of the reach remains relatively uncomplex with only one small side channel. At the 1-year flow, a long side channel is activated in the middle of the reach near the site of the avulsion discussed in the section above.

Based on the area inundated in the 2-year event, as well as the relative elevation map, PA 18.2 has much more potential for complexity throughout the reach. There appear to be several side channels, not activated at any of the three flows, that could increase complexity in this reach across the board. Restoration strategies in this reach should focus on activating these flows

PA 18.2 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

through adding instream structure and large woody material to promote geomorphic change as well as reconnecting some of these side channels through pilot channels or benching and removing high banks.

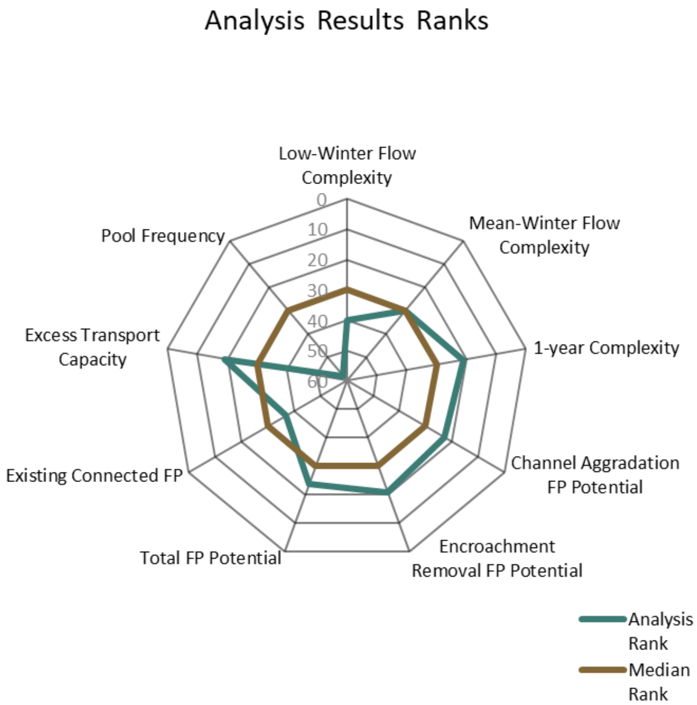
PA 18.2 also receives a low score in the Connectivity metric. Most of this disconnected area is located in the form of disconnected side channels and former channel locations in the floodplain. Employing the strategies of adding instream wood and cutting strategic pilot channels could have the added benefit of reconnecting the disconnected floodplain area near the downstream end of the reach. This reach receives a low score in the Excess Transport Capacity metric, indicating that any sediment transported into this reach will be easily stored and maintained with instream wood structure. While gravel augmentation is not a primary restoration strategy for this reach, the addition of gravel material could help to jumpstart geomorphic change and increase complexity and connectivity.

Finally, PA 18.2 ranks very low among project areas for the Pool Frequency metric. Adding instream wood and connecting side channels via pilot channel cuts will promote changes towards an increase in channel complexity, promoting the formation of pools. These restoration strategies should be employed to target increasing pool frequency in the reach.

Summary of Restoration Opportunities Identified

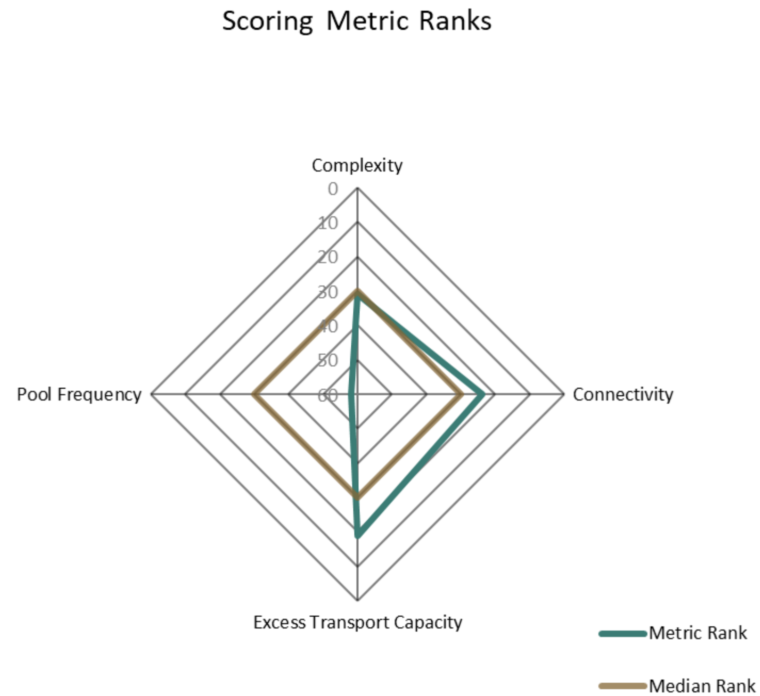
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)

PA 18.2 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

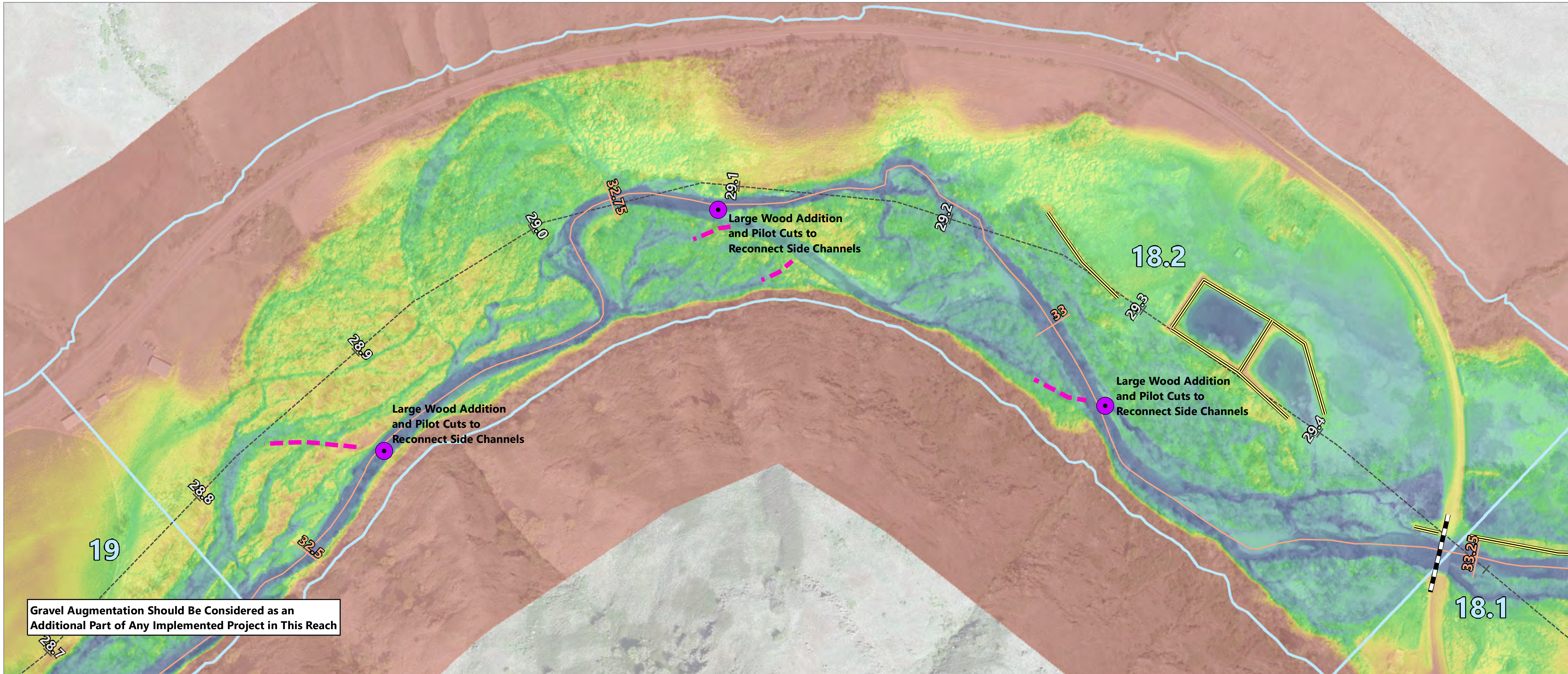
PA 18.2 Prioritization Scoring Summary

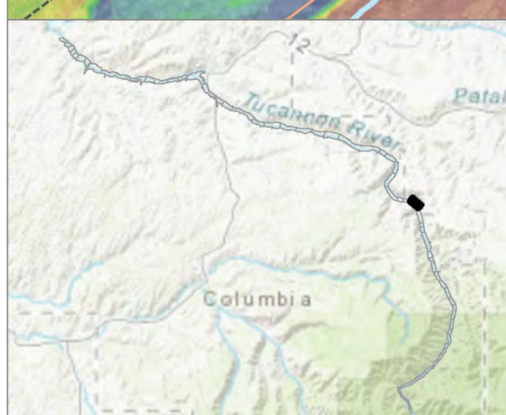


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 18.2 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.120	40	40%	Complexity	0.222	31	40% to 60%	3 of 5	5	40%	3.4	3	1	Untreated	3	1
Mean-Winter Flow Complexity	0.245	30	40%													
1-year Complexity	0.380	21	20%													
Channel Aggradation FP Potential	0.238	23	40%	Connectivity	0.211	24	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.091	21	40%													
Total FP Potential	0.397	24	20%													
Existing Connected FP	0.603	37	0%													
Excess Transport Capacity	0.12	19	100%	Excess Transport Capacity	1.000	19	30% to 52%	3 of 4	1	20%						
Pool Frequency	1.29	58	100%	Pool Frequency	0.033	58	90% to 100%	5 of 5	0	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel

Relative Elevation in Feet
High : 15
Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 32.46
RIVER MILE END: 33.24
VALLEY MILE START: 28.78
VALLEY MILE END: 29.48

0 500
Feet

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ANCHOR QEA

Project Area 18.2
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 20 Description

Project Area 20 begins at VM 27.91 and extends upstream to a bridge crossing for the Tucannon Road at VM 28.31. The 2017 RM length is 0.44 mile, which makes PA 20 relatively short compared to the other project areas. Field observations for this reach were conducted on October 29, 2018, when flow at the Starbuck gage was approximately 110 cfs.

Field observations and aerial imagery show a large sediment deposit that is immediately evident under the bridge at the upstream end of the reach. The geomorphic change analysis supports the idea that major aggradation has occurred at the upstream end of the reach. Similar to the conditions described in the previous Conceptual Restoration Plan (Anchor QEA 2010a), the upstream half of the reach is complex and multi-threaded, with multiple alder and cottonwood trees in the channel forcing several split flows and slow-moving side channels.

The downstream portion of the reach transitions to a single-thread, plane-bed channel, which continues into the reach immediately downstream (PA 21). The high left bank at the downstream end provides limited vegetation and little habitat opportunity, possibly due to grazing practices that were evident on the left bank during field observations. At the furthest downstream end of the reach, the channel is pinned between the valley wall on the right bank and a small levee and high floodplain on the left.

Project Area 20
Looking downstream, multiple pieces of instream wood and channel avulsions have caused floodplain connectivity and complexity.

Project Area 20 Reach Characteristics

VM Start (mi)	27.91
VM Length (mi)	0.40
Valley Slope	1.43%
RM Start (mi)	31.46
RM Length (mi)	0.44
Average Channel Slope	1.30%
Sinuosity	1.08
Connected FP (ac/VM)	16.55
Encroachment Removal (ac/VM)	1.17
Channel Aggradation (ac/VM)	6.08
Total FP Potential (ac/VM)	8.42
Encroaching Feature Length (ft)	434.03
Connected FP Rank	22

Because PA 20 is a short reach, any project implemented in this area could likely include the upstream or downstream project areas (PA 19 and PA 21, respectively). PA 19 and PA 21 both rank as Tier 2 Untreated projects, although PA 19 scores higher than PA 21. Both upstream and downstream project areas are very limited in floodplain opportunities, making the availability of floodplain potential in PA 20 more significant.

From the time of the previous assessment, it appears this reach has remained relatively constant with respect to large-scale geomorphic processes. The upper part of the reach is relatively complex with active migrations and wood recruitment, while the lower end is a stable plane-bed channel. The riparian and floodplain vegetation is still largely in poor condition, likely due to grazing activities in the area.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows several major geomorphic changes have occurred. At the upstream end of the reach, major aggradation of 1 to 4 feet has occurred for approximately 300 feet of the main channel. The beginning of this feature coincides with the location of the bridge at the upstream end of the reach, and it is possible that backwater and loss of energy from the bridge has caused sediment to deposit in this location. PA 20 ranks low in stream power compared to the other project areas, indicating that it may also be a depositional reach. The source of this sediment deposit is unclear; the project area just upstream (PA 19) shows some minor geomorphic change but not enough to account for the volume deposited here (box 1).

Regardless of the source, the deposition has caused major channel avulsions in the downstream half of the reach, with erosional areas on first the left bank and then the right bank as the channel begins to meander. These erosional areas are likely the source of the woody material observed during site visits throughout the reach. It is evident that the woody material has caused further erosional change downstream, and at about halfway down the reach the channel has left the location it occupied completely and moved into the right floodplain, creating split flow conditions at all but the lowest flows (boxes 2 and 3).

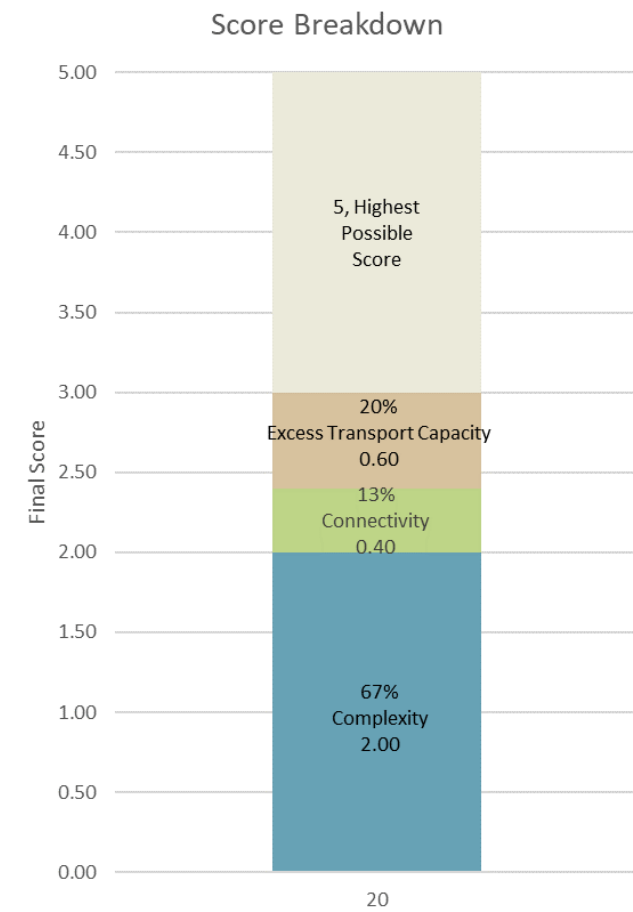
It should be noted that the processes ongoing in this reach and described here are similar to the results sought after with the gravel augmentation restoration strategy. Easily mobilized material from upstream gravel augmentation is deposited after moderate flow events, causing avulsions and erosion into the floodplain just downstream. These avulsions recruit more bedload material and woody material from the floodplain, hopefully repeating the cycle downstream.

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, the Complexity and Connectivity metrics make up the majority of the score for PA 20. The project area ranks particularly high in the Encroachment Removal analysis result and much lower in the Channel Aggradation analysis result, indicating most of the potential for improving floodplain connection lies in the restoration target of reconnecting disconnected floodplain. This may be because the reach has already undergone significant channel aggradation and has already achieved most of this potential at the 2-year flow event. Pilot channel cuts or encroachment removal, along with the addition of instream wood to reconnect disconnected floodplain, should be considered as primary restoration strategies for the reach.

PA 20 also receives a high score in the Complexity metric, ranking near the average in the 40th to 60th percentile of project areas. This range has been identified as having the most potential for complexity restoration for this assessment. The low-winter, mean-winter, and 1-year complexity analysis results all fall near the median of project areas and have similar respective rankings. This indicates that existing side channels are connected at the low-winter flow event and are stable even at the higher flow events. Because the upstream end has already seen aggradation as noted in the above section, this reach could possibly have the sediment supply to affect geomorphic change but not have the physical

PA 20 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

in-channel structure to hold this sediment long enough to establish vegetation on exposed islands and bars. For this reason, complexity should be increased through the addition of woody material and in-channel structural hardpoints to maintain the sediment transport process of the reach. Removing encroaching features in the reach will primarily benefit floodplain reconnection but will also allow for more complexity as secondary flow paths open up.

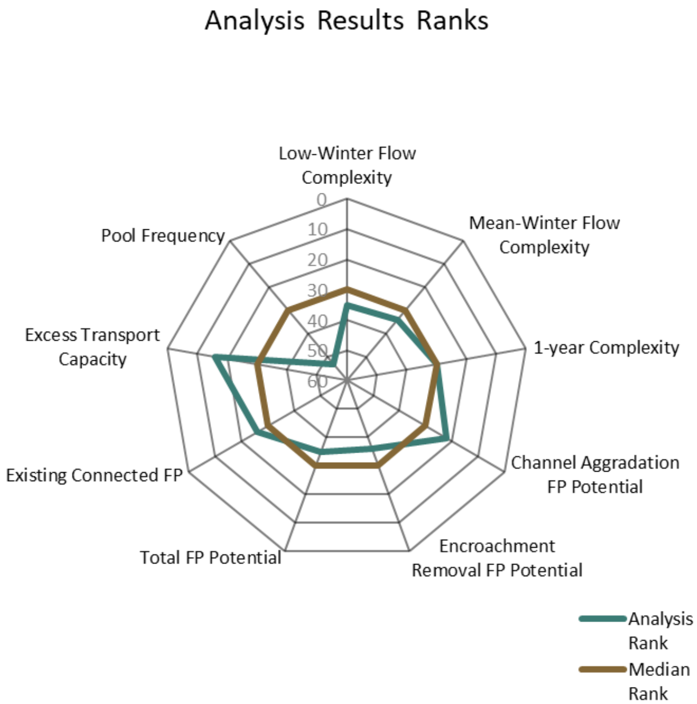
Finally, PA 20 ranks very low among project areas for the Pool Frequency metric. Adding instream wood and removing encroaching features will promote changes towards an increase in channel complexity, promoting the formation of pools. These restoration strategies should be employed to target increasing pool frequency in the reach.

Summary of Restoration Opportunities Identified

- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)

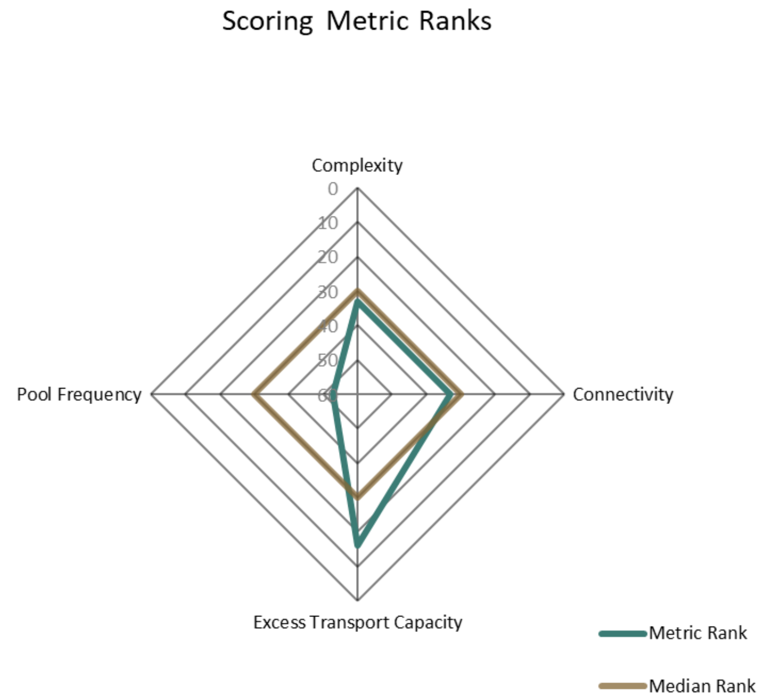
PROJECT AREA 20 TIER 1: UNTREATED

PA 20 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

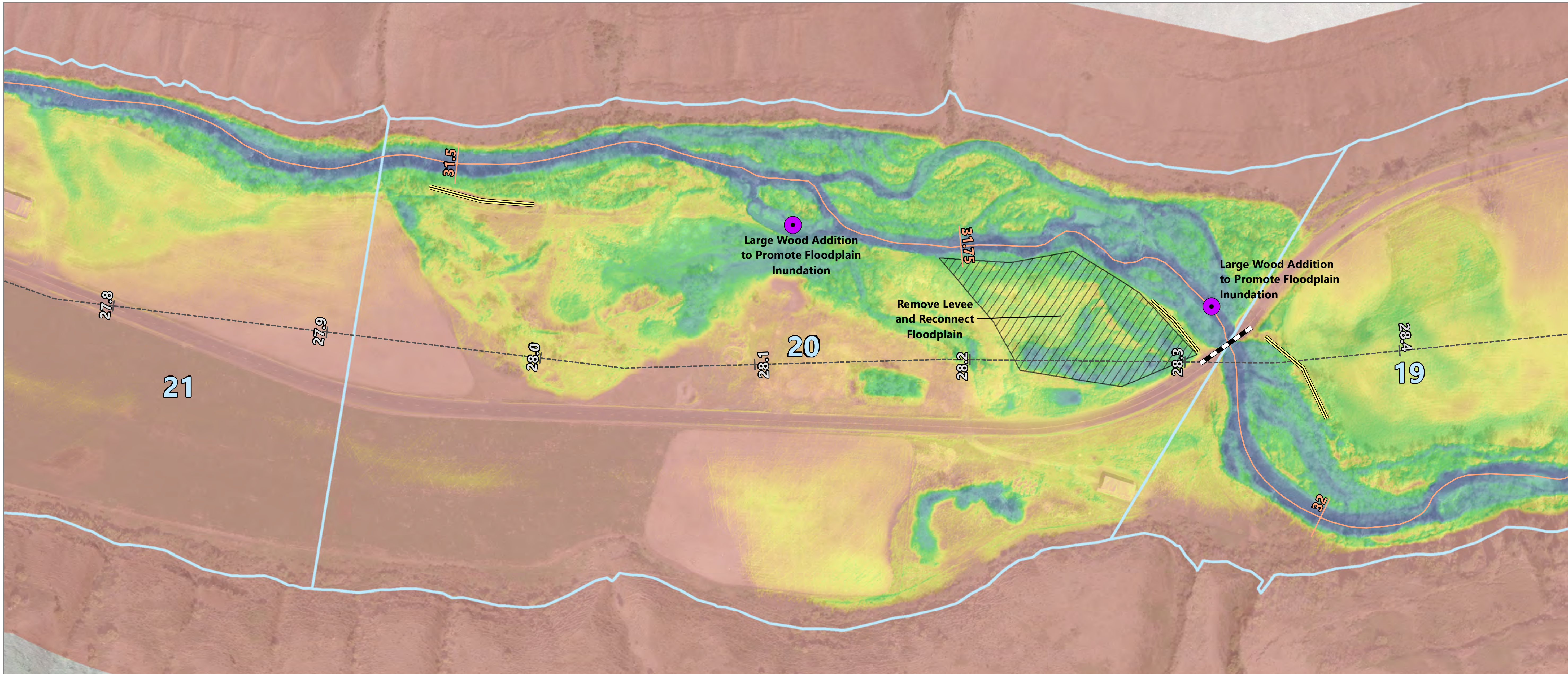
PA 20 Prioritization Scoring Summary

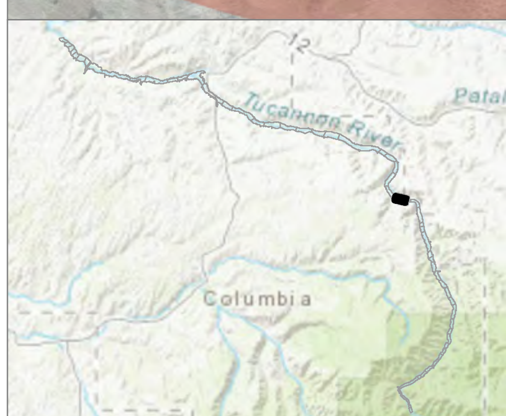


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 20 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.128	35	40%	Complexity	0.191	33	40% to 60%	3 of 5	5	40%	3.0	14	1	Untreated	10	1
Mean-Winter Flow Complexity	0.190	34	40%													
1-year Complexity	0.317	30	20%													
Channel Aggradation FP Potential	0.243	22	40%	Connectivity	0.184	33	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.047	36	40%													
Total FP Potential	0.337	35	20%													
Existing Connected FP	0.663	26	0%													
Excess Transport Capacity	0.14	16	100%	Excess Transport Capacity	3.000	16	10% to 30%	2 of 4	3	20%						
Pool Frequency	4.59	53	100%	Pool Frequency	0.118	53	60% to 90%	4 of 5	1	0%						





LEGEND:
- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet
High : 15
Low : -0

NOTES:
1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 31.46
RIVER MILE END: 31.9
VALLEY MILE START: 27.91
VALLEY MILE END: 28.31

0 500
Feet

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ANCHOR QEA

Project Area 20
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 25 Description

Project Area 25 begins at VM 23.9 at the Turner Road bridge and extends upstream to VM 24.35. The 2017 RM length is 0.54 mile, which is a relatively short reach. Field observations for this reach were conducted on November 1, 2018, when flow at the Starbuck gage was approximately 100 cfs.

At the time of the site visit, the upstream portion of the reach showed dynamic and complex bedforms and plan forms with bars and pools forming with gravel and cobble-sized substrate. One side channel was actively flowing through a stand of trees on the right bank, and other higher flow channels were apparent. The left bank had decent riparian growth with large, older cottonwoods, alders, and some willows. The right bank immediately abutted a field likely used for grazing, which was reinforced with large riprap in several locations. This field appears to be low-lying floodplain that is disconnected at the 5-year flow.

A large channel-spanning log jam near the middle of the reach had caused erosion and split flow on both the left and right banks. Large amounts of gravel and cobble-sized sediment were evident upstream of the log jam and likely contributed to the dynamic geomorphic conditions immediately upstream. Downstream of the log jam, the river makes a sharp bend and runs along the valley wall for the remainder of the reach, flowing over bedrock in several locations. On the right bank, a series of unmaintained levee sections and gravel berms prevent

Project Area 25
Location of channel erosion on the right bank and bar build on the left bank.

Project Area 25 Reach Characteristics

VM Start (mi)	23.90
VM Length (mi)	0.45
Valley Slope	1.20%
RM Start (mi)	26.98
RM Length (mi)	0.54
Average Channel Slope	1.03%
Sinuosity	1.20
Connected FP (ac/VM)	10.21
Encroachment Removal (ac/VM)	2.33
Channel Aggradation (ac/VM)	3.43
Total FP Potential (ac/VM)	11.21
Encroaching Feature Length (ft)	381.19
Connected FP Rank	48

the river from accessing several apparent meander scars. Several of these meander scars were inundated but not connected, likely from higher flows or possible spring or groundwater flows. Because of these levees, the downstream reach is much less complex than the upstream reach. Additionally, downstream of the channel-spanning log jam, sediment sizes on the channel bed were observed to increase significantly within the channel likely due to a combination of sediment being stored above the log jam, and increased transport capacity in the simplified section in the downstream reach. Finally, a rock vortex style weir with a large plunge pool is keyed into the levee and bedrock valley wall just upstream of the bridge at the downstream end of the reach.

Geomorphic Changes

PA 25 is a short reach and experienced only one significant location of geomorphic change based on analysis of the difference between the 2010 and 2017 LiDAR data. This change occurs near the middle of the reach and was noted during field observations to correspond with the location of a channel-spanning log jam, with significant deposition upstream. In this location, erosion of the left and right banks is apparent (box 1). Additionally, patches of aggradation upstream of this location are evident in both the floodplain and main channel, particularly in a right bank side channel, and may represent deposition due to the log jam. Just upstream of the log jam a point bar is building along with erosion on the left bank.

Downstream of the log jam, little to no change has occurred in the remainder of the reach to the Turner Road bridge.

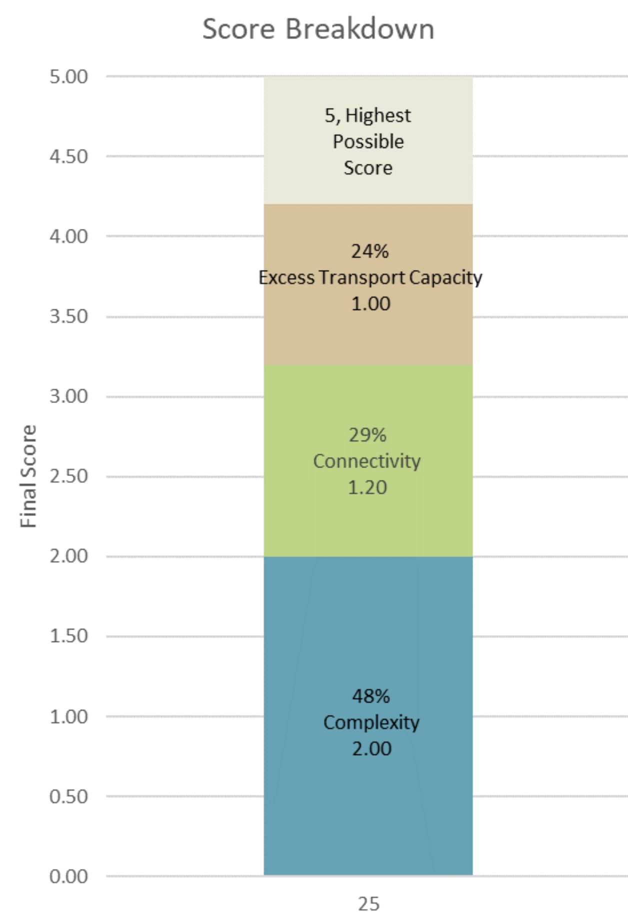
Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, high scores in the Complexity metric and the Excess Transport Capacity metric make up the majority of the score for PA 25, with a smaller score for the Connectivity metric. PA 25 ranks near average in the 40th to 60th percentile for complexity, a range identified for this assessment as having the most complexity potential. Most of the existing complexity for this reach comes at the upstream end where the channel has widened to form several mid-channel bars at the low-winter flow and activate a side channel at the mean-winter and 1-year flow events. However, based on the relative elevation map and floodplain connectivity at the 2-year event, there are several more locations for possible side channels in the upstream half of the reach. In this area, restoration strategies should include adding instream wood to promote geomorphic change and reconnecting side channels via pilot channel cuts on the floodplain.

The downstream half of the reach shows almost no complexity at any of the flows, and the relative elevation map and 2-year connectivity indicate any floodplain side channels would be difficult to access in this area. Promoting channel dynamics and fringe floodplain complexity should be the targeted restoration strategy for the downstream half of this project area. However, because this reach scores very highly in the Excess Transport Capacity metric, and field observations noted a perceived large typical bed material size, it is likely both gravel augmentation and developing instream structure will be necessary to affect any geomorphic change in this portion of the project area. Adding large woody material and other instream wood is unlikely to cause scour pools or promote channel avulsions in any timely fashion when the bed material is too large to be transported on a regular basis. In addition, any gravel added to the reach without instream structure would almost certainly be quickly transported downstream before causing any geomorphic change. These restoration techniques are both necessary and performing only one will be much less successful than performing both in tandem.

While the reach only scores in the 25th percentile for the Connectivity metric, the majority of the area that drives this is a large, low spot located on the right bank floodplain in a field with little to no mature vegetation and over 100 feet from the active floodplain. Additionally, since this score comes mostly from the Total Floodplain Potential analysis result, this area would require both channel aggradation and encroachment removal to be successful. There are several other small pockets for floodplain that could be reconnected with the removal of encroachments, but this restoration strategy should be seen as secondary to the goal of developing complexity and encouraging channel dynamics as already discussed.

PA 25 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

Finally, PA 25 ranks very low among project areas for the Pool Frequency metric. Adding instream wood and gravel augmentation will promote changes towards an increase in channel complexity, promoting the formation of pools. These restoration strategies should be employed to target increasing pool frequency in the reach.

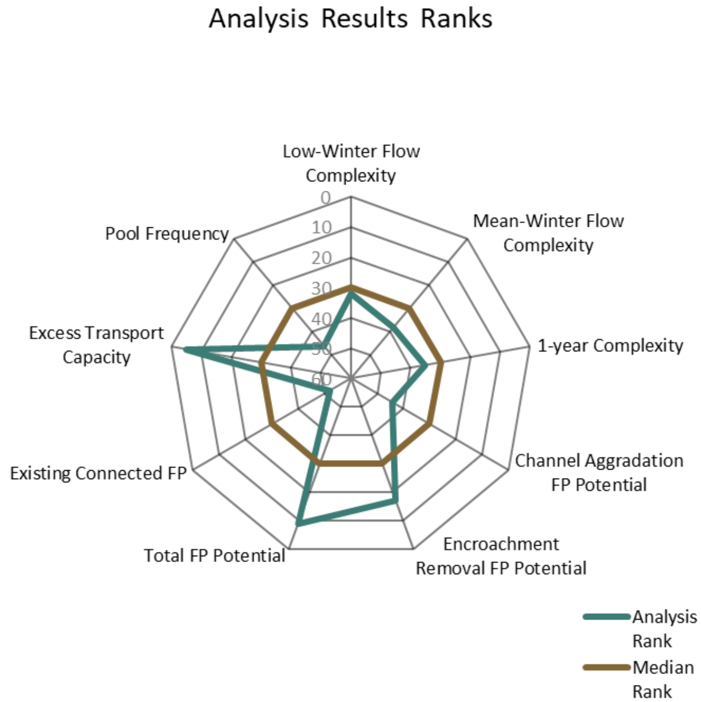
Summary of Restoration Opportunities Identified

- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)

Long-Term Opportunities in this Project Area

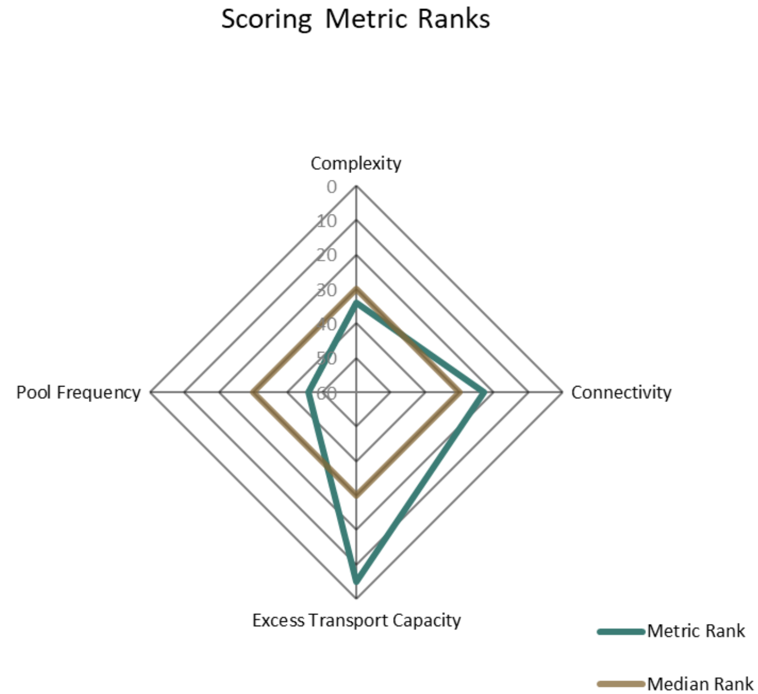
- Set back road against right valley wall for more floodplain connection and channel migration area.

PA 25 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

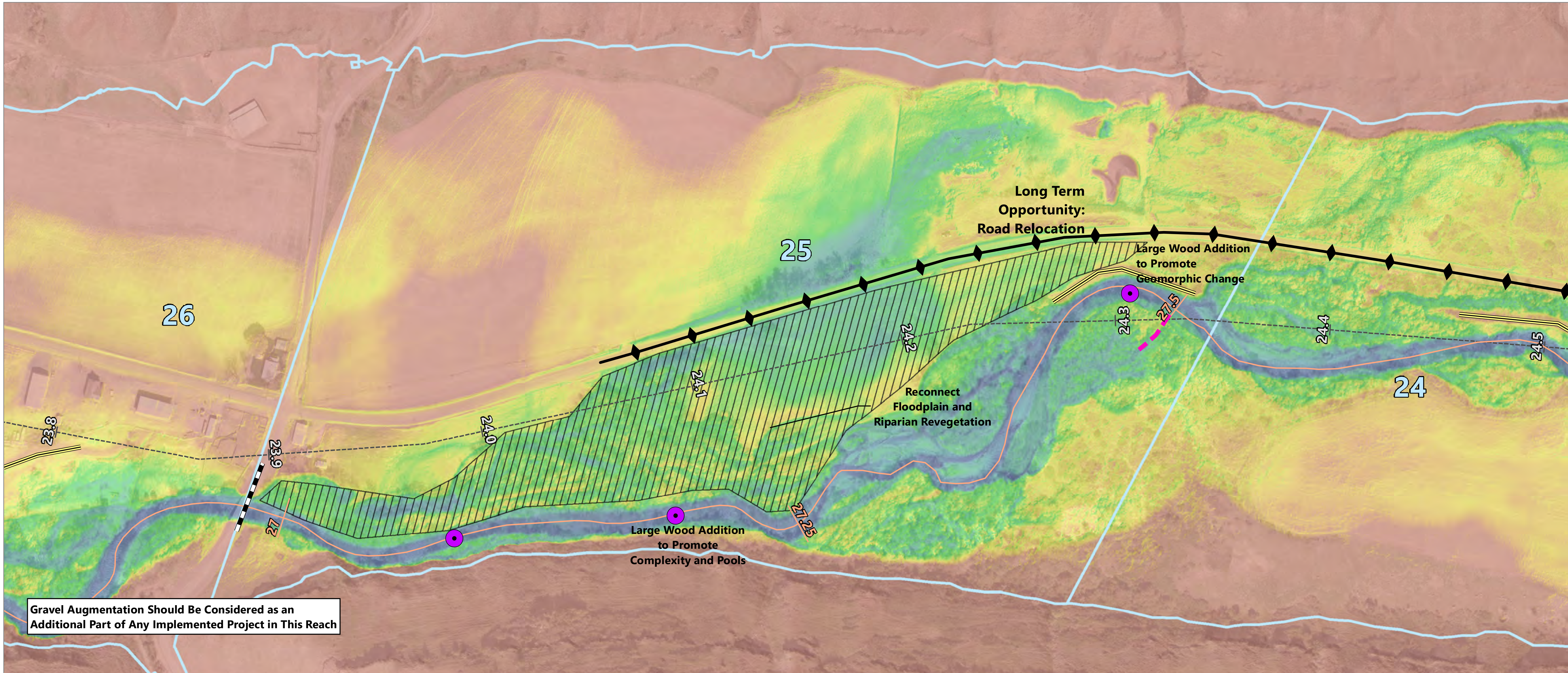
PA 25 Prioritization Scoring Summary

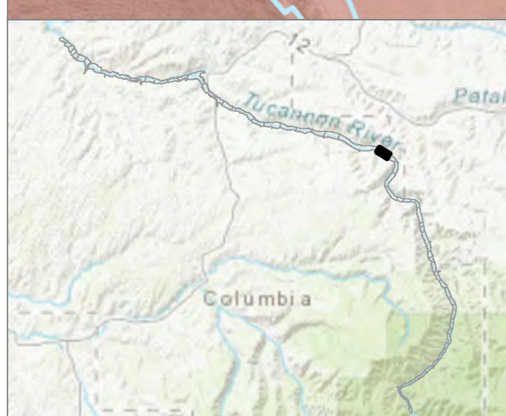


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 25 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.145	32	40%	Complexity	0.181	34	40% to 60%	3 of 5	5	40%	4.2	2	1	Untreated	2	1
Mean-Winter Flow Complexity	0.175	38	40%													
1-year Complexity	0.268	35	20%													
Channel Aggradation FP Potential	0.160	44	40%	Connectivity	0.212	23	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.109	17	40%													
Total FP Potential	0.523	9	20%													
Existing Connected FP	0.477	52	0%													
Excess Transport Capacity	0.27	5	100%	Excess Transport Capacity	5.000	5	1% to 10%	1 of 4	5	20%						
Pool Frequency	5.56	46	100%	Pool Frequency	0.143	46	60% to 90%	4 of 5	1	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential
- Long Term: Relocate Road

Relative Elevation in Feet
High : 15
Low : -0

NOTES:
1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 26.98
RIVER MILE END: 27.52
VALLEY MILE START: 23.9
VALLEY MILE END: 24.35

0 500
Feet

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ANCHOR QEA

Project Area 25
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 27 Description

Project Area 27 begins at VM 20.21 at the bridge for King Grade Road and extends upstream to VM 21.11. The 2017 RM length is 1.05 miles. Field observations for this reach were conducted on November 2, 2018, when a maximum daily flow of 107 cfs was recorded.

The reach is primarily characterized by an offset levee on the right bank for most of the reach; moderately accessible floodplain is evident. However, much of the floodplain has higher elevation encroachments, which may be either the remnants of old, unmaintained levees or high bank left after channel incision. These encroachments are evident both from field observations and the relative elevation map and, while they do not strictly confine the channel, they do inhibit free migration and geomorphic change into the small amount of floodplain before the primary levee.

The upper and lower sections of the reach are pinned on the left bank against the bedrock valley wall, providing poor habitat conditions and little opportunity for geomorphic processes to progress. On the right bank, and on the left bank where not bounded by the valley wall, the floodplain is moderately accessible with established vegetation including cottonwoods and alders. Some wood has been recruited recently, forcing small side channels into the floodplain. The site photograph in the sidebar shows the upstream end of one such example. One

Project Area 27
Upstream end of side channel on right bank, looking downstream on PA 27.

Project Area 27 Reach Characteristics

VM Start (mi)	20.21
VM Length (mi)	0.90
Valley Slope	0.96%
RM Start (mi)	22.95
RM Length (mi)	1.05
Average Channel Slope	0.84%
Sinuosity	1.17
Connected FP (ac/VM)	13.19
Encroachment Removal (ac/VM)	8.33
Channel Aggradation (ac/VM)	9.10
Total FP Potential (ac/VM)	21.62
Encroaching Feature Length (ft)	4,861.45
Connected FP Rank	37

rock habitat structure has been present on the right bank since before the previous geomorphic assessments.

Based on field observations, these conditions would suggest a reach that has potential for restoration via means of low-winter flow complexity development and floodplain access, as described in the Geomorphic Characterization and Restoration Strategies section below. PA 27 is bounded on the upstream end by PA 26, which has similar features such as a long bounding levee encroachment, and on the downstream side by PA 28.1, which has been worked on extensively over the past 10 years. This may provide the opportunity to combine project reaches with similar goals for management and monitoring work on the downstream project area.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows that this reach has experienced relatively little geomorphic change. The upstream end of the reach experienced some side channels and minor main channel avulsions, which are structures placed by the Columbia Conservation District in 2013 as part of a project for PA 26 (box 1).

In the middle section of the reach, the main channel has avulsed away from the bedrock wall on the left bank to form a low-winter flow bar before returning to be pinned against the bedrock wall (box 2). Further downstream, the opposite effect has happened with a gravel bar forming on the right bank pushing the main channel closer to the bedrock wall for a short distance. Immediately downstream of this avulsion, a new side channel has formed on the right bank, which, based on field observations, appears to be the product of both wood recruitment and sediment deposition and may be established for more than the immediate future (box 3). These changes are all relatively minor compared to other reaches in the system and are likely due to several factors. The downstream control of the bridge plays some role in keeping geomorphic change to a minimum but may also cause a backwater, making the reach depositional for small-sized sediment. However, the likely controlling factors for the reach are the main right bank levee, which is set only a short distance into the floodplain, the bedrock valley wall on the left bank, and the minor encroachments or old levee remnants.

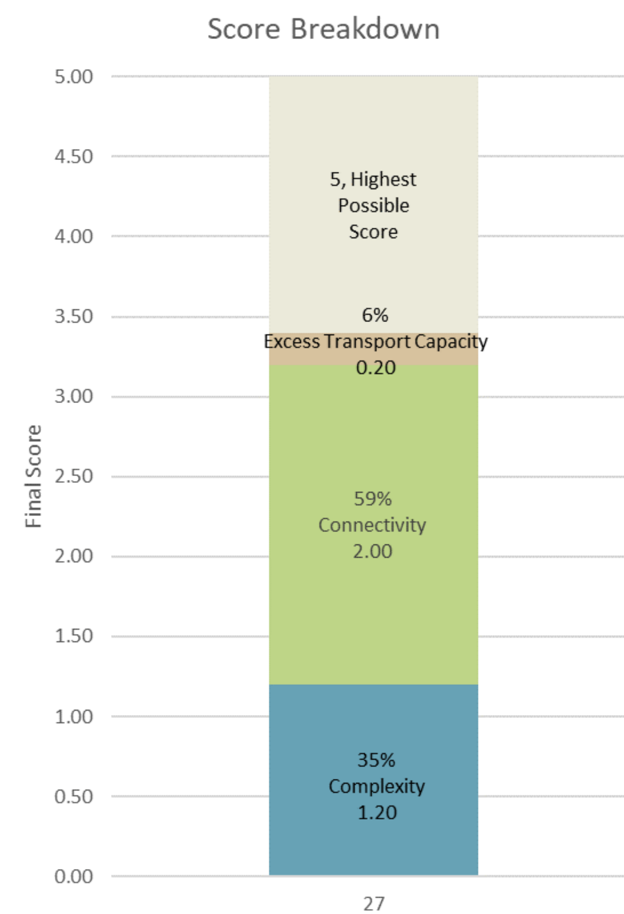
Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, the Connectivity and Complexity metrics make up the majority of the score for PA 27, along with a small score in the Excess Transport Capacity metric.

The high Connectivity score indicates this project area ranks near the top in the 75th to 99th percentile and is driven by high rankings in both the Channel Aggradation analysis result and Encroachment Removal analysis result. A large portion of the right bank floodplain in PA 27 is already low lying enough to be accessed at the 2-year event and disconnected via a high bank or old remnant levee. Breaching or removing these encroachments, along with adding structure to promote geomorphic change onto the floodplain, should be one of the highest priorities for this reach. Near the downstream end of the reach, a large portion of the right bank floodplain is connected at the 5-year event, indicating that any rise in the average water surface elevation in this reach would reconnect this area at a more frequent event. This rise could be accomplished through a combination of gravel augmentation and developing instream structure to hold and store sediment as well as increase roughness, slow flow, and create backwater. Encroachment removal can often work well in tandem with gravel augmentation; if the encroachments consist of a significant amount of transportable material, it can be easily reused after removal as a sediment source, and this could be particularly effective in PA 27.

PA 27 also receives a moderate score in the Complexity metric, ranking in the 60th to 90th percentile. While not the highest priority for complexity, this range indicates that the complexity in this reach is good enough to be nearly within the top 10% of project areas and, therefore, PA 27 receives a moderate complexity score. This Complexity score is driven by multiple side channels and split flows in the immediate floodplain, which provide good complexity but do not significantly extend into the floodplain. The restoration strategies of adding instream

PA 27 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

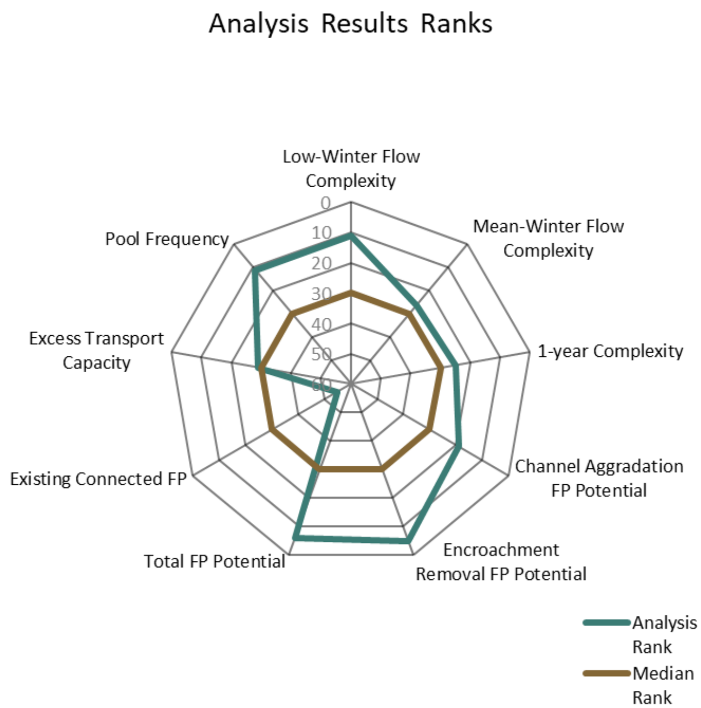
wood and gravel augmentation, as discussed previously, should allow access to more of the floodplain, and the reconnection of disconnected or abandoned side channels and flow paths in the targeted floodplain should be the priority for adding complexity. Adding wood and structure to the floodplain in this area will also be important to ensure that any activated side channels will remain in place with perennial flow.

Finally, PA 27 ranks well above average in the Pool Frequency metric, indicating a high amount of pools per river mile. The restoration strategy of adding instream structure and wood, along with gravel augmentation, should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be maintained and continue to form with the natural processes of the reach.

Summary of Restoration Opportunities Identified

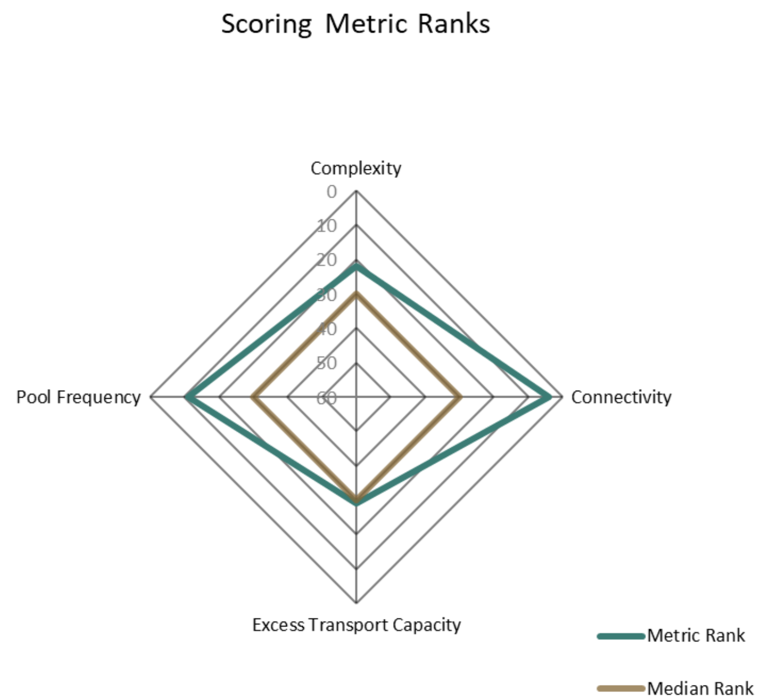
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)

PA 27 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

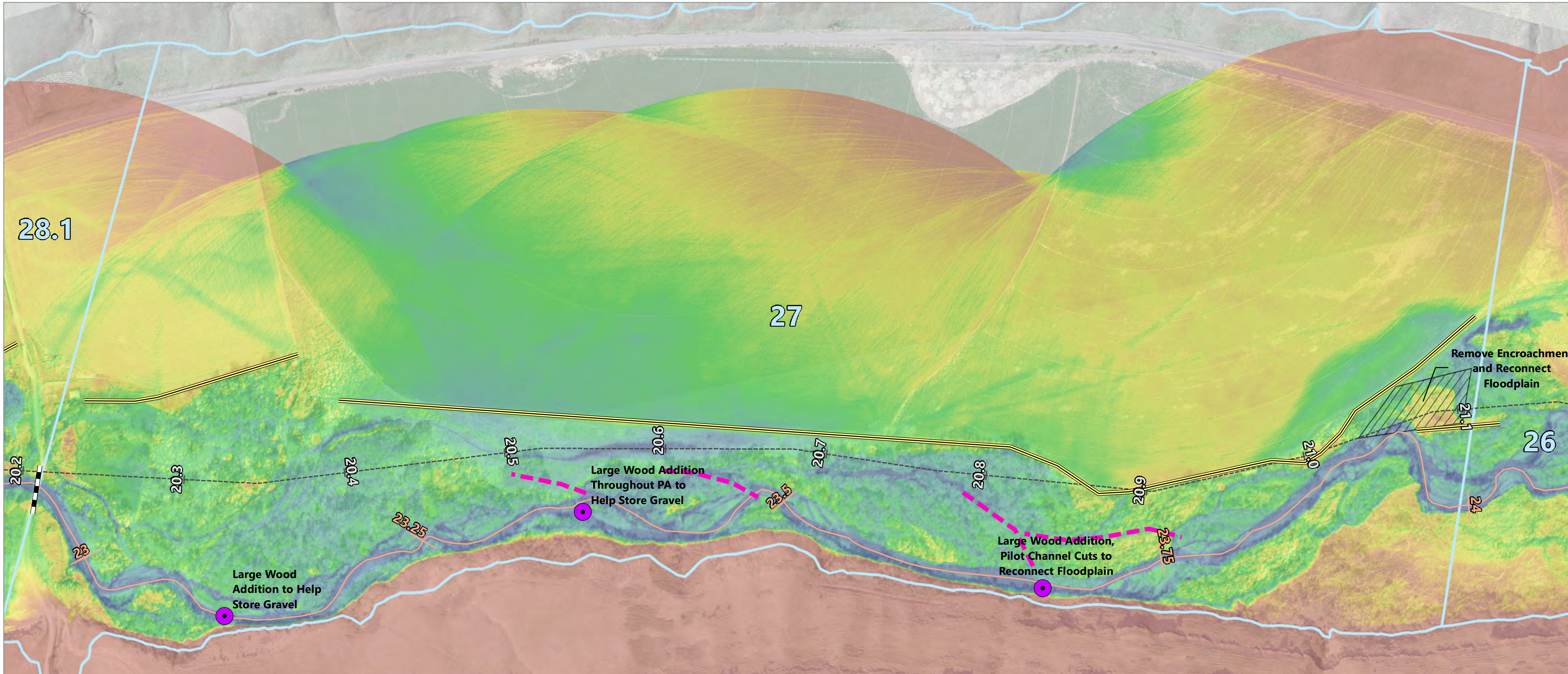
PA 27 Prioritization Scoring Summary

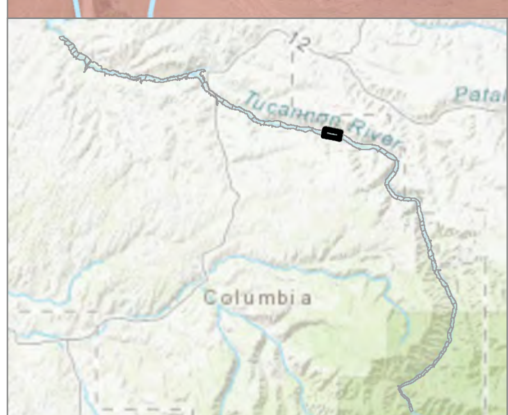


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 27 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.275	11	40%	Complexity	0.296	22	10% to 40%	2 of 5	3	40%	3.4	4	1	Untreated	4	1
Mean-Winter Flow Complexity	0.287	26	40%													
1-year Complexity	0.358	25	20%													
Channel Aggradation FP Potential	0.261	19	40%	Connectivity	0.325	4	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.239	5	40%													
Total FP Potential	0.621	6	20%													
Existing Connected FP	0.379	55	0%													
Excess Transport Capacity	0.04	29	100%	Excess Transport Capacity	1.000	29	30% to 52%	3 of 4	1	20%						
Pool Frequency	19.09	11	100%	Pool Frequency	0.490	11	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 22.95
RIVER MILE END: 23.99
VALLEY MILE START: 20.21
VALLEY MILE END: 21.11

0 500
Feet

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ANCHOR QEA

Project Area 27
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 32.1 Description

Project Area 32.1 begins at VM 13.42 at the bedrock Tucannon Falls and extends upstream to VM 14.11. The 2017 RM length is 0.79 mile. Field observations for this reach were conducted on October 10, 2018, when peak flow at the Starbuck gage was approximately 115 cfs.

For this assessment update, PA 32 as defined in the 2011 prioritization was separated into two project areas (PA 32.1 and PA 32.2) at the Tucannon Falls. The falls represent a natural geomorphic break and grade control. Upstream of the falls, PA 32.1 is almost entirely locked onto the left bank valley wall and often encounters bedrock. The reach also contains a small pocket of floodplain.

The upstream end of the reach begins on the right bank with a large swampy area in the floodplain, including multiple deep pools. A large avulsion near this area has created split flow and flow into the floodplain. Downstream of the avulsion, sediment on the floodplain is evident, indicating some material transport.

Downstream of the avulsion, the channel is migrating into the floodplain in several locations, eroding at the high bank and building bars on the inside of the bend. One of these erosion locations is threatening an irrigation pump station.

Further downstream, the channel is confined for most of the rest of the reach on the left bank by the valley wall and on the

Project Area 32.1
Sparse riparian vegetation up against the left bank valley wall. On the right a small split flow is returning from upstream.

Project Area 32.1 Reach Characteristics

VM Start (mi)	13.42
VM Length (mi)	0.69
Valley Slope	0.82%
RM Start (mi)	15.34
RM Length (mi)	0.79
Average Channel Slope	0.71%
Sinuosity	1.14
Connected FP (ac/VM)	12.40
Encroachment Removal (ac/VM)	13.74
Channel Aggradation (ac/VM)	13.72
Total FP Potential (ac/VM)	24.26
Encroaching Feature Length (ft)	3,552.17
Connected FP Rank	39

right by a high bank. However, several side channel opportunities exist behind what appears to be an old levee on the right bank. For most of the reach, a field with pivot infrastructure is set back a good distance from the old levee, and this could be a good opportunity for a setback levee.

At the downstream end of the reach, more bedrock is encountered before finally resulting in the bedrock at Tucannon Falls. While not observed during the field visit, the relative elevation map appears to show a long side channel forming on the right bank, which could circumvent the falls.

At the time of this assessment update, the Columbia Conservation District is in the process of implementing a plan that extends just past the falls into PA 32.2.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows three primary locations of geomorphic change in PA 32.1. At the upstream end, a large depositional area and associated channel avulsion and split flow formation has occurred. The depositional area extends out into the right bank floodplain, and field observations of the site revealed cobble-sized materials in the riparian area. This change seems to be driven by several natural log jams that have formed at the head of the island forcing flows to the left and allowing material to build up on the right bank (box 1).

Just downstream of this area, the channel sinuosity is starting to increase as several meander bends are beginning to form. Erosion is evident on the outside of alternating meander bends and associated bars are forming on the inside of the bends. The center meander bend has eroded up against the left bank valley wall and cannot meander any further, which occasionally causes the channel to straighten and run along the valley wall (box 2).

Finally, just downstream of the meander bends, a 200-foot section is eroding heavily at the right bank (box 3). After this section, the channel begins to encounter bedrock and no more geomorphic change is noted in the analysis of this reach.

Geomorphic Characteristics and Restoration Strategies

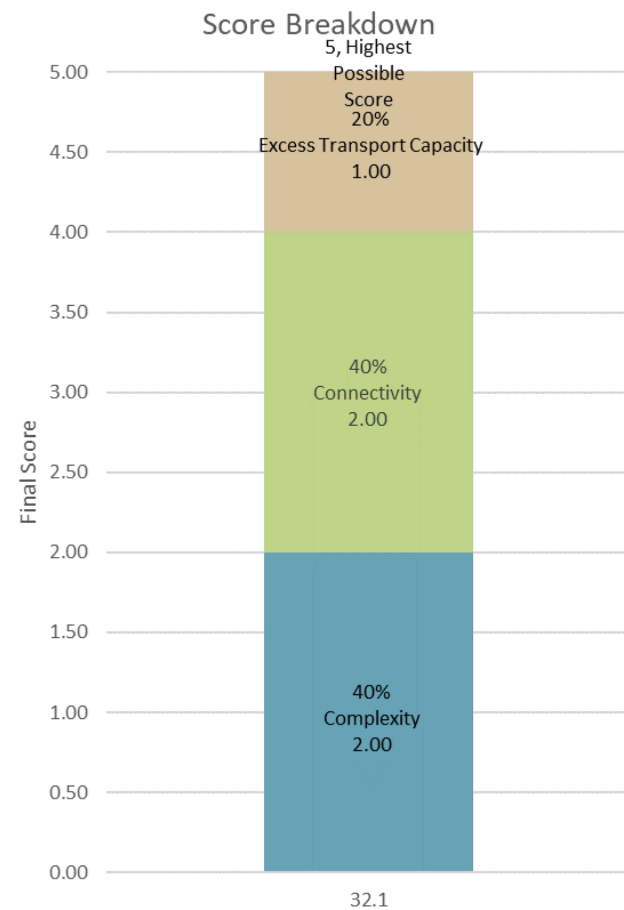
As shown in the following graphs and table, PA 32.1 scores highly in the prioritization metrics of Complexity, Connectivity, and Excess Transport Capacity. PA 32.1 ranks in the 40th to 60th percentile range for Complexity, which is the range in which reaches have the most potential for complexity without being too confined to allow realistic projects to be completed. For all three flows, this complexity is driven by the area near the upstream end of the reach, which has undergone a recent avulsion. The 1-year and mean-winter flows are both more complex than the low-winter flow, but this complexity occurs in the same general area, just activating more side channels. The downstream half of the reach shows no complexity value at any of the three flows.

The high Connectivity score in this reach is driven by high ranks in both the Channel Aggradation and Encroachment Removal analysis results. Several different areas in this reach contribute to these high ranks. First, a relatively low, swampy floodplain on the right bank is disconnected by a high bank and old levee. At the upstream end of the reach along the right bank, near where the recent avulsion has happened, there is a large disconnected wetland complex that appears to have some groundwater source, which is likely because this reach is just above a large bedrock falls. However, this area is pinned between two fields with pivot infrastructure and may be difficult to connect to the river. It should be noted that a large portion of the floodplain area in this reach was within the area of these fields with pivot infrastructure and was therefore marked “unobtainable” and not counted to any of the analyses in this assessment.

The primary area of floodplain connectivity is near the middle of the reach, where the floodplain is disconnected by high banks and possible old levees at the 2-year flow and connected, although intermittently, at the 5-year flow. This area could be connected either via channel aggradation or encroachment removal. Although the potential area to be gained with channel aggradation is greater than that of encroachment removal, it may be difficult in this reach to achieve significant floodplain aggradation.

This reach also scores very highly in the Excess Transport Capacity metric, likely due to the confined section downstream

PA 32.1 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

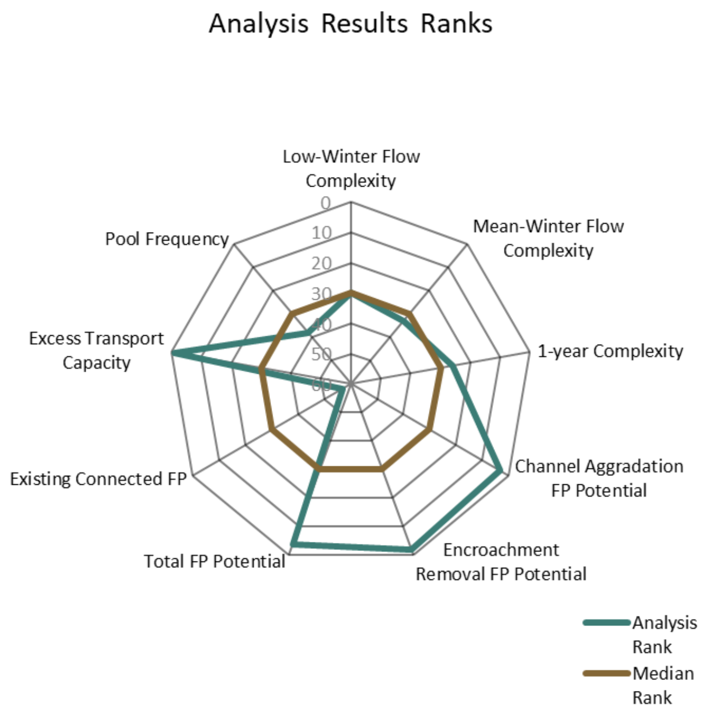
and the bedrock falls, which allows for a steep slope with no sediment transport wherever bedrock is present. Addressing this will be difficult, and the best restoration strategy will attempt to connect large portions of the floodplain upstream of the bedrock reach. This should be accomplished through cutting pilot channels and removing as much of the floodplain encroachment as possible, while adding LWD to promote geomorphic change and trap sediment where possible.

Finally, the Pool Frequency metric in this reach scores slightly below average. The identified restoration strategies of adding instream structure and wood, along with gravel augmentation, should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be maintained and continue to form with the natural processes of the reach.

Summary of Restoration Opportunities Identified

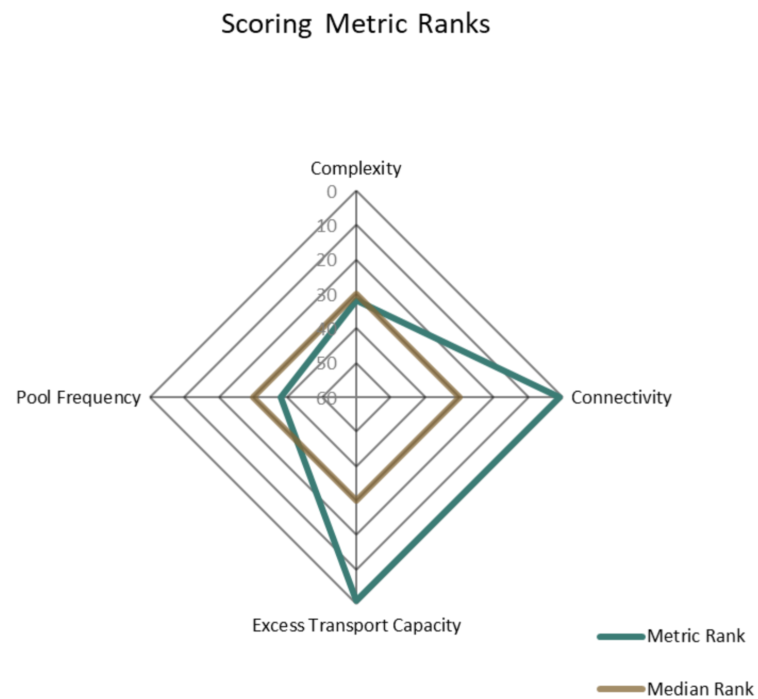
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)
- Riparian zone enhancement
- Modify or remove obstructions

PA 32.1 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

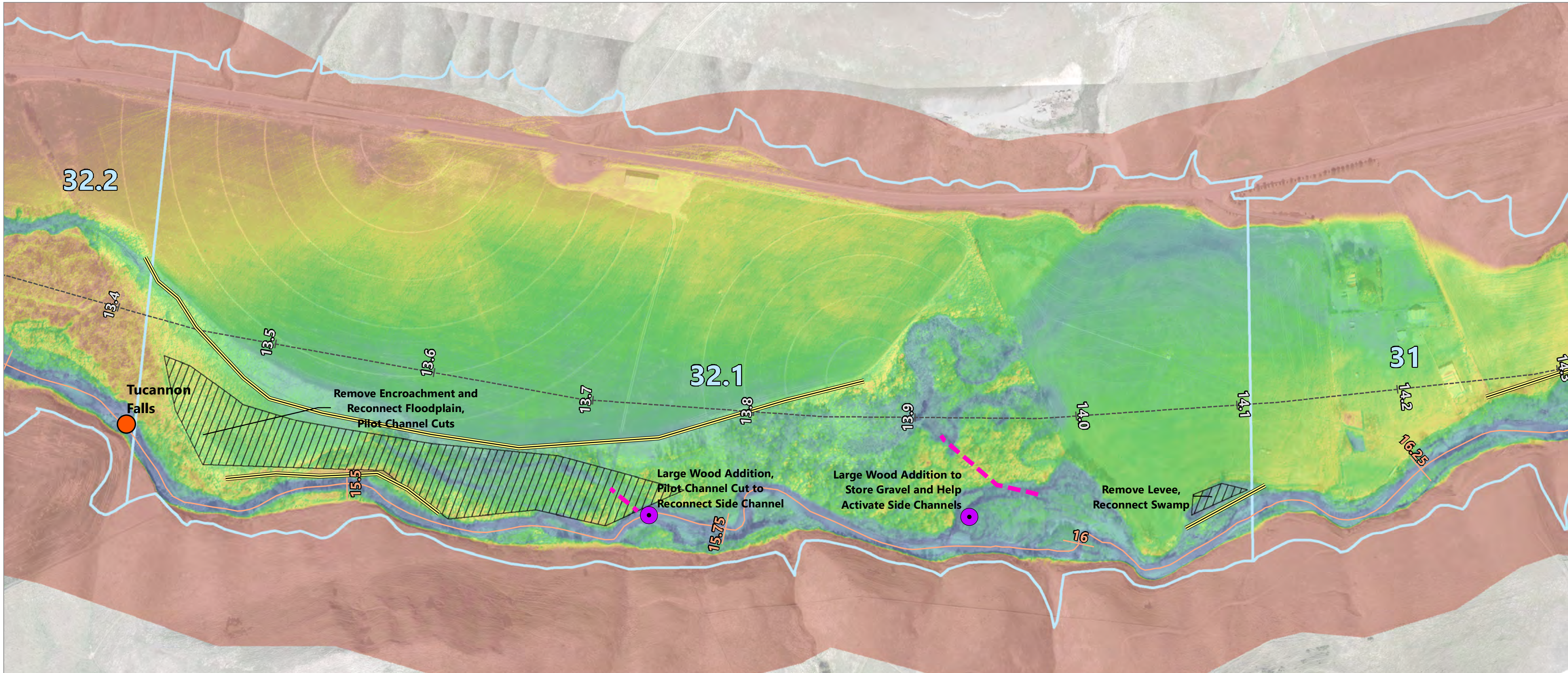
PA 32.1 Prioritization Scoring Summary

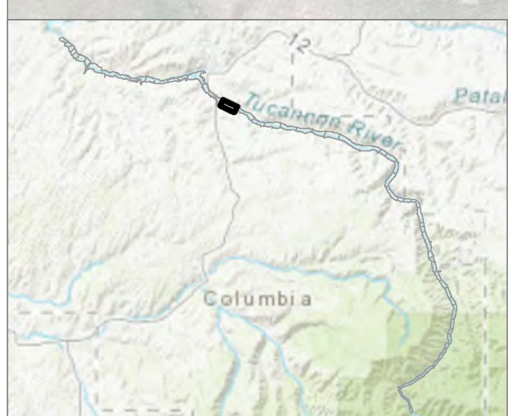


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 32.1 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.161	30	40%	Complexity	0.211	32	40% to 60%	3 of 5	5	40%	5.0	1	1	Untreated	1	1
Mean-Winter Flow Complexity	0.194	33	40%													
1-year Complexity	0.348	26	20%													
Channel Aggradation FP Potential	0.374	3	40%	Connectivity	0.432	1	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.375	2	40%													
Total FP Potential	0.662	4	20%													
Existing Connected FP	0.338	57	0%													
Excess Transport Capacity	0.36	1	100%	Excess Transport Capacity	5.000	1	1% to 10%	1 of 4	5	20%						
Pool Frequency	8.91	38	100%	Pool Frequency	0.229	38	60% to 90%	4 of 5	1	0%						





LEGEND:
- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential
- Placemark

Relative Elevation in Feet
High : 15
Low : -0

NOTES:
1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 15.34
RIVER MILE END: 16.13
VALLEY MILE START: 13.42
VALLEY MILE END: 14.11

0 500
Feet

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Project Area 32.1
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 32.2 Description

Project Area 32.2 begins at VM 13.42 at the Highway 12 bridge and extends upstream to VM 12.84 at the bedrock Tucannon Falls. The 2017 RM length is 0.69 mile. Field observations for this reach were conducted on October 10, 2018, when flow at the Starbuck gage was approximately 115 cfs.

For this assessment update, PA 32 as defined in the 2011 prioritization was separated into two project areas (PA 32.1 and PA 32.2) at the Tucannon Falls. The falls represent a natural geomorphic break and grade control. While not a fish barrier, these falls definitely are not ideal migration conditions. A large, low-lying side channel 500 feet into the floodplain on the right bank of PA 32.2 could provide an opportunity for a side channel that bypasses the falls.

Just downstream of the falls, the reach is relatively confined with a bedrock bottom that ends shortly downstream of the falls. Several side channel opportunities exist on the left and right banks as the channel goes through several meanders before reaching the bridge at the downstream end of the project area. Some of these meanders are migrating and causing erosion on the outside of the bends. One in particular is causing erosion behind a rock bank barb structure and could reconnect to a low-lying area.

The floodplain has patches of well-developed forested areas but also goes through large stretches of exposure with little

Project Area 32.2
Downstream end of PA 32.2 showing woody material on banks and instream complexity.

Project Area 32.2 Reach Characteristics

VM Start (mi)	12.84
VM Length (mi)	0.58
Valley Slope	0.95%
RM Start (mi)	14.63
RM Length (mi)	0.69
Average Channel Slope	0.80%
Sinuosity	1.19
Connected FP (ac/VM)	14.60
Encroachment Removal (ac/VM)	2.12
Channel Aggradation (ac/VM)	10.16
Total FP Potential (ac/VM)	10.86
Encroaching Feature Length (ft)	501.93
Connected FP Rank	20

cover, often near where the meander bends are beginning to migrate towards fields.

A large channel-spanning log jam near the downstream end of the reach has caused multiple geomorphic changes in the immediate area; while the channel here is complex with multiple flow paths, these changes may be unstable in the future.

The bridge for Highway 12 was rebuilt but the old bridge still remains. However, this does not have a large impact because the two bridges are only 200 feet apart and the confining levee for the bridge crossing encompasses both bridges and protects a field on the left bank.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows several locations of geomorphic change in PA 32.2. At the very upstream end, where the Tucannon Falls are located, erosion on the right bank is cutting around the existing falls, which was also noted during field observations. While it is likely the bedrock shelf that forms the existing falls extends into the floodplain where this erosion is occurring, scouring on the right bank could increase the channel length and lower the distance of the drop (box 1).

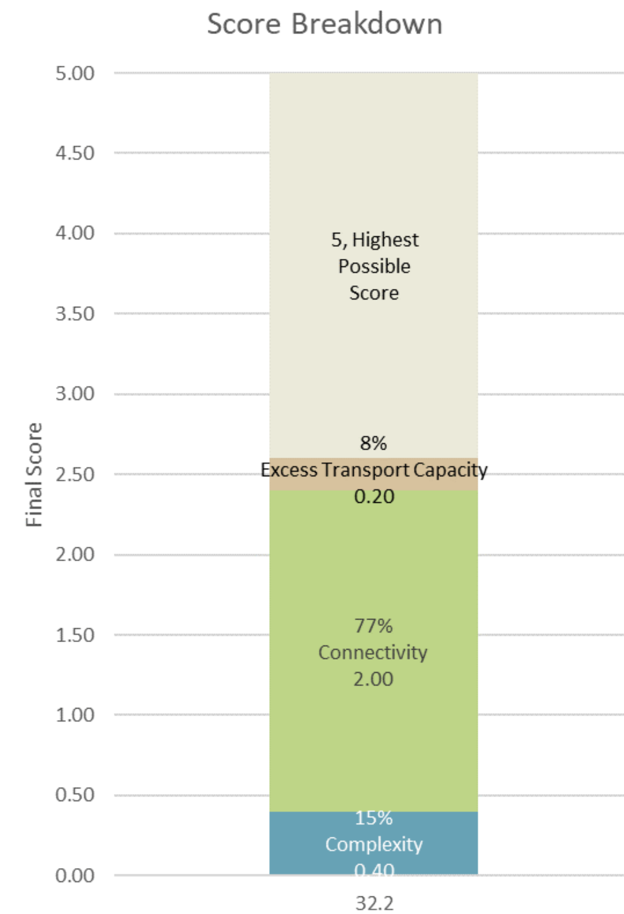
About 600 feet downstream of the falls, the channel goes through a long, straight reach with thick canary grass on the right bank. This area shows up as aggradation on the change analysis; it is unclear if this apparent aggradation is real or a result of this vegetation growth (box 2). Immediately downstream, the bar is building on the left bank and inside of the meander bend, with associated erosion on the right bank (box 3). This is a common geomorphic process in meander bends, but it could be exacerbated by the aggradation on the right bank and may be the beginning of a new meander bend. Further downstream, another meander bend is forming with bar building on the right bank and erosion on the left bank. A disconnected side channel near this erosional bend also shows downcutting, possibly indicating that there could be channel downcutting (box 4). After this meander bend, deposition on the left bank is forcing a minor channel avulsion to the right where erosion and downcutting are evident (box 5).

Finally, at the downstream end of this project area and just upstream of the Highway 12 bridge, the channel has gone through several major avulsions. There are some minor areas of deposition on the floodplain in this area, but these avulsions are primarily driven by erosion in several locations. Based on field observations and the 2018 aerial imagery, several large channel-spanning log jams in the channel here may be forcing this geomorphic change (box 5).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 32.2 receives the majority of its prioritization score in the Connectivity metric. PA 32.2 ranks in the top 25% of all project areas for Connectivity and ranks among the top project areas for the Channel Aggradation analysis result and near average for the Encroachment Removal metric. The high rank for the Channel Aggradation analysis result is mostly due to low-lying areas immediately surrounding the active 2-year floodplain. This indicates that this channel is likely slightly incised, as would be expected for the reach immediately downstream of the Tucannon Falls, and a large amount of the total available floodplain can be connected at the 2-year event through channel aggradation. The primary restoration strategy for this reach should be gravel augmentation in conjunction with the addition of instream wood to store and retain the sediment and cause channel aggradation. PA 32.2 receives a low score in Excess Transport Capacity, indicating that instream wood should easily trap and maintain sediment. The disconnected area in this reach, indicated by the average ranking in the Encroachment Removal analysis result, exists mostly in side channel areas that would be reconnected with channel aggradation. This is why the Total Floodplain Potential analysis result is lower than the combined Encroachment Removal and Channel Aggradation analysis results.

PA 32.2 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

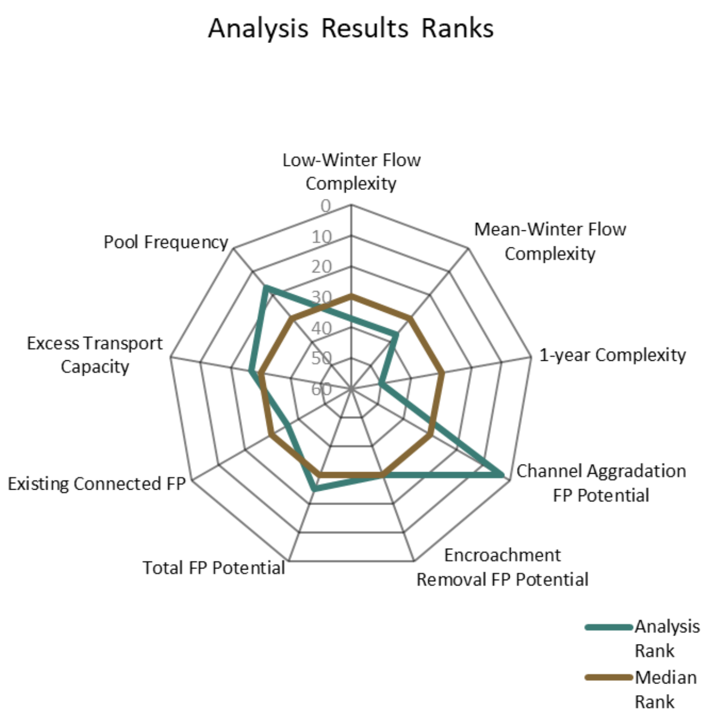
PA 32.2 receives a low score in the Complexity metric, indicating that it ranks below average in the 10th to 40th percentile. This range has been identified as having poor enough complexity that a high level of restoration would be needed to reach a good level of complexity. However, the above identified restoration strategies can be used to also increase the total amount of complexity in the reach. Several side channel opportunities exist throughout the reach that can be connected at a perennial event with pilot channel cuts and the addition of strategic placement of instream wood. Placing instream wood to store sediment and promote geomorphic change, along with pilot channel cuts and gravel augmentation to access more the of the floodplain, should be the primary restoration strategies in the reach.

Finally, the Pool Frequency analysis result indicates that this project area ranks relatively high for number of pools per valley mile. The identified restoration strategies of adding instream wood and gravel augmentation should assist in maintaining and increasing the number of pools in this reach.

Summary of Restoration Opportunities Identified

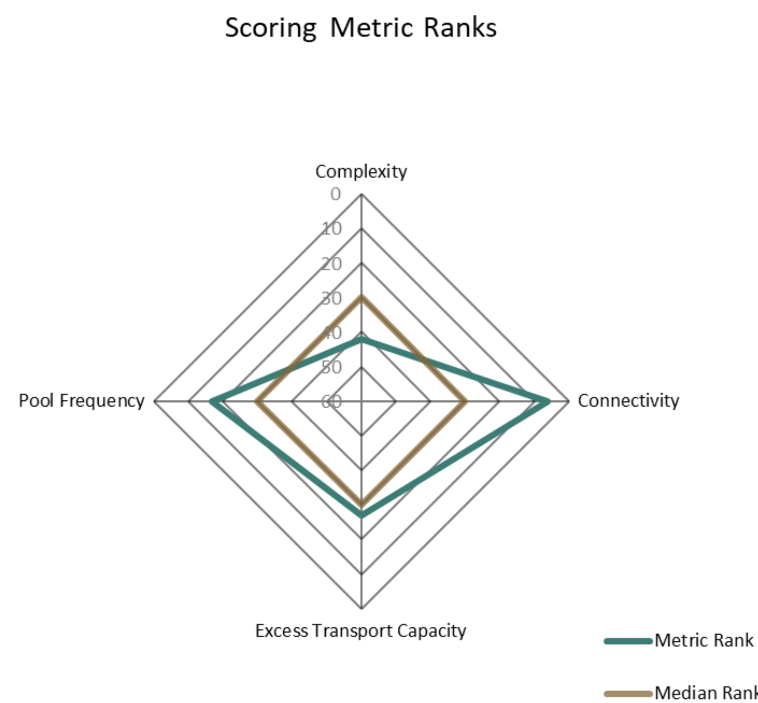
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)
- Modify or remove obstructions

PA 32.2 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

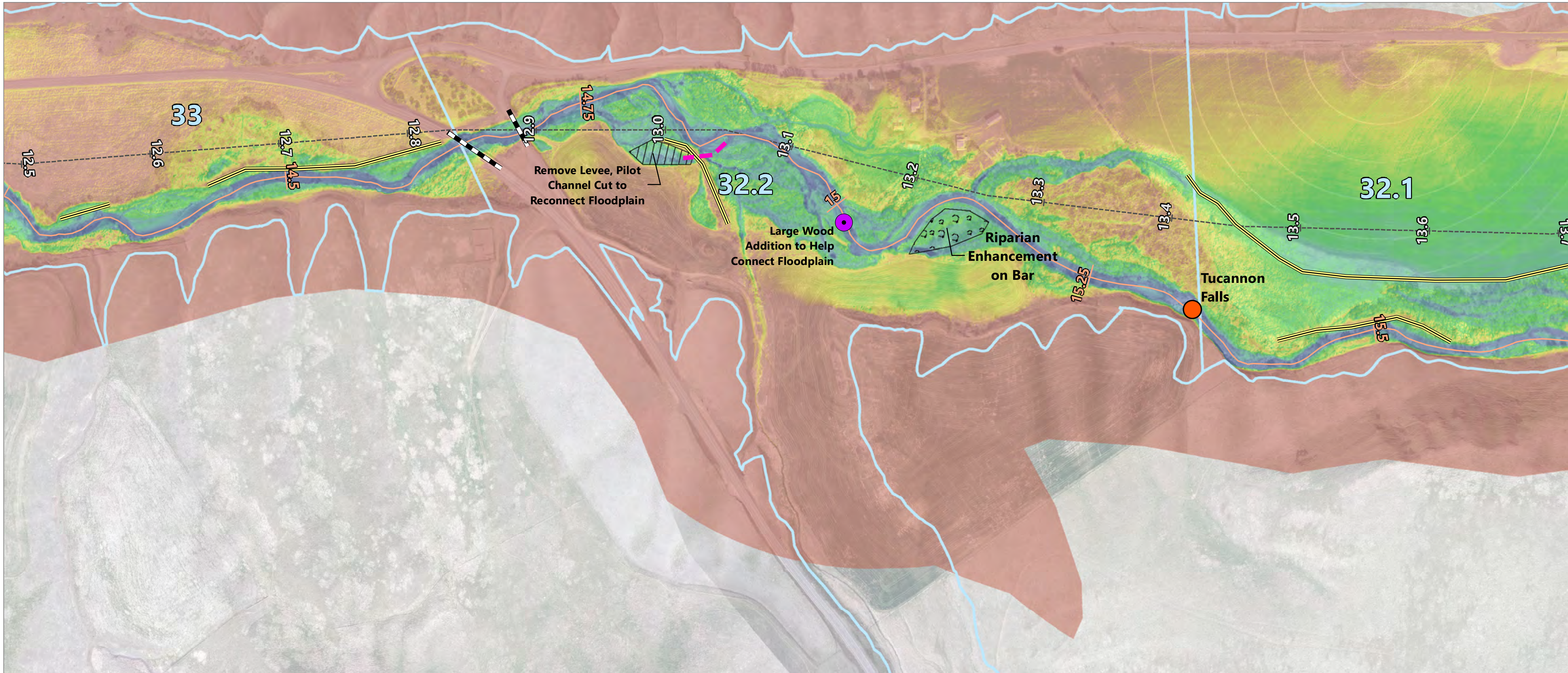
PA 32.2 Prioritization Scoring Summary

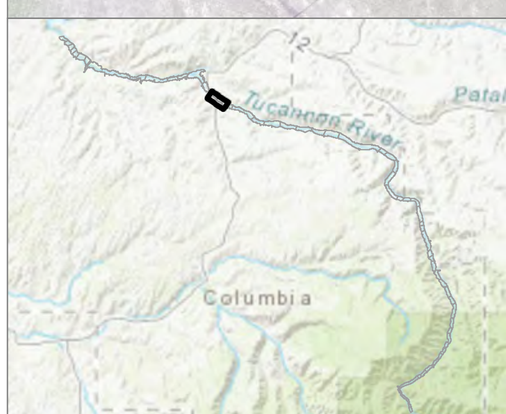


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 32.2 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.125	37	40%	Complexity	0.149	42	60% to 90%	4 of 5	1	40%	2.6	17	1	Untreated	9	1
Mean-Winter Flow Complexity	0.180	37	40%													
1-year Complexity	0.138	50	20%													
Channel Aggradation FP Potential	0.394	3	40%	Connectivity	0.276	6	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.084	30	40%													
Total FP Potential	0.422	25	20%													
Existing Connected FP	0.578	36	0%													
Excess Transport Capacity	0.03	27	100%	Excess Transport Capacity	1.000	27	30% to 52%	3 of 4	1	20%						
Pool Frequency	15.84	17	100%	Pool Frequency	0.407	17	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential
- Riparian Enhancement
- Placemark

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 14.65
RIVER MILE END: 15.34
VALLEY MILE START: 12.84
VALLEY MILE END: 13.42

0 500
Feet

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ANCHOR QEA

Project Area 32.2
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 34.1 Description

Project Area 34.1 begins at VM 10.58 and extends upstream to a bridge crossing for the Territorial Road at VM 11.71. The 2017 RM length is 1.14 miles. The 2011 prioritization separated PA 34 into two geomorphically distinct sections (PA 34.1 and PA 34.2) for analysis. Due to lack of landowner access, no field observations were conducted in this reach in 2011 or 2018.

From the relative elevation map, the upstream end of PA 34.1 appears to be confined between a close right bank levee and the valley wall.

The confluence with Pataha Creek, which is a major tributary of the Tucannon River, is near the downstream end of this reach. From the relative elevation map, this area appears to be much more complex, with a relatively large amount of floodplain.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows three notable areas of geomorphic change in PA 34.1. Near the middle of the reach, there is significant aggradation of the right bank but none of it is in the actual channel; it is possible that these higher elevation locations are not a result of natural geomorphic processes and could be manmade (box 1).

Just upstream of the confluence of Pataha Creek, the channel is forming two alternating meander bends, with erosion occurring

Project Area 34.1
No site photograph available.

Project Area 34.1 Reach Characteristics

VM Start (mi)	10.55
VM Length (mi)	1.17
Valley Slope	0.62%
RM Start (mi)	12.28
RM Length (mi)	1.14
Average Channel Slope	0.63%
Sinuosity	0.98
Connected FP (ac/VM)	23.44
Encroachment Removal (ac/VM)	7.18
Channel Aggradation (ac/VM)	6.24
Total FP Potential (ac/VM)	19.09
Encroaching Feature Length (ft)	4,184.52
Connected FP Rank	11

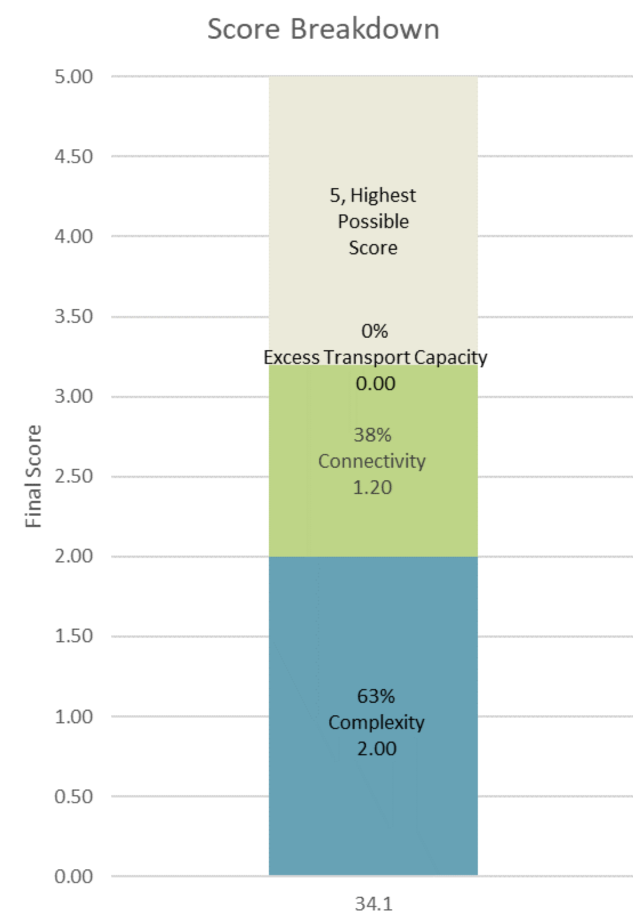
on the outside of the bends and bar building occurring on the inside. The second meander bend is working towards the Pataha Creek channel and has the potential to avulse and occupy that channel should the erosion on the outside right bank continue. There may already be some flow between the two channels at this point given that there are some signs of erosion between them (box 2).

Finally, at the very downstream end of the reach, between the bridge and the confluence of Pataha Creek, there is a large depositional area with aggradation both in the channel and in the floodplain. This is likely additional material that has been transported by Pataha Creek, and the bridge may be causing a backwater effect that is reducing sediment transport capacity in this area. This section of the reach appears to have been more complex at one time, based on evidence of several large meander scars with sediment aggradation, but the 2017 aerial imagery shows the channel as relatively straight (box 3).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 34.1 receives a high score in the Complexity prioritization metric, ranking in the 40th to 60th percentile, which is a range that has been identified for this assessment as having the most potential for restoration. This reach also has a high score for floodplain connectivity potential, ranking above average in the 50th to 75th percentile range and, although this is not the highest

PA 34.1 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

score, floodplain connectivity should still be targeted for restoration. Finally, the Excess Transport Capacity metric ranks around average for PA 34.1, and receives no prioritization score.

The low-winter flow complexity analysis result is well below average and is driven by the fact that the complex area near the confluence of Pataha Creek is not connected at this flow. At the mean-winter flow, multiple side channels in this area are activated including a side channel that connects to Pataha Creek before the confluence. Some additional complexity is achieved in this area and downstream at the 1-year flow but the complexity score does not increase significantly. At all flows, the upstream half of the reach is relatively uncomplex except for a few mid-channel bars at the 1-year flow. In the upstream half of the reach, restoration techniques should include developing instream wood and structure to promote in-channel bars, small side channels, and pools. For the downstream half of the reach, restoration techniques should focus on activating the high-flow channels to perennial flow through making strategic side channel cuts and adding instream wood to promote geomorphic change into the floodplain.

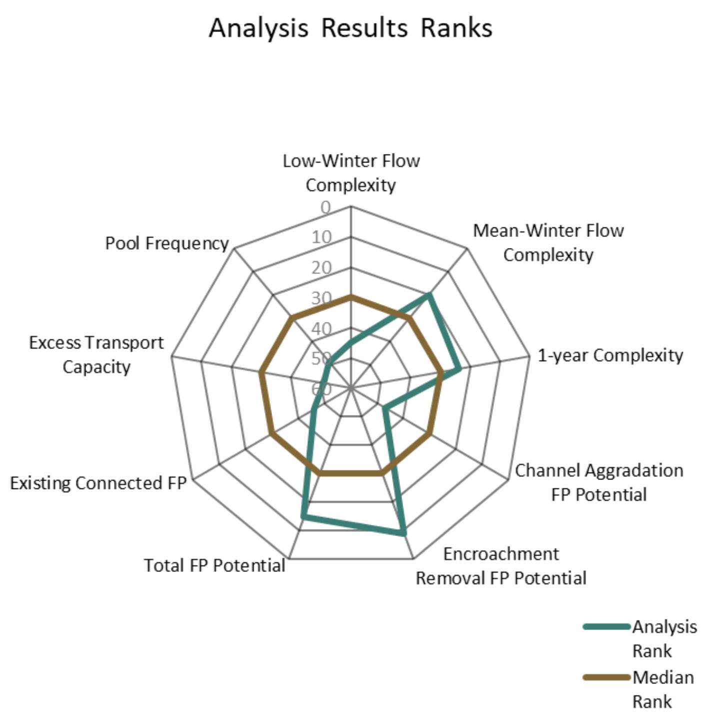
The floodplain connectivity potential score is driven almost entirely by a large amount of low-lying floodplain on the left bank floodplain, and appears to be in a field with no pivot irrigation infrastructure. Taking advantage of this area would require removing the levee that protects this field, and because this area is currently an agricultural field, heavy riparian zone enhancement should occur before attempting to connect this area. There are a few other pockets of floodplain potential that could be connected through floodplain encroachment removal on the right bank near the upstream end of the reach. While these areas are relatively small, the river through this reach currently has very little floodplain and connecting these areas through encroachment removal and adding instream wood could benefit both the complexity and connectivity in the upper part of the project area.

Finally, the Pool Frequency metric in this reach scores very low. The identified restoration strategies of adding instream structure and wood should help to promote geomorphic change towards more in-channel complexity and conditions where pools are more likely to form in the future.

Summary of Restoration Opportunities Identified

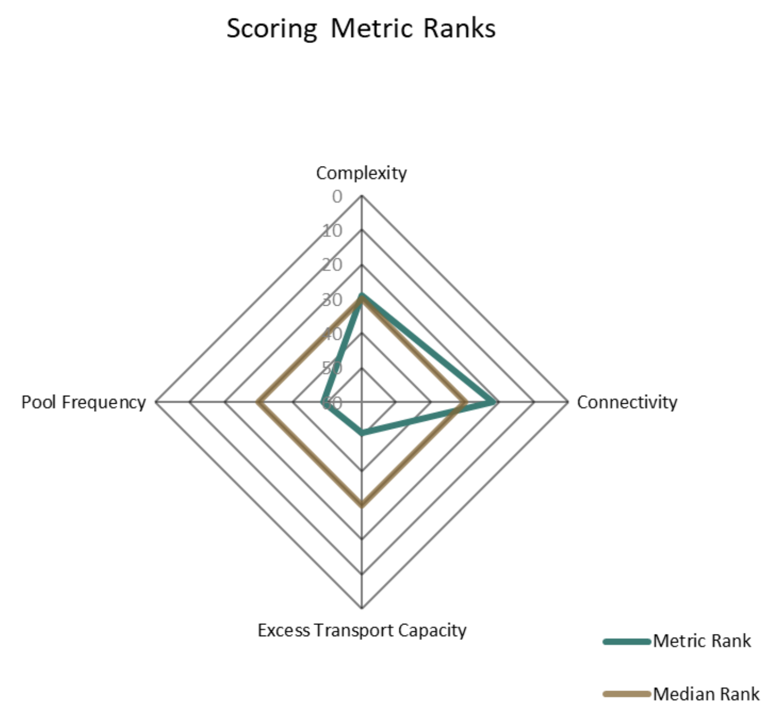
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)

PA 34.1 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

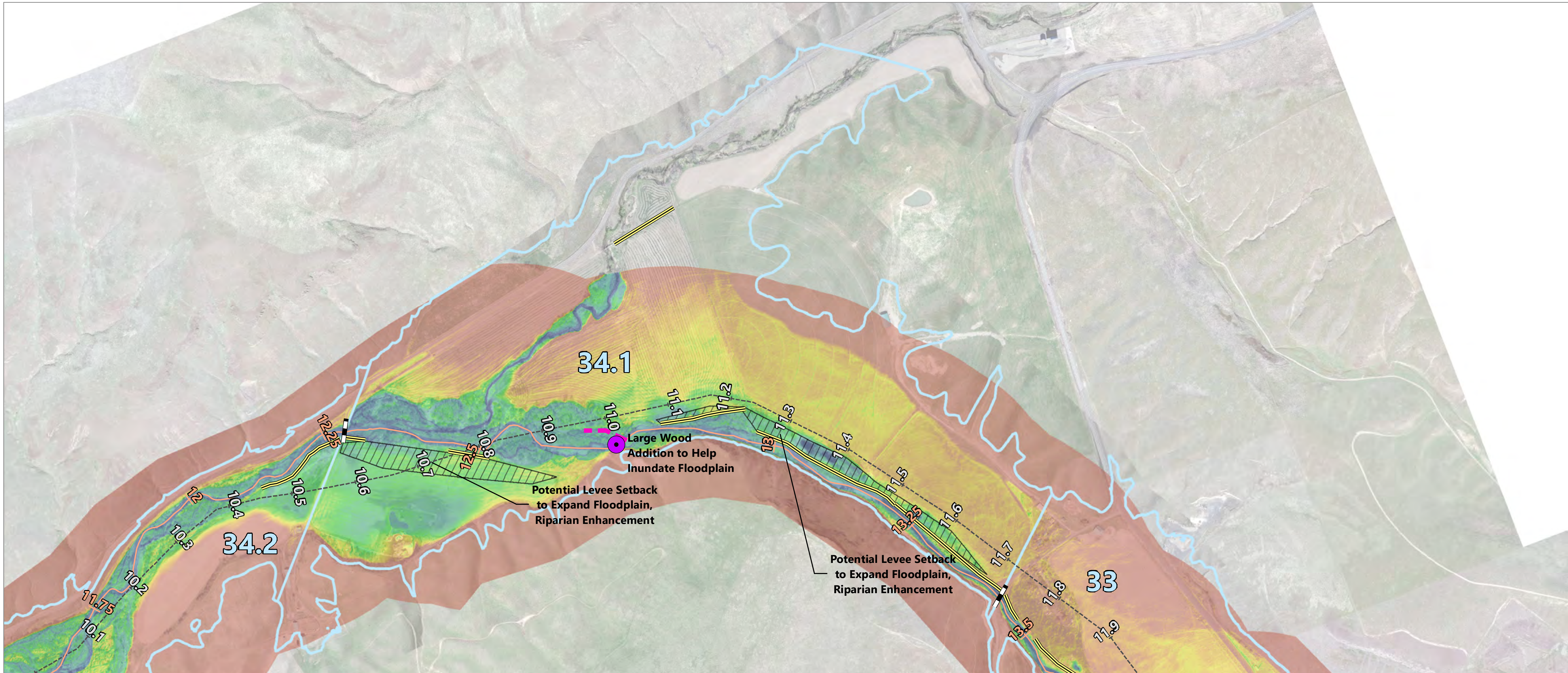
PA 34.1 Prioritization Scoring Summary



This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 34.1 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.098	45	40%	Complexity	0.235	29	40% to 60%	3 of 5	5	40%	3.2	11	1	Untreated	8	1
Mean-Winter Flow Complexity	0.310	20	40%													
1-year Complexity	0.360	24	20%													
Channel Aggradation FP Potential	0.147	47	40%	Connectivity	0.216	22	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.169	9	40%													
Total FP Potential	0.449	15	20%													
Existing Connected FP	0.551	46	0%													
Excess Transport Capacity	-0.14	51	100%	Excess Transport Capacity	0.000	51	52% to 100%	4 of 4	0	20%						
Pool Frequency	5.25	49	100%	Pool Frequency	0.135	49	60% to 90%	4 of 5	1	0%						



LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 12.28
RIVER MILE END: 13.43
VALLEY MILE START: 10.55
VALLEY MILE END: 11.71

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Feet

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ANCHOR QEA

Project Area 34.1
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 41 Description

Project Area 41 begins at VM 2.85 and extends upstream to VM 3.16. The 2017 RM length is 0.35 mile. Field observations for PA 41 were conducted on October 10, 2018, when flow at the Starbuck gage was approximately 115 cfs.

PA 41 is relatively short compared to the other project areas but has complex flow for the majority of the reach. At the upstream end of PA 41, a large log jam has created complex flow with multiple side channels through the forested riparian area. Large trees have fallen into the flow paths in multiple locations, causing deep scour pools. However, it is unclear if this wood will remain in the reach after higher flows, and this reach may require additional hard points or stabilization.

At VM 3, a large gravel bar appears to have been recently manipulated in the floodplain for access and this has pushed the channel into the trees on the left bank.

Downstream of this complex area, the channel goes through a short section of single-thread flow, with a forested riparian area on the left bank but an exposed area on the right bank. This section of the reach still has a large amount of gravel and fine material, and any addition of large woody material would likely result in geomorphic change. At the time of the site visit, this section of the reach did not have much large woody material. This section ends with a steep eroding left bank bordering an irrigated field.

Project Area 41
Looking downstream from PA 40 to the log jam and avulsion at the beginning of PA 41.

Project Area 41 Reach Characteristics

VM Start (mi)	2.85
VM Length (mi)	0.31
Valley Slope	0.73%
RM Start (mi)	3.68
RM Length (mi)	0.35
Average Channel Slope	0.64%
Sinuosity	1.14
Connected FP (ac/VM)	37.40
Encroachment Removal (ac/VM)	7.08
Channel Aggradation (ac/VM)	20.44
Total FP Potential (ac/VM)	37.01
Encroaching Feature Length (ft)	759.10
Connected FP Rank	1

Immediately downstream of this eroding left bank, the channel flows through the riparian forested floodplain, and the reach becomes very complex again, with multiple flow paths, instream wood, and evident scour pools in gravel material. At the downstream end of the project area, the channel enters an exposed area of the floodplain with little riparian cover.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows that PA 41 has had significant deposition across almost the entire reach. At the upstream end, a series of natural log and debris jams have triggered a channel avulsion through the forested right bank floodplain where complex multi-channel flow has formed. This area is associated with a large amount of deposition in the former main channel as well as the left bank floodplain (box 1).

This deposition in the main channel continues to the next highlighted area of change, where several log jams have caused erosion towards the left bank that appears to be threatening some pivot infrastructure (box 2). The pattern of deposition in the main channel and floodplain continue for the remainder of the reach.

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 41 receives equal scores in the Connectivity and Complexity metrics, which make up the entire prioritization score. Both prioritization metrics received moderate scores. For Connectivity, this indicates that PA 41 ranks near the top in the 60th to 90th percentile of all project areas, which is a range that has been identified as only needing a slight boost to reach a high level of complexity. For Connectivity, this indicates that PA 41 ranks above average in the 50th to 75th percentile of all project areas.

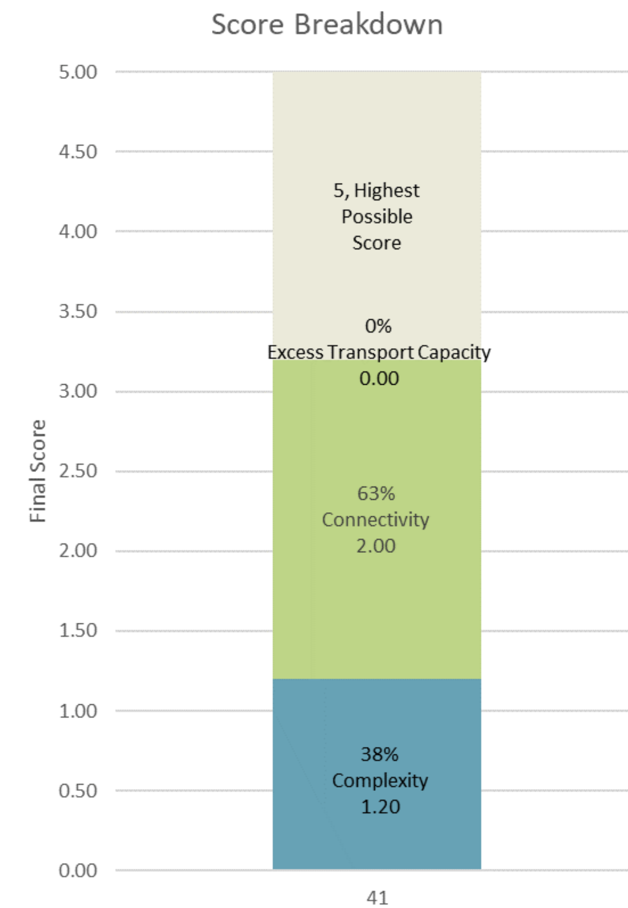
PA 41 ranks highly in all three flows for the Complexity analysis results. However, while the project area ranks near the top in low-winter flow complexity, the mean-winter flow complexity is slightly lower, and the 1-year flow complexity is only slightly above average. This indicates that many of the islands and side channels are being washed out during the higher flow events. A primary restoration strategy should be to add instream wood to ensure that complex flow channels are maintained during higher flow events. Because PA 41 currently has a large amount of natural log jams, it may be possible to stabilize these log jams via large rock or piles.

The connectivity potential in this reach is driven by both the Channel Aggradation analysis result and the Encroachment Removal analysis result, both of which rank PA 41 slightly above average. Total Floodplain Potential is greater than the sum of the two alone, indicating more floodplain can be gain when both potential reconnection methods are targeted. However, the majority of the potential floodplain is outside of the levee and in the bordering fields. Reconnection to the floodplain may be difficult and would require extensive revegetation efforts with riparian species. The remainder of the potential area exists in small patches in the forested floodplain and can be reconnected with channel bed aggradation. Because this reach was noted to be extremely depositional in nature in the geomorphic change analysis, gravel augmentation is probably not necessary, and restoration strategies should focus on adding instream wood and structure to store and maintain the sediment already available. PA 41 receives no score in the Excess Transport Capacity metric, indicating that any added gravel material will be easily stored and maintained with the addition of instream wood.

While gravel augmentation is not currently necessary, it may be possible that this reach is part of a larger gravel augmentation plan for several reaches in the area, in which case the extra material will likely only serve to add some slight complexity and connectivity. Should this reach ever reverse its trend of being a depositional reach, gravel augmentation would likely be necessary along with the addition of instream wood to achieve the desired results.

Finally, PA 41 ranks very highly in the Pool Frequency metric, indicating a high amount of pools per valley mile. The restoration strategy of adding instream structure and wood should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be maintained and continue to form with the natural processes of the reach.

PA 41 Score Breakdown

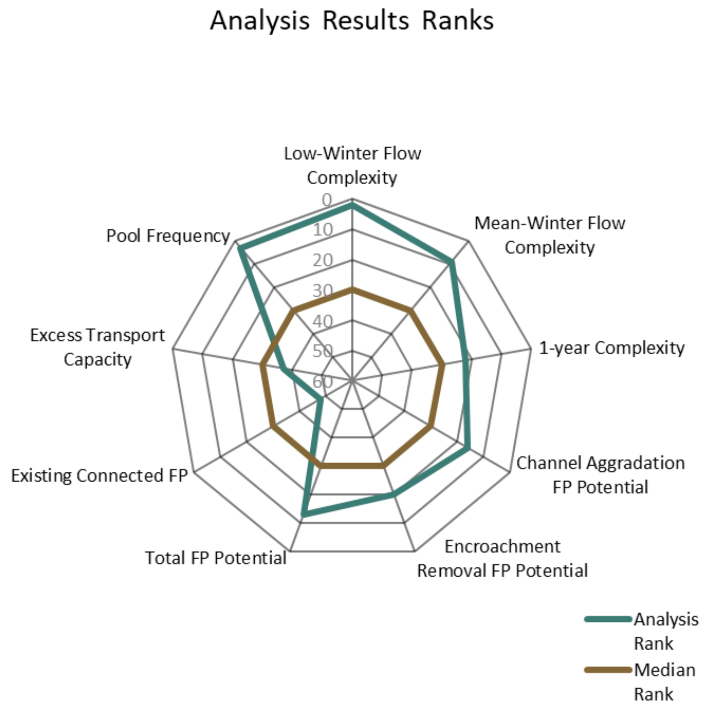


This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

Summary of Restoration Opportunities Identified

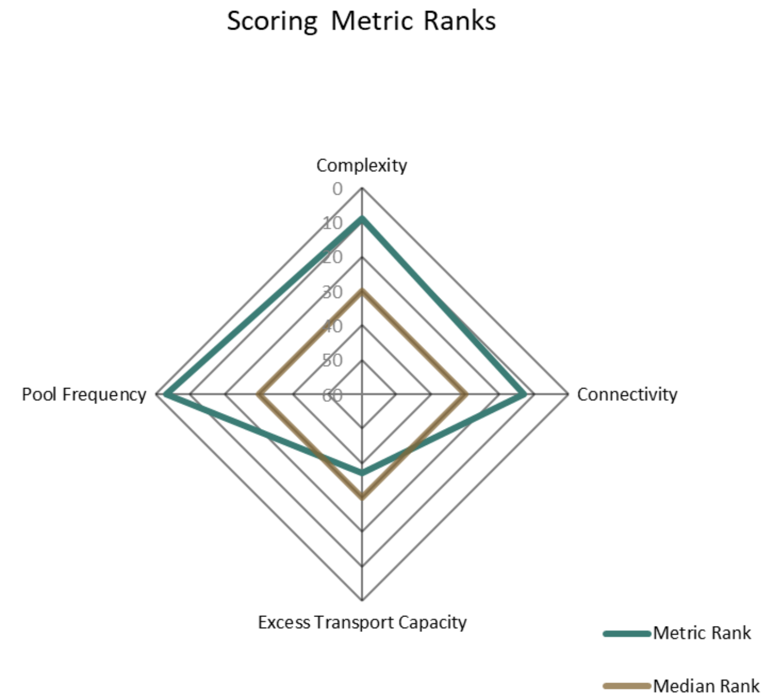
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

PA 41 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

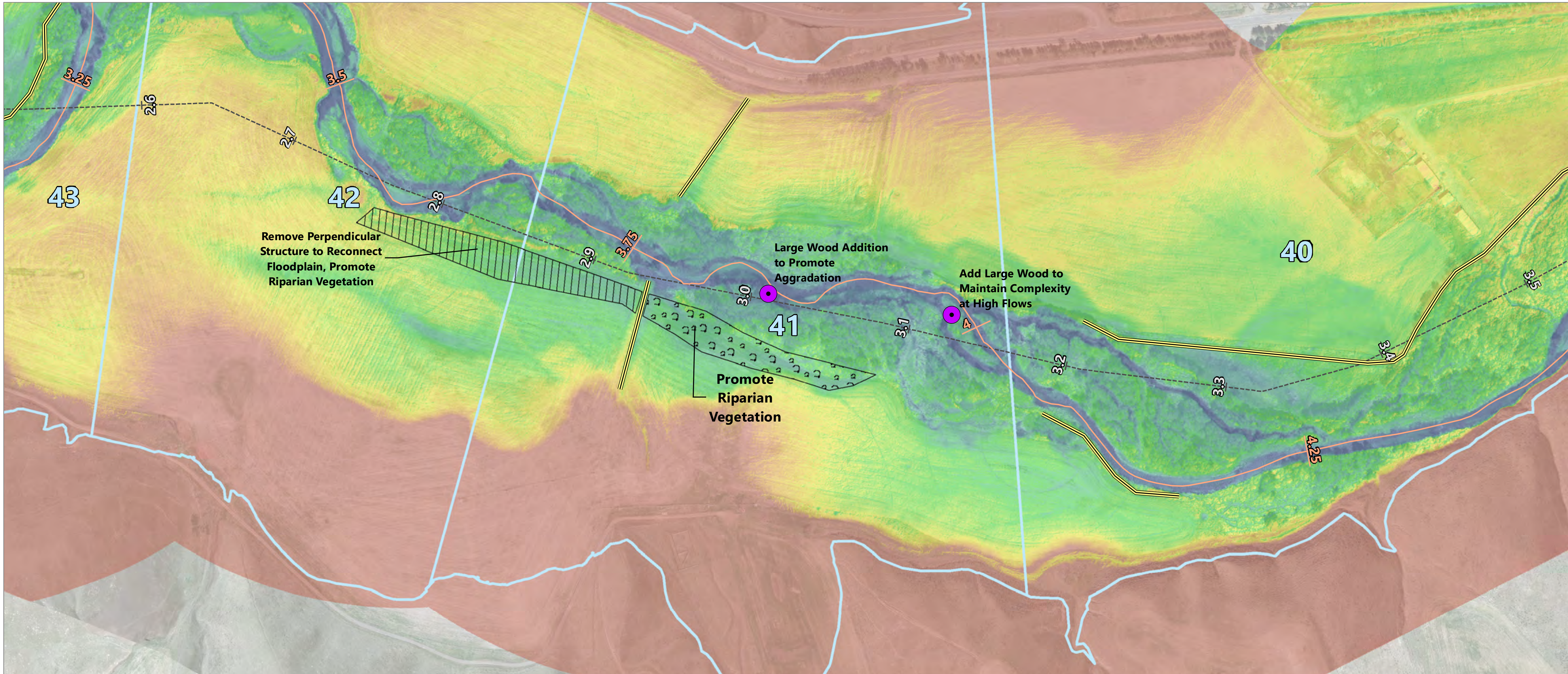
PA 41 Scoring Metric Ranks

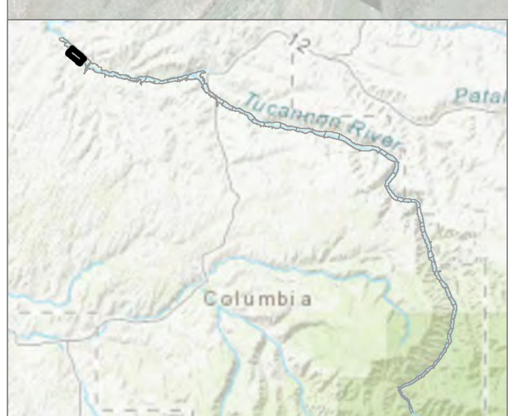


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 41 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.415	2	40%	Complexity	0.423	9	10% to 40%	2 of 5	3	40%	3.2	12	1	Untreated	9	1
Mean-Winter Flow Complexity	0.454	9	40%													
1-year Complexity	0.377	22	20%													
Channel Aggradation FP Potential	0.275	16	40%	Connectivity	0.247	13	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.095	20	40%													
Total FP Potential	0.497	13	20%													
Existing Connected FP	0.503	48	0%													
Excess Transport Capacity	-0.05	37	100%	Excess Transport Capacity	0.000	37	52% to 100%	4 of 4	0	20%						
Pool Frequency	31.21	3	100%	Pool Frequency	0.801	3	1% to 10%	1 of 5	0	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential
- Riparian Enhancement

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 3.68
RIVER MILE END: 4.03
VALLEY MILE START: 2.85
VALLEY MILE END: 3.16

0 500
Feet

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Filepath: \\orcas\gis\Jobs\TucannonRiver_1006\Maps\Conceptual Maps\Tucannon Untreated Project Areas_mg.mxd

ANCHOR QEA

Project Area 41
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 44 Description

Project Area 44 begins at VM 2.01 at the Powers Road bridge and extends upstream to VM 2.32. The 2017 RM length is 0.43 mile. Field observations for this reach were conducted on October 10, 2018, when flow at the Starbuck gage was approximately 115 cfs.

PA 44 is mostly a single-thread uniform channel, which meanders across the accessible floodplain. At the upstream end of the reach, the left bank is heavily forested while the right bank runs along a cultivated field. From the mid-reach to the downstream end, the channel bends through the forested area so that the left bank runs along an exposed field and the right bank is heavily forested. In the downstream section, irrigation infrastructure is very close to the eroding left bank; this should be addressed before the problem requires emergency actions.

The area in both forested sections of the floodplain is relatively low, with multiple flow path options that could be candidates for split flows or side channels to direct flow away from eroding outside banks. One large log jam on the right bank, near where the channel switches to the other side of the floodplain, is causing some bank erosion. Otherwise, instream wood and channel complexity in this reach are very low but the reach has the potential to achieve both of these with more connection and interaction with the already forested portions of the floodplain.

Project Area 44
PA 44 mid-reach, looking downstream at erosion into a field on the left bank on the outside of a meander bend.

Project Area 44 Reach Characteristics

VM Start (mi)	2.01
VM Length (mi)	0.31
Valley Slope	0.75%
RM Start (mi)	2.49
RM Length (mi)	0.43
Average Channel Slope	0.55%
Sinuosity	1.39
Connected FP (ac/VM)	21.15
Encroachment Removal (ac/VM)	1.08
Channel Aggradation (ac/VM)	28.50
Total FP Potential (ac/VM)	44.65
Encroaching Feature Length (ft)	178.24
Connected FP Rank	13

Geomorphic Changes

Analysis of the change between the 2010 and 2017 LiDAR for PA 44 shows that the reach is geomorphically active but, because it is also a relatively short reach, only three significant locations are highlighted here. The first area of significant geomorphic change begins at the upstream boundary of the project area, where a large meander bend protrudes into the right bank field. This meander bend is migrating outward as the inside bar is building and erosion can be seen on the outside of the bend. Just downstream, a second meander is forming with bar building and erosion seen on the opposite banks (box 1).

The second area of significant geomorphic change is further downstream at another bend in the river bordered by a steep bank to the agricultural field. Significant erosion appears to be working through the steep bank to the field (box 2).

At the downstream end of this project area, just upstream of the Powers Road bridge, a large log jam appears to be contributing to significant erosion on both sides of the channel. Deposition has occurred immediately downstream of this log jam, possibly as a direct result of this erosion and also considering that the bridge likely creates a low-energy backwater effect at higher flows (box 3).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 44 receives most of its prioritization score from the Connectivity metric and is ranked in the top 25% of all project areas for this metric. This high rank is driven mostly by the Channel Aggradation analysis result. This potential is located almost entirely on the right bank in a large, low-lying area inside of the river bend. Raising the bed elevation through the reach would help to access this area more frequently and should be the target of restoration in this reach. This project area is near the downstream end of the basin and should be able to receive easily transportable material from upstream reaches. Additionally, this project area receives a low score in the Excess Transport Capacity metric, indicating that the shear stress for this reach is near normal levels for the slope of the reach and will store sediment given instream wood and structure. The primary restoration strategy in this reach should be to add wood structures to the main channel and floodplain to trap and store sediment with the objective of raising the channel bed elevation.

Additionally, several high-flow channels are located in this floodplain and accessing them could provide an opportunity to inundate a portion of this floodplain. Cutting pilot channels into the floodplain, along with the placement of wood structure in channel, will help to inundate this area and should be included as part of the restoration strategy for this reach.

This project also directly borders an agricultural field on the left bank with little to no riparian area. Pushing flow into the right bank floodplain will take some of the flow out of this exposed area, but enhancing the riparian area should also be considered as a restoration strategy for this reach.

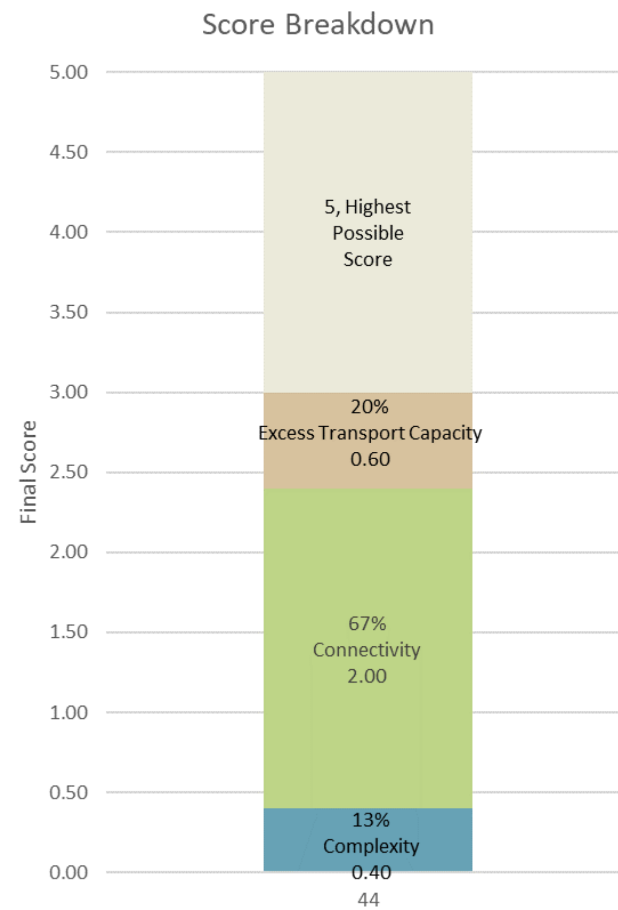
This project area ranks below average in the Complexity metric for all three flows, indicating that a high level of complexity would be difficult to achieve through restoration. However, the identified restoration strategies will also add to complexity if pilot channels are cut to an elevation so that they receive flow on a regular basis. Cutting perennial pilot channels, along with the addition of instream wood and structure, should be a secondary restoration strategy for this reach.

Finally, the Pool Frequency metric in this reach ranks very highly, indicating a large amount of pools per river mile. The restoration strategies of adding instream wood and cutting pilot channels should promote more geomorphic change and complexity that will maintain existing pools and form new ones so that the pool frequency in this reach remains high.

Summary of Restoration Opportunities Identified

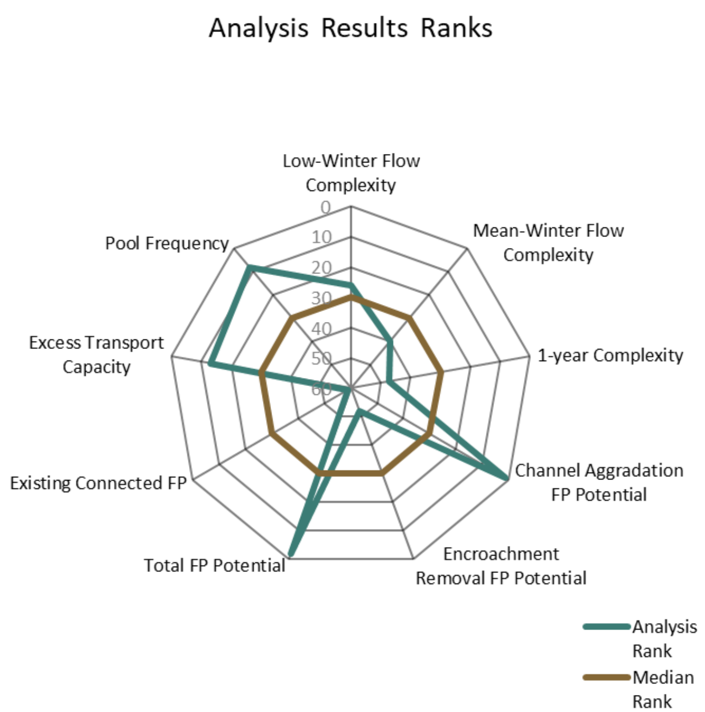
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement
- Modify or remove obstructions

PA 44 Score Breakdown



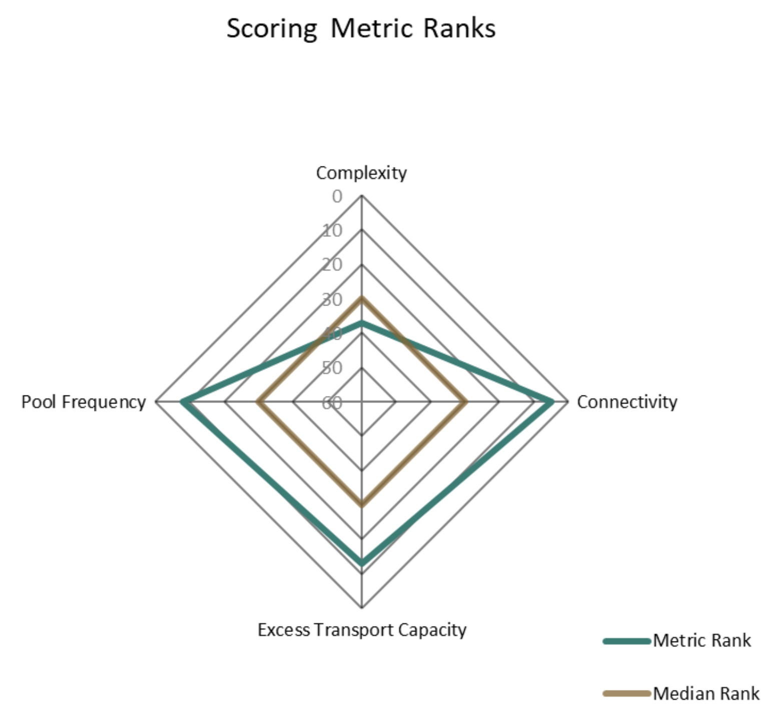
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 44 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

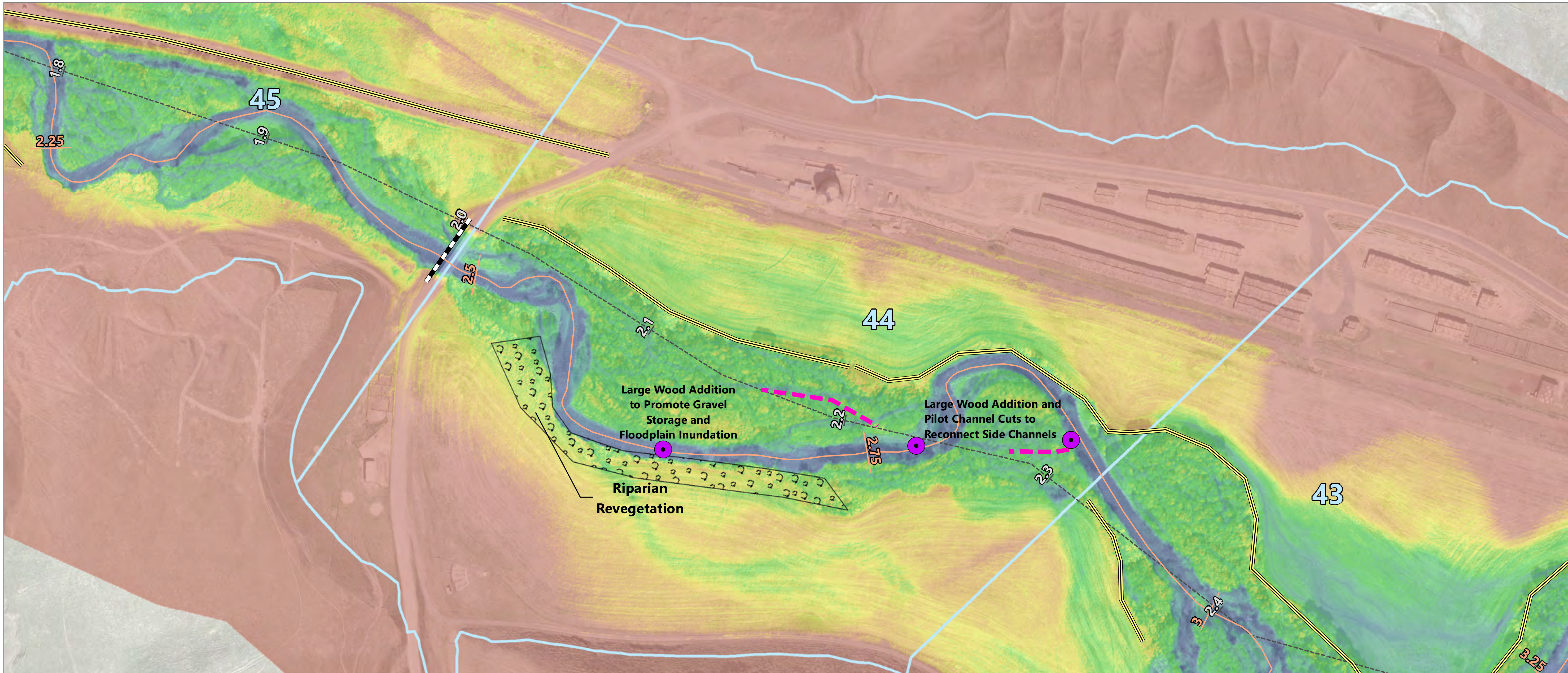
PA 44 Prioritization Scoring Summary

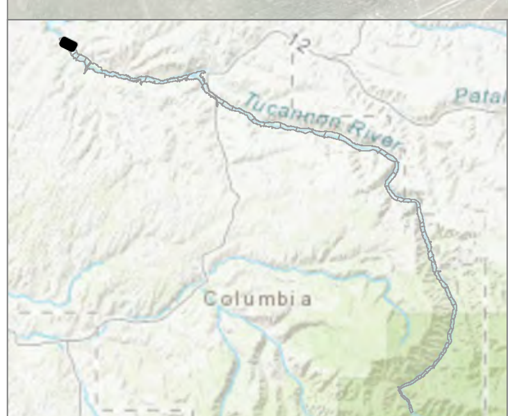


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 44 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.182	26	40%	Complexity	0.169	37	60% to 90%	4 of 5	1	40%	3.0	17	1	Untreated	12	1
Mean-Winter Flow Complexity	0.159	40	40%													
1-year Complexity	0.161	47	20%													
Channel Aggradation FP Potential	0.433	1	40%	Connectivity	0.316	5	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.016	52	40%													
Total FP Potential	0.679	2	20%													
Existing Connected FP	0.321	59	0%													
Excess Transport Capacity	0.16	13	100%	Excess Transport Capacity	3.000	13	10% to 30%	2 of 4	3	20%						
Pool Frequency	23.17	8	100%	Pool Frequency	0.595	8	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Riparian Enhancement

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 2.49
RIVER MILE END: 2.92
VALLEY MILE START: 2.01
VALLEY MILE END: 2.32

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ANCHOR QEA

Project Area 44
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

APPENDIX J.2
TIER 2: UNTREATED PROJECT AREAS

Project Area 3.1 Description

Project Area 3.1 begins at VM 42.73 and extends upstream to the bridge crossing at Tucannon Road at VM 43.10. The 2017 RM length is 0.37 mile. Field observations for PA 3.1 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

For this assessment update, PA 3 as defined in the 2011 prioritization was separated into two project areas (PA 3.1 and PA 3.2) for distinct analysis because only PA 3.2 was treated. The downstream boundary of PA 3.1 marks the beginning of the restoration work that took place in PA 3.2.

Based on the relative elevation map and aerial imagery, this reach appears to be mostly straight with several significant side channel opportunities. The channel through PA 3 is characterized as a single-thread channel containing both plane-bed and forced pool-riffle sections. Local steep rapids are present; in these sections, the thalweg is typically deep with high velocities. In the 2011 assessment, one rock weir and multiple rock and rootwad restoration features were identified in the project area. Other than rock armor along the Cow Camp bridge abutments and an approximately 350-foot riprap bank downstream of the bridge, no other significant infrastructure was identified in the channel. Only a few side channels were observed that appeared to provide minimal habitat benefit.

Project Area 3.1
Plane-bed, straight, and uniform section of river with little instream complexity. View is from the bridge upstream of PA 3.1 and looking downstream.

Project Area 3.1 Reach Characteristics

VM Start (mi)	42.73
VM Length (mi)	0.37
Valley Slope	1.59%
RM Start (mi)	48.23
RM Length (mi)	0.37
Average Channel Slope	1.55%
Sinuosity	1.01
Connected FP (ac/VM)	6.54
Encroachment Removal (ac/VM)	1.73
Channel Aggradation (ac/VM)	2.24
Total FP Potential (ac/VM)	5.02
Encroaching Feature Length (ft)	356.27
Connected FP Rank	59

The availability and quality of instream habitat was limited by lack of complexity and hydraulic conditions that prevented the retention of sufficient volumes of LWD and sediment. The spatial distribution of existing LWD was limited. Large log jams and sediment deposits were present but sporadic; the log jams that were observed were typically associated with local areas of high temporary sediment storage, split flow, and side channels. However, the majority of the project area is made up of long, straight, plane-bed stretches that lack any adequate cover or hydraulic complexity.

Throughout a majority of the project area, the channel is moderately entrenched between the bedrock valley wall and remnant alluvial fan and hillslope deposits, resulting in a relatively high floodplain surface. Thus, much of the valley floor is not within the low floodplain.

The influence of the riprap to floodplain connectivity does not appear to be significant, although the armoring likely prevents channel migration and transfers energy downstream along the left bank. A relatively low former channel position was located in the western portion of the floodplain. Flowing water was observed through the channel, although it was unclear if it was supplied by hyporheic exchange or a groundwater spring. No fish use was observed within this feature.

The 2011 assessment noted that the riparian zone was in a moderately healthy condition, with local areas that had been degraded by infrastructure, fire, and development. Riparian trees were mixed deciduous and conifer, dominated by ponderosa pine, alder, and dogwood. The banks upstream of the Little Tucannon River were dominated by alder saplings, grasses and other emergent vegetation, buttercup, and other invasive species.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows very little significant geomorphic change has occurred over the past 7 years. Near the upstream end of the reach, some deposition has occurred in the channel forming a mid-channel bar. There is some minor erosion on the opposite bank associated with this bar (box 1).

The only other significant change in this reach is a meander bar forming on the right bank near the downstream end of the channel. No erosion is evident on the opposite bank, and this is likely just a depositional area (box 2).

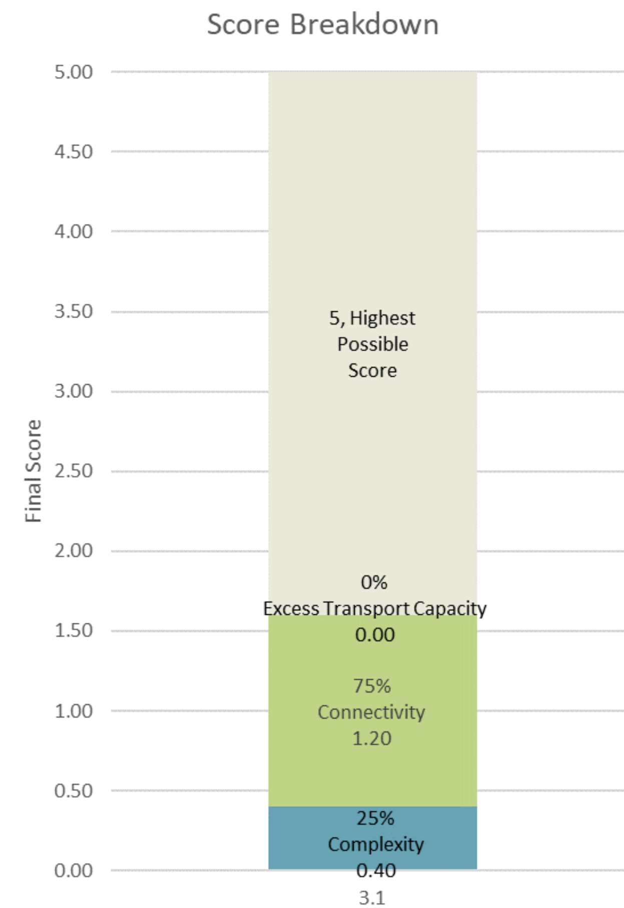
The few geomorphic changes in this reach could indicate that there is not enough instream wood and gravel material, or the reach is highly incised and resistant to change.

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 3.1 receives the majority of its prioritization score from the Connectivity metric. PA 3.1 ranks within the 50th to 75th percentile of all project areas for Complexity and ranks near average in the Channel Aggradation analysis result and well above average in the Encroachment Removal analysis result. This high rank in the Encroachment Removal analysis result is driven almost entirely by a large, low-lying area on the left bank floodplain that appears to be an old channel location or side channel location. This area is disconnected at the upstream end either by a high bank or channel incision. A primary restoration strategy for this reach should be to connect this area through pilot channel cuts and the addition of instream wood. The channel aggradation potential is mostly driven by areas directly surrounding the active 2-year floodplain. Channel aggradation should be targeted through a restoration strategy of gravel augmentation along with the addition of instream wood to store sediment. Raising the channel bed will also likely help reconnect the low-lying area by increasing flows through pilot channel cuts. PA 3.1 receives no score for Excess Transport Capacity and any instream wood or structure added should be able to store and maintain sediment material from gravel augmentation.

PA 3.1 receives a low score in Complexity, indicating that it falls within the 10th to 40th percentile of all project areas for this

PA 3.1 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

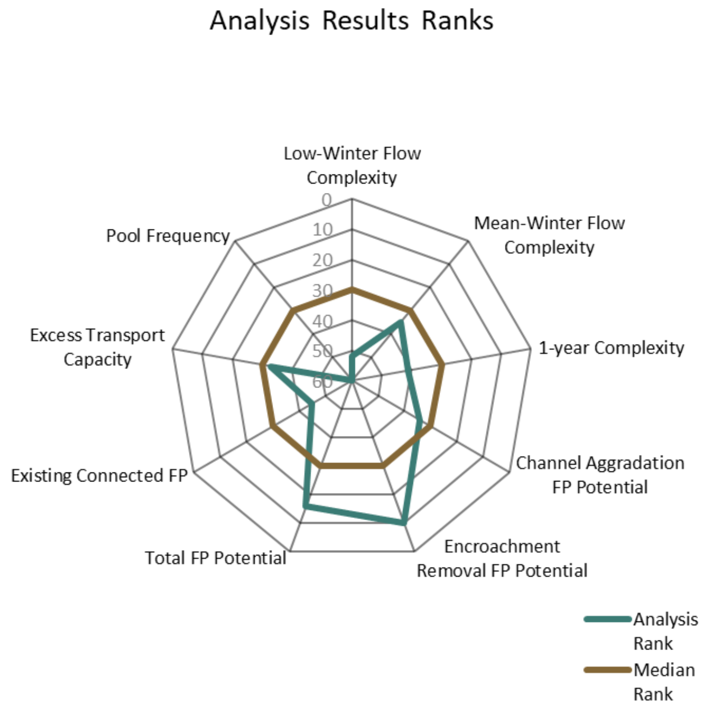
metric, and all three Complexity analysis results rank below average; the low-winter flow complexity result is particularly low as several side channels are connected at the mean-winter and 1-year flow events but not at the low-winter flow event. Restoration strategies for complexity should focus initially on reconnecting these side channels. This can be accomplished through the addition of instream wood and pilot channel cuts in the areas of the side channels. A gravel augmentation strategy may also help to raise the water surface elevation and reconnect some of these channels. Reconnecting the former channel should provide opportunities to increase complexity as well.

Finally, PA 3.1 ranks very low among project areas in the Pool Frequency metric. Adding instream wood and gravel augmentation will promote changes towards an increase in channel complexity, promoting the formation of pools. These restoration strategies should be employed to target increasing pool frequency in the reach.

Summary of Restoration Opportunities Identified

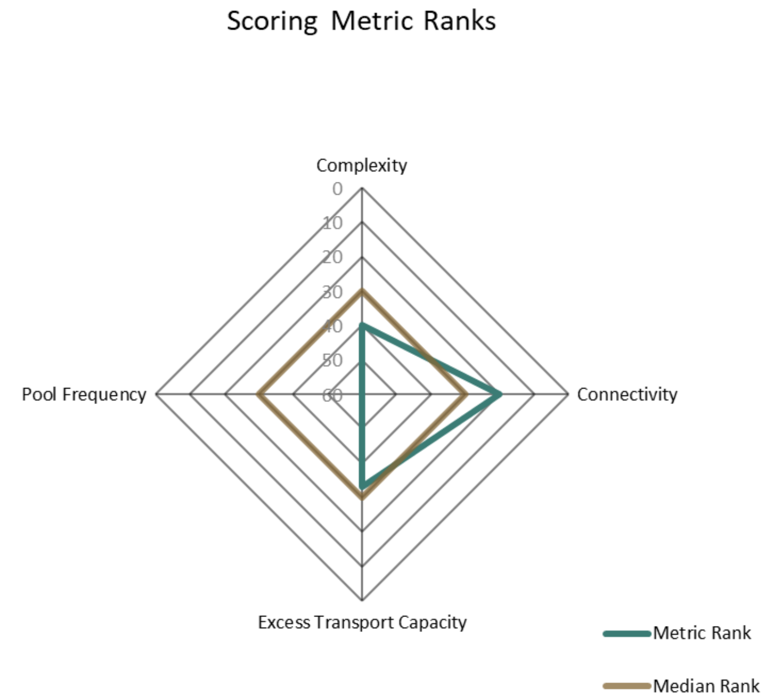
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)

PA 3.1 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

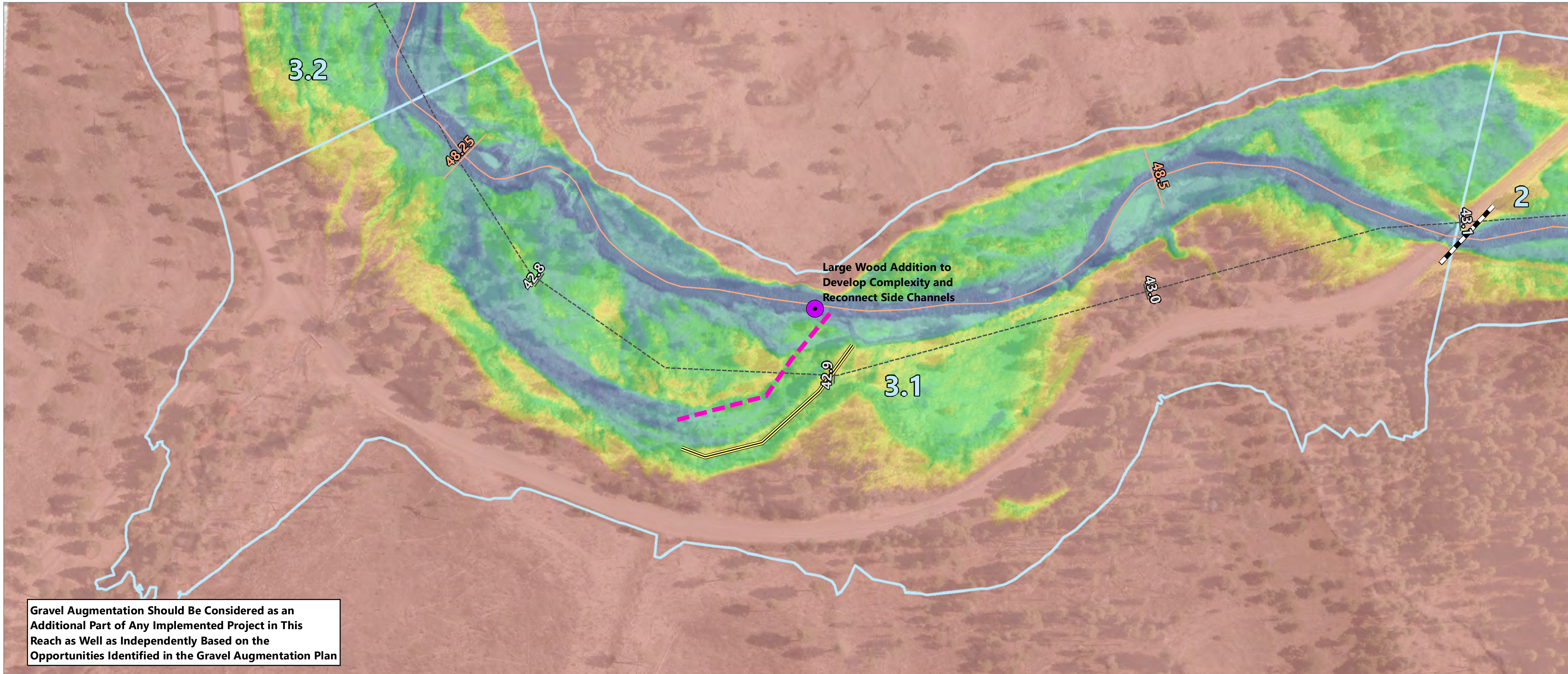
PA 3.1 Scoring Metric Ranks



This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 3.1 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.093	52	40%	Complexity	0.152	40	60% to 90%	4 of 5	1	40%	1.6	36	2	Untreated	23	2
Mean-Winter Flow Complexity	0.182	35	40%													
1-year Complexity	0.211	41	20%													
Channel Aggradation FP Potential	0.194	34	40%	Connectivity	0.224	20	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.149	10	40%													
Total FP Potential	0.435	16	20%													
Existing Connected FP	0.565	45	0%													
Excess Transport Capacity	-0.01	33	100%	Excess Transport Capacity	0.000	33	52% to 100%	4 of 4	0	20%						
Pool Frequency	0.00	60	100%	Pool Frequency	0.000	60	90% to 100%	5 of 5	0	0%						



LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel

Relative Elevation in Feet
High : 15
Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 48.23
RIVER MILE END: 48.6
VALLEY MILE START: 42.73
VALLEY MILE END: 43.1

0 500
Feet

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ANCHOR QEA

Project Area 3.1
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 16 Description

Project Area 16 begins at VM 31.05 at a bridge crossing for the Tucannon Road near McGovern Lane and extends upstream to VM 32.29. The 2017 RM length is 1.39 miles. Field observations for PA 16 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

In 2011, the channel through PA 16 was characterized as a single-thread, plane-bed channel with occasional pools forced by engineered structures and resistant banks. The channel was located through a highly developed residential area and was significantly affected by several levees, armored banks, and rock and LWD structures. These structures were providing limited habitat benefits and preventing channel migration and floodplain connectivity. In addition, portions of the left bank were confined against resistant alluvial fan deposits. Some banks within the project area were actively eroding and migrating. Remnant levee or spoil piles were observed on the right bank at approximately RM 35.9 and from about RM 35.7 to the mouth of Tumalum Creek. Large right bank levees with LWD and rock structures at the toe were observed from RM 35.45 to just downstream of RM 35.2. Large left bank levees were observed from approximately RM 35.2 to 35.1. Both banks from RM 35.1 to 34.9 were sporadically armored with large angular rock and riprap. Larger J-hook structures at the upstream end of the project area to approximately RM 36.2

Project Area 16
Photograph taken from the 2011 prioritization showing bank erosion adjacent to a private infrastructure, looking across at the right bank.

Project Area 16 Reach Characteristics

VM Start (mi)	31.05
VM Length (mi)	1.24
Valley Slope	1.24%
RM Start (mi)	34.97
RM Length (mi)	1.39
Average Channel Slope	1.09%
Sinuosity	1.12
Connected FP (ac/VM)	9.30
Encroachment Removal (ac/VM)	4.36
Channel Aggradation (ac/VM)	5.16
Total FP Potential (ac/VM)	10.43
Encroaching Feature Length (ft)	5,172.54
Connected FP Rank	52

likely have had an influence on the channel grade. Very few off-channel areas were observed except the mouth of Tumalum Creek and a short side channel at approximately RM 35.25 that appeared to be maintained for water diversion. Instream habitat was limited by a lack of complexity and hydraulic conditions due to confinement. The confined condition of the channel likely has resulted in high velocities during seasonal high flows and flooding that prevents the retention of sufficient volumes of LWD for cover and refuge, or sediment for spawning areas. Few pools were observed except at man-made structures, many of which were fast-moving along outer banks. Preferred juvenile rearing areas were very limited due to the absence of side channels. Much of the channel had little overhanging vegetation.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows several notable locations of geomorphic change in PA 16, although they are relatively minor and isolated. The first location of geomorphic change in this reach is at the outlet of Tumalum Creek where there is a depositional area typical of the alluvial fan of a tributary. While this area does not directly influence the Tucannon River mainstem channel, it appears to have raised the right bank floodplain and may be more influential in the future (box 1). Downstream of Tumalum Creek, the next notable change is not a natural geomorphic change but a location where the road bordering the river has been raised significantly (box 2).

Near the downstream end of the reach are the two most notable geomorphic changes for this reach. Both areas are located were there has been significant bank erosion, first on the right bank and then on the left bank. The upstream area is also associated with bar building on the left bank and may have been caused by a log jam on an island near the left bank (boxes 3 and 4).

Geomorphic Characteristics and Restoration Strategies

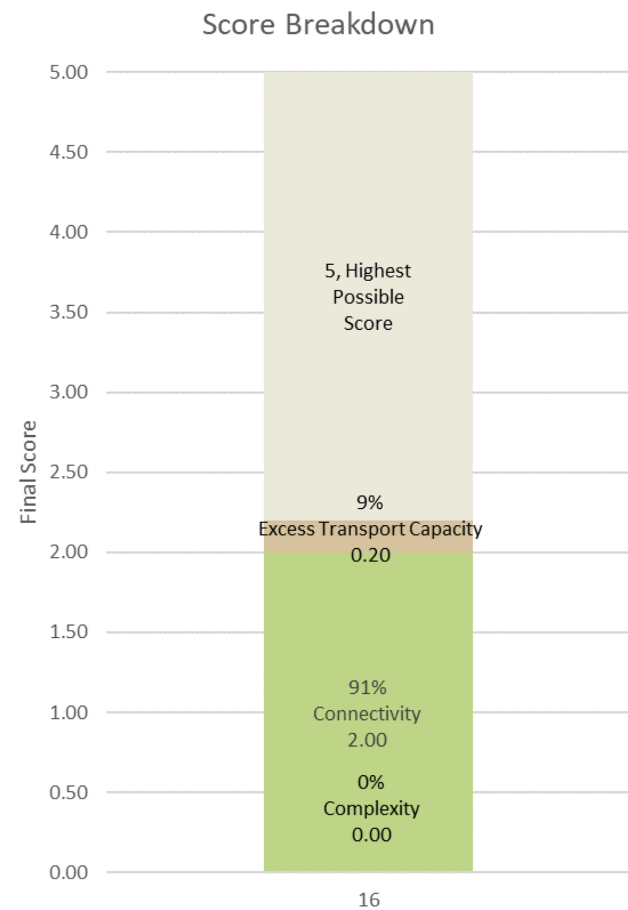
As shown in the following graphs and table, PA 16 received the highest possible score in the Connectivity metric, ranking in the top 25% of all project areas. There appears to be significant opportunity for both channel aggradation and encroachment removal techniques in several locations throughout the reach based on the rankings in the analysis results. In most places, some sort of levee or encroachment removal will be necessary to reconnect the floodplain, but there are also several locations where raising the water surface elevation through gravel augmentation could reconnect isolated floodplain. Gravel augmentation and levee and encroachment removal should be considered primary restoration strategies for this reach, along with the addition of instream wood to promote geomorphic changes and channel dynamics.

PA 16 also received a moderate score for excess transport capacity, ranking in the 70th to 90th percentile of all project areas for that metric, indicating there is excess transport capacity in this reach. The moderate score indicates that this reach probably transports gravel sediment easily as would be expected of a mostly confined and straight reach. In order for gravel augmentation to be successful in activating abandoned floodplain, in-channel and floodplain structure should be added to promote sediment storage near the middle part of the reach. A large amount of wood and structure should also be added to the upstream portion of the reach to promote channel dynamics and geomorphic change, which could release sediment stored in the floodplain and restart the natural sediment transport processes in the reach.

The valley through this reach is occupied by mostly residential land use, and the riparian vegetation is very poor based on the aerial imagery and notes from the 2011 assessment. Any restoration activity in this reach should be accompanied by heavy riparian zone enhancement in any areas where other planned restoration strategies are going to be implemented.

Finally, pool frequency in the project area scores well below average, indicating a low amount of pools per river mile. The identified restoration strategies of gravel augmentation and adding instream wood should promote the natural processes that will encourage pools to form more frequently and be sustained with changing geomorphic conditions.

PA 16 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

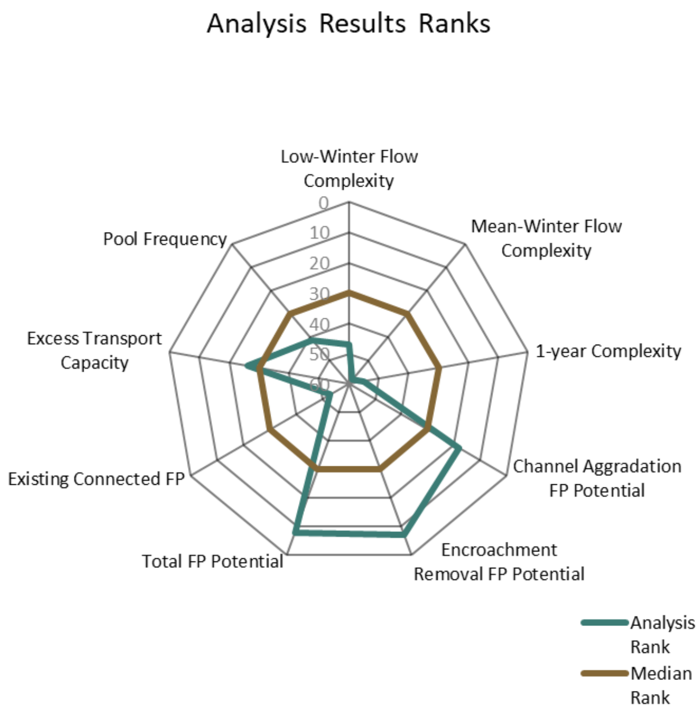
Summary of Restoration Opportunities Identified

- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Riparian Zone Enhancement

Long-Term Opportunities in this Project Area

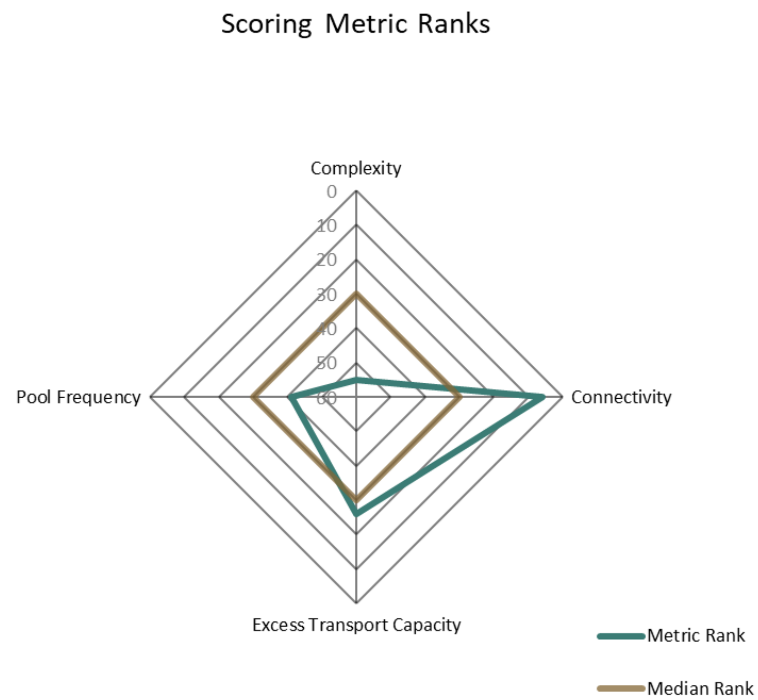
- Set back road against left valley wall for more floodplain connection and channel migration area.

PA 16 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

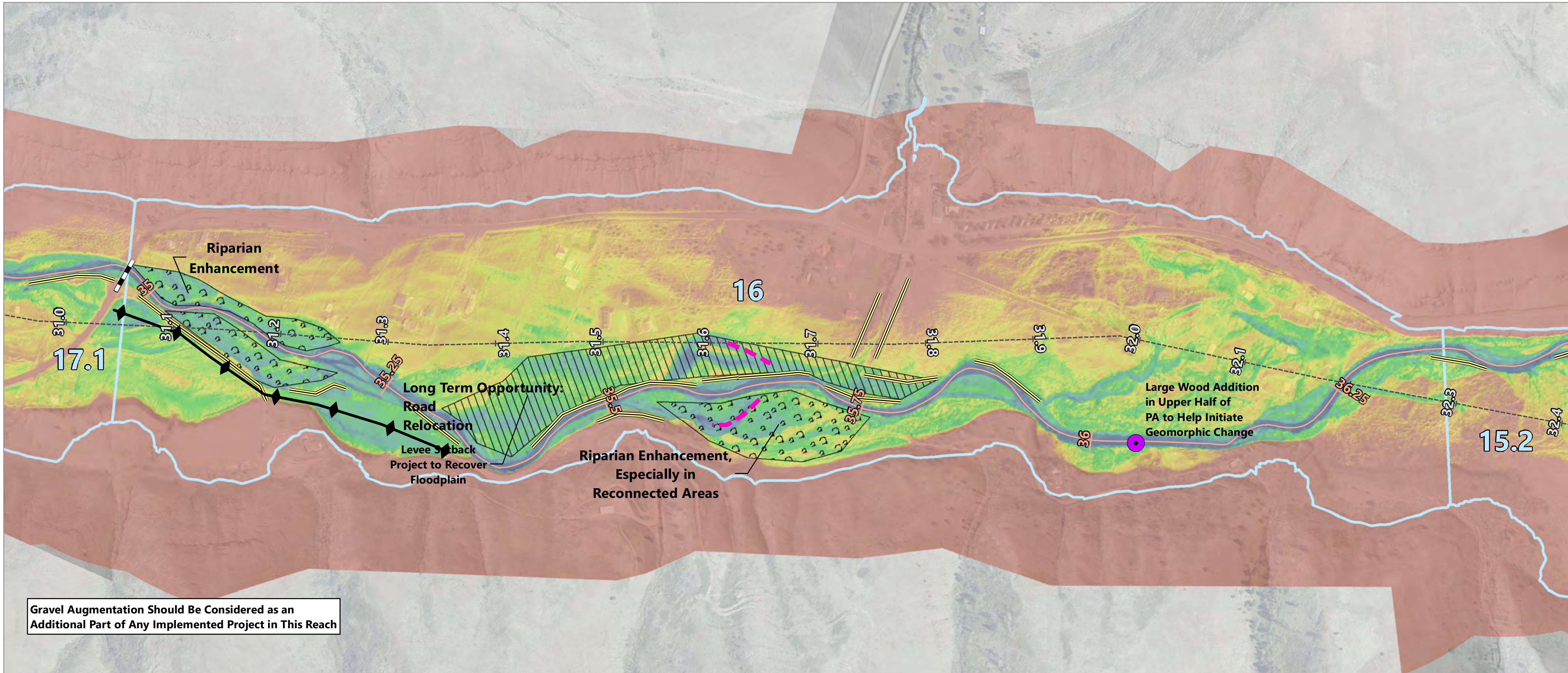
PA 16 Prioritization Scoring Summary

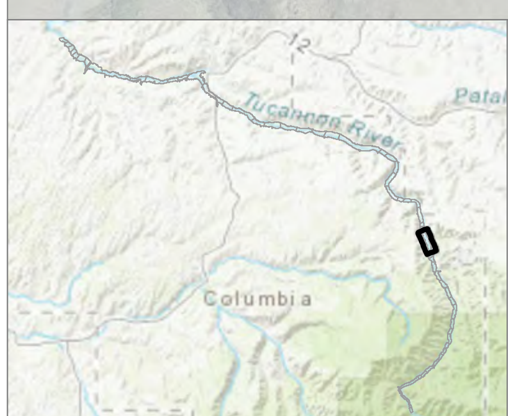


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 16 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.097	47	40%	Complexity	0.094	55	90% to 100%	5 of 5	0	40%	2.2	26	2	Untreated	19	2
Mean-Winter Flow Complexity	0.094	58	40%													
1-year Complexity	0.092	55	20%													
Channel Aggradation FP Potential	0.262	18	40%	Connectivity	0.299	6	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.221	7	40%													
Total FP Potential	0.529	8	20%													
Existing Connected FP	0.471	53	0%													
Excess Transport Capacity	0.06	26	100%	Excess Transport Capacity	1.000	26	30% to 52%	3 of 4	1	20%						
Pool Frequency	7.90	41	100%	Pool Frequency	0.203	41	60% to 90%	4 of 5	1	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential
- Long Term: Relocate Road
- Riparian Enhancement

Relative Elevation in Feet
High : 15
Low : -0

NOTES:
1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 34.97
RIVER MILE END: 36.36
VALLEY MILE START: 31.05
VALLEY MILE END: 32.29

0 500
Feet

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ANCHOR QEA

Project Area 16
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

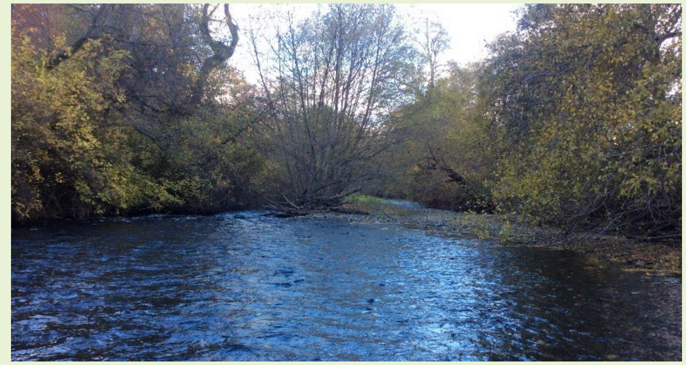
Project Area 19 Description

Project Area 19 begins at VM 28.31 at a bridge crossing for the Tucannon Road and extends upstream to VM 28.78. The 2017 RM length is 0.56 mile. Field observations for PA 19 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

It should be noted that PA 18.1 (just upstream of PA 19) was treated with a large amount of wood shortly before these data were collected, which could have had a significant effect on the geomorphic characteristics of this reach not reflected in the data.

The river through PA 19 is characterized as a single-thread, plane-bed channel. The channel is wide and shallow with little complexity. The 2011 assessment noted that a rock-armored levee was located along the right bank, and other large boulders and riprap were observed along the left bank upstream of the bridge. The bridge abutments were lined with corrugated steel sheeting. The bridge span and low chord elevation created a narrow opening beneath the bridge. This was likely constricting the river during high flows and creating high velocities through the bridge opening and on the downstream side. The bridge appeared to be old and in disrepair. No available off-channel areas other than a minor flow split near RM 32.0 were observed in this project area.

Project Area 19
Looking downstream at a split flow around a vegetated island with good riparian cover.



Project Area 19 Reach Characteristics

VM Start (mi)	28.31
VM Length (mi)	0.47
Valley Slope	1.07%
RM Start (mi)	31.90
RM Length (mi)	0.56
Average Channel Slope	0.89%
Sinuosity	1.20
Connected FP (ac/VM)	16.03
Encroachment Removal (ac/VM)	0.53
Channel Aggradation (ac/VM)	4.96
Total FP Potential (ac/VM)	5.05
Encroaching Feature Length (ft)	723.55
Connected FP Rank	23

Instream habitat was characterized by a wide, shallow channel with a lack of pools, off-channel areas, cover, and hydraulic refuge. Only small LWD and some undercut root masses provided cover in the channel. During high flows, the bridge crossing and the area downstream likely contained very high velocities that may be detrimental to fish, particularly juveniles.

Geomorphic Changes

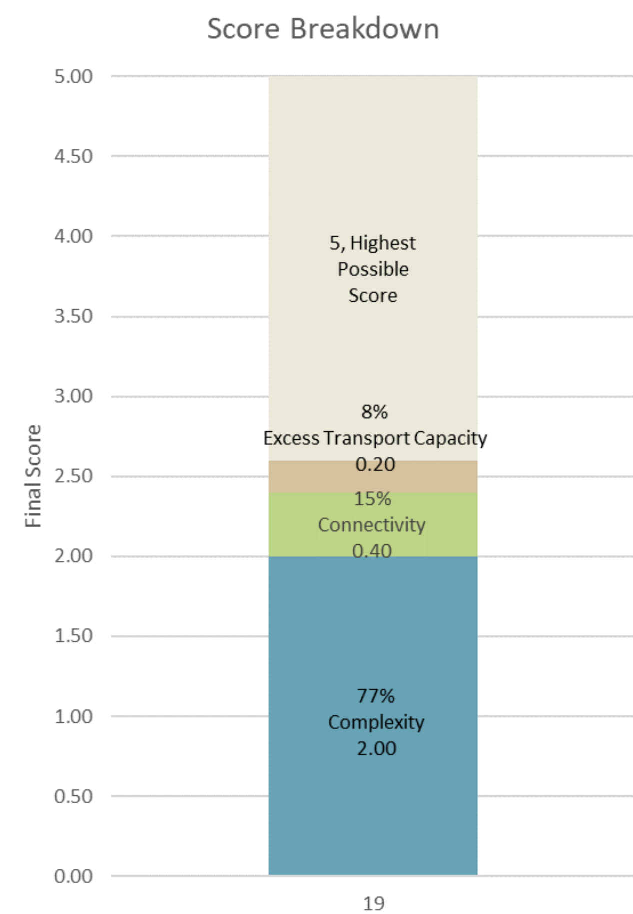
Analysis of the difference between the 2010 and 2017 LiDAR data shows only two locations of relatively minor geomorphic change in PA 19. Near the upstream end of the reach, there appears to be the very beginnings of two meander bends forming. Aggregation appears on the inside of the bend during bar building and some erosion is occurring on the outside of the bend on the second meander bend, although this meander appears to be running along the left bank valley wall and is unlikely to progress any further (box 1).

After running along the valley wall for approximately 800 feet, the channel appears to contain a log jam that spans the channel and is causing aggregation and erosion on the left bank, forming a pool and alcove that were noted during field observations (box 2).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 19 received its only score in the complexity metric. This project area falls in the

PA 19 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

bottom 25% of floodplain connectivity potential and near average for transport capacity. PA 19 scores in the 40th to 60th percentile for complexity (which is the range in which reaches have the most potential for complexity without being too confined to allow realistic projects to be completed). This complexity score is driven by all three flows falling near average for project areas in this assessment. Existing side channels are distributed evenly throughout the reach, with each high-flow event adding some small amount of complexity in generally the same locations.

There are a limited number of floodplain connectivity locations where the inundated area for the 5-year flood event is larger than the inundated area for the 2-year flood event, and there are almost no locations for encroachment removal, which is why the floodplain connection potential score is so low. However, by looking at these areas as well as the relative elevation maps, the low-lying areas and high-flow channels that could be activated become apparent, with several existing high-flow channels near the middle of the reach and another cluster near the bottom of this reach.

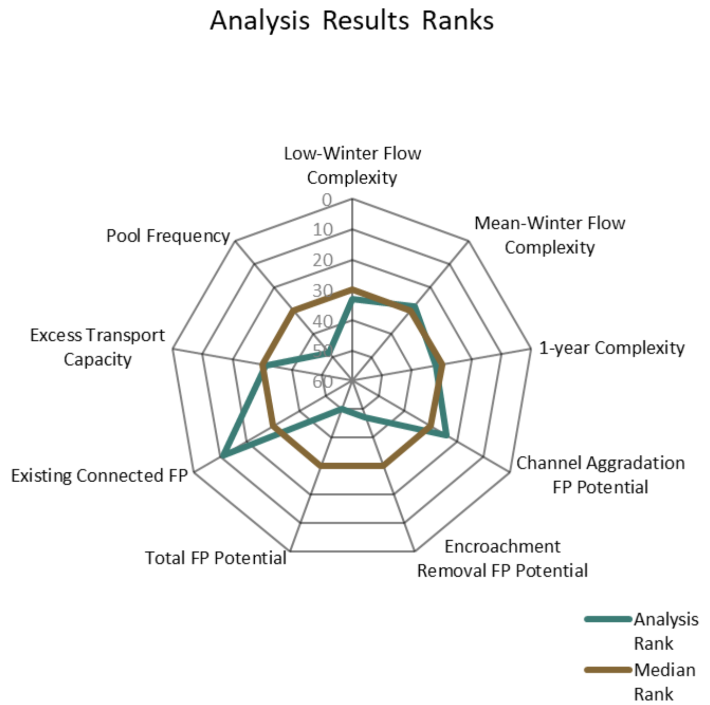
To increase complexity in this reach, restoration strategies should target getting perennial flow into these higher flow channels as well as increasing channel complexity in locations where there is little low-lying floodplain available. The primary restoration strategy should be adding instream wood structure to promote floodplain geomorphic change for in-channel complexity. Some side channels may also need to be initially connected with pilot channels to jumpstart geomorphic change.

Finally, PA 19 ranks very low among project areas in the Pool Frequency metric. Adding instream wood will promote changes towards an increase in channel complexity, promoting the formation of pools. These restoration strategies should be employed to target increasing pool frequency in the reach.

Summary of Restoration Opportunities Identified

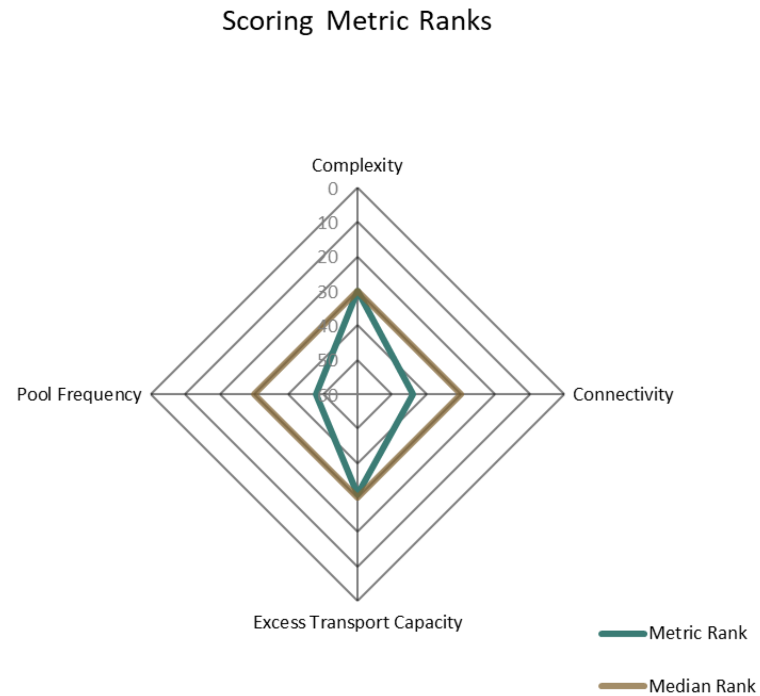
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)

PA 19 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

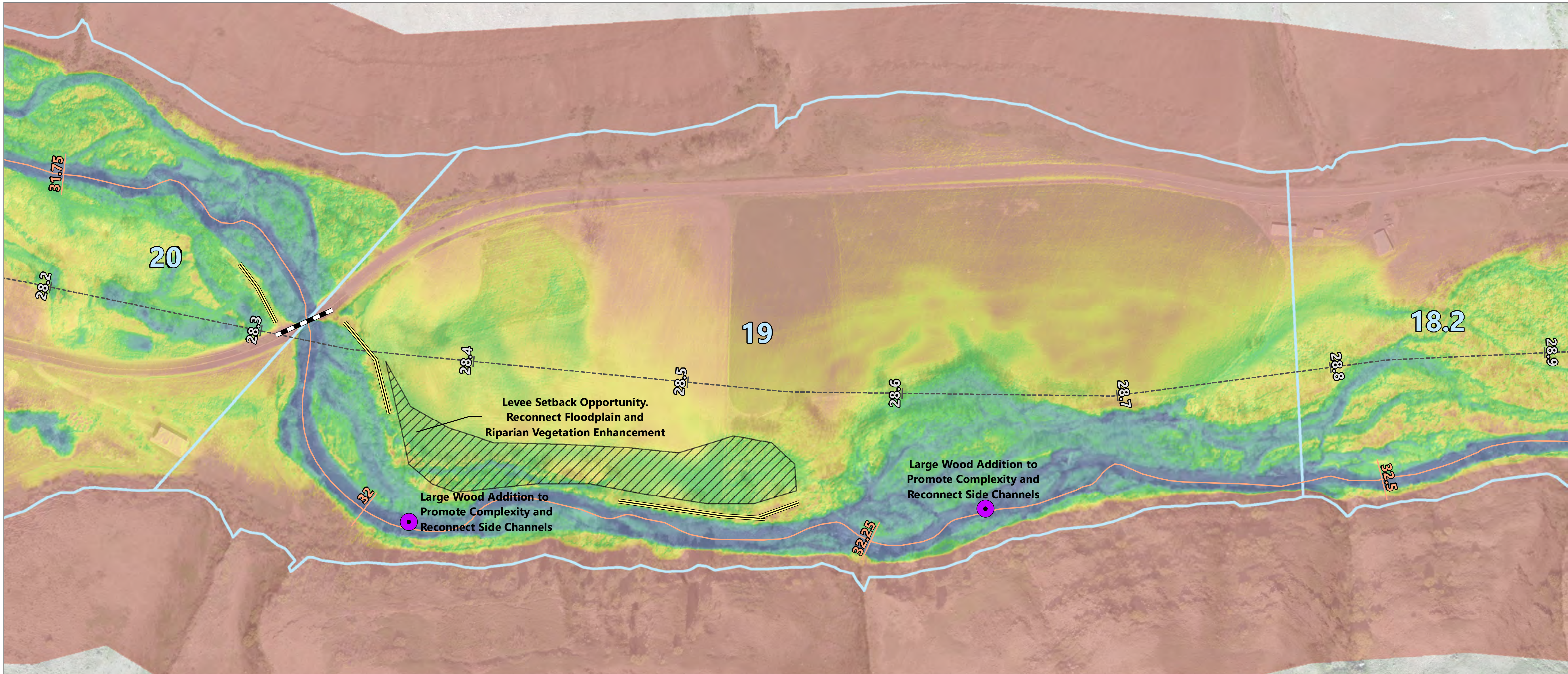
PA 19 Scoring Metric Ranks

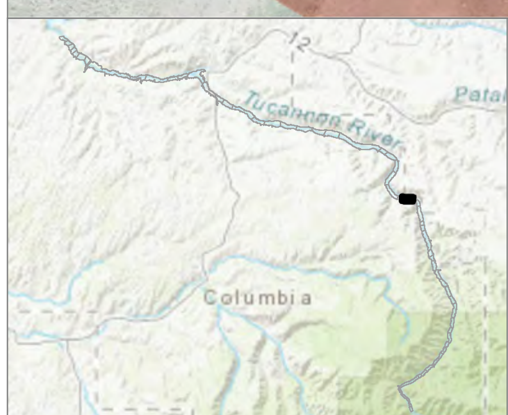


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 19 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.143	33	40%	Complexity	0.227	30	40% to 60%	3 of 5	5	40%	2.6	19	2	Untreated	13	2
Mean-Winter Flow Complexity	0.266	28	40%													
1-year Complexity	0.314	32	20%													
Channel Aggradation FP Potential	0.235	24	40%	Connectivity	0.152	44	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.025	47	40%													
Total FP Potential	0.240	50	20%													
Existing Connected FP	0.760	11	0%													
Excess Transport Capacity	0.02	31	100%	Excess Transport Capacity	1.000	31	30% to 52%	3 of 4	1	20%						
Pool Frequency	5.35	48	100%	Pool Frequency	0.137	48	60% to 90%	4 of 5	1	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 31.9
RIVER MILE END: 32.46
VALLEY MILE START: 28.31
VALLEY MILE END: 28.78

0 500
Feet

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ANCHOR QEA

Project Area 19
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 28.1 Description

Project Area 28.1 begins at VM 19.42 and extends upstream to VM 20.21. The 2017 RM length is 0.87 mile. Field observations for PA 17.1 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

For this assessment update, PA 28 as defined in the 2011 prioritization was separated into three project areas (PA 28.1, PA 28.2, and PA 28.3. In 2016, the lower sections of this project area (PA 28.2 and PA 28.3) were the subject of a restoration project, while PA 28.1 has remained untreated. PA 28.2 and PA 28.3 represent distinct parts of the restoration project and were therefore separated for distinct analysis.

The channel through PA 28 contains primarily a dynamic, multiple-thread channel with forced pools, riffles, and rapid sections. The 2011 assessment noted that, for the majority of this reach, the channel was actively migrating and aggrading. Several recently recruited trees and newly formed side channels were observed throughout this area, along with a high volume of temporary sediment storage in the form of gravel point bars and islands. Deep pools were observed at rootwad logs, larger log jams, and along the outside of meander bends. One engineered log jam was observed that contained a very large pool and ample cover that many fish were utilizing. This section of the project area did not contain any significant bank

Project Area 28.1
Photograph taken from the 2011 prioritization showing forced pools and riffles near the upstream end of the reach.

Project Area 28.1 Reach Characteristics

VM Start (mi)	19.42
VM Length (mi)	0.79
Valley Slope	1.00%
RM Start (mi)	22.08
RM Length (mi)	0.87
Average Channel Slope	0.88%
Sinuosity	1.09
Connected FP (ac/VM)	24.87
Encroachment Removal (ac/VM)	5.30
Channel Aggradation (ac/VM)	7.44
Total FP Potential (ac/VM)	15.32
Encroaching Feature Length (ft)	2,799.68
Connected FP Rank	8

armoring, but some remnant spoil piles or pushup levees were present in the floodplain. However, these did not appear to significantly impair channel migration or floodplain connectivity.

Instream habitat conditions were generally good in the dynamic portions of the project area where the channel is in a recovery state. Channel migration had recruited a significant amount of LWD in several areas and there were many side channels with various hydraulic conditions. Ample deep holding pools were present at LWD and along eroding bends. The riffles formed between the pools and the sediment deposits in the lee of LWD and on point bars provided good spawning areas. The many alcoves and side channels observed are preferred habitat for juvenile fish.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows many geomorphic changes throughout the reach, with minor pockets of deposition occurring frequently in the channel and floodplain. Three areas are highlighted for this narrative, but areas of deposition occur almost constantly in this reach.

At the upstream end, deposition in the channel has caused some minor erosion on the left bank and multiple split flow channels have formed (box 1). Shortly downstream, another split flow has formed with deposition on the resulting island and erosion in both of the channels (box 2).

Finally, an area of erosion and deposition on alternate banks occurs for several hundred feet. Meander bends are forming as the channel avulses into the location of erosion in this area (box 3).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 28.1 receives its prioritization score from moderate scores in the Connectivity and Complexity metrics. The complexity score indicates it falls above average in the 60th to 90th percentile of project areas. This range has been identified as needing only a small boost from restoration work to achieve a high level of complexity.

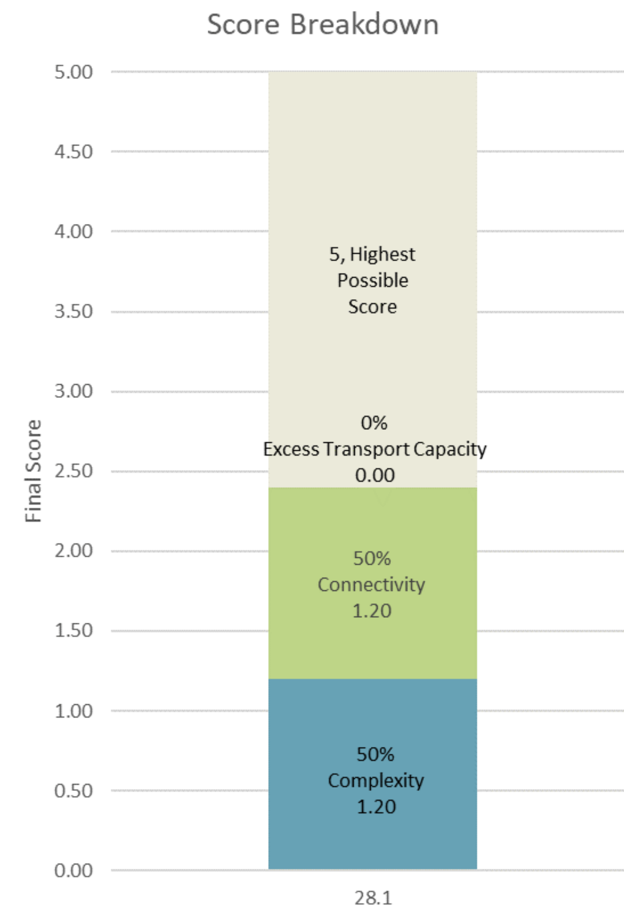
The analysis results for Complexity remain relatively constant across all three flows, indicating that side channels are connected at lower flows and are stable at higher flows. Based on the relative elevation map, there are several low-flow paths in a large, connected area of the upstream right bank floodplain. Several more pockets of channel connection opportunities exist in pockets throughout the reach. The upstream area may be a good candidate for a levee setback because several levee remnants may need to be removed in this area. In general, the restoration strategy should be to reconnect side channels through pilot channel cuts and blockage removal as well as the addition of instream wood to promote geomorphic change. Gravel augmentation should also be considered as an additional restoration strategy to promote dynamic changes and raise the bed elevation for easier access to pilot cut side channels.

The floodplain connection score is driven mostly by a higher than average encroachment removal score. The field on the right bank at the upstream end of the floodplain has been disconnected through the road and road levee and presents a large opportunity for floodplain reconnection through removal or breaching of the levee. Removing or breaching this levee should be considered the primary restoration opportunity for this reach. This opportunity should be pursued in tandem with adding LWD and pilot channel cuts in order to increase complexity at lower flows and increase floodplain inundation in this area.

Summary of Restoration Opportunities Identified

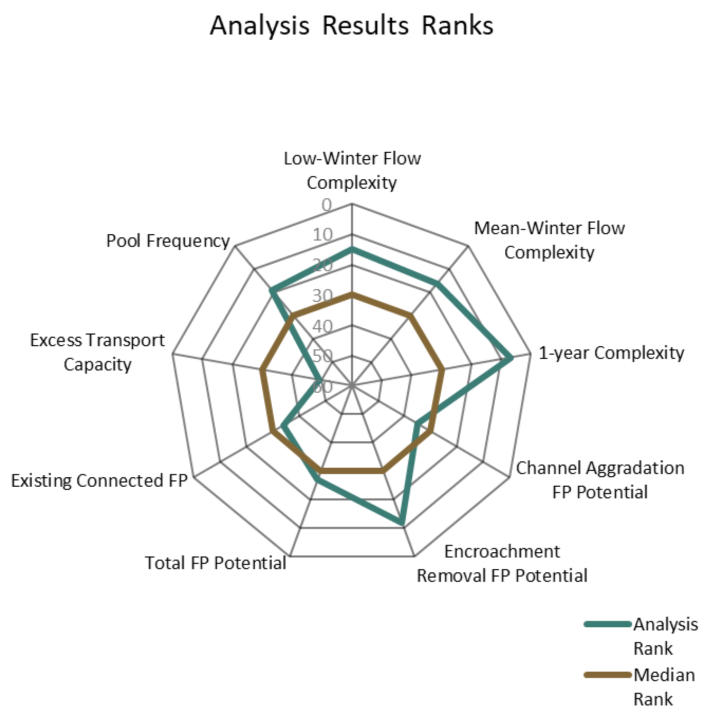
- Address encroaching features
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)
- Gravel augmentation

PA 28.1 Score Breakdown



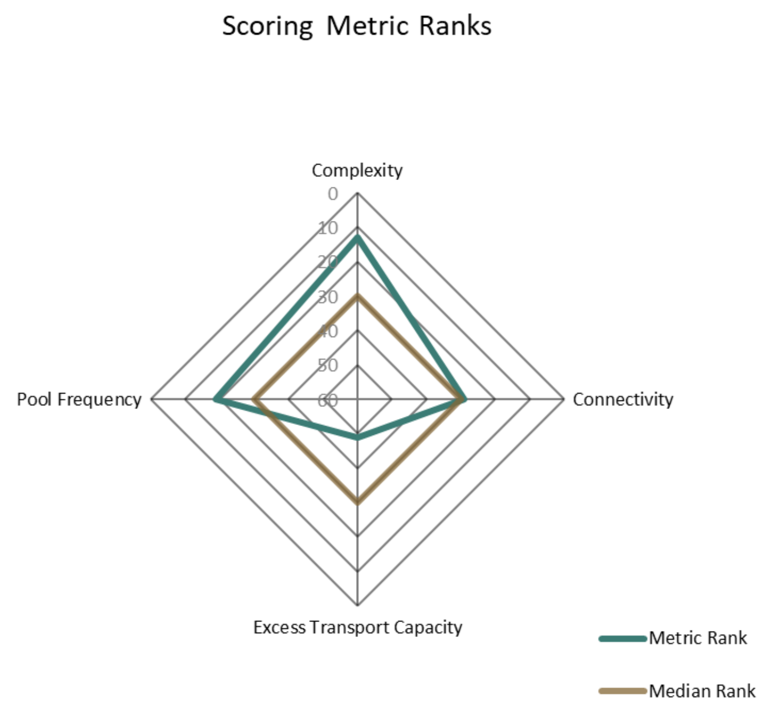
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 28.1 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

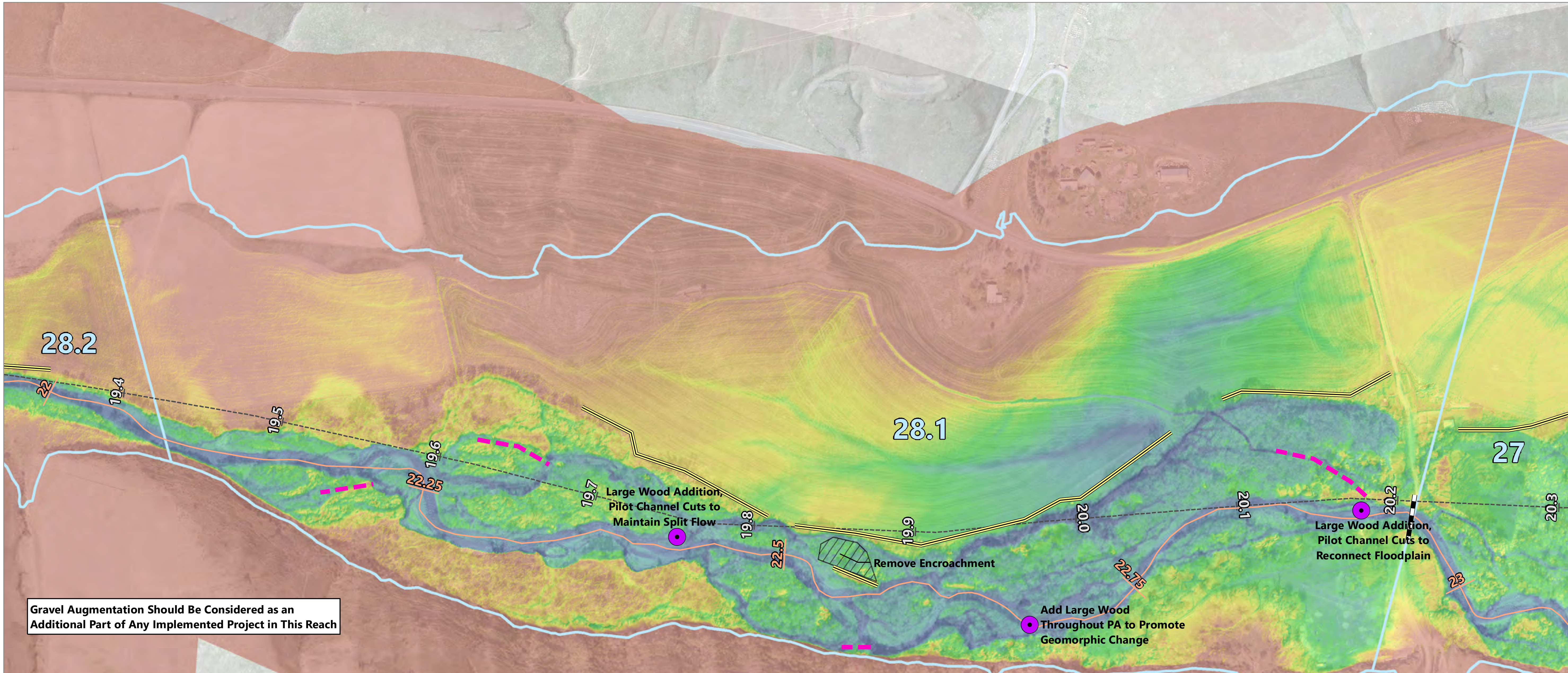
PA 28.1 Scoring Metric Ranks

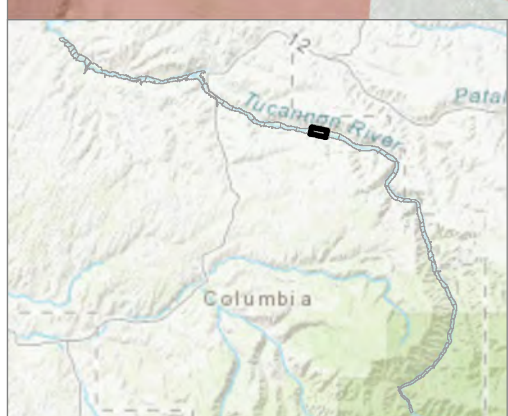


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 28.1 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.262	15	40%	**Complexity**	0.371	13	10% to 40%	2 of 5	3	40%	2.4	21	2	Untreated	14	2
Mean-Winter Flow Complexity	0.345	16	40%													
1-year Complexity	0.640	7	20%													
Channel Aggradation FP Potential	0.185	35	40%	**Connectivity**	0.203	29	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.132	12	40%													
Total FP Potential	0.381	27	20%													
Existing Connected FP	0.619	34	0%													
Excess Transport Capacity	-0.13	49	100%	**Excess Transport Capacity**	0.000	49	52% to 100%	4 of 4	0	20%						
Pool Frequency	14.98	19	100%	**Pool Frequency**	0.385	19	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 22.08
RIVER MILE END: 22.95
VALLEY MILE START: 19.42
VALLEY MILE END: 20.21

0 500
Feet

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ANCHOR QEA

Project Area 28.1
Conceptual Restoration Opportunities

Project Area 31 Description

Project Area 31 begins at VM 14.11 and extends upstream to VM 15.54. The 2017 RM length is 1.49 miles. Field observations for PA 31 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

The river through PA 31 is primarily characterized by a low-sinuosity, single-thread, plane-bed channel, with local areas of split flow, LWD, or bedrock-forced pools, and depositional areas. The 2011 assessment noted that the project area was highly influenced in places by bedrock outcrops along the left bank and in the channel bed. Bedrock maintained the grade of the channel and controlled the left bank along the valley wall. Pools were found throughout the project area and were associated with bedrock, armored banks, and locally recruited LWD. In the upper extent of the project area, the channel was highly confined between the valley wall (along the left bank) and levees and revetments along the right bank. Minimal bedrock was exposed along the channel bed in this confined segment.

Downstream, the 2011 assessment noted that the channel widened and deposition was occurring with an unvegetated gravel bar developing in the channel. In this area, an active side channel was located along the right bank. In the lower segment of the project area, bedrock controlled the channel grade.

Project Area 31
Photograph taken from the 2011 prioritization showing the plane-bed channel with a bedrock bank, looking downstream.

Project Area 31 Reach Characteristics

VM Start (mi)	14.11
VM Length (mi)	1.44
Valley Slope	0.75%
RM Start (mi)	16.13
RM Length (mi)	1.49
Average Channel Slope	0.71%
Sinuosity	1.04
Connected FP (ac/VM)	13.78
Encroachment Removal (ac/VM)	2.64
Channel Aggradation (ac/VM)	3.54
Total FP Potential (ac/VM)	9.10
Encroaching Feature Length (ft)	4,359.76
Connected FP Rank	28

Grazing in the channel was noted. There was a small falls (identified as DeRuwe Falls) with a large, deep pool at the bottom. Downstream of the falls, the channel was moderately to highly confined between the valley wall on the left bank and rock levees along the right bank, with deposition in the less confined areas.

Throughout PA 31, the channel was moderately to highly confined with some areas of floodplain connectivity. The bedrock valley wall limited floodplain development along the left bank and the right bank was mostly confined by rock levees and revetments to limit flooding and channel migration into the adjacent agricultural fields. The channel was incised through much of the project area, with overbank flooding in areas that were less confined.

The riparian zone was in generally poor to moderate health. Overall, the riparian corridor was relatively narrow and flanked by fields and pastures along the right bank. Riparian trees were predominantly mature alders with few cottonwoods with moderate density. The riparian vegetation provided shading along the channel margins. Stands of riparian trees were lacking in places along the left bank where the river is adjacent to the valley wall, which is composed of bedrock along much of the project area. Understory consisted of sparse coverage of invasive species.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows several locations of minor geomorphic change over the project area since the previous assessment. The upstream end of the reach is highly confined by a levee on the right bank and the valley wall on the left bank, and as expected no geomorphic change was observed in this reach.

Immediately downstream of the highly confined portion of this project area, a pattern of minor deposition and erosion on opposite and alternating banks is evident. This pattern is typical of meander bends beginning to form (box 1).

A short distance downstream of here, a log jam and mid-channel bar have caused a small side channel where significant erosion has occurred in the left bank floodplain. Deposition is seen shortly downstream of here and is likely the sediment sourced from the upstream erosion (box 2).

Finally, near the downstream end of the reach, some erosion has occurred on the right bank of the channel, and shortly downstream sediment has deposited on the right bank floodplain (box 3).

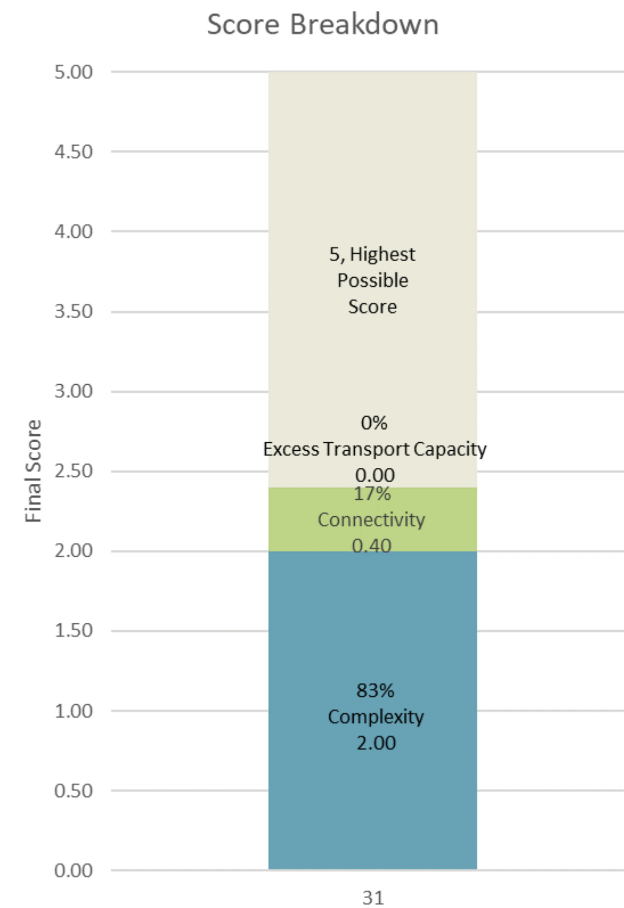
Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 31 receives a low score in the Connectivity metric, and the highest possible score in the Complexity metric, which account for the entire prioritization scores. The high Complexity score indicates that this project area ranks just above average in the 40th to 60th percentile, which is a range that has been identified as having a high amount of potential for restoring channel complexity at the lower flows. The low Connectivity score indicates that this project area also ranks below average in the 25th to 50th percentile range for connectivity potential.

The Connectivity score is driven mostly by the Encroachment Removal analysis result, which ranks PA 31 above average. This potential area is located almost entirely in a large, low-lying field on the right bank mid-reach that does not appear to be supported by irrigation pivot infrastructure. This field is disconnected by a large levee and there are several residential structures nearby so reconnecting this area might be difficult. The Complexity score in this reach is driven mostly by several side channels and mid-channel bars in this same area, where the floodplain is a bit wider than the rest of the reach.

In general, this reach is relatively confined, especially at the upstream end. The downstream end has more connected floodplain and will likely be the area where gains for complexity

PA 31 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

are realized. Restoration strategies for this reach should be to add instream wood and structure along with gravel augmentation to promote geomorphic change in the lower portion of this reach. The upper portion of the reach should also be treated with instream wood, but the complexity gain in this reach will mostly be from in-channel bars, pools, and riffles.

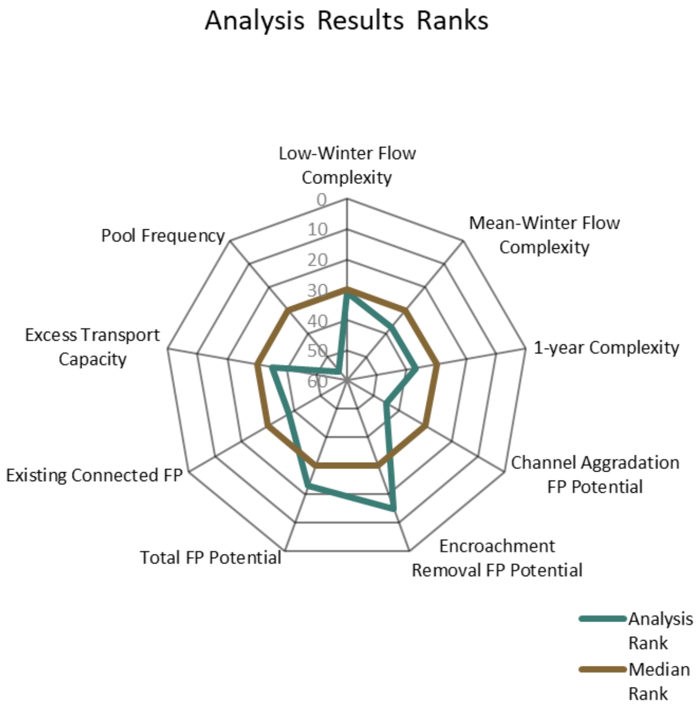
Should the opportunity arise to remove or set back the levee in this reach, it would greatly benefit the connectivity and complexity of this project area. Adding instream wood and gravel augmentation would remain the primary restoration strategies after the levee has been removed.

Finally, PA 31 scores very poorly in pool frequency, likely due to the confined nature of this reach. The identified restoration strategies of widening the floodplain, adding instream wood, and providing gravel augmentation should allow more complexity to form and create the conditions that will allow pools to form more regularly through natural geomorphic processes.

Summary of Restoration Opportunities Identified

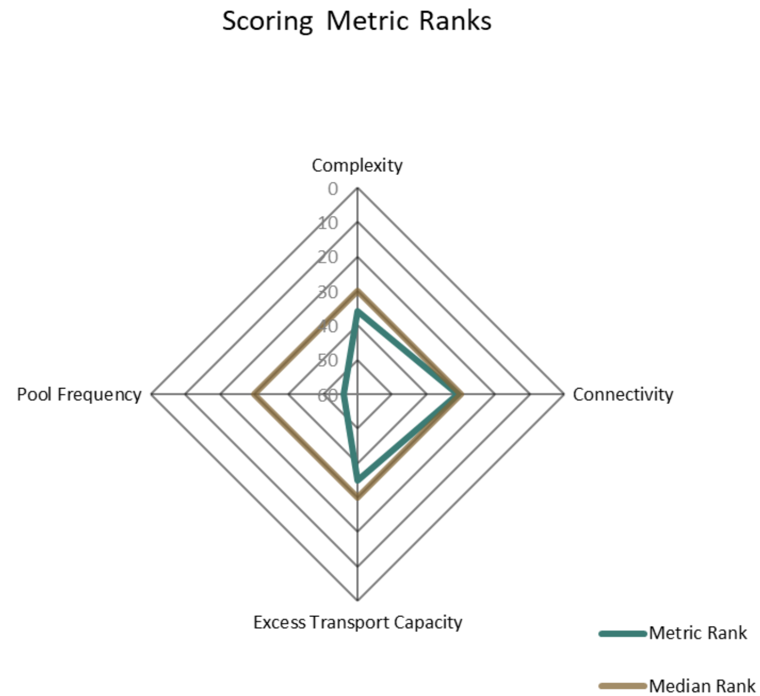
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)

PA 31 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

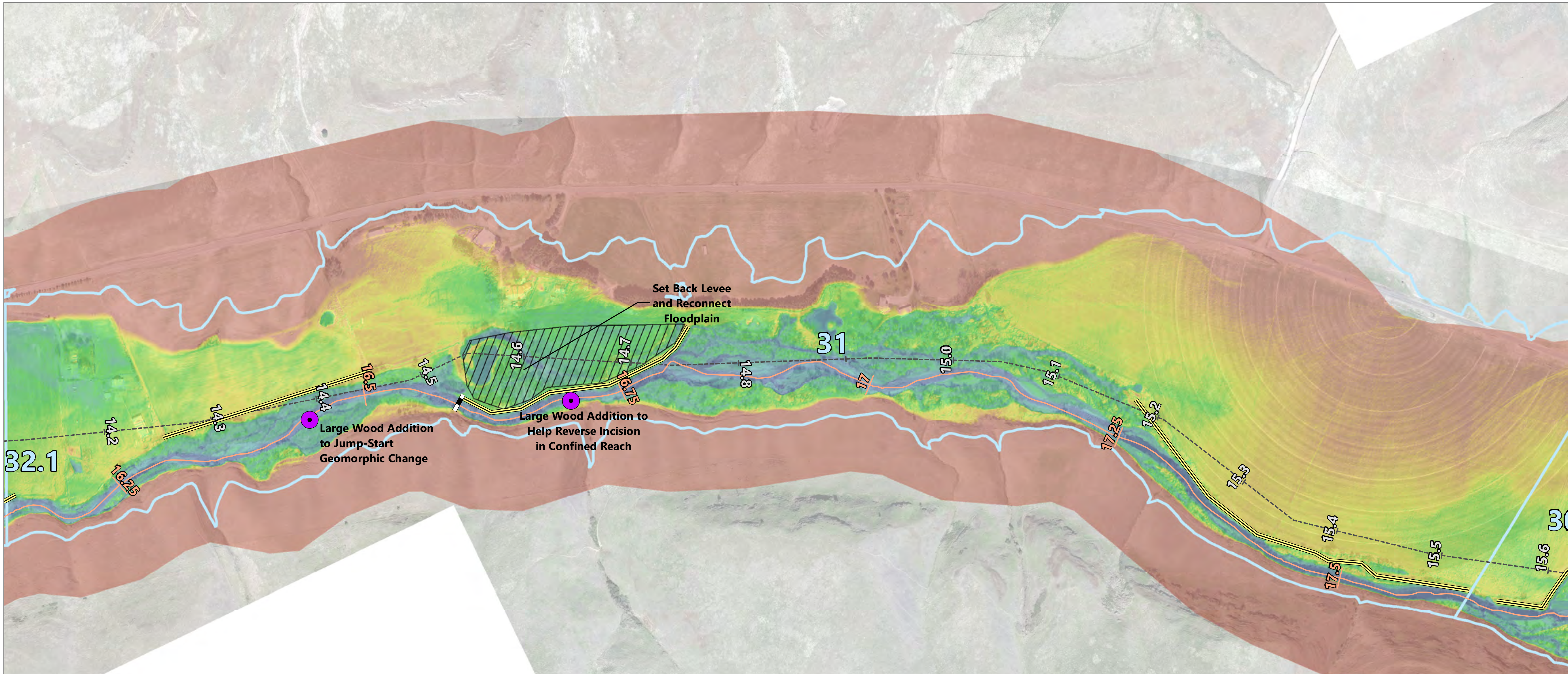
PA 31 Scoring Metric Ranks

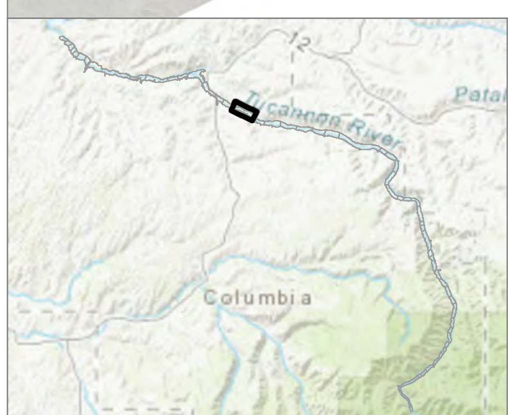


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 31 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.146	31	40%	Complexity	0.173	36	40% to 60%	3 of 5	5	40%	2.4	22	2	Untreated	15	2
Mean-Winter Flow Complexity	0.177	37	40%													
1-year Complexity	0.218	37	20%													
Channel Aggradation FP Potential	0.155	45	40%	Connectivity	0.188	31	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.115	15	40%													
Total FP Potential	0.398	23	20%													
Existing Connected FP	0.602	38	0%													
Excess Transport Capacity	-0.03	35	100%	Excess Transport Capacity	0.000	35	52% to 100%	4 of 4	0	20%						
Pool Frequency	3.35	56	100%	Pool Frequency	0.086	56	90% to 100%	5 of 5	0	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 16.13
RIVER MILE END: 17.62
VALLEY MILE START: 14.11
VALLEY MILE END: 15.54

0 500
Feet

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ANCHOR QEA

Project Area 31
Conceptual Restoration Opportunities

Project Area 34.2 Description

PA 34.2 begins at VM 9.92, just upstream of a large lateral levee on PA 35, and extends to a bridge for a private road at VM 10.58. The 2017 RM length is 0.78 mile. Field observations for PA 34.2 were conducted on November 1, 2018, when flow at the Starbuck gage was approximately 100 cfs.

From the upstream end of the reach to approximately VM 10.41, the reach is characterized by the valley wall and road riprap on the right bank and a large levee on the left bank. This section contains instream wood and channel complexity due to several log jams and side channel opportunities, but a significant portion of the floodplain is disconnected by the levee.

Downstream of VM 10.41, the levee becomes less well defined, and remnants of an old levee are partially protecting floodplain. Several long side channels appear to be connected by groundwater and high flow. At VM 10.1, a large split flow has one flow path going through the riparian forested area and another eroding into loose fine sediment material in the banks.

Throughout this area, the right bank has a large, forested riparian area with mature vegetation. The entire reach has patches of mature forested riparian area in the floodplain but also meanders through long exposed sections with very little cover. The mid-channel section is mostly exposed with little established vegetation.

Project Area 34.2
Instream wood from an upstream avulsion is forcing water towards the right bank where the channel is migrating into the floodplain with sparse vegetation.

Project Area 34.2 Reach Characteristics

VM Start (mi)	9.92
VM Length (mi)	0.63
Valley Slope	0.83%
RM Start (mi)	11.50
RM Length (mi)	0.78
Average Channel Slope	0.64%
Sinuosity	1.25
Connected FP (ac/VM)	27.92
Encroachment Removal (ac/VM)	5.85
Channel Aggradation (ac/VM)	8.15
Total FP Potential (ac/VM)	17.21
Encroaching Feature Length (ft)	779.80
Connected FP Rank	5

In general, wood loading was high throughout most of this reach during the site visit, but most pieces were not yet entrenched and could be easily mobilized during subsequent flood events.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows several major geomorphic changes evident in the change analysis. At the upstream end of the reach, a massive reach of deposition and degradation in the main channel has continued from the upstream PA 34.1. This is just downstream of the confluence with Pataha Creek, and this sediment is likely input from that major tributary. This has caused erosion and channel avulsion towards the left bank, which is also evident in the change analysis (box 1). In this same area, it is clear from the LiDAR that the levee along the left bank in this reach has been built up and improved within the past 7 years.

Just downstream of here is a large depositional area on the right bank floodplain, which is likely still influenced by the sediment input from Pataha Creek, as well as some more minor deposition on the left bank floodplain and some erosion towards the left bank in the main channel (box 2).

Further downstream, the channel is avulsing towards the left bank, with erosion evident there, and deposition on the opposite right bank bar. More deposition is evident on the left bank floodplain in this area likely due to high-flow events depositing material here (box 3).

Closer to the downstream end of the reach, the river has formed a long split flow, which includes an avulsion through a large, forested area of the left bank floodplain. The main channel has further avulsed as it erodes into the right bank in this split flow. A large log jam is evident at the head of the island formed here as well as another at the downstream end of the former main channel, and likely both log jams helped trigger this geomorphic change (box 4).

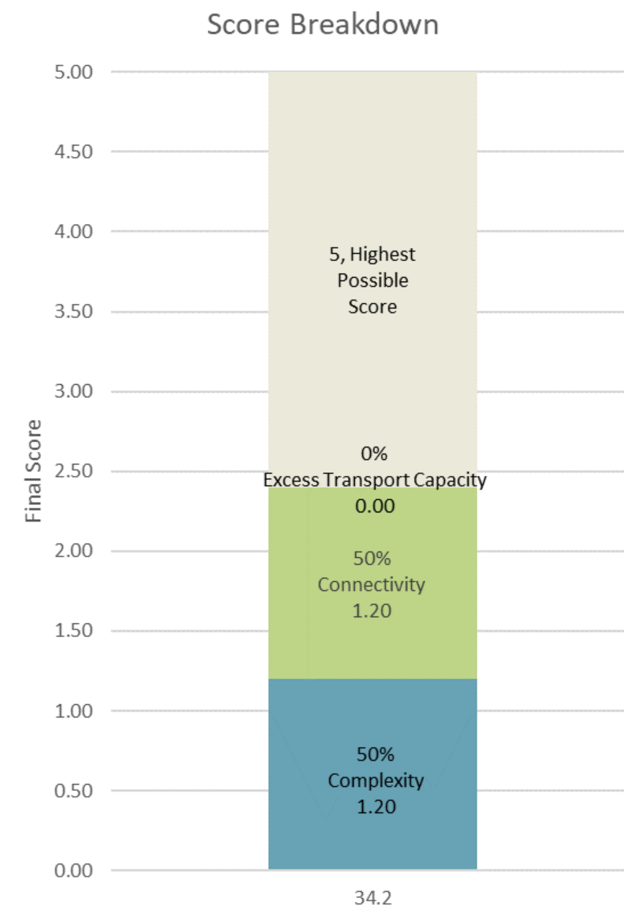
Finally, at the very downstream end of the reach, the channel has avulsed towards the right bank floodplain, with erosion evident there, and deposition on the opposite right bank (box 5).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 34.2 receives the majority of its prioritization score in the Complexity metric. PA 34.2 received a moderate score in Complexity, indicating that it ranked in the 60th to 90th percentile for project areas, a range which has been identified as needing only a small boost from restoration work to achieve a high level of complexity. The analysis results show complexity is relatively high for all three flows, ranking well above average, although a slight dip at the 1-year complexity indicates that some of the side channels and split flows may be washed out or inundated and may be unstable at the higher flow. Looking at the GIS layers for islands and complexity, it appears that this complexity is distributed evenly across the reach and is concentrated in many of the areas noted has having geomorphic change in the above analysis. The primary restoration strategy for this reach should be to add instream wood structure to ensure flow paths at the mean-winter and low-winter flows are maintained or replaced after higher flow events. Several low-lying areas also present an opportunity for additional side channels to be connected at all flows. A strategic pilot channel cut, along with coordinated placement of instream wood to promote geomorphic change into the areas and establish perennial side channels and split flows, should be considered as part of the primary restoration strategy to boost complexity across all three flows.

PA 34.2 also receives a low score in the Connectivity metric, indicating that it ranks in the 25th to 50th percentile of all project areas. This low score is driven mostly by the Encroachment Removal analysis result, which ranks PA 34.2 well above average. The opportunity for encroachment removal exists almost entirely at the upstream end of the project area. A large portion of the floodplain that appears to be outside of the agricultural fields nearby, based on the 2018 aerial imagery, is disconnected by a levee that extends from the road and bridge at the upstream end of this project area. It should be noted that this levee has been built up since 2011, as noted in the LiDAR change analysis above. Reconnection of this area

PA 34.2 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

through levee removal and setback should be considered a primary restoration strategy for this reach, in addition to the strategies of pilot channel cuts and instream wood placement.

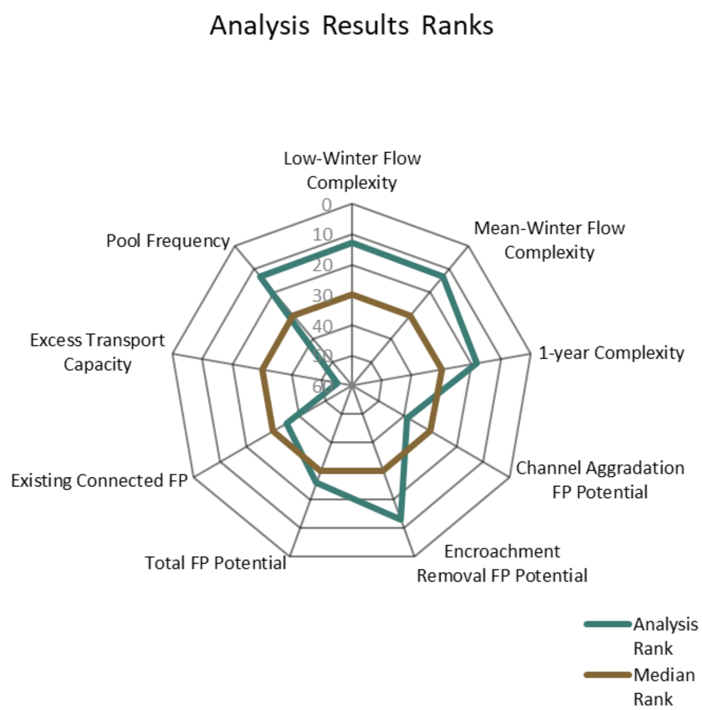
This reach receives no score in the Excess Transport Capacity metric, indicating it is a depositional reach, which is consistent with a reach just downstream of a major tributary with large sediment input. Some consideration should be given to the fact that this reach needs to process the sediment input from Pataha Creek and should be factored into restoration design. Gravel augmentation is almost certainly not necessary in this reach.

Finally, PA 34.2 ranks well above average in the Pool Frequency metric, indicating a high amount of pools per river mile. The identified restoration strategy of adding instream structure and wood should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be maintained and continue to form with the natural processes of the reach.

Summary of Restoration Opportunities Identified

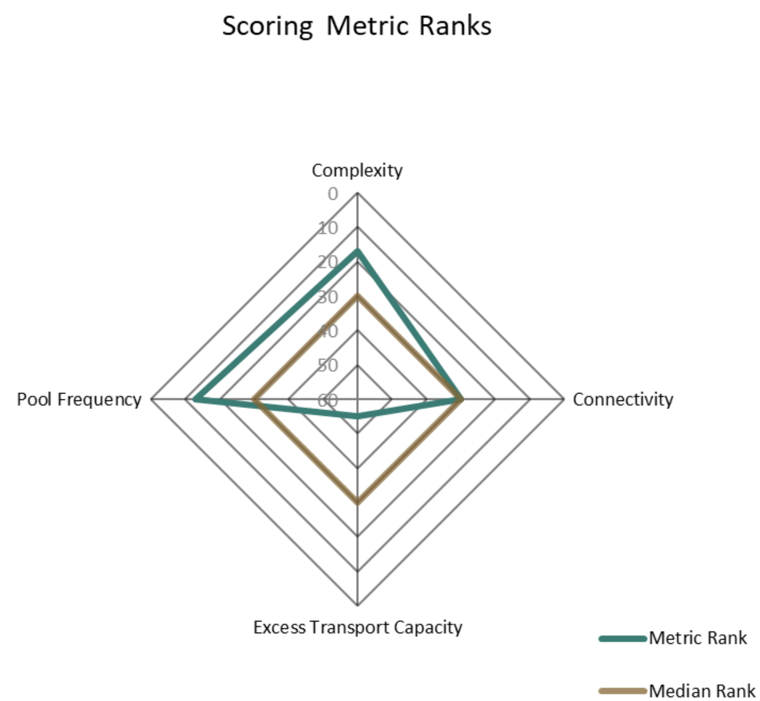
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Modify or remove obstructions

PA 34.2 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

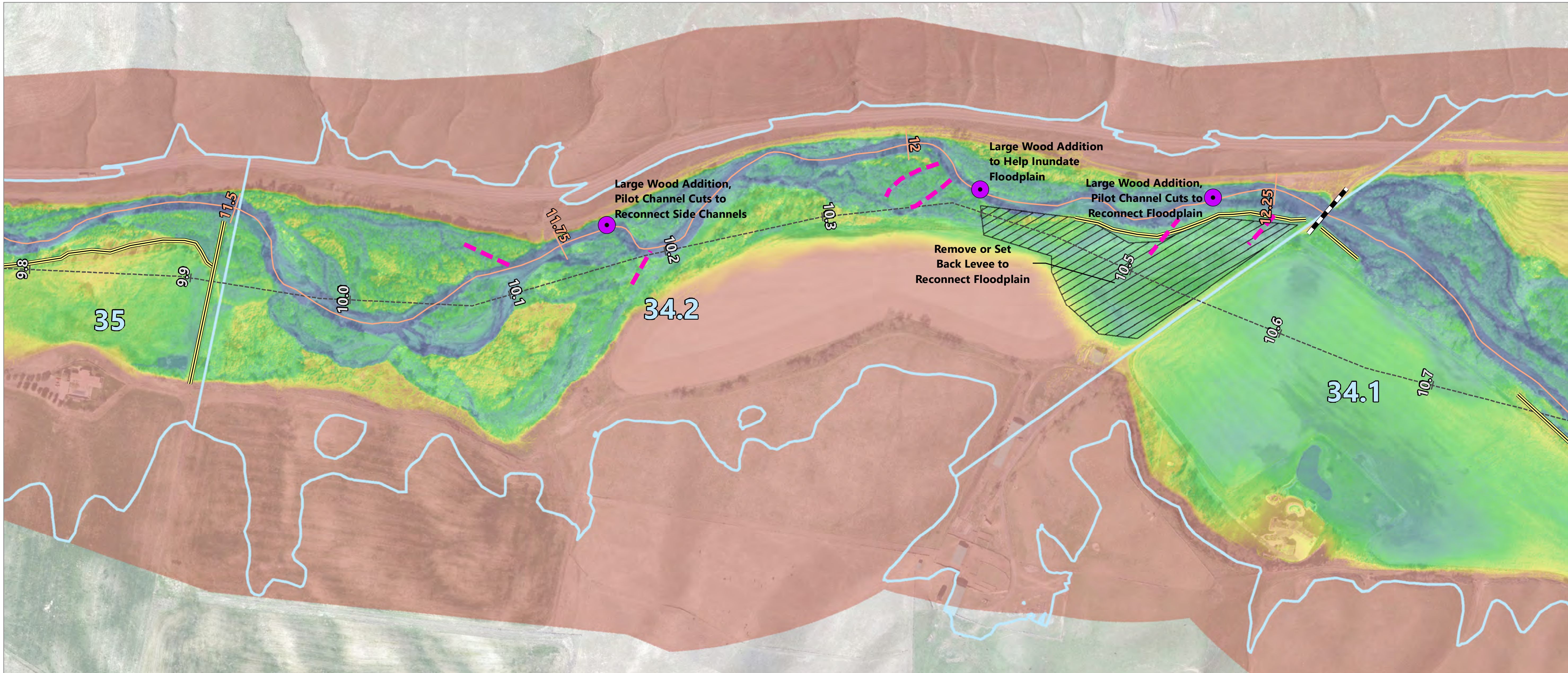
PA 34.2 Scoring Metric Ranks



This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 34.2 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.266	13	40%	Complexity	0.351	17	10% to 40%	2 of 5	3	40%	2.4	23	2	Untreated	16	2
Mean-Winter Flow Complexity	0.408	13	40%													
1-year Complexity	0.408	18	20%													
Channel Aggradation FP Potential	0.181	39	40%	Connectivity	0.200	30	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.130	13	40%													
Total FP Potential	0.381	26	20%													
Existing Connected FP	0.619	35	0%													
Excess Transport Capacity	-0.19	55	100%	Excess Transport Capacity	0.000	55	52% to 100%	4 of 4	0	20%						
Pool Frequency	17.91	13	100%	Pool Frequency	0.460	13	10% to 40%	2 of 5	3	0%						



LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 11.5
RIVER MILE END: 12.28
VALLEY MILE START: 9.92
VALLEY MILE END: 10.55

0 500
Feet

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ANCHOR QEA

Project Area 34.2
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 35 Description

Project Area 35 begins at VM 9.30 and extends upstream to VM 9.92 just upstream of a large lateral levee. The 2017 RM length is 0.66 mile. Field observations for this reach were conducted on November 1, 2018, when flow at the Starbuck gage was approximately 100 cfs.

This reach is characterized by a long, parallel levee that runs along the left bank for the entire reach, beginning with the lateral levee at the upstream end. On the right bank, the channel is bordered closely by the road, confining the floodplain to only a few channel widths for the entire reach.

Behind the levee are several fields that, based on site observations, appear to be relatively low and accessible without pivot or irrigation infrastructure. Pockets of floodplain with some mature riparian vegetation exist on alternating banks as the river meanders within the levee's limits.

A small amount of instream wood was noted during field observations, possibly from upstream avulsions, but the channel in general seems to be straight and uniform without much instream complexity. Mid-way through the reach there is a bridge for River Ranch Lane.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows a relatively large amount of significant geomorphic

Project Area 35
The reach is confined by a levee on the left bank in PA 35. The instream wood seen in the distance has fallen in from the old levee.

Project Area 35 Reach Characteristics

VM Start (mi)	9.27
VM Length (mi)	0.65
Valley Slope	0.52%
RM Start (mi)	10.81
RM Length (mi)	0.69
Average Channel Slope	0.49%
Sinuosity	1.05
Connected FP (ac/VM)	13.30
Encroachment Removal (ac/VM)	10.20
Channel Aggradation (ac/VM)	5.85
Total FP Potential (ac/VM)	40.21
Encroaching Feature Length (ft)	3,980.57
Connected FP Rank	32

change for PA 35, despite being a relatively confined reach. There are four areas of major geomorphic change noted in this reach. The first area occurs at VM 9.8 where a depositional area is evident on the right bank floodplain and associated erosion on the left bank, allowing the channel to migrate almost a full channel width (box 1). A few hundred feet downstream, deposition in the main channel has caused a channel migration towards the left bank where another channel-wide erosional area is evident, before the channel runs along the riprap bank for the old railway (box 2).

Just downstream of the River Ranch Lane bridge that bisects this project area, the beginnings of several meander bends are evident, with alternating erosion on the outside and bar building on the inside of each bend. A large log jam noted just downstream during field observations is likely helping to promote this process (box 3).

Finally, at VM 9.45 a channel avulsion has occurred with gravel deposition in the former main channel on the right and a large erosional area on the left bank where the channel currently runs. Field observations noted that the floodplain alluvial material appears to be gravel-sized and small cobble-sized and would be a good source of transportable material (box 4).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 35 receives most of its prioritization score from the Connectivity metric and is ranked in the top 25% of all project areas for this metric. This high ranking is driven almost entirely by the Encroachment Removal analysis result as well as the Total Floodplain Potential analysis result, both of which rank PA 35 near the top of all project areas. This encroachment removal potential is located entirely on the left bank floodplain for the entire reach of the project. The left bank floodplain is currently occupied by two agricultural fields, separated by River Ranch Lane and protected by a levee for the length of the river. A large portion of both fields would be almost entirely within the 5-year floodplain without the levee, and neither field appears to be supported by existing irrigation infrastructure (which would disqualify this area as part of this prioritization). The downstream field has a large portion already low enough to be connected at the 2-year event and appears to be connected via spring or tributary flow at the downstream end, going into PA 36.

The primary restoration strategy for this reach should be to reconnect this area via a combination of levee removal, pilot channel cuts, and strategic instream wood placement to promote geomorphic change. The downstream low-lying area is distant enough from the active channel that levee removal alone is unlikely to reconnect the floodplain, so pilot channel cuts will likely be necessary to jumpstart reconnection of the floodplain in this area.

Because this area is currently occupied by agricultural fields, a restoration strategy of riparian zone enhancement should also be considered to promote riparian species growth in the area connected through restoration.

The upstream field has less area that is low enough to be connected at the 2-year event, so removal of this levee does not gain as much benefit. However, much of the field is within the 5-year floodplain, and a restoration strategy that targeted both levee removal and channel aggradation could eventually see benefit at the 2-year event, as shown by the high ranking for Total Floodplain Potential. Additionally, this reach scores below average in the Excess Transport Capacity metric, indicating that added gravel material is likely to be easily stored and maintained in this reach, forcing geomorphic change. Gravel augmentation along with levee removal in this project area would be necessary to achieve connection to the floodplain in the upper reach of the project area.

Another reason to consider the gravel augmentation restoration strategy is to promote complexity throughout the reach. PA 35 receives a low score for the Complexity metric, indicating that it ranks in the 10th to 40th percentile of all project areas, and complexity in this reach may be difficult to achieve. Complexity ranks well below average in all three flows for this project area, and the little complexity that does exist consists of a few in-channel split flows. However, gravel augmentation, along with adding instream wood structure, could greatly improve the

PA 35 Score Breakdown

This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

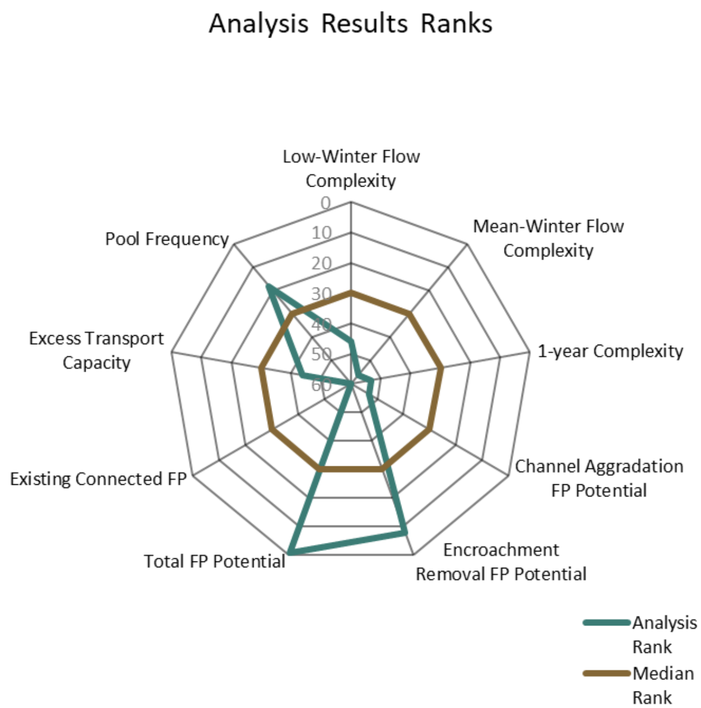
complexity in the reach. These restoration strategies are already identified for reconnecting the floodplain in the lower and upper reaches of the project area, and they should also be employed with the intent of increasing complexity. In addition, pilot channel cuts targeted for the low-winter and mean-winter flow events should also be considered in the floodplain between the levee and the river to activate complexity in this area.

Finally, the Pool Frequency metric in this reach scores slightly above average. The identified restoration strategies of adding instream structure and wood, along with gravel augmentation, should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be maintained and continue to form with the natural processes of the reach.

Summary of Restoration Opportunities Identified

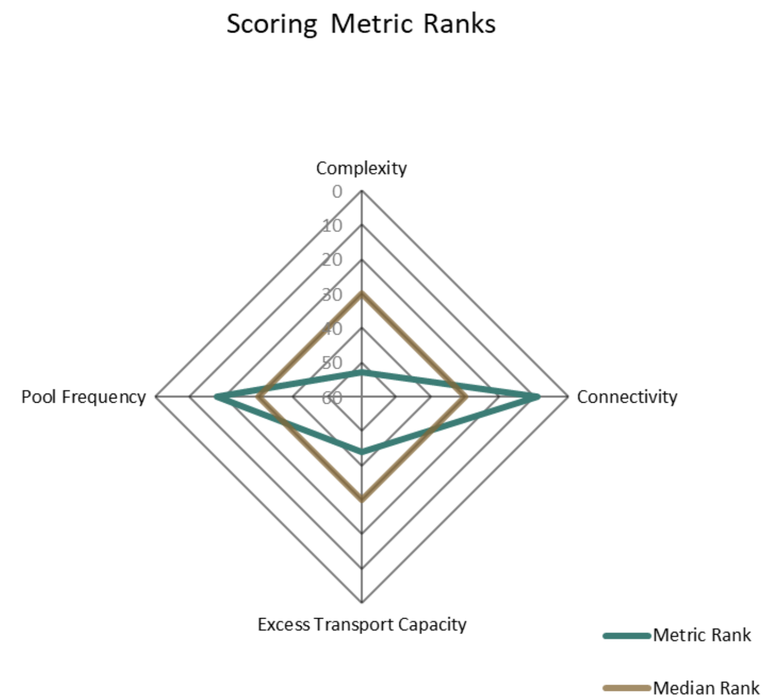
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

PA 35 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

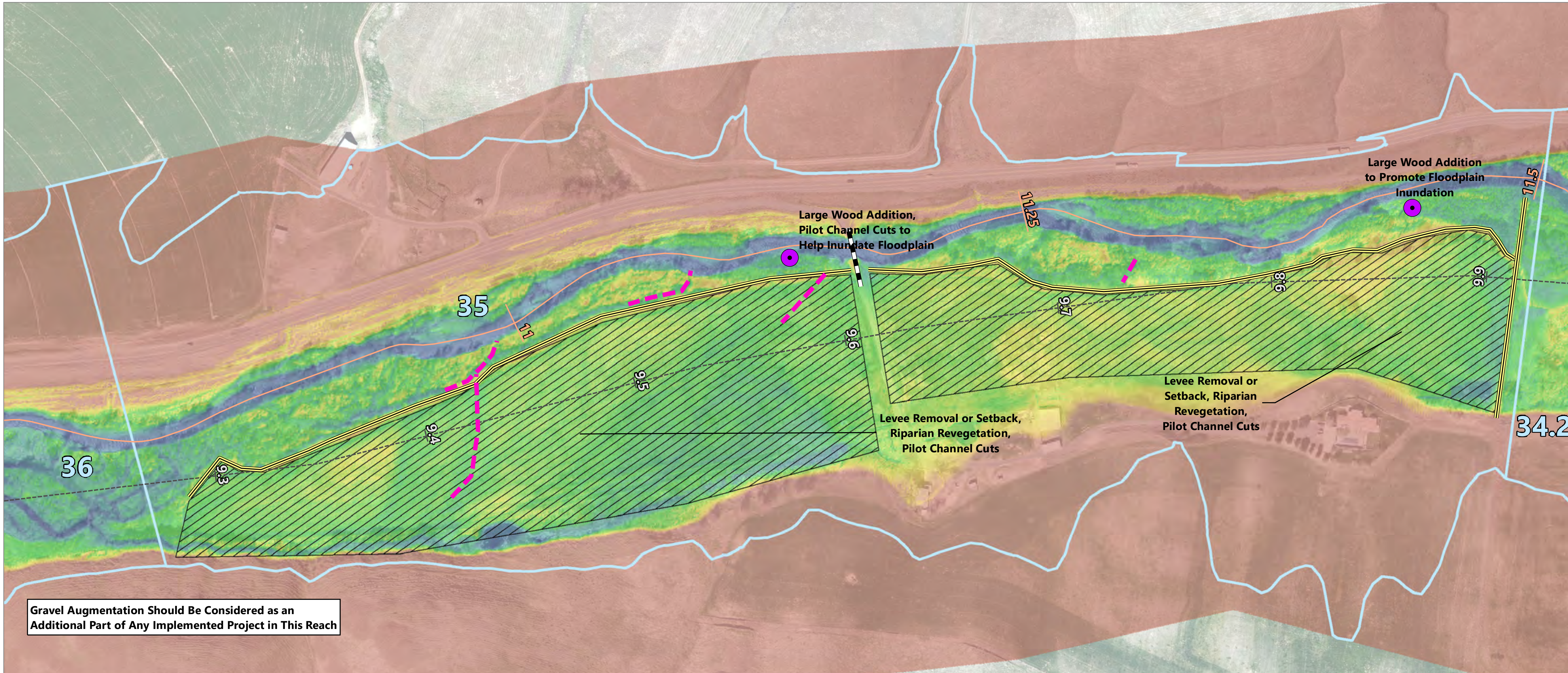
PA 35 Prioritization Scoring Summary

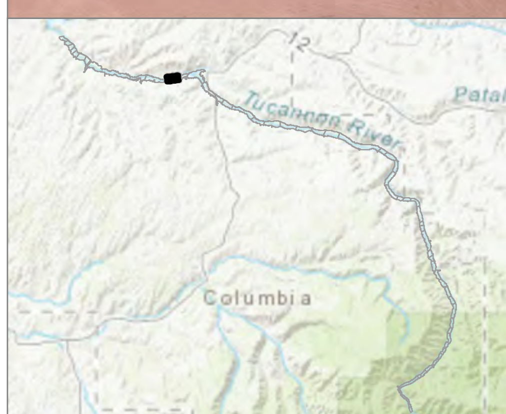


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 35 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.098	46	40%	Complexity	0.100	53	60% to 90%	4 of 5	1	40%	2.4	24	2	Untreated	17	2
Mean-Winter Flow Complexity	0.098	56	40%													
1-year Complexity	0.111	53	20%													
Channel Aggradation FP Potential	0.109	53	40%	Connectivity	0.270	9	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.191	8	40%													
Total FP Potential	0.751	1	20%													
Existing Connected FP	0.249	60	0%													
Excess Transport Capacity	-0.09	44	100%	Excess Transport Capacity	0.000	44	52% to 100%	4 of 4	0	20%						
Pool Frequency	15.24	18	100%	Pool Frequency	0.391	18	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 10.81
RIVER MILE END: 11.5
VALLEY MILE START: 9.27
VALLEY MILE END: 9.92

0 500
Feet

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Project Area 35
Conceptual Restoration Opportunities

Project Area 36 Description

Project Area 36 begins at VM 7.83 at the beginning of the Tucannon RV Park levee and extends to VM 9.30. The 2017 RM length is 1.73 miles. Field observations for this reach were conducted on November 30, 2018, when flow at the Starbuck gage was approximately 110 cfs. On August 14, 2019, another field observation was conducted per the landowner's request to look at several locations where recent avulsions were causing erosion near fields on the left bank and the railroad prism on the right bank.

The upstream end of PA 36 is uniform, straight, and mostly plane-bed with small sections of split flows and side channels. Some floodplain opportunity is available, and a tributary flows in from upstream behind the PA 35 left bank levee, creating a wetland area with established large vegetation.

Through the middle portion of the reach, the channel becomes more confined and disconnected from the floodplain as it runs along the valley wall on the left bank with high disconnected floodplain on the right bank. A steady flow through reed canary grass enters on the right bank. It is unclear whether this is a groundwater spring, irrigation runoff from the other side of the road, or a tributary from the other side of the valley. In any case, high fish use was observed in this location.

At VM 8.5, a large debris jam has caused an avulsion toward the right bank through the forested floodplain. The channel

Project Area 36
Natural wood material in the river downstream of a large avulsion through the floodplain trees. This section of riparian habitat has thick undergrowth but very few mature trees.

Project Area 36 Reach Characteristics

VM Start (mi)	7.83
VM Length (mi)	1.44
Valley Slope	0.68%
RM Start (mi)	9.11
RM Length (mi)	1.70
Average Channel Slope	0.57%
Sinuosity	1.18
Connected FP (ac/VM)	33.79
Encroachment Removal (ac/VM)	2.14
Channel Aggradation (ac/VM)	19.14
Total FP Potential (ac/VM)	19.59
Encroaching Feature Length (ft)	2,207.60
Connected FP Rank	3

through here is extremely complex with multiple jams and split flows. As of 2019, the abandoned channel was disconnected at the top but reconnected through a small side channel and groundwater seepage; this area is overgrown with the invasive false indigo, which is highly prevalent throughout this reach. As expected of a recent avulsion, the channel through this section has a high amount of instream wood, often forcing deep pools.

Near the end of this complex section, the river currently runs along the riprapped embankment for the old railway and is likely one of the areas of concern for the landowner. The channel becomes uniform and straight for a short distance before entering another complex reach around VM 8, where a meander scar on either bank has good, young cottonwood growth but is lacking in mature vegetation and cover. The right bank abandoned channel shows signs of heavy beaver activity.

This complexity continues to the end of the project area, where the right bank floodplain begins to be impacted by a levee and high bank for an RV park.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows a particularly large amount of geomorphic change, and active geomorphic change was noted during field observations in 2018 and 2019 Some of the larger scale processes and more major change locations are highlighted here, but because this reach is so active there are many other locations that could be noted.

One observation not highlighted in the data sets is that aggregation appears to be occurring in the floodplain and in some channel locations from the upstream end of the reach to the first location of geomorphic change. This could indicate that flood flows are depositing material on the floodplain through this reach. The first location of geomorphic change is a clear bar building and associated erosion bend into the right bank field (box 1).

Near the middle of the reach, a major channel avulsion has occurred. A large sediment deposit occurred at a log jam in the channel and the river avulsed and downcut into the forested right bank floodplain. In the abandoned main channel downstream of this sediment deposit and erosion, additional erosion and downcutting has occurred, and field observations confirmed that this location was flowing with surface water from side channels through the forest floodplain. More erosion and downcutting has occurred downstream in both the main channel and side channel where several large log jams are located in the main channel (box 2).

Just downstream of this avulsion, the channel has caused major erosion first on the left and then the right bank. The first erosional bend is working its way into an agricultural field and the second is running along the armored bank for the old railway line. Several large log jams are present in this section and it is possible this change was initiated by these log jams (box 3). Just downstream of this area is another large erosional area on the right bank, also associated with several natural channel-spanning log jams (box 4).

Further downstream is a major erosional area on the left bank, and the river has subsequently moved back closer to its old location, leaving a large meander scar filled with cottonwoods. The abandoned channel location has filled in to some degree with sediment, and a large beaver complex was noted here during field observations. Just downstream of this area is another large erosional area on the right bank, but this flow path has been blocked by LWD and moved back into the former channel location, leaving a deep backwater in the erosional scar. It is interesting that sinuosity increased in this location through increased erosional meander bends and then subsequently straightened out again, abandoning the meanders. Depending on the timing of the two events, it is possible that the river was responding to a large amount of sediment supply released by the upstream channel avulsion (box 5).

At the downstream end of this project area, several more channel migrations are forming bars and erosional bends, but these are less extreme than those just upstream. Additionally, there are several large depositional areas in this location on both the left and right floodplains (box 6).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 36 has a moderate score for both complexity and floodplain connectivity potential but no score for excess transport capacity, which was below the assessment average. This reach has several large depositional areas, so the lack of excess transport capacity indicates that it is already acting as a depositional reach.

This project area falls in the 50th to 75th percentile for floodplain connectivity potential, but this score is primarily driven by channel aggradation potential, which scores much higher than the encroachment removal potential or both combined. It appears the potential area to be gained via channel aggradation is spread across the project area, and much of it exists in the areas between high-flow channels where the floodplain is already connected at the 2-year event. However, there are several significant areas that are connected at the 5-year event and could be connected at the 2-year event given channel aggradation or another method of raising the water surface elevation. At the upstream end, there are two fields with no pivot irrigation infrastructure that could potentially be connected. At VM 8.36 there is a large area of potential floodplain connection that includes some unused but non-vegetated land and a portion of a field with no pivot irrigation infrastructure. Some of this area is low enough that it could also be connected at the 2-year event by removing the encroachments that are disconnecting it, but these areas are patchy and not as large as the channel aggradation potential area. Channel aggradation should be a primary restoration objective in this reach, and because this reach already seems to be depositional, gravel augmentation is likely not necessary at the time of this assessment. However, a restoration strategy for this reach should be to add wood structure to trap and store sediment to potentially trigger aggradation on the bed of the channel. There are already several observed log jams in this project area, so securing these against being washed away in high-flow events could be a part of this strategy.

PA 36 falls in the 60th to 90th percentile for complexity, a range that still shows moderate complexity but does not place it in the top 10% of project areas, an objective that could be achieved with relatively little effort. Because the complexity in this project area already falls close to the 90th percentile mark, which no longer receives any points for prioritization, there appears to be good complexity across the whole reach. All three flows score at or above the assessment average, but the highest score for complexity is the 1-year flow. This increase is driven in large part by the connection of several side channels at the very upstream end of the project area; connecting these year-round would be an easy way to increase overall complexity. Adding wood structure and opening or lowering high-flow channels should be the restoration strategy employed for increasing complexity. It should be noted that

PA 36 Score Breakdown

This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

any increase in connected floodplain will also likely result in increased complexity for this reach.

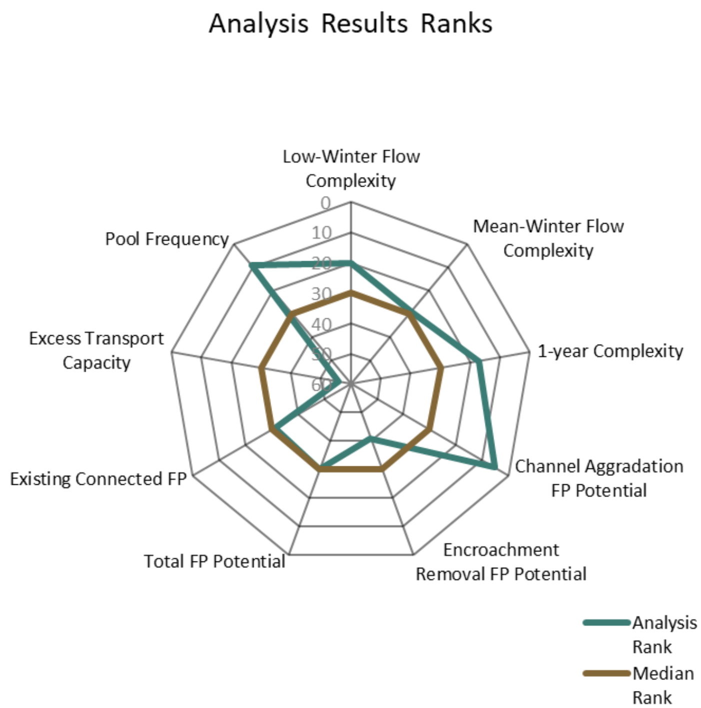
Riparian zone enhancement and plantings will be an essential part of any set of restoration strategies used in this project area. Much of the potential floodplain and side channels exist in large, open agricultural fields. Initiating riparian vegetation growth in these areas should be done along with or even prior to any of the above restoration strategies.

Finally, PA 36 ranks well above average in the Pool Frequency metric, indicating a high amount of pools per river mile. The restoration strategy of adding instream structure and wood should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be maintained and continue to form with the natural processes of the reach.

Summary of Restoration Opportunities Identified

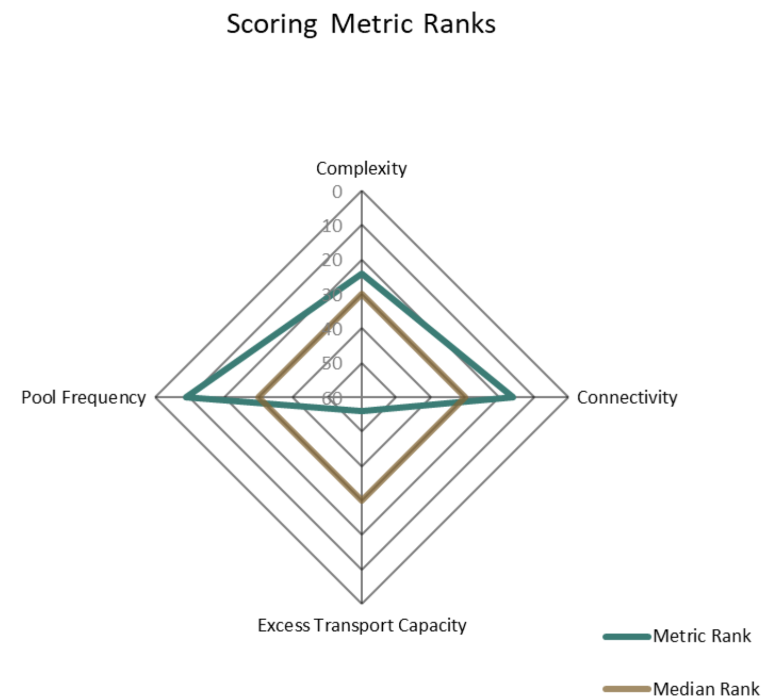
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

PA 36 Analysis Results Summary



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

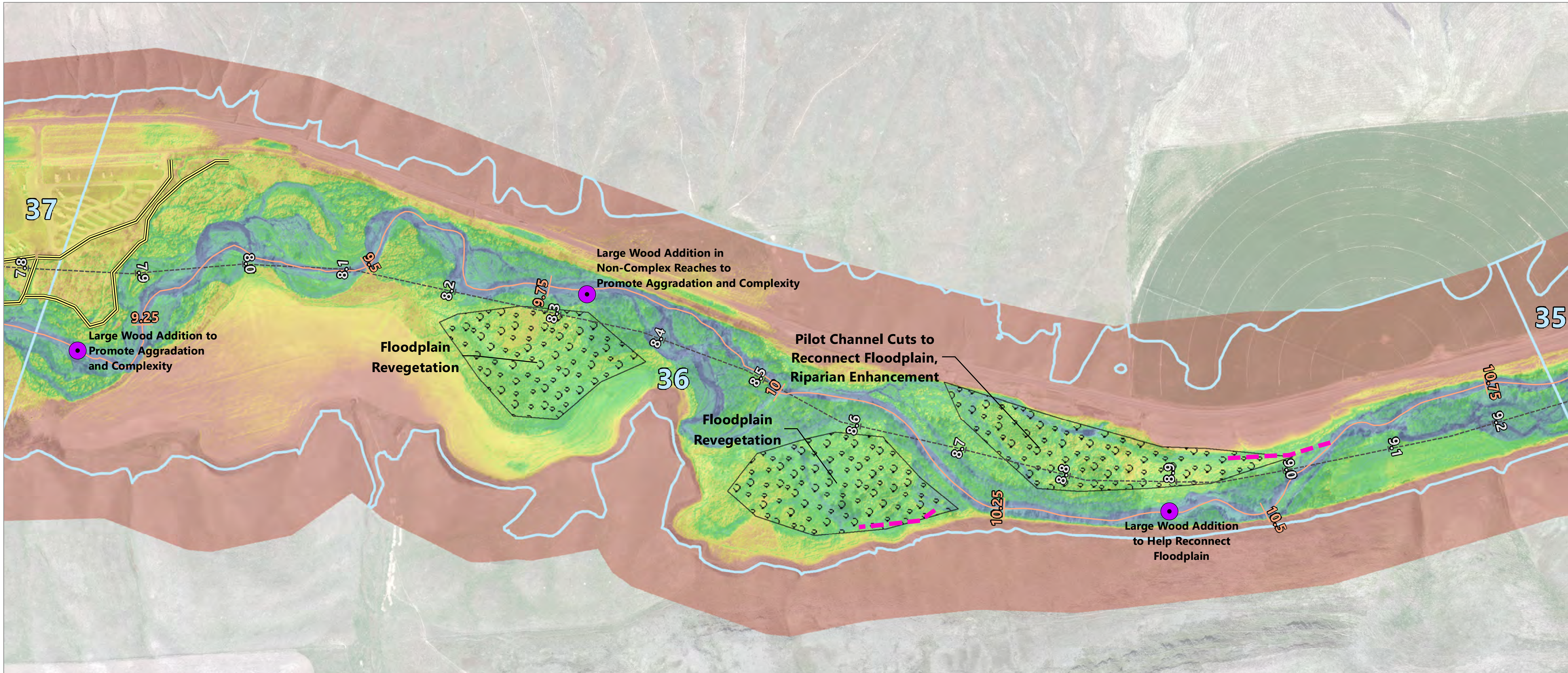
PA 36 Prioritization Scoring Summary

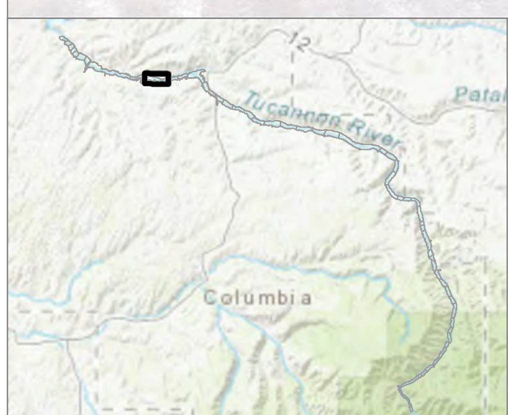


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 36 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.229	20	40%	Complexity	0.278	24	10% to 40%	2 of 5	3	40%	2.4	25	2	Untreated	18	2
Mean-Winter Flow Complexity	0.256	29	40%													
1-year Complexity	0.421	17	20%													
Channel Aggradation FP Potential	0.359	5	40%	Connectivity	0.233	16	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.040	41	40%													
Total FP Potential	0.367	30	20%													
Existing Connected FP	0.633	31	0%													
Excess Transport Capacity	-0.20	56	100%	Excess Transport Capacity	0.000	56	52% to 100%	4 of 4	0	20%						
Pool Frequency	20.76	9	100%	Pool Frequency	0.533	9	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Riparian Enhancement

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 9.11
RIVER MILE END: 10.81
VALLEY MILE START: 7.83
VALLEY MILE END: 9.27

0 500
Feet

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ANCHOR QEA

Project Area 36
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 38 Description

Project Area 38 begins at the lateral Starbuck levee at VM 4.09 and extends upstream to VM 6.86. The 2017 RM length is 2.97 miles. Field observations for PA 38 were conducted October 9, 2018, when flow at the Starbuck gage was approximately 105 cfs.

PA 38 is one of the longest project areas and is largely a straight and uniform channel with very little instream wood and channel complexity. The left bank is confined by the valley wall for the entirety of the reach and does not stray more than one or two channel widths from the base of the wall. On the right bank, the channel is confined either by a high bank or levee and is often armored.

At the upstream end at VM 6.76, a rock berm extends into the active channel to divert water into a ditch for irrigation. This irrigation ditch runs for a long distance on the high right bank to approximately VM 6.11, where it begins to spill back into the river. There is potential to utilize this irrigation ditch as side channel habitat but much of it runs through reed canary grass with very little other vegetative cover.

At VM 5.48, Tucannon Dam presents a potential fish migration impediment, and at VM 5.22 a bridge for a private road crosses the river. Upstream of the bridge, pocket floodplain areas and high-flow path exist on the inside of the small meander bends between the levee and the valley wall. There are mature

Project Area 38
Looking upstream near the upstream end of the reach at a straight, plane-bed channel with fringe floodplain pockets behind levees (left) and high banks (right).

Project Area 38 Reach Characteristics

VM Start (mi)	4.09
VM Length (mi)	2.77
Valley Slope	0.56%
RM Start (mi)	5.04
RM Length (mi)	2.97
Average Channel Slope	0.51%
Sinuosity	1.07
Connected FP (ac/VM)	13.29
Encroachment Removal (ac/VM)	1.59
Channel Aggradation (ac/VM)	6.56
Total FP Potential (ac/VM)	8.83
Encroaching Feature Length (ft)	15,772.97
Connected FP Rank	33

deciduous trees in this area but they are often dead, and a large amount of dry rotting logs were observed on the floodplain.

Downstream of the bridge, a slightly larger amount of floodplain is available with good riparian cover and mature deciduous trees. However, this reach is still highly confined by the levee high bank and valley wall.

Bed material throughout this reach is mostly larger and resistant to sediment transport with little gravel material. It is likely that this straight and confined reach acts as a transport reach, moving most gravel material out in any flood event.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows very few instances of significant geomorphic change have occurred in PA 38 since the previous assessment, especially considering PA 38 is one of the longest reaches in the assessment area. This is likely due to the fact the PA 38 is highly confined between the valley wall on the left bank and levees on the right bank, as well as through natural incision.

At VM 6.4 towards the upstream end of the reach, a minor avulsion has occurred towards the right bank with associated erosional area. Based on the 2018 aerial imagery, there appears to be a log jam forcing some of this change (box 1).

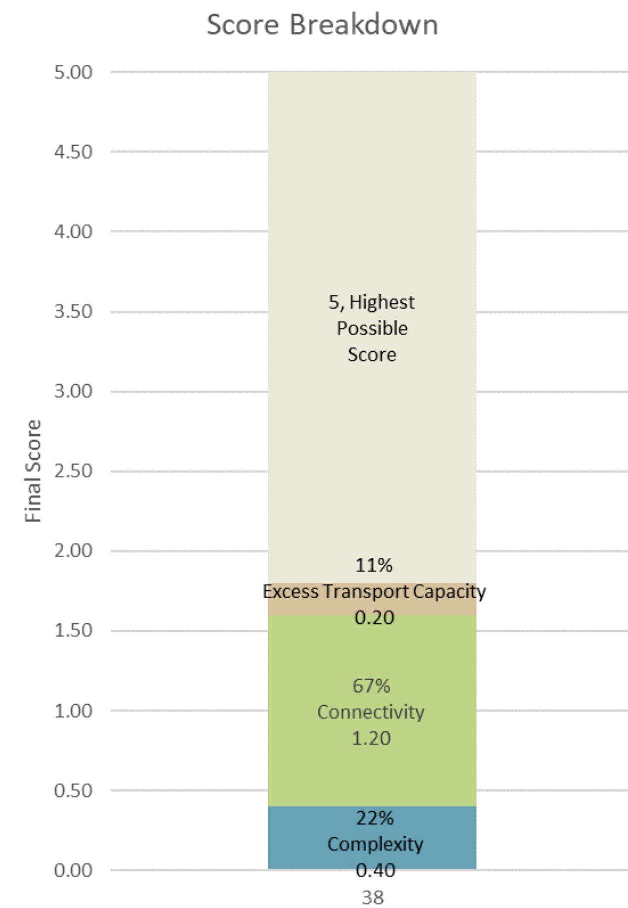
The next area highlighted for discussion at VM 5.6 is a very similar avulsion and erosional area towards the right bank as well (box 2). Between these two highlighted areas, the entire channel appears to be almost entirely erosional. This area occurs almost entirely where the active channel is the same for 2017 and 2011, which could indicate that it is a false reading based on the differences in ability of the 2017 LiDAR to detect channel bathymetry compared to the 2011 LiDAR, as discussed in the Geomorphic Assessment (Anchor QEA 2019). However, as it is consistent over such a long reach, it may be possible that this is a real indicator of incision occurring in this reach, especially considering the confined nature of PA 38.

Finally, the most significant area of geomorphic change occurs near the very downstream end of the reach at VM 4.5. Here the channel is forming several meander bends, with consecutive and alternative erosion on one bank and depositional bars forming on the other. At the downstream end of this pattern, the channel has formed a mid-channel bar with evident deposition. It is unclear what precipitated these changes as no significant log jams are evident in the 2018 aerial imagery, and this section of PA 38 was not walked for this assessment (box 3).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 38 receives the majority of its prioritization score from the Connectivity metric. PA 38 received a moderate score in Connectivity, indicating that it is above average and ranks in the 50th to 75th percentile of project areas. PA 38 ranks very highly in the Channel Aggradation analysis result and near average for the Encroachment Removal analysis result, and both should be considered as potential for floodplain connection. The channel aggradation potential is driven mostly by a large area of what appears to be currently used as pasture between the Tucannon Dam and the bridge near the middle of this reach. Additional areas for reconnection via channel aggradation exist in small pockets behind the levee along the reach. Several of these areas could also be reconnected through removal of the high bank or old levee that is disconnecting them at the 2-year event, so either levee removal or aggradation would be possible. There are several similar pockets of floodplain that exist on the outside of the levee that would need to be reconnected through pilot channel cuts or removal of the levee or encroachment. The primary restoration strategies for the reconnection of these areas to the 2-year floodplain should be gravel augmentation to raise the bed elevation, addition of instream wood to store and maintain the sediment in the reach, and strategic pilot channel cuts or removal of entire sections of levee.

PA 38 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 38 receives a low score in the Excess Transport Capacity metric, indicating that it could have slightly more transport capacity than would be expected of a reach with this average slope. Instream wood placement should be relatively aggressive and dense to ensure that sediment material from gravel augmentation is not washed away.

PA 38 receives a low score in the Complexity metric, indicating it ranks below average in the 10th to 40th percentile of all project areas. Across the three flows evaluated for complexity in the analysis results, PA 38 ranks particularly low for low-winter flow complexity, almost the worst in the assessment area. It appears that several flow paths in the floodplain, that are still between the levee and the river, are activated at the mean-winter and 1-year flow events. In general, although complexity is poor throughout this reach with the exception of a few pockets at the mean-winter and 1-year flows, reconnecting the floodplain should open up many more opportunities for the river to form complex flow. The addition of instream wood and gravel augmentation will also promote in-channel complexity. Pilot channel cuts are already identified as opportunities to reconnect floodplain at the 2-year event, but additional pilot channel cuts should be considered that target reconnecting flow paths at the low-flow event as well as completely disconnected flow paths to promote complexity across the board.

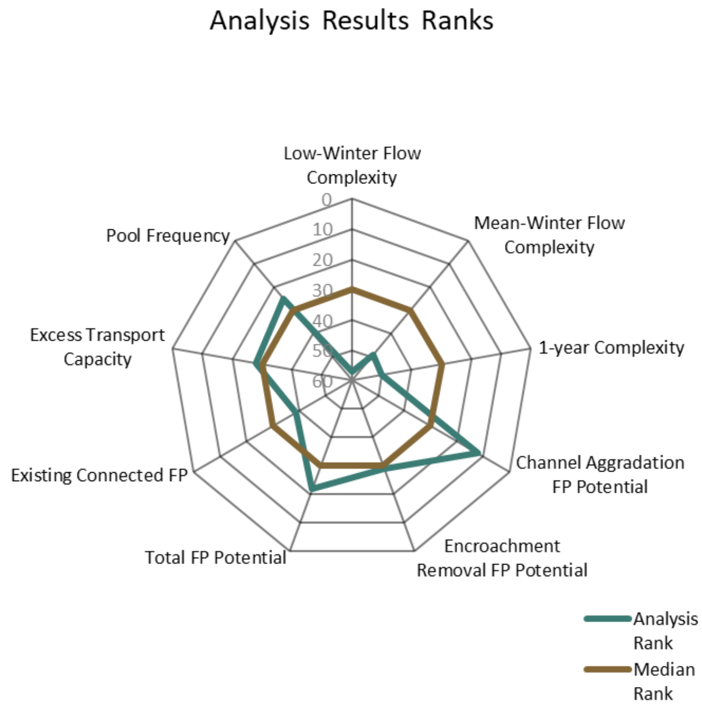
PA 38 ranks near average among project areas in the Pool Frequency metric. Adding instream wood and gravel augmentation will promote changes towards an increase in channel complexity, promoting the formation of pools. These restoration strategies should be employed to target maintaining and increasing pool frequency in the reach.

Finally, it should be noted that the Tucannon Dam plays a large role in the geomorphic processes that occur in this reach. Until the dam is removed, it may not be possible to achieve self-sustaining channel aggradation downstream of the dam even after some gravel augmentation. If the dam is not removed, it is possible continuous gravel augmentation will be necessary to promote geomorphic change in this area. If the dam is removed, it should be noted that the effective slope and gradient of this reach will increase drastically, and transport capacity will be much higher. Removal of the dam should be associated with drastic measures of floodplain reconnection to reverse the incision seen upstream and promote a more sinuous and longer channel length to effectively decrease the slope of the channel in this reach.

Summary of Restoration Opportunities Identified

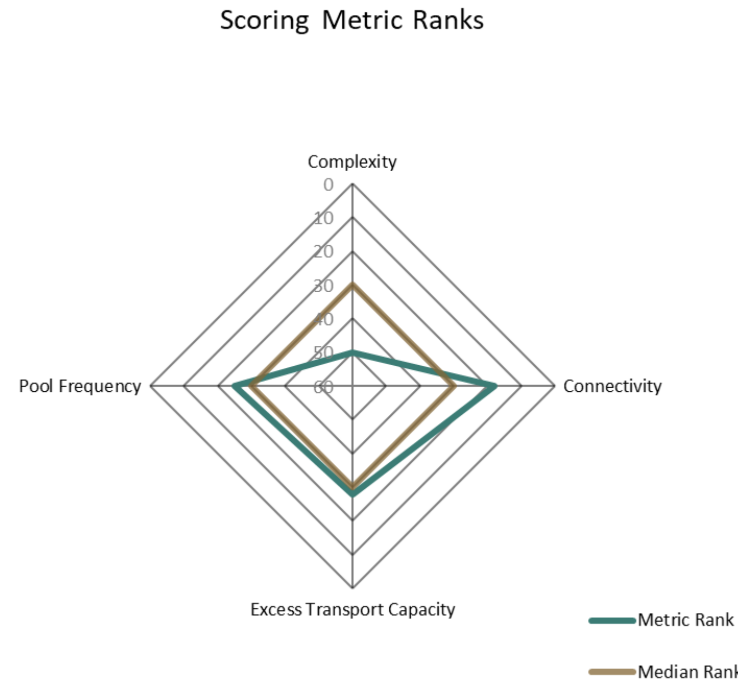
- Gravel augmentation
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement
- Modify or remove obstructions

PA 38 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

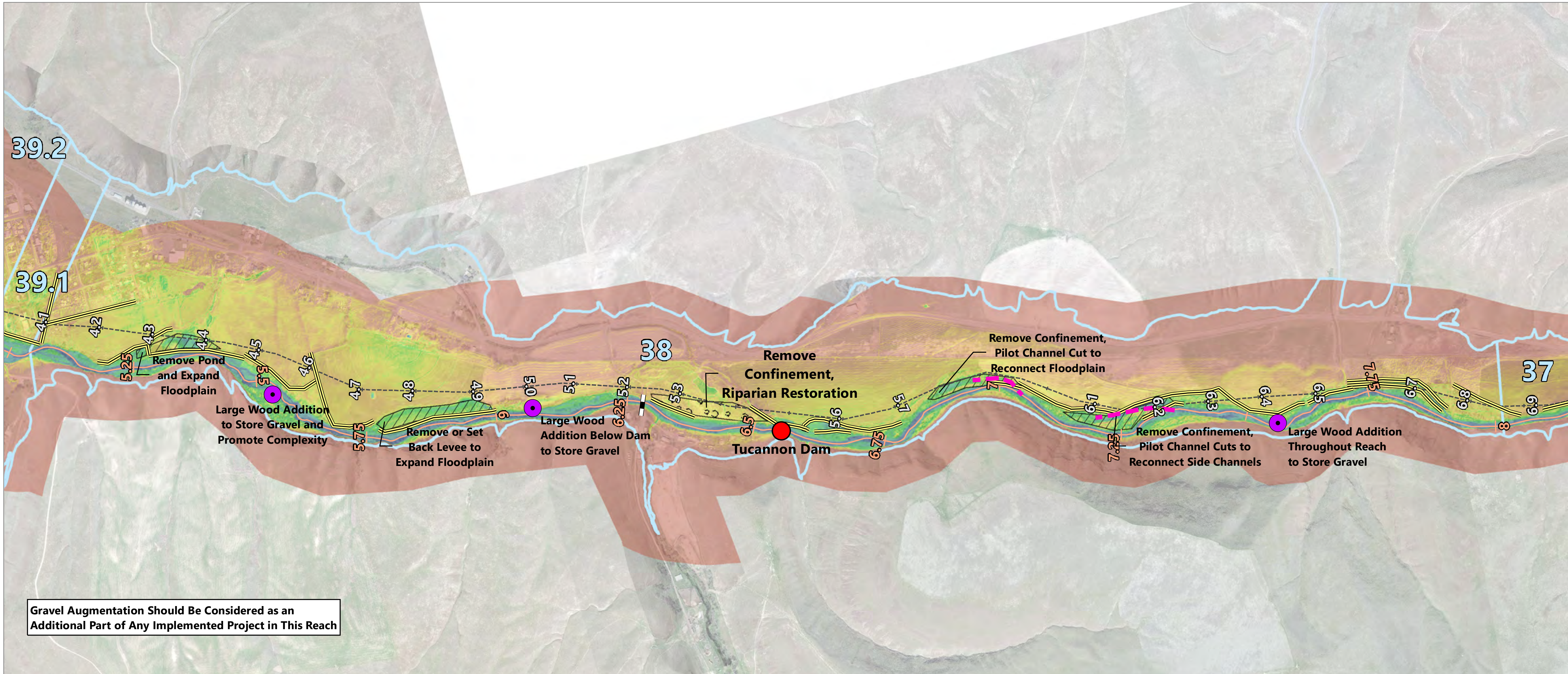
PA 38 Scoring Metric Ranks

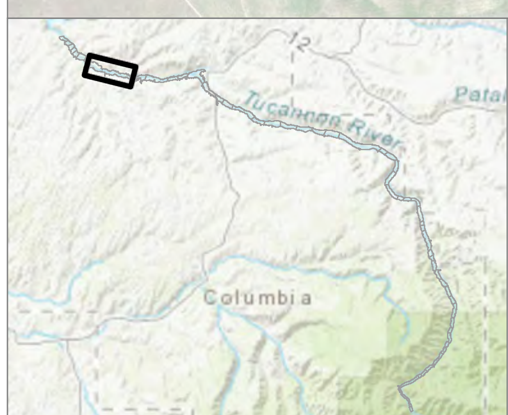


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 38 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.084	57	40%	Complexity	0.112	50	60% to 90%	4 of 5	1	40%	1.8	34	2	Untreated	21	2
Mean-Winter Flow Complexity	0.126	49	40%													
1-year Complexity	0.138	50	20%													
Channel Aggradation FP Potential	0.296	12	40%	Connectivity	0.227	18	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.072	29	40%													
Total FP Potential	0.399	22	20%													
Existing Connected FP	0.601	39	0%													
Excess Transport Capacity	0.05	28	100%	Excess Transport Capacity	1.000	28	30% to 52%	3 of 4	1	20%						
Pool Frequency	12.45	25	100%	Pool Frequency	0.320	25	40% to 60%	3 of 5	5	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential
- Riparian Enhancement
- Current Infrastructure in River Corridor

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 5.04
RIVER MILE END: 8.01
VALLEY MILE START: 4.09
VALLEY MILE END: 6.86

0 500
Feet

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ANCHOR QEA

Project Area 38
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 39.1 Description

Project Area 39.1 begins at VM 4.00 and extends upstream to VM 4.09 and is entirely behind the Starbuck levee. The 2017 RM length is 0.1 mile. Field observations for PA 39.1 were not conducted in 2018 as part of this assessment update. PA 39.1 represents a unique case among the project areas of this assessment. This project area was split before the last assessment, with the idea of isolating a section for a possible project that was never completed. PA 39 is such a short reach that many of the data-driven statistics for this reach may be slightly skewed and so the following analysis has been completed with that in mind.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows one significant change that occurs over the length of PA 39.1. The channel is eroding a significant amount of the left bank, and has moved more than a channel width into the floodplain since the 2011 assessment, along with deposition on the right bank. This erosion is extremely close to a bend in Kellogg Creek, which currently enters the Tucannon River further downstream in PA 39.2. Should this avulsion cut off Kellogg Creek in this location, there would be a significant elevation change that could possibly cause a headcut up Kellogg Creek (box 1).

Project Area 39.1
No site photograph available.

Project Area 39.1 Reach Characteristics

VM Start (mi)	4.00
VM Length (mi)	0.09
Valley Slope	0.26%
RM Start (mi)	4.94
RM Length (mi)	0.10
Average Channel Slope	0.21%
Sinuosity	1.15
Connected FP (ac/VM)	20.80
Encroachment Removal (ac/VM)	0.03
Channel Aggradation (ac/VM)	3.80
Total FP Potential (ac/VM)	3.83
Encroaching Feature Length (ft)	831.64
Connected FP Rank	15

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 39.1 receives the majority of its prioritization score from the Complexity and Excess Transport Capacity metrics. However, due to the extremely short length of this reach, and the fact that it contains only one modeled cross section, these scores are partially artificial. There is complexity potential in PA 39.1, short as it is, and the restoration strategy for the reach should be to add instream structure to stabilize the left bank, and promote split flow through the small wooded area on the right bank.

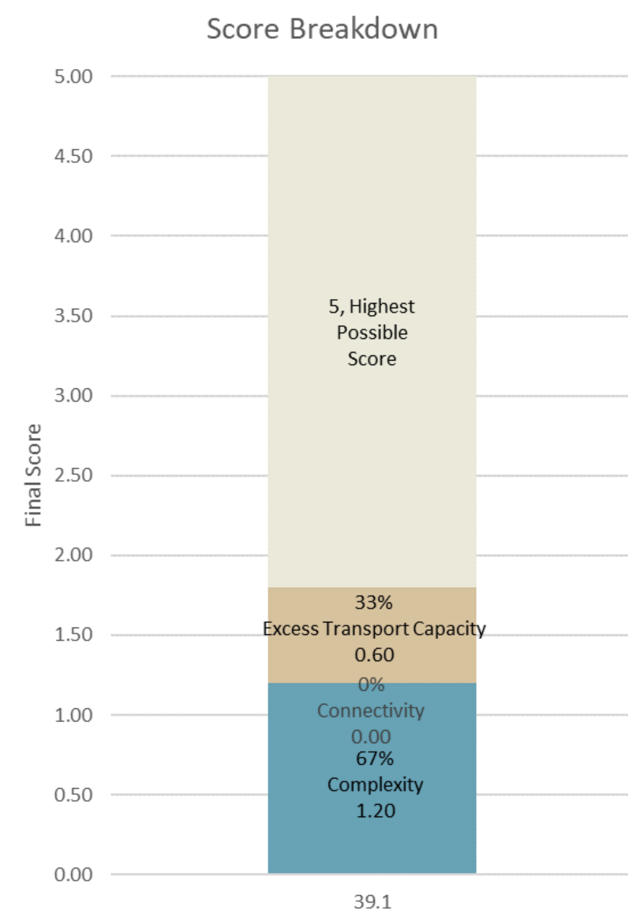
The Pool Frequency metric scores highly but again is deceiving due to the length of the reach. Adding instream wood will help to promote channel complexity and maintain several pools throughout the reach.

In general, restoration in this reach should be folded into either PA 38 or PA 39.2, which score as Tier 2 and Tier 3 untreated reaches, respectively.

Summary of Restoration Opportunities Identified

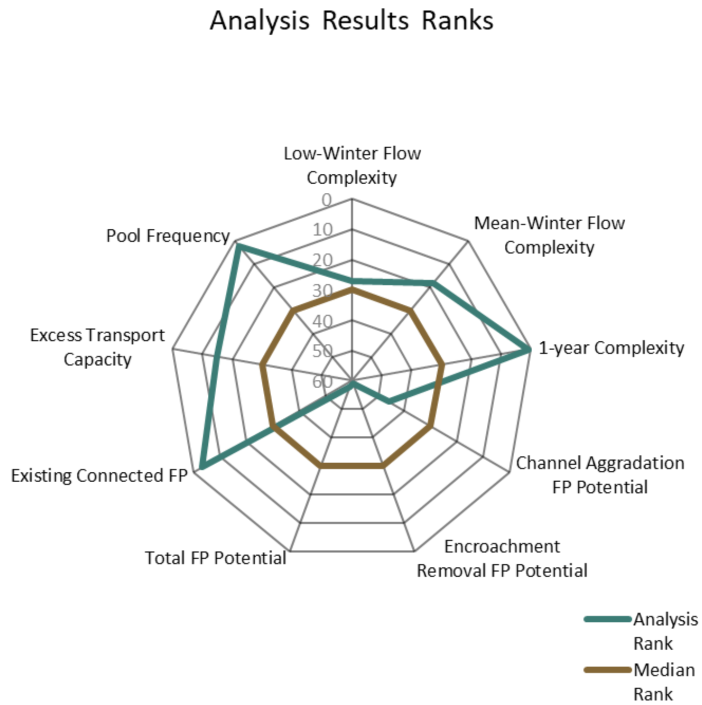
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

PA 39.1 Score Breakdown



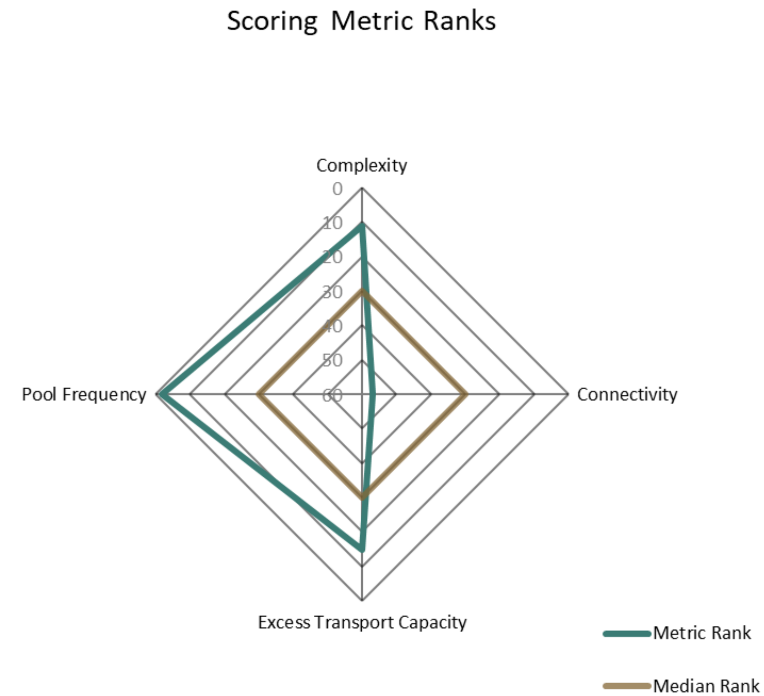
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 39.1 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

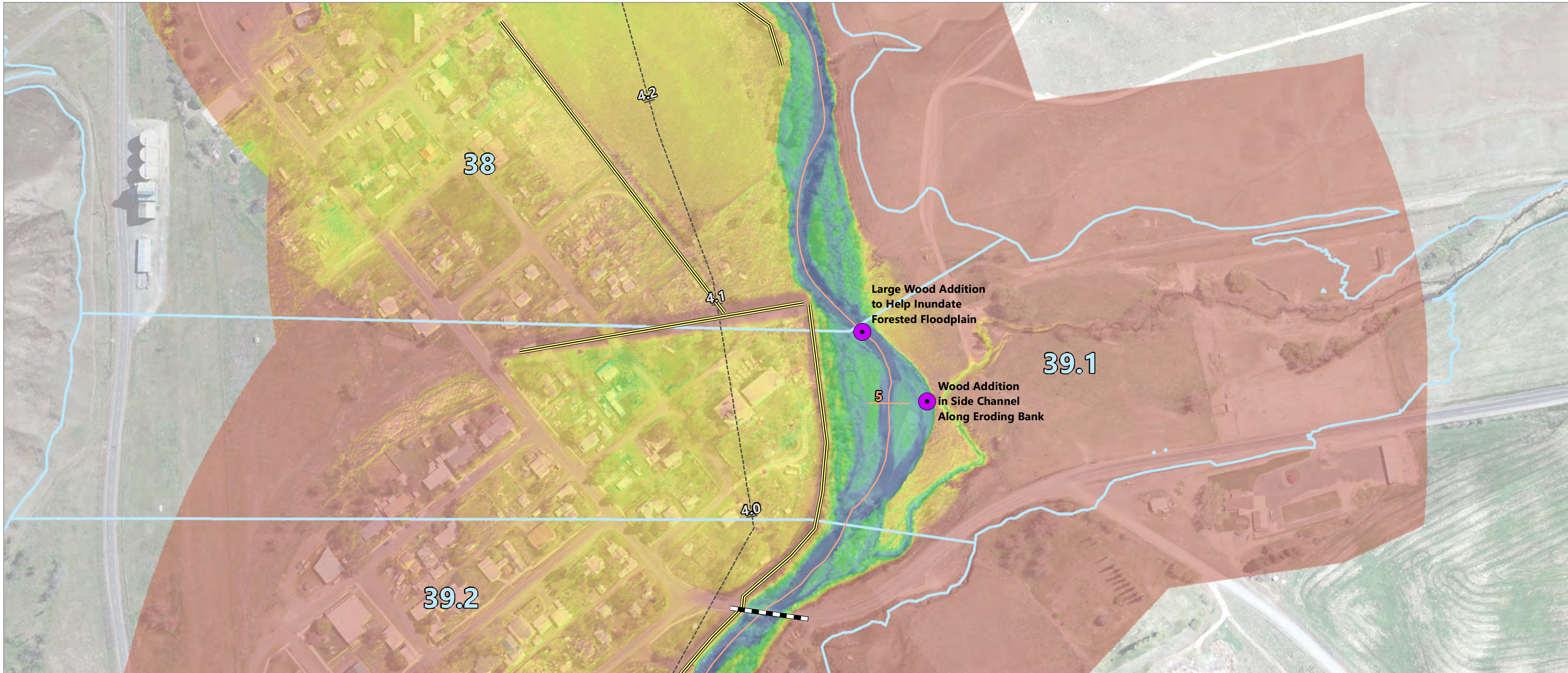
PA 39.1 Scoring Metric Ranks

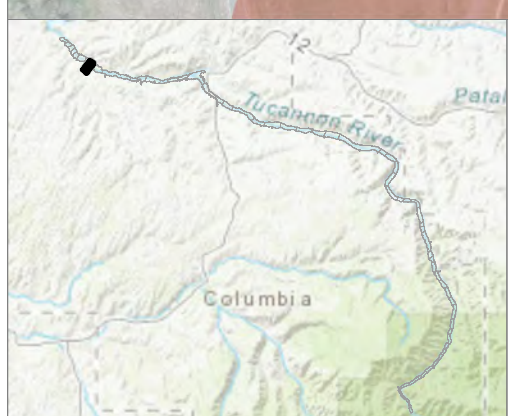


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 39.1 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.166	27	40%	Complexity	0.381	11	10% to 40%	2 of 5	3	40%	1.8	35	2	Untreated	22	2
Mean-Winter Flow Complexity	0.340	18	40%													
1-year Complexity	0.892	1	20%													
Channel Aggradation FP Potential	0.154	46	40%	Connectivity	0.093	57	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.001	59	40%													
Total FP Potential	0.156	58	20%													
Existing Connected FP	0.844	3	0%													
Excess Transport Capacity	0.14	15	100%	Excess Transport Capacity	3.000	15	10% to 30%	2 of 4	3	20%						
Pool Frequency	38.51	2	100%	Pool Frequency	0.989	2	1% to 10%	1 of 5	0	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 4.94
RIVER MILE END: 5.04
VALLEY MILE START: 4
VALLEY MILE END: 4.09

0 500
Feet

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ANCHOR QEA

Project Area 39.1
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 42 Description

Project Area 42 begins at VM 2.60 and extends upstream to VM 2.85. The 2017 RM length is 0.33 mile. Field observations for PA 42 were conducted on October 10, 2018, when flow at the Starbuck gage was approximately 115 cfs.

PA 42 is a very short reach that is bounded by cultivated fields for the majority of the reach and is heavily influenced by these neighboring agricultural fields. The upstream end has small pockets of riparian floodplain with trees on the right bank. At VM 2.75, an irrigation pipe supplying a pivot close to the left bank crosses the river on a metal truss. On the right bank in this same location, a vegetated pocket of floodplain has some side channel opportunities that are currently disconnected. At the very downstream end, the floodplain is low and disconnected from the channel at this flow by a gravel berm, with very little vegetation.

The bed material throughout this reach includes plenty of transportable gravel material, indicating that adding some instream wood could easily increase the channel complexity. However, very little instream wood was observed in this reach and channel complexity was relatively poor, especially compared to PA 41 upstream and PA 43 downstream.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows many significant locations of geomorphic change in

Project Area 42
Looking downstream at an irrigation pipe crossing. The channel has complex planforms but little instream wood and poor riparian cover.

Project Area 42 Reach Characteristics

VM Start (mi)	2.60
VM Length (mi)	0.26
Valley Slope	0.78%
RM Start (mi)	3.35
RM Length (mi)	0.33
Average Channel Slope	0.59%
Sinuosity	1.29
Connected FP (ac/VM)	27.44
Encroachment Removal (ac/VM)	3.01
Channel Aggradation (ac/VM)	5.50
Total FP Potential (ac/VM)	19.71
Encroaching Feature Length (ft)	0.00
Connected FP Rank	6

this short reach. At the very upstream end, significant bank erosion is occurring on the outer edge of a meander bend, with associated bar building deposition on the inside of the bend (box 1).

Immediately downstream, deposition in the main channel has caused significant erosion on the left bank where the channel appears to be threatening some pivot infrastructure (box 2).

Near the midpoint of the reach, the channel has made a significant avulsion into the right bank floodplain with deposition in the main channel and erosion in the right bank floodplain. It is not immediately clear from the aerial imagery or field observation what has caused this avulsion (box 3). Another long avulsion has occurred just downstream of here, again with deposition in the main channel and this time erosion towards the left bank (box 4). The combination of these two changes has effectively straightened the channel significantly throughout this reach.

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 42 receives the majority of its prioritization score from the Complexity metric. PA 42 ranks near the top in the 60th to 90th percentile of all project areas for Complexity, which is a range that has been identified as only needing a slight boost to reach a high level of complexity. Similarly to the upstream PA 41, PA 42 ranks highly in all three flows for the Complexity analysis results. However, while PA 42 ranks near the top in low-winter flow complexity, the mean-winter flow complexity is significantly lower, and the 1-year flow complexity is around average. This indicates that many of the islands and side channels are being washed out during the higher flow events. A primary restoration strategy should be to add instream wood to ensure that complex flow channels are maintained during higher flow events. There are several additional low-flow paths, evident in the relative elevation map, that are not being connected at any of the three flows. Reconnecting these for perennial flow through a combination of instream wood placement and pilot channel cuts should be primary restoration strategies for this reach to boost complexity across all three flows.

If geomorphic response to the addition of instream wood does not occur, it may be possible that gravel augmentation is necessary to jumpstart geomorphic change and should be considered as a secondary restoration strategy. PA 42 received no score in the Excess Transport Capacity metric, indicating that any added gravel material will be easily stored and maintained with the addition of instream wood.

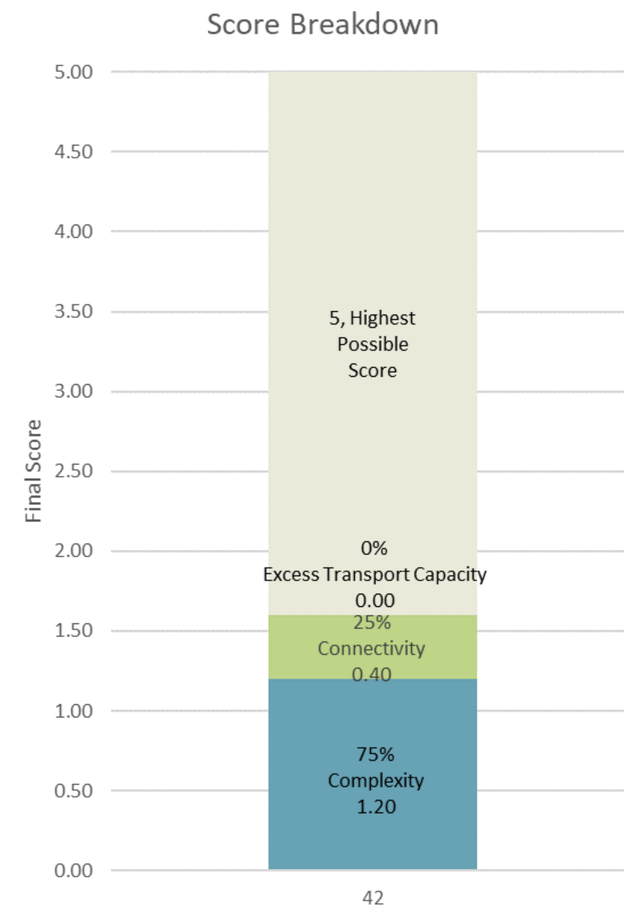
PA 42 ranks below average in the 25th to 50th percentile for Connectivity. Both the Channel Aggradation and Encroachment Removal analysis results score well below average, but the Total Floodplain Potential analysis result scores above average, indicating that both potential reconnection methods will be necessary to achieve results. However, the majority of this potential floodplain is outside of the levee and in the bordering fields. Reconnection to the floodplain may be difficult and would require extensive revegetation efforts with riparian species. Given that both channel aggradation and encroachment removal would be required to access this area, they should only be considered as a secondary restoration priority after boosting the complexity with the addition of instream wood, pilot cuts, and gravel augmentation.

Finally, PA 42 ranks very highly in the Pool Frequency metric, indicating a high amount of pools per river mile. The identified restoration strategies of adding instream structure and wood should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be maintained and continue to form with the natural processes of the reach.

Summary of Restoration Opportunities Identified

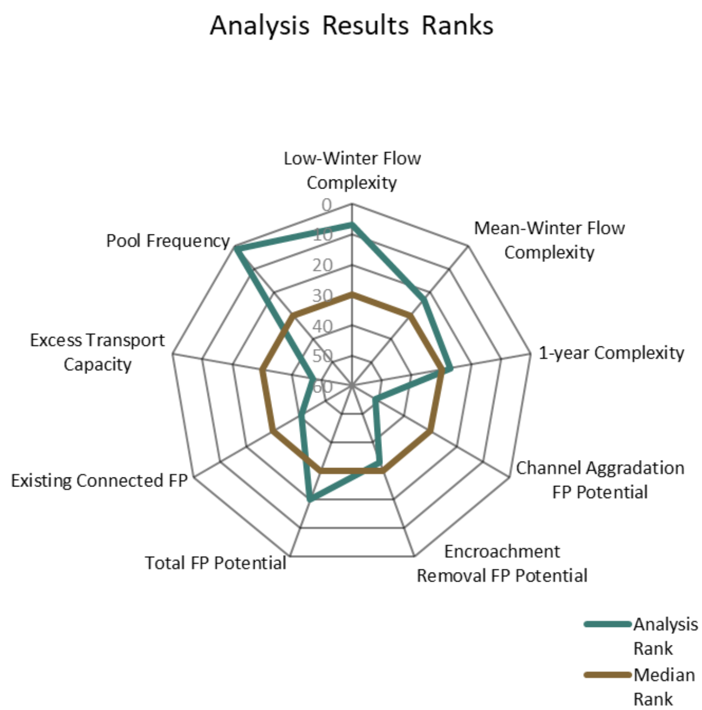
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

PA 42 Score Breakdown



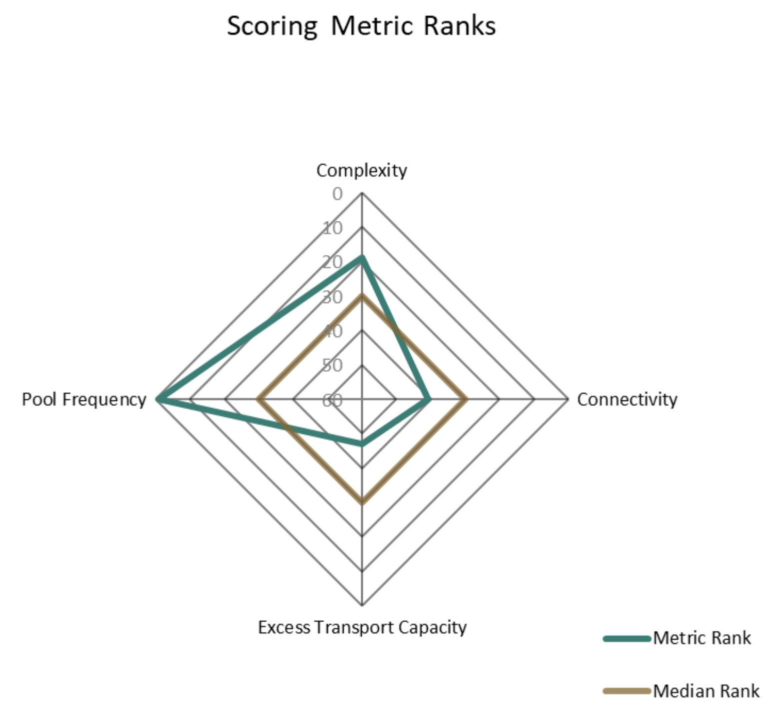
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 42 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

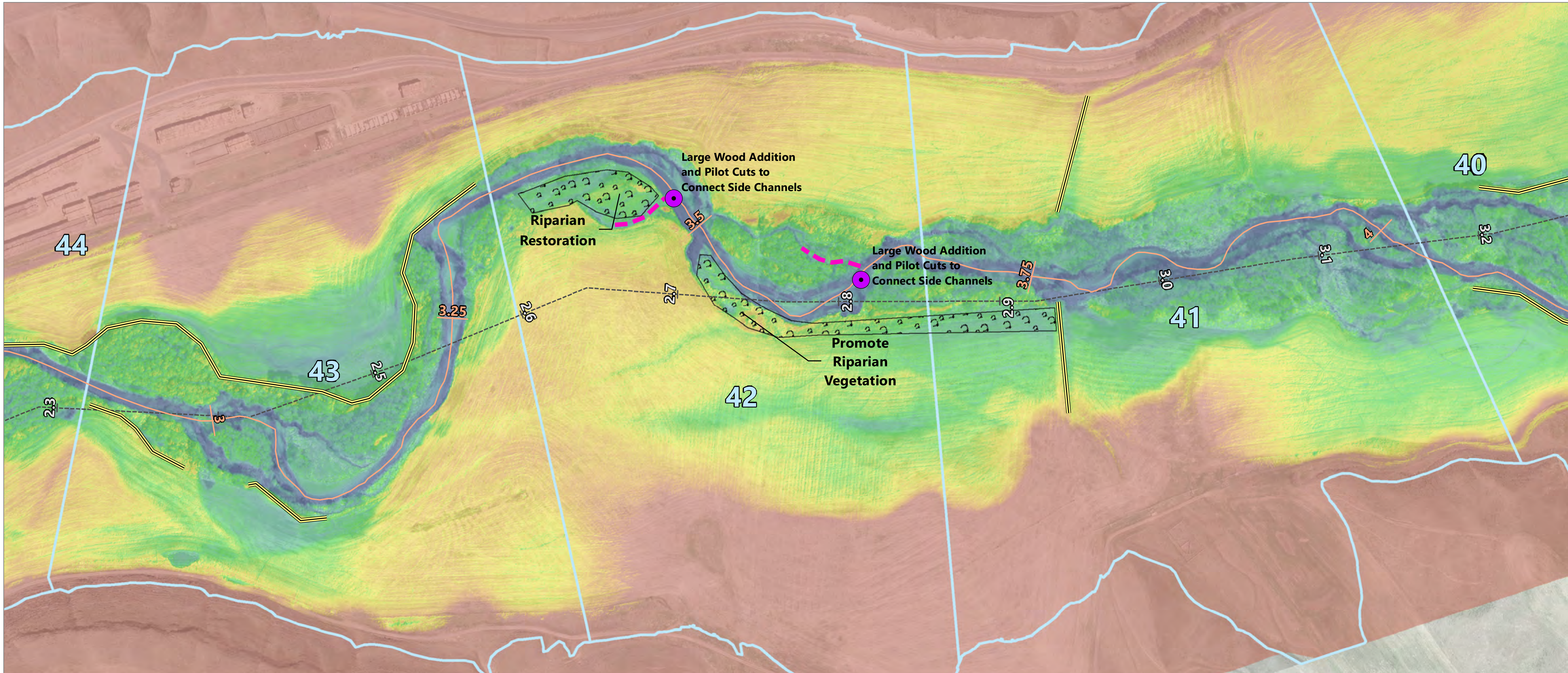
PA 42 Scoring Metric Ranks

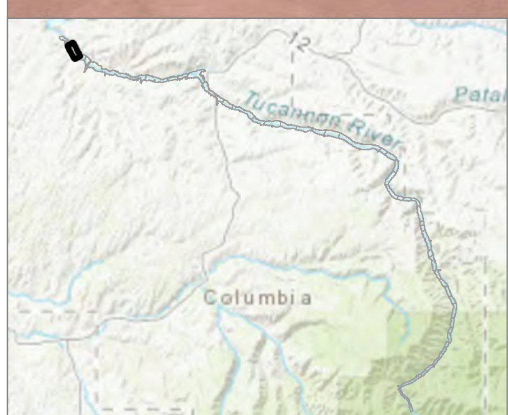


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 42 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.320	7	40%	Complexity	0.313	19	10% to 40%	2 of 5	3	40%	1.6	39	2	Untreated	24	2
Mean-Winter Flow Complexity	0.293	23	40%													
1-year Complexity	0.341	27	20%													
Channel Aggradation FP Potential	0.117	51	40%	Connectivity	0.156	41	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.064	33	40%													
Total FP Potential	0.418	20	20%													
Existing Connected FP	0.582	41	0%													
Excess Transport Capacity	-0.12	47	100%	Excess Transport Capacity	0.000	47	52% to 100%	4 of 4	0	20%						
Pool Frequency	38.95	1	100%	Pool Frequency	1.000	1	1% to 10%	1 of 5	0	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Riparian Enhancement

Relative Elevation in Feet

High : 15

Low : -0

NOTES:
1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 3.35
RIVER MILE END: 3.68
VALLEY MILE START: 2.6
VALLEY MILE END: 2.85

0 500
Feet

Publish Date: 2021/01/25, 3:56 PM | User: mgieschen
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ANCHOR QEA

Project Area 42
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 43 Description

Project Area 43 begins at VM 2.32 and extends upstream to VM 2.60. The 2017 RM length is 0.43 mile. Field observations for PA 43 were conducted on October 10, 2018, when flow at the Starbuck gage was approximately 115 cfs.

At the upstream end of the reach, the channel is flowing directly into the right bank levee, which is protecting a very low cultivated field. Several trees have fallen in at this location and the landowner reports water flooding this area regularly. This field is protected by an inconsistent levee already behind a buffer of vegetation on the right bank. Throughout this area on the left bank, the channel borders exposed agricultural fields with little to no riparian vegetation.

Just downstream and still behind the levee, the channel becomes extremely complex, beginning with a channel-spanning log jam at VM 2.56. Multiple low-flow paths travel through the trees. A large amount of woody material and abundant transportable material have caused dynamic geomorphic conditions and channel planforms.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows significant geomorphic changes occurring throughout the reach. At the very upstream end, significant bank erosion is occurring on the outer edge of a meander bend, with associated bar building deposition on the inside of

Project Area 43
Looking downstream at a recent avulsion area with multiple areas of channel-spanning woody material. This section of PA 43 was extremely complex at the time of the site visit.

Project Area 43 Reach Characteristics

VM Start (mi)	2.32
VM Length (mi)	0.28
Valley Slope	0.79%
RM Start (mi)	2.92
RM Length (mi)	0.43
Average Channel Slope	0.51%
Sinuosity	1.52
Connected FP (ac/VM)	34.58
Encroachment Removal (ac/VM)	22.40
Channel Aggradation (ac/VM)	33.06
Total FP Potential (ac/VM)	63.40
Encroaching Feature Length (ft)	300.57
Connected FP Rank	2

the bend. This area was pointed out to Anchor QEA field staff as a location of concern by the landowner (box 1).

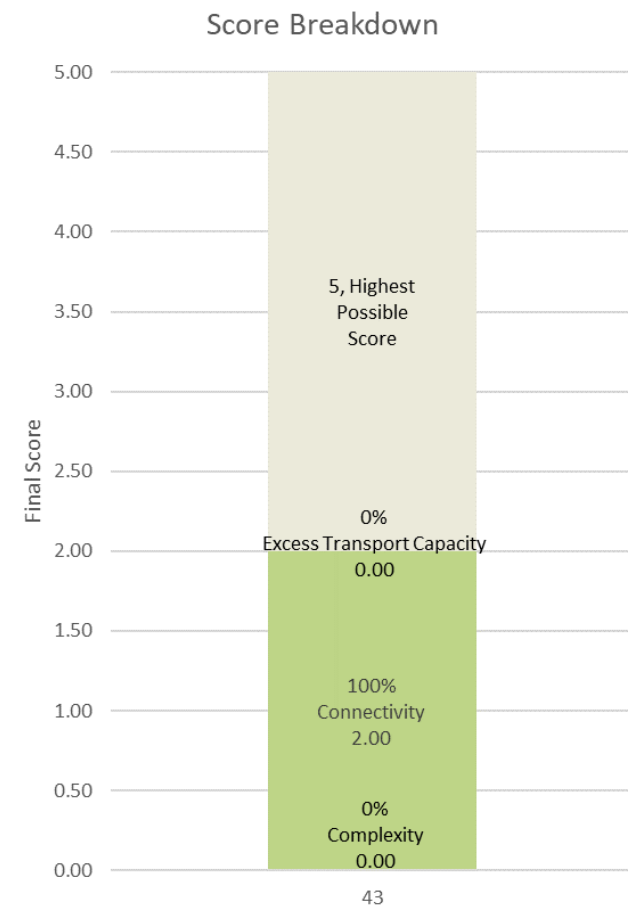
Shortly downstream of here and occupying the majority of the remainder of the reach, a large debris and log jam has caused significant geomorphic changes. The changes begin with sediment deposition over a large right bank bar. Further downstream, the debris jam has caused a channel avulsion and split flow through the forested floodplain creating multiple complex flow channels, which are apparent as erosional areas in the change analysis (box 2).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 43 receives its entire score in the Complexity metric. This project area has the highest possible score and ranks in the top tier of project areas in the 75th to 100th percentile range. This high score is driven almost entirely by the Encroachment Removal analysis result, which ranks PA 43 near the top of project areas in the assessment, while Channel Aggradation potential ranks near the bottom, although the Total Floodplain Potential analysis result indicates there may be some benefit to targeting both.

This potential area is located entirely in the bordering agricultural fields behind established levees and may not be accessible for restoration efforts. Should these areas become available for restoration activities, the primary restoration

PA 43 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

strategy should be to remove or breach the levees disconnecting these areas and add instream wood to promote geomorphic change into these areas. Pilot channel cuts could be considered as an additional restoration strategy to potentially access this area more quickly and add some immediate benefit to complexity. It should be noted that because these areas are currently agricultural fields, riparian vegetation enhancement will be a necessary restoration strategy in this reach to ensure a well-vegetated floodplain.

PA 43 receives no score in the Complexity metric because this project area ranks among the highest in the 90th to 100th percentile of all project areas for Complexity. While this range has been identified as complex enough to no longer require restoration, the addition of instream wood and the expansion of the floodplain will likely help create even more complexity in this reach.

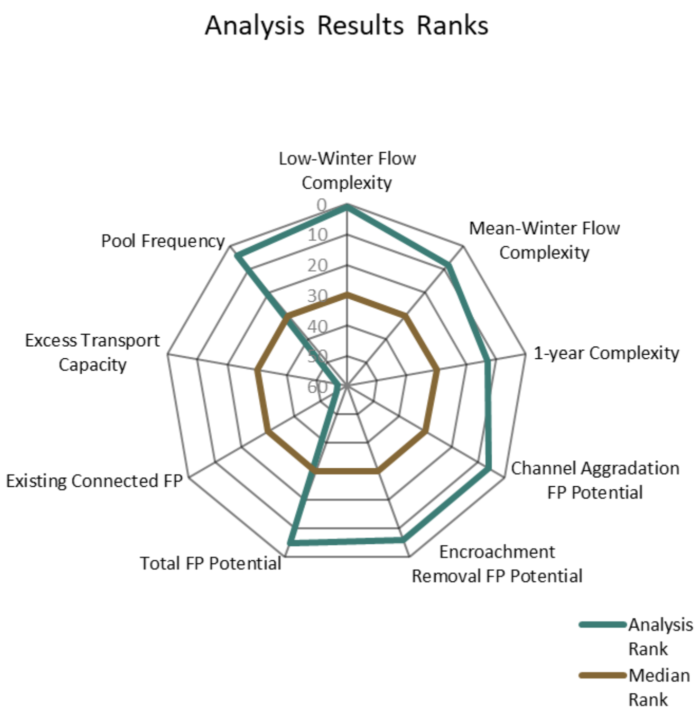
PA 43 also receives no score in Excess Transport Capacity, indicating it should trap and store sediment easily. While gravel augmentation is not currently necessary, it may be possible that this reach is part of a larger gravel augmentation plan for several reaches in the area, in which case the extra material will likely only serve to add some slight complexity and connectivity.

Finally, PA 43 ranks very highly in the Pool Frequency metric, indicating a high amount of pools per river mile. The restoration strategy of adding instream structure and wood should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be maintained and continue to form with the natural processes of the reach.

Summary of Restoration Opportunities Identified

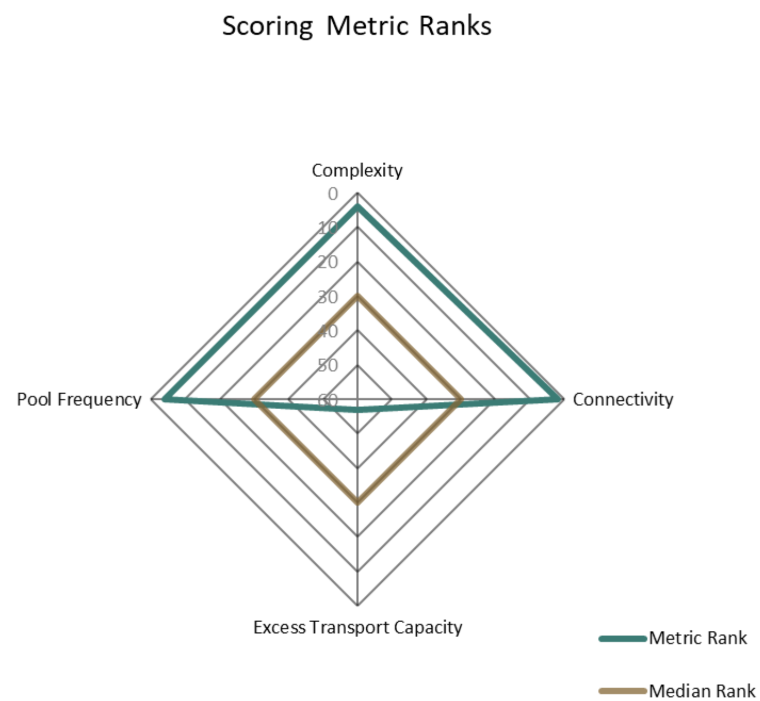
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)

PA 43 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

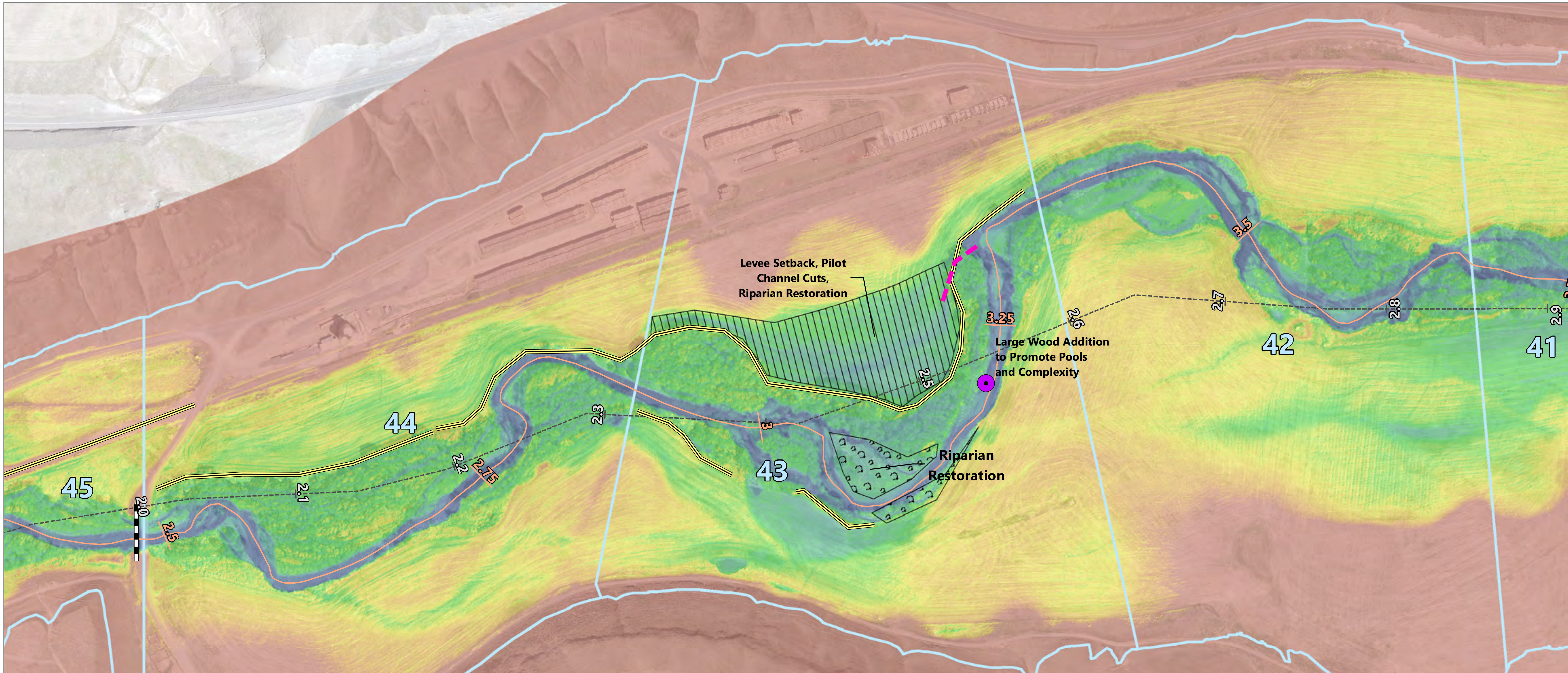
PA 43 Scoring Metric Ranks

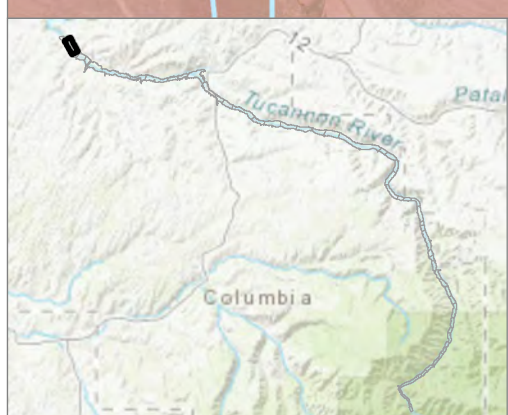


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 43 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.449	1	40%	Complexity	0.468	4	1% to 10%	1 of 5	0	40%	2.0	30	2	Untreated	20	2
Mean-Winter Flow Complexity	0.473	8	40%													
1-year Complexity	0.495	13	20%													
Channel Aggradation FP Potential	0.337	6	40%	Connectivity	0.356	2	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.229	6	40%													
Total FP Potential	0.647	5	20%													
Existing Connected FP	0.353	56	0%													
Excess Transport Capacity	-0.21	57	100%	Excess Transport Capacity	0.000	57	52% to 100%	4 of 4	0	20%						
Pool Frequency	30.32	4	100%	Pool Frequency	0.778	4	1% to 10%	1 of 5	0	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential
- Riparian Enhancement

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 2.92
RIVER MILE END: 3.35
VALLEY MILE START: 2.32
VALLEY MILE END: 2.6

0 500
Feet

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ANCHOR QEA

Project Area 43
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

APPENDIX J.2
TIER 3: UNTREATED PROJECT AREAS

Project Area 1.2 Description

Project Area 1.2 begins at VM 43.66 and extends upstream to VM 44.02. The 2017 RM length is 0.39 mile. Field observations for PA 1.2 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

For this assessment update, PA 1 as defined in the 2011 prioritization was separated into two project areas (PA 1.1 and PA 1.2) for distinct analysis. In 2014, PA 1.1 was the subject of a restoration project, while PA 1.2 has remained untreated.

The channel through PA 1.2 is characterized as a single-thread, plane-bed channel with local rapid sections. This project area is located in a relatively steep, narrow section of the valley. In the 2011 assessment, several minor side channels were observed during site reconnaissance, although many of these features are likely dry during the low-flow period.

The quality of instream habitat was limited by the lack of hydraulic and bedform complexity in the channel. Very few key logs were observed, so pools and instream cover were generally limited to the locations of man-made structures and small side channels. Overall, woody debris retention and temporary sediment storage was low.

In 2011, floodplain connectivity appeared to be unaffected by infrastructure, although remnant alluvial fan and hillslope

Project Area 1.2
Looking upstream at the end of the side channel that marks the delineation between PA 1.1 and PA 1.2. PA 1.2 has more sections that are single-thread, plane-bed channels as shown here.

Project Area 1.2 Reach Characteristics

VM Start (mi)	43.66
VM Length (mi)	0.36
Valley Slope	1.62%
RM Start (mi)	49.24
RM Length (mi)	0.39
Average Channel Slope	1.47%
Sinuosity	1.09
Connected FP (ac/VM)	6.29
Encroachment Removal (ac/VM)	1.09
Channel Aggradation (ac/VM)	1.13
Total FP Potential (ac/VM)	3.46
Encroaching Feature Length (ft)	493.83
Connected FP Rank	60

deposits have created moderately high surfaces that restrict the area of the low floodplain throughout much of the project area. Small sections of remnant levees and sections of riprap were located in a few places; however, the influence of these features to natural processes appeared to be minor.

The riparian zone was generally in a moderately healthy condition, with local areas that had been degraded by recreational use, development, and fire.

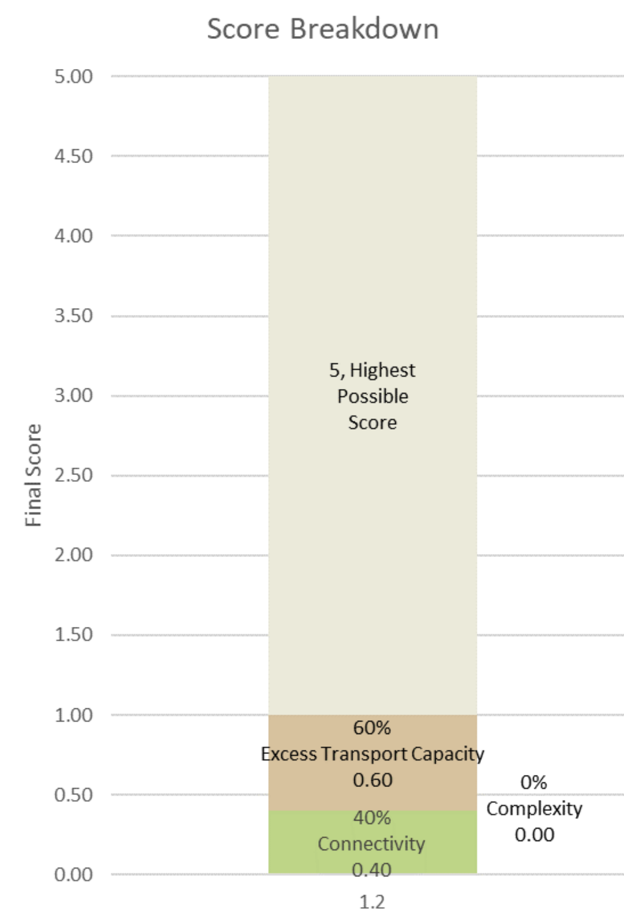
Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows very little geomorphic change has occurred in PA 1.2 since 2011. The only notable location of change is a small area of deposition on a right bank bar near the upstream end of the project area (box 1). Some minor areas of deposition and erosion occur periodically throughout the reach but are not worth noting.

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 1.2 receives a low score in the Connectivity metric and a moderate score in the Excess Transport Capacity metric, which combine to make the entire prioritization score for PA 1.2. The low Connectivity score indicates that PA 1.2 ranks below average in the 25th to 50th percentile for project areas in the assessment. This

PA 1.2 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

Connectivity score is driven almost entirely by encroachment removal potential, which is located in several disconnected side channels on the left bank floodplain of the reach. The primary restoration strategy for this reach should be to reconnect these disconnected side channels through pilot channel cuts and the addition of instream wood to promote geomorphic change into these areas.

This project area scores near the bottom in the 10th percentile for the Complexity metric, a range which has been identified as typically having complexity that is too poor to target in restoration efforts. However, this analysis does not account for the fact that reconnecting the disconnected floodplain would greatly improve the opportunities for improving complexity. Pilot channel cuts for floodplain reconnection are a primary restoration strategy, and targeting a lower flow for reconnection, along with the addition of instream wood to promote geomorphic change throughout the reach, should greatly increase the complexity throughout this reach with minimal added effort.

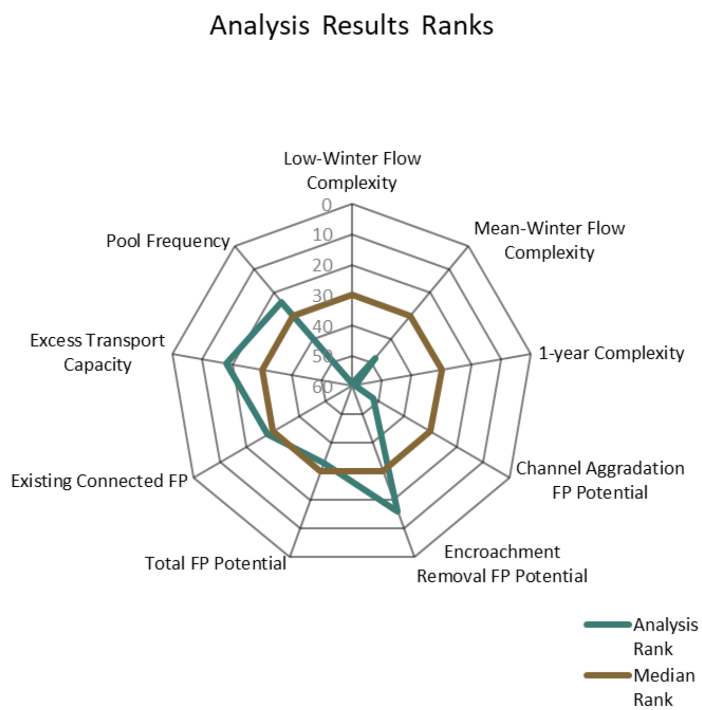
PA 1.1 has had little change since 2011 and appears to be resistant to geomorphic change, which is likely due to large bed sediment size and a lack of transportable material. Gravel augmentation should also be considered as a primary restoration strategy for this reach, to help promote geomorphic change into the disconnected floodplain areas and improve in-channel complexity. However, this reach receives a moderate score in the Excess Transport Capacity metric, indicating that added sediment could be quickly flushed out of the system without adequate instream wood to store and retain the sediment. The addition of instream wood should be dense and aggressive in this reach to induce the most geomorphic change from gravel augmentation. Opening the floodplain should also decrease this excess amount of transport capacity.

Finally, PA 1.2 ranks above average in the Pool Frequency metric, indicating a higher amount of pools per river mile. The restoration strategy of adding instream wood and gravel augmentation should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be maintained and continue to form with the natural processes of the reach.

Summary of Restoration Opportunities Identified

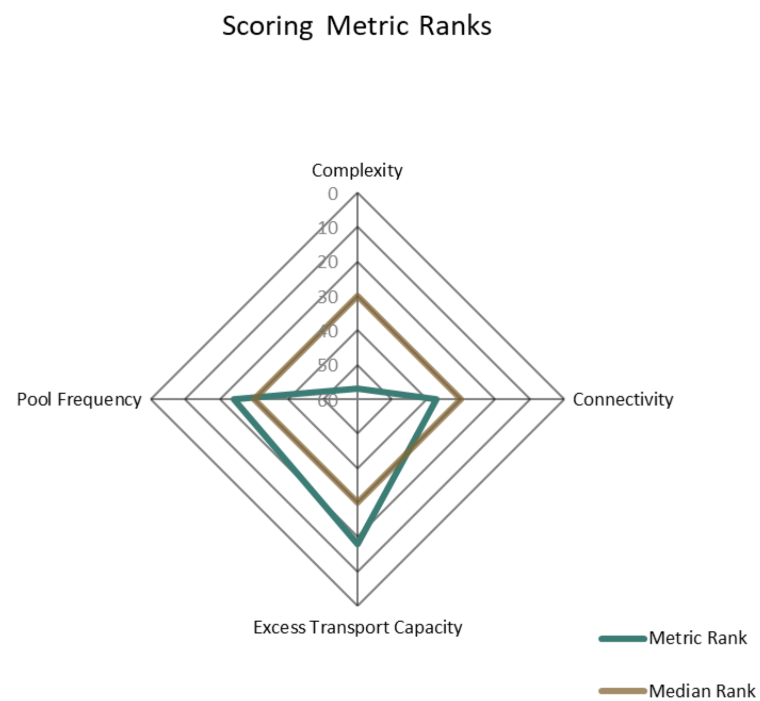
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)

PA 1.2 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

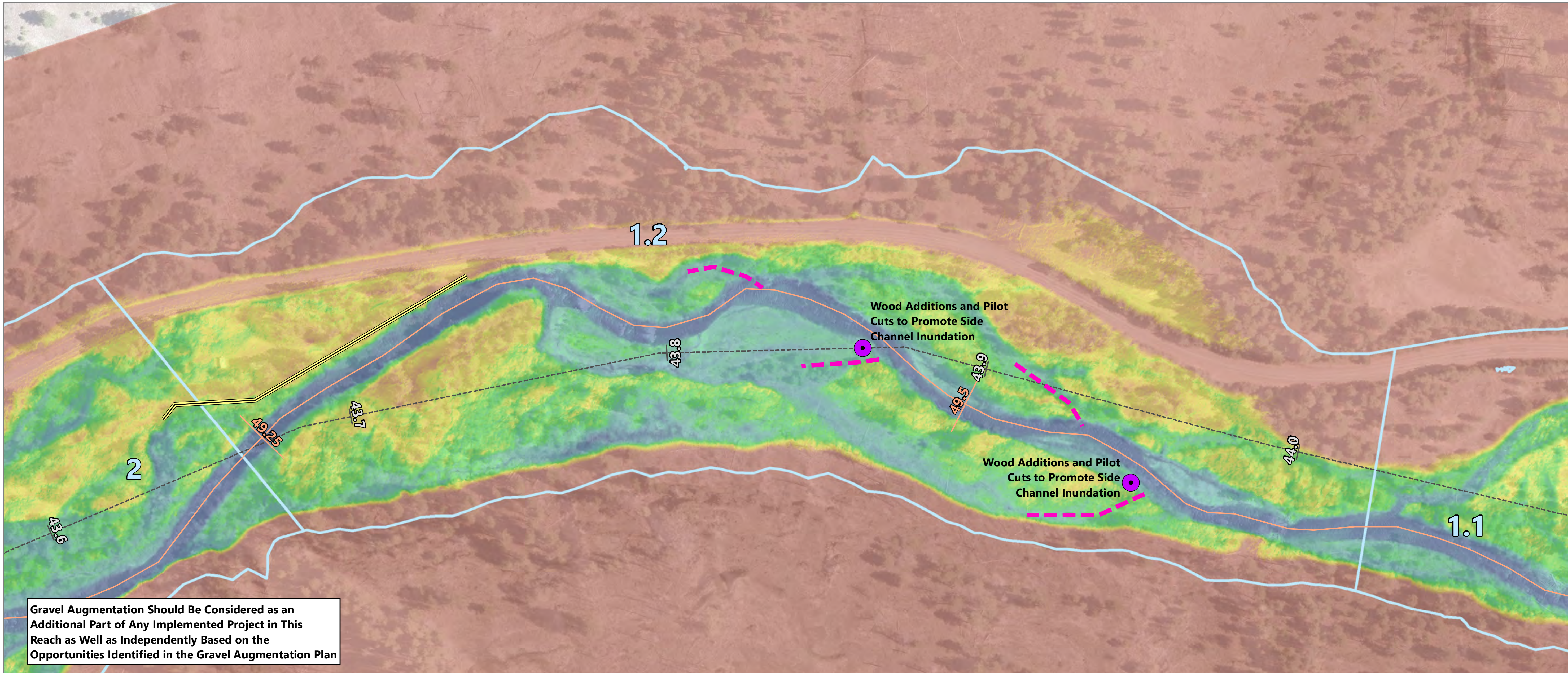
PA 1.2 Scoring Metric Ranks



This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 1.2 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.071	59	40%	Complexity	0.093	57	90% to 100%	5 of 5	0	40%	1.0	49	3	Untreated	29	3
Mean-Winter Flow Complexity	0.126	48	40%													
1-year Complexity	0.071	59	20%													
Channel Aggradation FP Potential	0.116	52	40%	Connectivity	0.162	37	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.112	16	40%													
Total FP Potential	0.354	33	20%													
Existing Connected FP	0.646	28	0%													
Excess Transport Capacity	0.13	18	100%	Excess Transport Capacity	3.000	18	10% to 30%	2 of 4	3	20%						
Pool Frequency	12.75	24	100%	Pool Frequency	0.327	24	10% to 40%	2 of 5	3	0%						



LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition Throughout Project Area
- Reconnect Side Channel

Relative Elevation in Feet
High : 15
Low : -0

NOTES:
1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 49.24
RIVER MILE END: 49.63
VALLEY MILE START: 43.66
VALLEY MILE END: 44.02

0 500
Feet

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ANCHOR QEA

Project Area 1.2
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 4 Description

Project Area 4 begins at VM 41.23 and extends upstream to VM 41.44. The 2017 RM length is 0.24 mile. Field observations for PA 4 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

The river and floodplain in PA 4 are highly confined between a levee and the road grade, which has resulted in a single-thread, high-velocity channel with large armor substrate and angular riprap banks. The levee on the right bank currently serves as an access road to the upstream side of the Camp Wooten facilities, including Donnie Lake.

The 2011 assessment noted that the quality of instream habitat in this project area was limited by the lack of hydraulic and bedform complexity in the channel. Although a few trees were observed in the channel, the high-velocity conditions likely prevent any retention of mobile debris or sediment deposition, and these trees were likely to be transported downstream during the next high-flow event.

Floodplain connectivity was greatly limited by the right bank road levee, which confined the channel to the left side of the valley and cut off a majority of the floodplain to the right. A large amount of low floodplain area and low-lying channel paths existed within the cutoff portion of the floodplain. One of these channels originated on the downstream side of the levee

Project Area 4
Looking upstream at PA 4 from the top of PA 5. The channel is straight, uniform, and tightly confined by the right bank levee.

Project Area 4 Reach Characteristics

VM Start (mi)	41.23
VM Length (mi)	0.21
Valley Slope	1.48%
RM Start (mi)	46.55
RM Length (mi)	0.24
Average Channel Slope	1.30%
Sinuosity	1.11
Connected FP (ac/VM)	11.00
Encroachment Removal (ac/VM)	0.92
Channel Aggradation (ac/VM)	1.70
Total FP Potential (ac/VM)	3.06
Encroaching Feature Length (ft)	1,340.82
Connected FP Rank	42

and flowed through the camp on the southeast side of the valley. During the 2011 assessment, the channel was dry at the upstream end and became wetted where a tributary meets the main valley; this tributary may be spring-fed, although it was unclear if the flow is perennial due to the unusually wet conditions at the time of observation.

The riparian zone was generally in a moderately healthy condition, where it had not been cleared or disturbed for development of the Camp Wooten site and for other recreational use. Riparian trees were predominantly immature deciduous trees, with very few mature or coniferous trees in the area. The riparian zone narrowed to approximately 5 to 10 feet wide and vegetation was limited with little overhang. In the overall project area, species were moderately diverse.

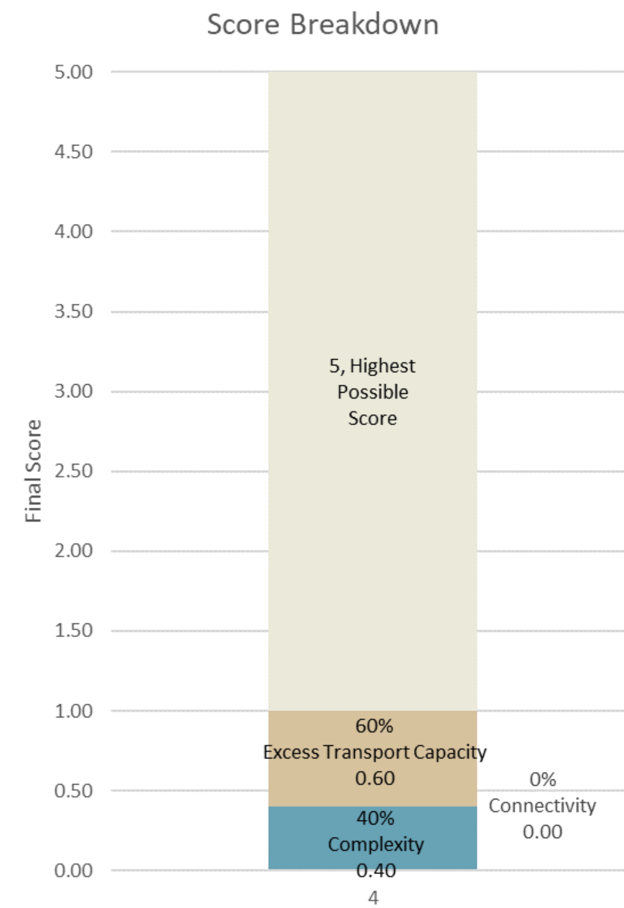
Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows very little geomorphic change over the entire reach. This reach is highly confined and leveed making geomorphic change difficult. The only notable change occurs near the upstream end of the reach, where deposition has occurred on a right bank bar (box 1).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 4 receives the majority of its score from the highest possible score in the

PA 4 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

Excess Transport Capacity metric. PA 4 also receives a low score in the Complexity metric, which indicates that the reach ranks low among project areas in the 10th to 40th percentile. This range has been identified as having a small amount of existing complexity but would likely require a large restoration effort to achieve higher levels. This is especially true of PA 4, which is highly confined by the valley wall on the left bank and a levee on the right bank. The analysis results show that the actual complexity values are nearly constant across all three flows, although this appears as a decrease in rank in the following graphs because most project areas increase from the low to winter flows. Some small amount of instream complexity may be gained with the addition of instream wood and should be the primary restoration strategy for this reach.

It is unlikely that the levee in this reach will be removed or set back in the foreseeable future due to the infrastructure behind it. However, should the opportunity ever become available, the reach would see the most possible benefit from setting back or removing this levee, and providing more riparian area for the channel to establish complexity and connectivity. If the levee were removed or set back, restoration strategies should be to aggressively add instream wood and promote channel aggradation through gravel augmentation.

On the right bank near the upstream end of the project area and on the river side of the levee, the small spring channel noted in the 2011 field assessment presents some opportunity for connection. Improving the floodplain connection and side channels in this area to capture the spring as an off-channel cold water input should also be considered as a restoration strategy in this reach.

PA 4 is tied for the worst ranking in the Pool Frequency metric, with no pools found with this assessment. Pools are transient and this may not always be the case, but the highly confined and uniform nature of this reach makes the lack of pools an expected condition. Until the levee is removed or set back, it is unlikely this reach will ever have decent pool frequency. However, some pools may be promoted through the addition of instream wood in the main channel.

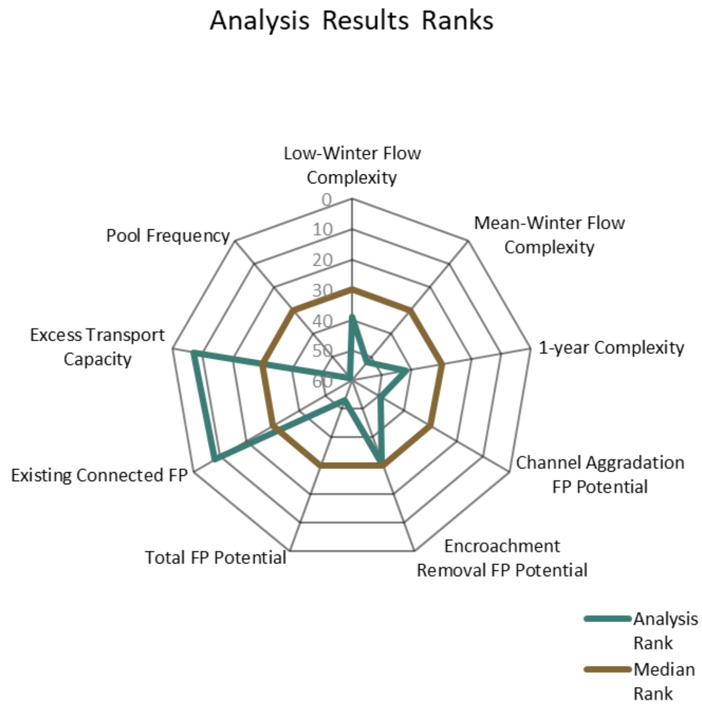
Summary of Restoration Opportunities Identified

- Gravel augmentation
- Address encroaching features
- Add instream structure (LWD)

Long-Term Opportunities in this Project Area

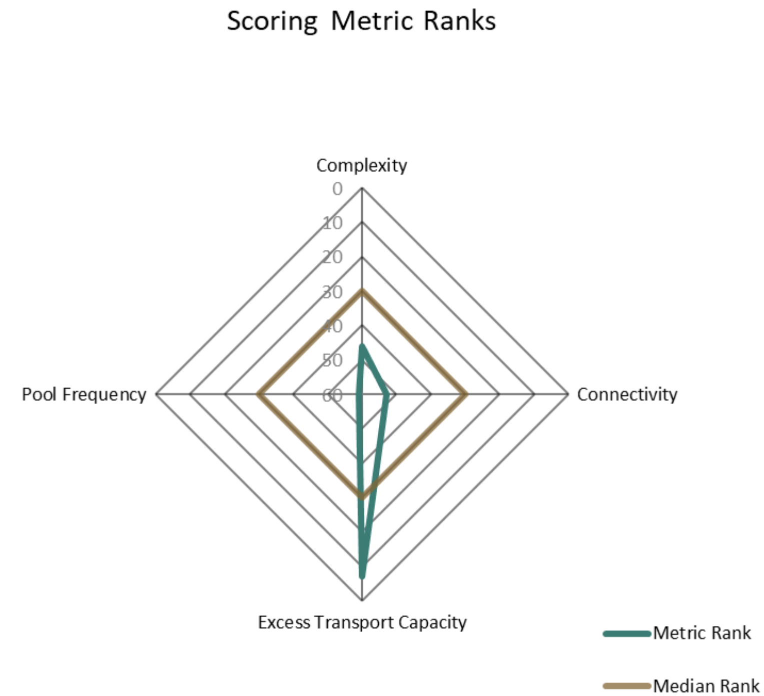
- Set back Camp Wooten road to expand floodplain.
- Relocate bridge to Camp Wooten to confined reach and remove the bridge downstream.

PA 4 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

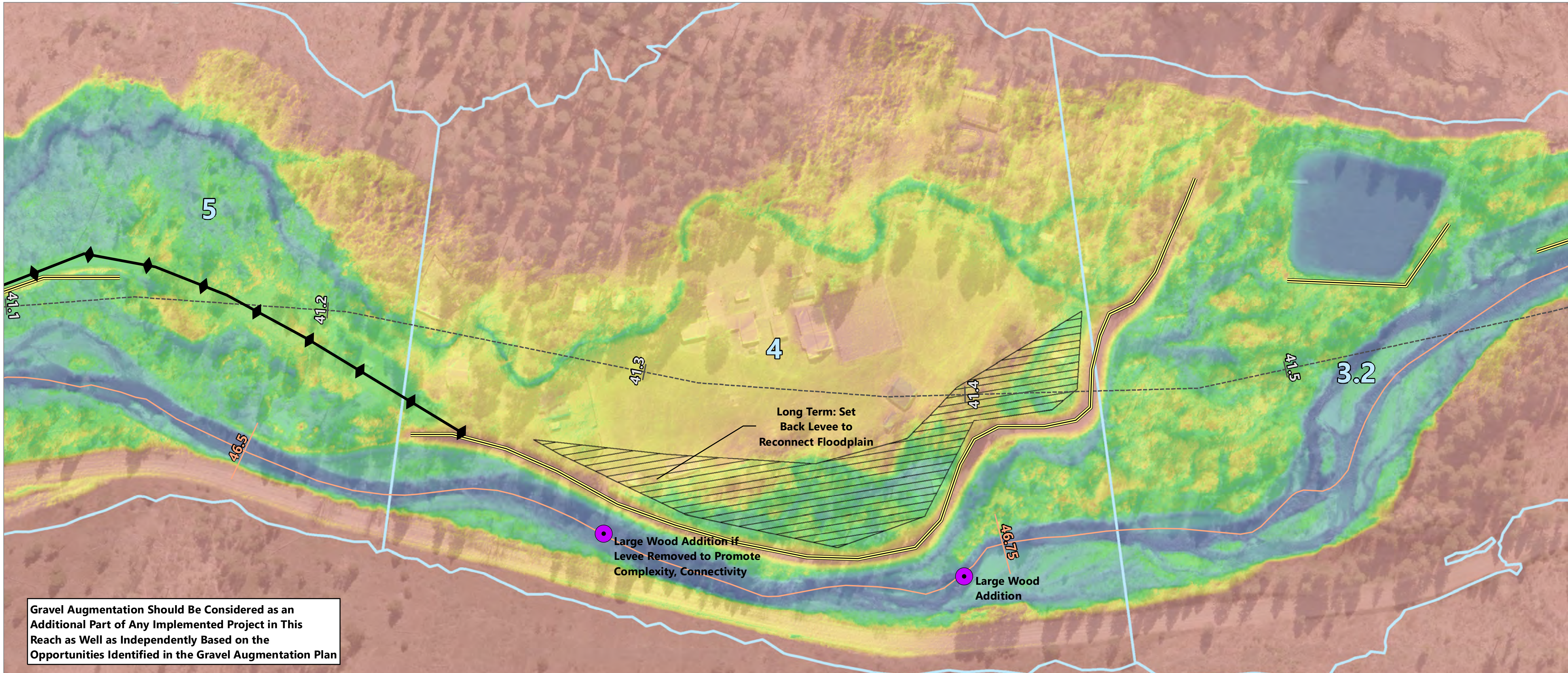
PA 4 Scoring Metric Ranks

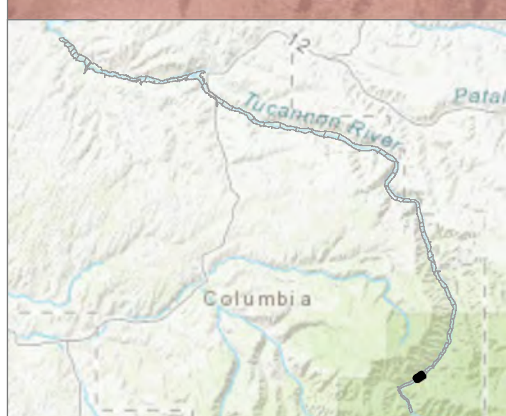


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 4 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.124	39	40%	Complexity	0.135	46	60% to 90%	4 of 5	1	40%	1.0	50	3	Untreated	30	3
Mean-Winter Flow Complexity	0.114	52	40%													
1-year Complexity	0.201	42	20%													
Channel Aggradation FP Potential	0.121	49	40%	Connectivity	0.118	53	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.065	31	40%													
Total FP Potential	0.218	53	20%													
Existing Connected FP	0.782	8	0%													
Excess Transport Capacity	0.22	7	100%	Excess Transport Capacity	3.000	7	10% to 30%	2 of 4	3	20%						
Pool Frequency	0.00	59	100%	Pool Frequency	0.000	59	90% to 100%	5 of 5	0	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential
- Long Term: Relocate Road

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 46.55
RIVER MILE END: 46.79
VALLEY MILE START: 41.23
VALLEY MILE END: 41.44

0 500
Feet

Publish Date: 2021/01/25, 3:43 PM | User: mgieschen
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ANCHOR QEA

Project Area 4
Conceptual Restoration Opportunities

Project Area 7 Description

Project Area 7 begins at VM 39.74 and extends upstream to VM 40.16. The 2017 RM length is 0.45 mile. Field observations for PA 7 were conducted on October 11, 2018, when flow at the Starbuck gage was approximately 100 cfs.

PA 7 is just upstream of Curl Lake, which is part of the Tucannon Hatchery program infrastructure. The upper part of the reach is closely confined on the left bank by Tucannon Road, which is often protected with large riprap. On the right bank, the upper part of the reach is confined by the valley wall and a high bank upland area, which may possibly be an abandoned floodplain terrace but is now 6 to 10 feet above the channel with some low areas only 4 feet above the channel. Riparian vegetation on this terrace and through much of the floodplain is dominated by conifers and upland vegetation. At the downstream end of this terrace, a low area along the wall is filled with large cut logs and other woody debris. This area may be inundated during high flows but does not likely receive any flow.

At approximately VM 39.83, a large diversion structure spans the main channel to supply water to Curl Lake downstream. A large log jam has been built on the right bank opposite the diversion structure, possibly to create additional head for the diversion as well as provide some marginal habitat. Downstream, several more large log jam structures were observed in the last quarter mile of PA 7, built as part of the

Project Area 7
Looking downstream at PA 7, which is a straight, confined channel largely disconnected from the riparian area with upland vegetation, but with some instream wood and geomorphic planforms.

Project Area 7 Reach Characteristics

VM Start (mi)	39.74
VM Length (mi)	0.42
Valley Slope	1.51%
RM Start (mi)	44.90
RM Length (mi)	0.45
Average Channel Slope	1.38%
Sinuosity	1.07
Connected FP (ac/VM)	9.03
Encroachment Removal (ac/VM)	1.12
Channel Aggradation (ac/VM)	1.11
Total FP Potential (ac/VM)	3.50
Encroaching Feature Length (ft)	1,061.49
Connected FP Rank	53

restoration project done on PA 8. These structures are interacting with flow and providing habitat, with some better channel complexity but with limited deep pools.

Near the same location of this diversion structure, the channel moves away from the road on the left bank and a large, low-lying area is partially leveed off in a pocket upstream of Curl Lake. It appears that there has been some floodplain manipulation in this area and it is possible that this area may have served some purpose for the operation of Curl Lake. However, at the time of the site visit, this area had good riparian vegetation growth and seemed to be a good opportunity for floodplain reconnection.

Throughout the whole reach, bed material is relatively large, with few patches of more easily transportable gravel material. In addition to the engineered log jams near the downstream end of the project area, some instream wood was observed. However, given the lack of gravel material and the low amount of instream wood, this is not enough to cause significant geomorphic complexity or planform variation in a reach that is for the most part extremely confined and disconnected from the floodplain.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows very little change has occurred in PA 7 since the previous assessment. PA 7 is highly confined by levees and the valley wall, which makes geomorphic change difficult. The one location highlighted for discussion occurs near the middle of the reach. A log jam has caused mid-channel deposition forming a bar and split flow, along with erosion on the left bank, where field observations noted a steep bank and deep pool (box 1).

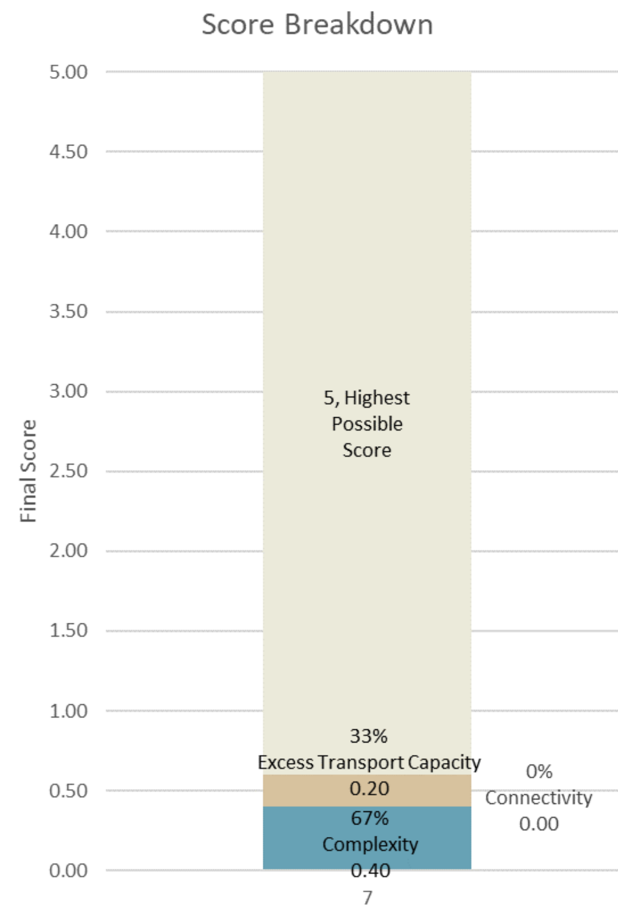
Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 7 receives the majority of its score from a moderate score in the Excess Transport Capacity metric. PA 4 also receives a low score in the Complexity metric, which indicates that the reach ranks low among project areas in the 10th to 40th percentile. This range has been identified as having some small existing complexity but would likely require a large restoration effort to achieve higher levels. This is especially true of PA 7, which is highly confined by the valley wall on the right bank and the road and high bank on the left bank. The analysis results show that the actual complexity values are nearly constant across all three flows with a slightly higher rank in the mean-winter flow than both the 1-year and low-winter flow complexity analysis results. At the upstream end of the reach, very little opportunity for complexity exists, but several lower flow paths are evident on the relative elevation map near mid-reach on the right bank and at the downstream end on the left bank. However, between these two areas, the infrastructure for the intake for Curl Lake ties the river to its current location. The primary restoration strategy for this reach, as it is now, should be to add instream wood to promote channel complexity and create pilot channel cuts where possible.

Gravel augmentation should also be considered in this reach to promote more in-channel complexity and geomorphic responses to the addition of instream wood, although the intake for Curl Lake may make this more difficult. Because this reach receives a moderate score in the Excess Transport Capacity metric, a large amount of instream wood should be added to ensure gravel material is not washed out of the reach immediately.

This reach is highly confined by the road and levee on the left bank, and the relative elevation map shows there is a large amount of low-lying floodplain on the opposite side of this infrastructure. It is unlikely that this road and levee will be removed at any point in the foreseeable future, so until then the identified restoration strategies noted earlier should be the primary focus for this reach. However, should the opportunity arise to set the road back against the valley wall and remove the levee, these opportunities would provide the most possible benefit to the reach by allowing more connectivity and room for complexity. If the road and levee were moved, the restoration strategies should be to aggressively add instream wood and promote channel aggradation through gravel augmentation. Expanding the floodplain and reversing incision

PA 7 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

would drastically reduce the excess amount of transport capacity in this reach.

Finally, PA 7 ranks around average in the Pool Frequency metric, indicating a moderate amount of pools per river mile. The identified restoration strategy of adding instream wood and gravel augmentation should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be promoted with the natural processes of the reach.

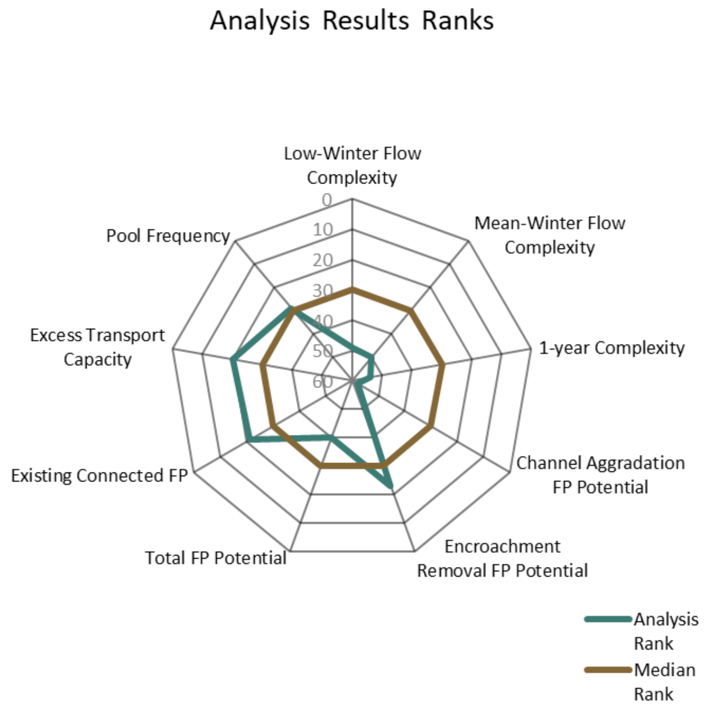
Summary of Restoration Opportunities Identified

- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Modify or remove obstructions

Long-Term Opportunities in this Project Area

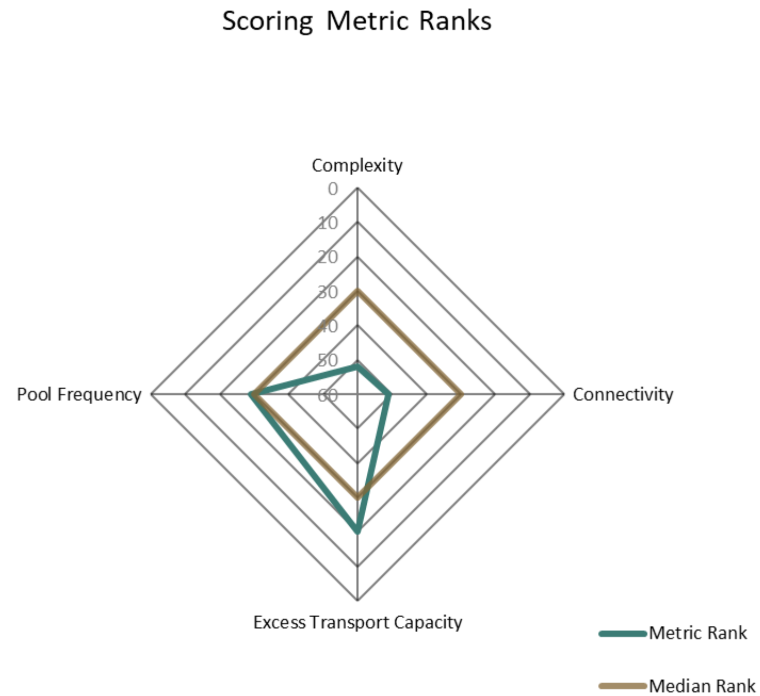
- Set back road against left valley wall for more floodplain connection and channel migration area.

PA 7 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

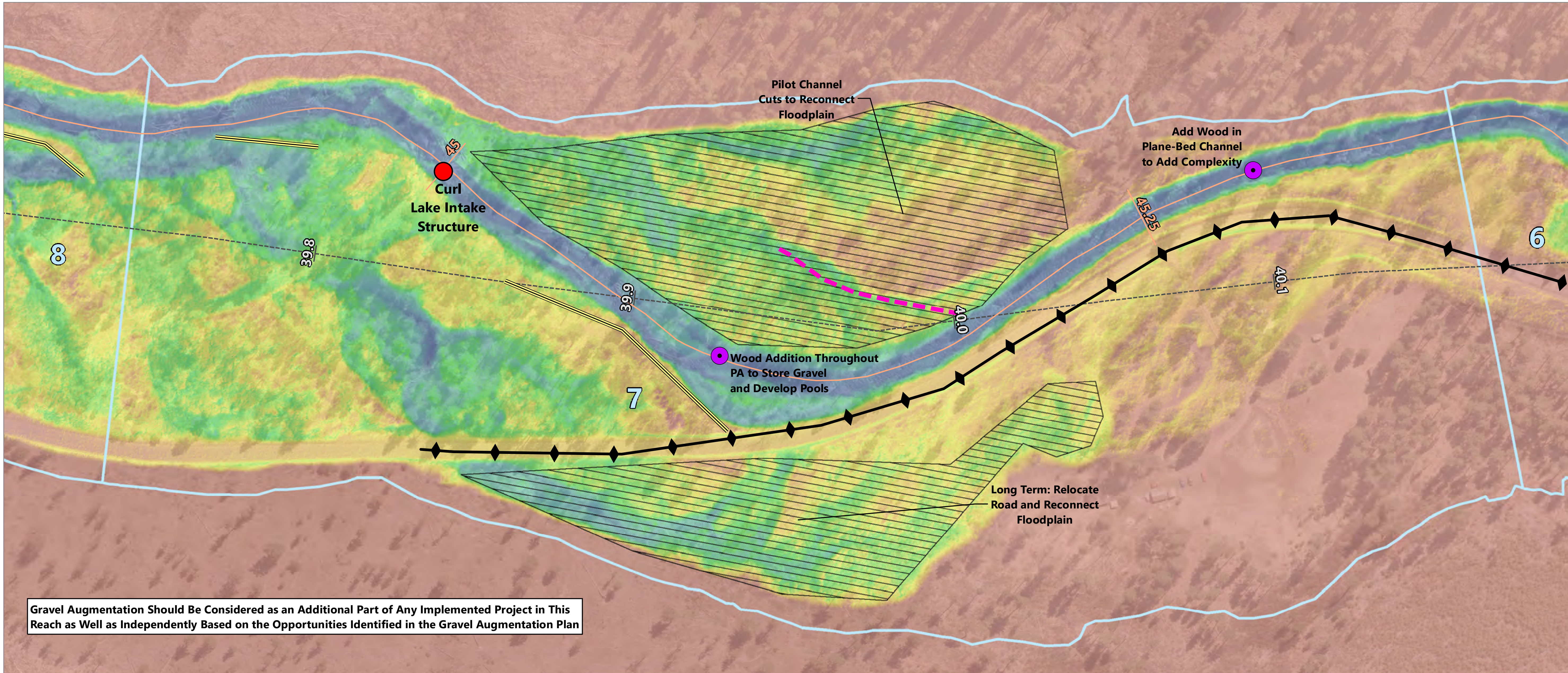
PA 7 Scoring Metric Ranks

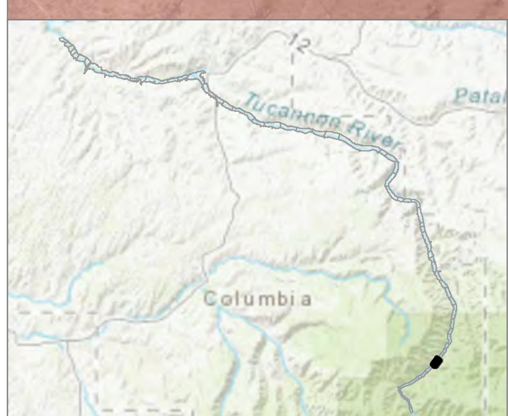


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 7 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.095	49	40%	Complexity	0.104	52	60% to 90%	4 of 5	1	40%	0.6	55	3	Untreated	34	3
Mean-Winter Flow Complexity	0.119	50	40%													
1-year Complexity	0.095	54	20%													
Channel Aggradation FP Potential	0.088	58	40%	Connectivity	0.127	51	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.090	23	40%													
Total FP Potential	0.279	40	20%													
Existing Connected FP	0.721	21	0%													
Excess Transport Capacity	0.11	20	100%	Excess Transport Capacity	1.000	20	30% to 52%	3 of 4	1	20%						
Pool Frequency	11.10	29	100%	Pool Frequency	0.285	29	40% to 60%	3 of 5	5	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential
- Long Term: Relocate Road
- Current Infrastructure in River Corridor

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 44.9
RIVER MILE END: 45.35
VALLEY MILE START: 39.74
VALLEY MILE END: 40.16

0 500
Feet

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ANCHOR QEA

Project Area 7
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 12 Description

Project Area 12 begins at the Hatchery Dam at VM 35.48 and extends upstream to VM 36.00. The 2017 RM length is 0.65 mile. Field observations for PA 12 were conducted on October 31, 2018, when flow at the Starbuck gage was approximately 95 cfs.

Channel conditions for PA 12 are very similar to the conditions of the reach in 2011. The channel through PA 12 is relatively complex with many flow pathways through a relatively wide corridor; natural processes are occurring that are aiding in recovery through this area. No major infrastructure was observed within the channel, although the Hatchery Dam at the downstream end of the project area is a significant grade control. Several side channels were observed, a majority of which are initiated by LWD. An anabranching channel pattern is located mid-reach, where a significant side channel has cut through the floodplain along the left valley floor. This channel runs below a power line adjacent to the road through a grassy area. Another major side channel was conveying at least a third of the total discharge at the time of observation.

Several side channels are head cutting through the right bank floodplain and it is apparent that the entire floodplain has a large amount of groundwater flow. Some of these channels were hidden beneath deep canary reed grass, preventing other riparian vegetation from establishing.

Project Area 12
Looking downstream. The channel has highly complex flow, high wood loading, and floodplain inundation, but with little riparian vegetation.

Project Area 12 Reach Characteristics

VM Start (mi)	35.48
VM Length (mi)	0.52
Valley Slope	1.66%
RM Start (mi)	40.08
RM Length (mi)	0.65
Average Channel Slope	1.41%
Sinuosity	1.25
Connected FP (ac/VM)	18.24
Encroachment Removal (ac/VM)	1.01
Channel Aggradation (ac/VM)	5.58
Total FP Potential (ac/VM)	6.83
Encroaching Feature Length (ft)	1,675.76
Connected FP Rank	20

Instream habitat in PA 12 is currently limited but recovering. The project area contains a moderate amount of LWD that provides some amount of cover and initiates channel and hydraulic complexity. The reach is still in the process of recovering from the 2005 School Fire, but moderate vegetation growth has been established on many previously bare gravel bars and floodplain areas.

Bed material throughout the reach contains a large amount of fine material and gravel and is likely a direct result of the dam providing a grade control location at the downstream end of the reach.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows many significant changes have occurred in PA 12 since the last assessment. At the upstream end of the reach, deposition has occurred in a side channel and there no longer appears to be flow in this channel (box 1).

Several hundred feet from the upstream end of the reach, a large amount of deposition has occurred in the main channel, and the main flow path has shifted into the left bank floodplain, although the former main channel still has significant flow and this split continues for the remainder of the reach (box 2).

Complex multi-threaded flow extends from the right bank floodplain channel and there is some evidence of new channels forming with associated erosion in this location. Field observations noted several deep and dynamic channels through this area (box 3).

Further downstream in the main channel, where all but the main split flow has merged together, a log jam on the left bank has triggered some deposition and erosion on the opposite bank (box 4).

Just upstream of the confluence of the two main channels, a large log jam has caused significant erosion on the left bank and a large amount of deposition on the right bank. This deposition appears to be partially blocking a side channel through this area (box 5). At the actual confluence of the two main channels, deposition has caused several split flows and associated erosion (box 6).

Immediately downstream of here, a large amount of erosion has occurred on the alternating left and right bank and is associated with some deposition on the left bank as meander bends begin to form in this reach (box 7).

Finally, at the downstream end of the reach, a small drop has formed over a log jam with deep erosion here and large amounts of deposition on the right bank floodplain (box 8).

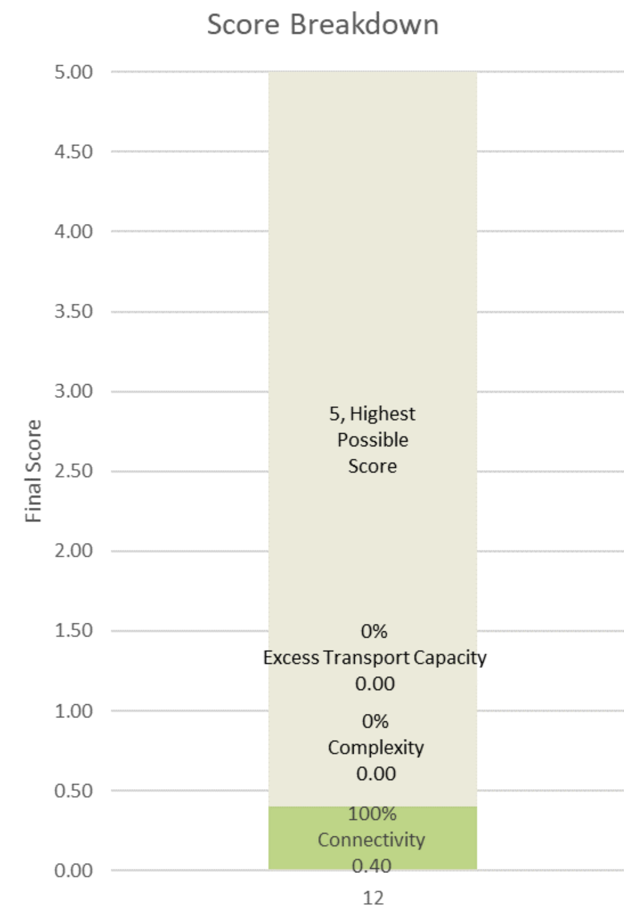
Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 12 receives its entire prioritization score from a low score in the Connectivity metric. This score indicates that PA 12 ranks below average in the 25th to 50th percentile of project areas for Connectivity. Most of this score is driven by the Channel Aggradation analysis result, which ranks PA 12 slightly above average. However, based on the GIS layer for connectivity, this potential area exists mostly in the areas immediately around the existing connected 2-year floodplain. In reality, PA 12 is already well connected. Because this project area is upstream of the Hatchery Dam, it holds the grade and creates a large depositional zone in this area. Potentially some more of this area could be accessed through the restoration strategy of adding instream wood to allow the dynamic channels to continue, but gravel augmentation is likely not necessary in this reach. PA 12 ranks highly in Complexity in the 90th to 99th percentile, indicating that this reach likely has little additional complexity potential to be gained.

Because the riparian vegetation is still in recovery from the 2005 fire, riparian vegetation enhancement should be the primary restoration strategy for this reach.

It is unlikely that the dam at the downstream end of this reach will be removed in the foreseeable future. However, should the

PA 12 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

opportunity arise, drastic measures in this reach will need to be taken to prevent the loss of complexity.

Finally, the pool frequency in this reach scores below average, which does not reflect the conditions observed during field visits. However, pools are a transitory outcome of complexity and the frequency, size, and location may vary from year to year. Maintaining the high sediment load, as well as adding some instream wood either naturally through recruitment or artificially through restoration, should continue to create the conditions that will promote complexity and form pools.

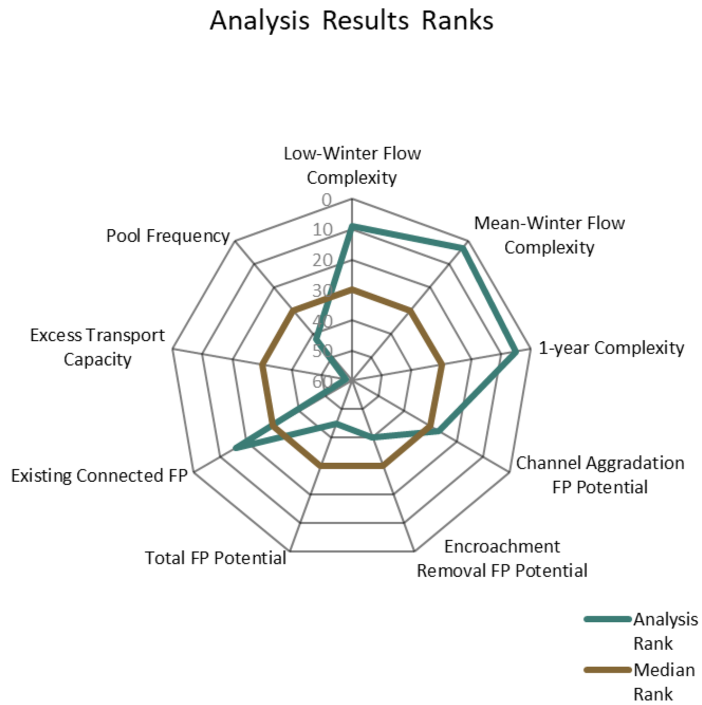
Summary of Restoration Opportunities Identified

- Add instream structure (LWD)
- Riparian zone enhancement
- Modify or remove obstructions

Long-Term Opportunities in this Project Area

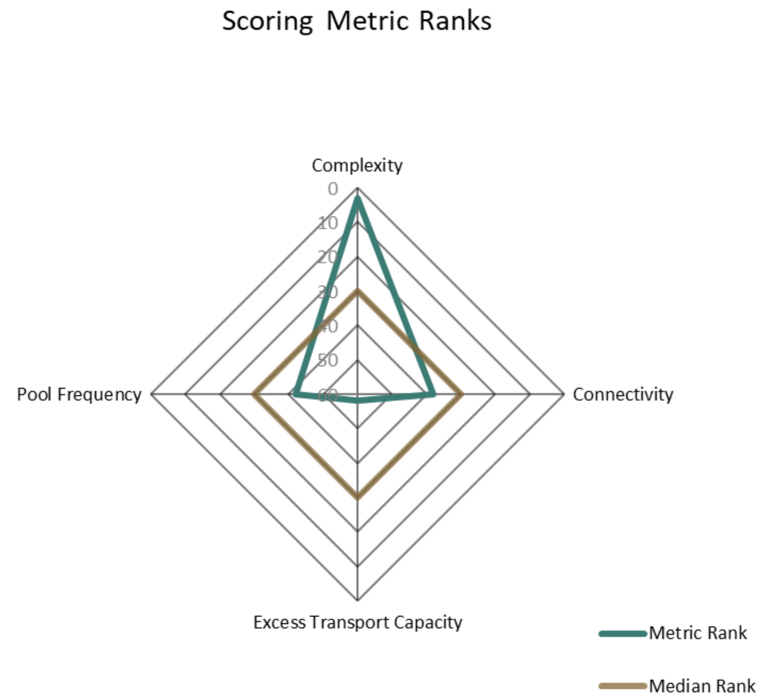
- Reconfigure Deer Lake to reconnect floodplain and consider decommissioning and removing if ever feasible.

PA 12 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

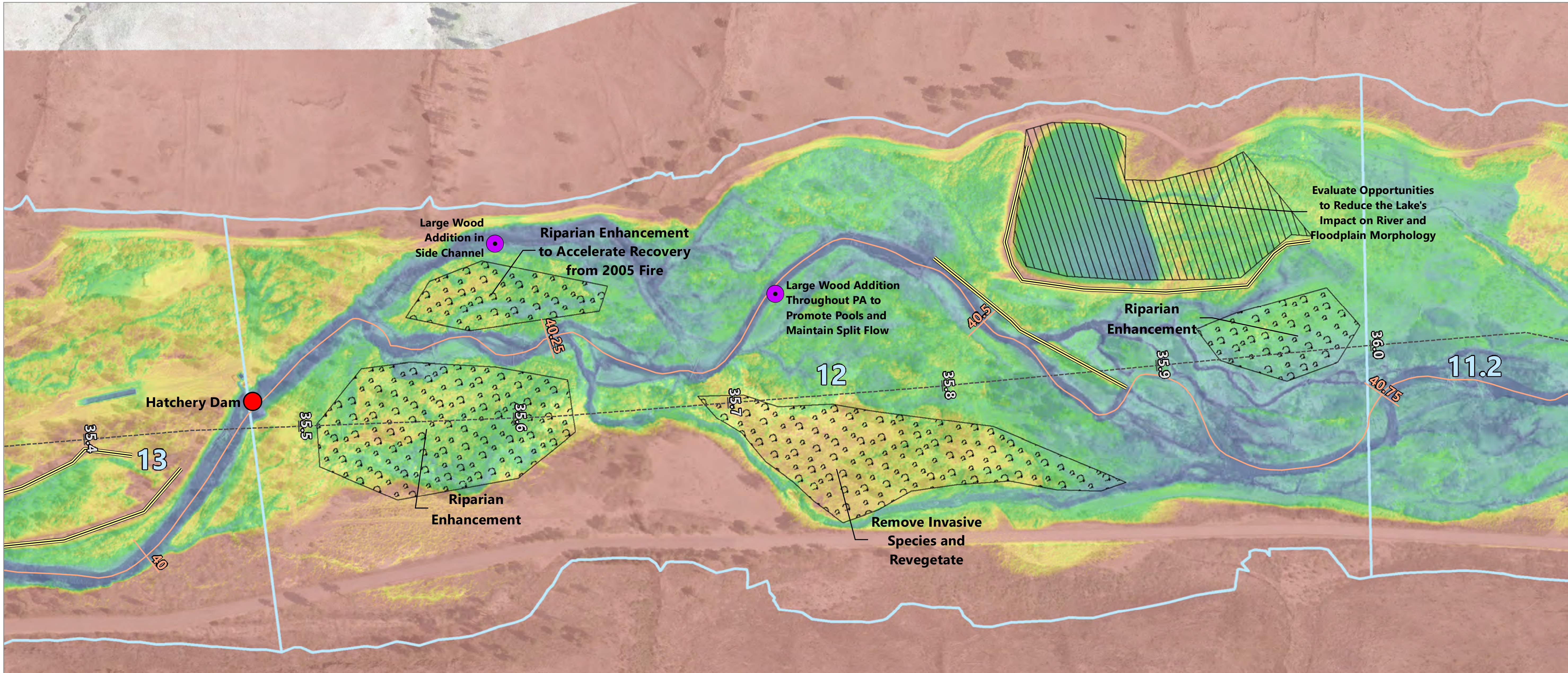
PA 12 Scoring Metric Ranks

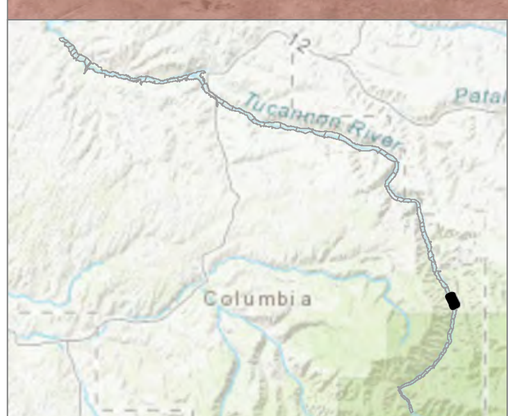


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 12 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.305	9	40%	Complexity	0.484	3	1% to 10%	1 of 5	0	40%	0.4	60	3	Untreated	37	3
Mean-Winter Flow Complexity	0.562	3	40%													
1-year Complexity	0.685	5	20%													
Channel Aggradation FP Potential	0.223	27	40%	Connectivity	0.160	38	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.040	40	40%													
Total FP Potential	0.272	45	20%													
Existing Connected FP	0.728	16	0%													
Excess Transport Capacity	-0.29	58	100%	Excess Transport Capacity	0.000	58	52% to 100%	4 of 4	0	20%						
Pool Frequency	7.68	42	100%	Pool Frequency	0.197	42	60% to 90%	4 of 5	1	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential
- Riparian Enhancement
- Current Infrastructure in River Corridor

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 40.08
RIVER MILE END: 40.73
VALLEY MILE START: 35.48
VALLEY MILE END: 36

0 500
Feet

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ANCHOR QEA

Project Area 12
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 13 Description

Project Area 13 begins at the Rainbow Lake Road bridge at VM 34.81 and extends upstream to the Hatchery Dam at VM 35.48. The 2017 RM length is 0.77 mile. Field observations for PA 13 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization. A restoration project has been planned for PA 13 to add wood structure and widen the floodplain, and the following description become outdated after the restoration project is completed.

The channel through PA 13 is characterized as a single-thread, plane-bed channel with forced pool-riffle and local rapid sections. The channel is typically straight, wide, and contains little complexity in much of the project area. Large levees confine the channel along the right bank and are typically heavily armored with large, angular boulders. The Hatchery Dam at the upstream end of the project area controls the channel grade. The 2011 assessment noted that the dam had an approximately 3-foot drop in water surface elevation with a deep plunge pool on the downstream side. No significant side channels or off-channel areas were observed in the project area at the time of field reconnaissance.

The quality and availability of instream habitat was restricted by the lack of channel and hydraulic complexity. The straight and confined channel has resulted in hydraulic conditions that

Project Area 13
Photograph taken from the 2011 prioritization showing the main channel just upstream of the large levee on the right bank, looking downstream.

Project Area 13 Reach Characteristics

VM Start (mi)	34.81
VM Length (mi)	0.67
Valley Slope	1.46%
RM Start (mi)	39.32
RM Length (mi)	0.77
Average Channel Slope	1.26%
Sinuosity	1.15
Connected FP (ac/VM)	7.45
Encroachment Removal (ac/VM)	0.16
Channel Aggradation (ac/VM)	0.79
Total FP Potential (ac/VM)	1.14
Encroaching Feature Length (ft)	4,990.88
Connected FP Rank	58

create high velocities and high transport capacity. These conditions do not support the retention of LWD and bedload, and, therefore, lack hydraulic complexity. A few downed logs and one log jam provided pools and cover in the actively eroding area, but overall very few adequate pools for adult fish holding were available. The lack of side channels (except some apparent high-flow channels) limited the quantity of habitat for rearing juveniles.

In 2011, floodplain connectivity in this project area was affected by the presence of infrastructure, and little low-lying floodplain was present. Although there was not a high quantity of disconnected floodplain, likely because of local channel incision, the levees prevented channel migration and the development of gravel bars and low-lying emergent floodplain, which exacerbated the limited floodplain connectivity. Rainbow Lake, the public camping areas, and the access road to these areas are located atop a terrace and not within the low-lying floodplain.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows very little geomorphic change in PA 13 since the previous assessment. PA 13 is highly confined by levees and the valley wall, which makes geomorphic change difficult. The one location highlighted for discussion occurs near the middle of the reach. A log jam has triggered significant right bank erosion and left bank deposition and the river appears to be trending towards cutting two sharp turns in the channel (box 1).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 13 receives its entire prioritization score from a moderate score in the Excess Transport Capacity metric. Both the Complexity and Connectivity metrics rank PA 13 so low that only a large amount of restoration effort could add complexity and connectivity.

The primary restoration strategy for PA 13 would be to remove the confinement on the left and right banks to create more floodplain opportunity. This restoration effort would require a massive amount of earthwork and movement of material, because benching would be required in much of the floodplain to make it accessible. This restoration effort should also include a large amount of instream wood to begin to promote geomorphic change in the newly created floodplain. Gravel augmentation will likely also be necessary to create some channel aggradation and reverse the effects of incision. It is possible gravel augmentation will have to occur regularly below the dam because the dam likely hampers most natural sediment transport. Restoration efforts of this magnitude should have the effect of widening the floodplain and reducing the excess transport capacity in this reach. It should be noted that a restoration effort to reduce confinement in this reach has begun at the time of this report.

Pool frequency in PA 13 is well below average, as would be expected in a reach that is starved of sediment supply and severely confined. The identified restoration strategies of widening the floodplain, adding instream wood, and providing gravel augmentation, should greatly benefit the natural processes of complexity and connectivity that will promote pool formation in this reach.

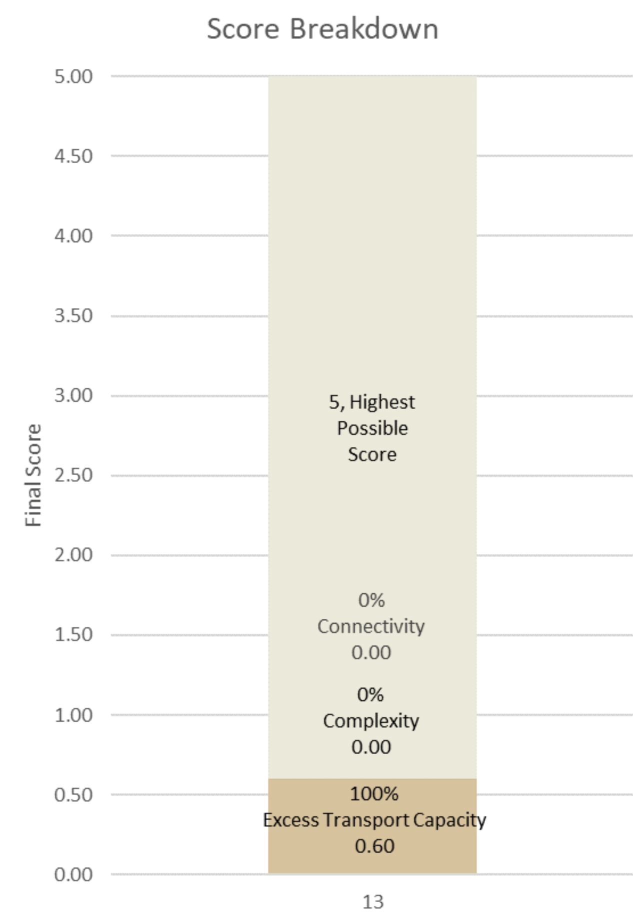
Summary of Restoration Opportunities Identified

- Gravel augmentation
- Address encroaching features
- Add instream structure (LWD)
- Modify or remove obstructions

Long-Term Opportunities in this Project Area

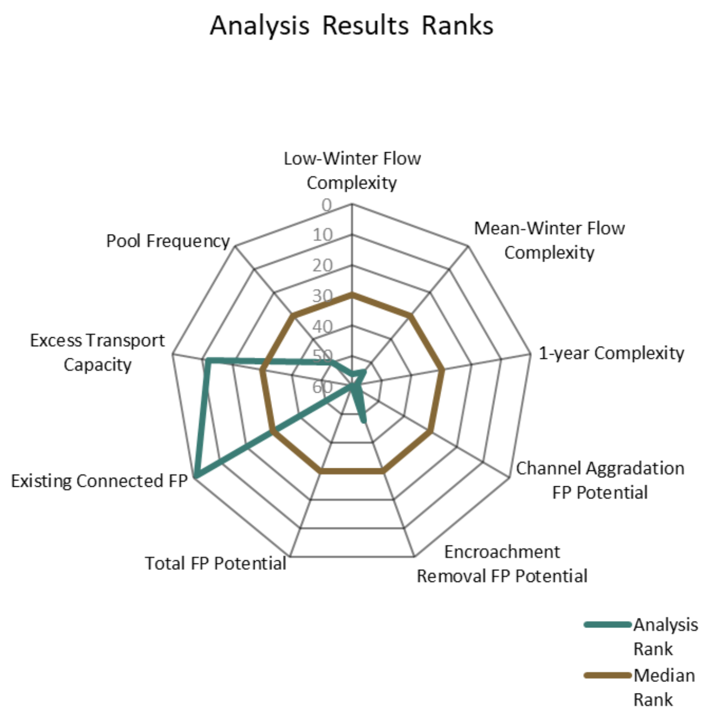
- Reconfigure Rainbow Lake to reconnect floodplain and consider decommissioning and removing if ever feasible.

PA 13 Score Breakdown



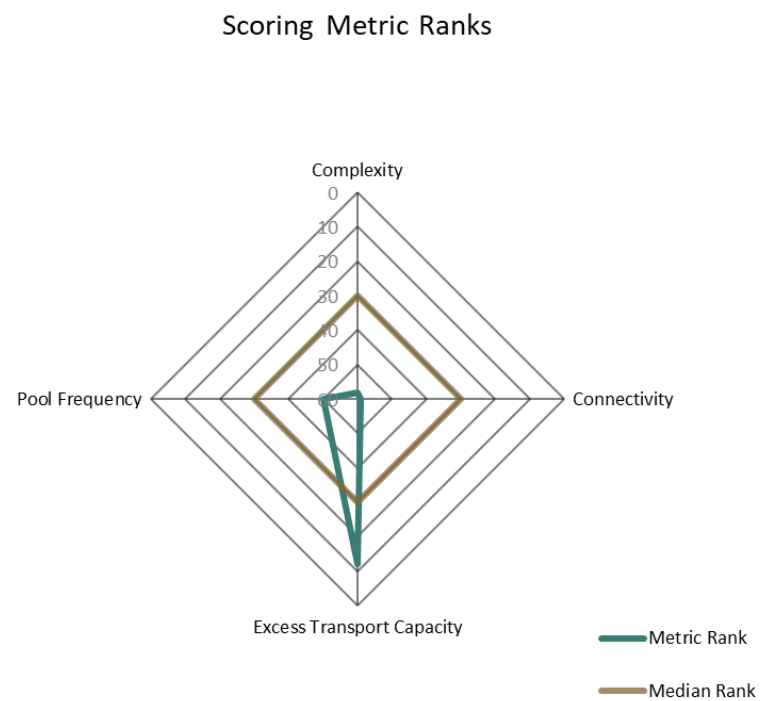
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 13 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

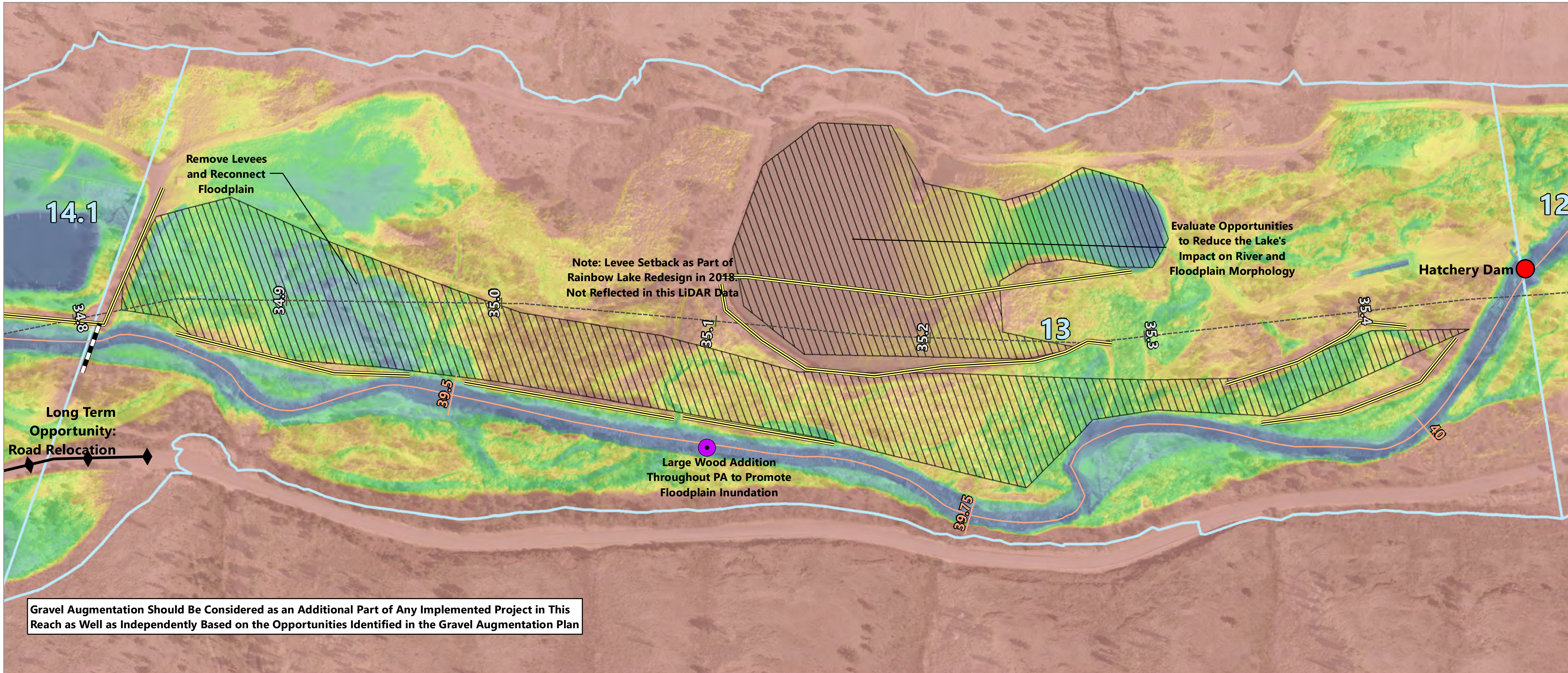
PA 13 Scoring Metric Ranks

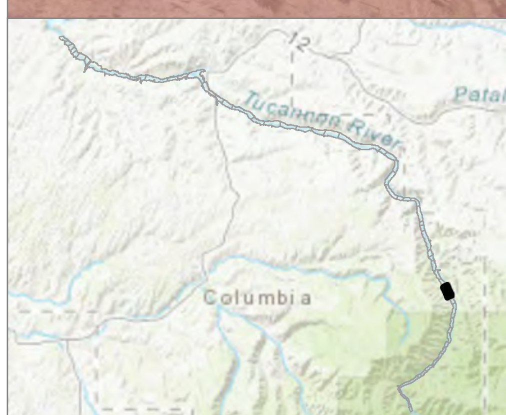


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 13 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.088	56	40%	Complexity	0.091	58	90% to 100%	5 of 5	0	40%	0.6	56	3	Untreated	35	3
Mean-Winter Flow Complexity	0.102	54	40%													
1-year Complexity	0.075	58	20%													
Channel Aggradation FP Potential	0.091	57	40%	Connectivity	0.071	59	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.019	48	40%													
Total FP Potential	0.133	60	20%													
Existing Connected FP	0.867	1	0%													
Excess Transport Capacity	0.16	12	100%	Excess Transport Capacity	3.000	12	10% to 30%	2 of 4	3	20%						
Pool Frequency	5.23	50	100%	Pool Frequency	0.134	50	60% to 90%	4 of 5	1	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential
- Long Term: Relocate Road
- Current Infrastructure in River Corridor

Relative Elevation in Feet
High : 15
Low : -0

NOTES:
1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 39.32
RIVER MILE END: 40.08
VALLEY MILE START: 34.81
VALLEY MILE END: 35.48

0 500
Feet

Publish Date: 2021/01/25, 3:45 PM | User: mgieschen
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ANCHOR QEA

Project Area 13
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 17.1 Description

Project Area 17.1 begins at VM 30.71 and extends upstream to the bridge crossing at Tucannon Road at VM 31.05. The 2017 RM length is 0.34 mile. Field observations for PA 17.1 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

The channel through PA 17.1 is characterized as a single-thread, plane-bed channel with local deep, rapid sections that contain little hydraulic complexity. Resistant fine-grained material is located along much of the left bank. The 2011 assessment noted bank armoring in the upstream portion of the project area on both the left and right banks. From this section to the downstream end the channel is incised and disconnected from the floodplain. Riparian planting projects undertaken here have been largely unsuccessful, likely due to channel incision and lowering of the water table.

Instream habitat was limited by lack of complexity and high-velocity conditions through the incised portion of the project area. Very little LWD was observed. The straight, confined, and incised conditions found throughout much of the project area likely result in high velocities during seasonal high flows and floods, which prevent the retention of sufficient volumes of LWD that would provide cover, refuge, or sediment deposition

Project Area 17.1
Looking downstream on plane-bed uniform channel in PA 17.1.

Project Area 17.1 Reach Characteristics

VM Start (mi)	30.71
VM Length (mi)	0.34
Valley Slope	1.01%
RM Start (mi)	34.62
RM Length (mi)	0.34
Average Channel Slope	0.99%
Sinuosity	1.01
Connected FP (ac/VM)	14.44
Encroachment Removal (ac/VM)	1.17
Channel Aggradation (ac/VM)	7.14
Total FP Potential (ac/VM)	8.98
Encroaching Feature Length (ft)	1,189.71
Connected FP Rank	26

for spawning areas. Few side channels were available to provide preferred rearing habitat for juveniles.

In 2011, floodplain connectivity in this project area was poor to moderate. There was little low-lying floodplain on the left bank of the river due to natural alluvial fan deposits. Much of the right floodplain was composed of remnant alluvial fan and hillslope deposits that were reworked during the 1996/1997 flooding. These surfaces were covered in cobble and supported little vegetation. Some remnant spoils and armor material were observed on the floodplain, which limited the channel from naturally migrating and expanding into the low areas of the floodplain. Terraces were also present that appear to provide some level of erosion resistance. Dry channels were observed that likely convey floodwaters during high-flow events. Channels observed in the floodplain were largely dry.

The 2011 assessment noted that the riparian zone adjacent to the channel was generally in a moderately healthy condition, with some local areas that had been degraded by development, historic flooding, or poor hyporheic connection with the channel. The riparian zone was generally in poor health and contained few mature trees, sparse vegetation coverage, and an overall narrow riparian corridor. The upstream end of the reach contained the poorest conditions; the floodplain vegetation appeared to have a poor hyporheic connection with the channel and little to no soil development. Riparian trees were mostly immature deciduous species.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows almost no significant geomorphic change has occurred in PA 17.1. Some erosion is apparent in the channel but could be the result of the difference in LiDAR technology for sensing the channel bottom, as discussed in the Geomorphic Assessment. PA 17.1 is highly confined, which prevents most geomorphic change other than incision, so the apparent channel downcutting could be real.

Geomorphic Characteristics and Restoration Strategies

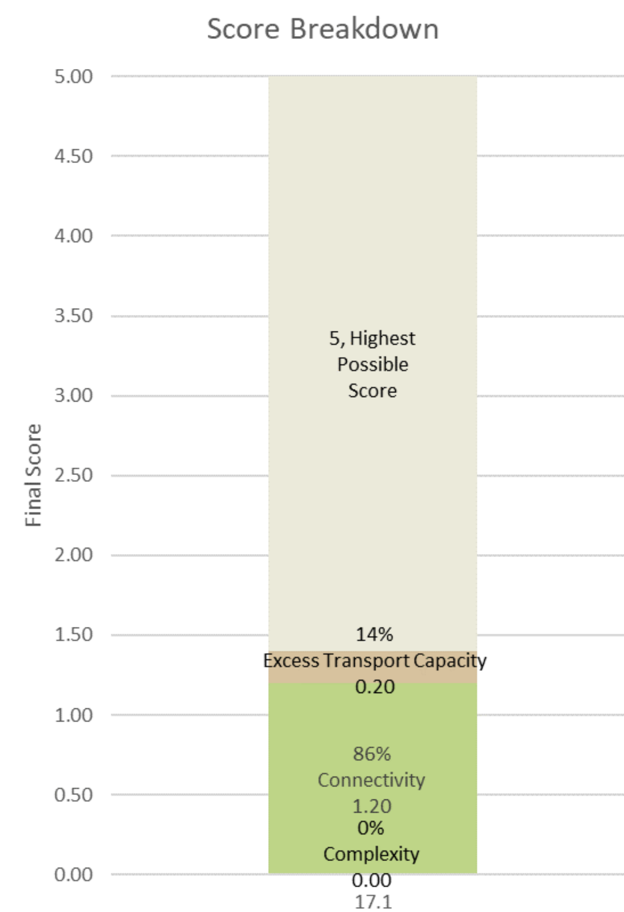
As shown in the following graphs and table, PA 17.1 receives most of its prioritization score from the Connectivity metric. PA 17.1 receives a moderate score in Connectivity, indicating that it falls in the 50th to 75th percentile of project areas for floodplain connectivity potential. Several former channels or side channels have created isolated opportunities in the floodplain that could be connected most effectively by channel aggradation. PA 17.1 ranks very highly in the Channel Aggradation analysis result. The primary restoration target for PA 17.1 should be to raise the bed elevation and reverse the trend of incision in the reach. Gravel augmentation should be considered the primary restoration strategy for this reach in order to accomplish this. However, PA 17.1 also receives a moderate score in the Excess Transport Capacity metric, indicating that material will likely be transported quickly through the reach. Therefore, an equally important restoration strategy will be to heavily add instream wood to store and maintain any added sediment in the reach. Pilot channel cuts should also be pursued to quickly allow flows into these low-lying areas as a secondary restoration strategy.

PA 17.1 receives no score in the Complexity metric and ranks very poorly in all three flows of the Complexity analysis results, meaning PA 17.1 ranks in the bottom 10% of all project areas for complexity. This range of complexity has been identified as being too poor to warrant restoration effort. Despite this, the restoration strategies of adding instream wood, gravel augmentation, and pilot channel cuts should also help to increase complexity. Achieving greater floodplain connectivity and reversing incision in this reach should also provide more room for complex channel features to form.

It should be noted that, because most of the floodplain in this reach is disconnected, the riparian vegetation is relatively poor. Therefore, a restoration strategy of riparian vegetation enhancement should be strongly considered as part of the restoration plan for this reach.

Finally, PA 17.1 ranks very low among project areas in the Pool Frequency metric. Adding instream wood and gravel augmentation will promote changes towards an increase in channel complexity, promoting the formation of pools. These restoration strategies should be employed to target increasing pool frequency in the reach.

PA 17.1 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

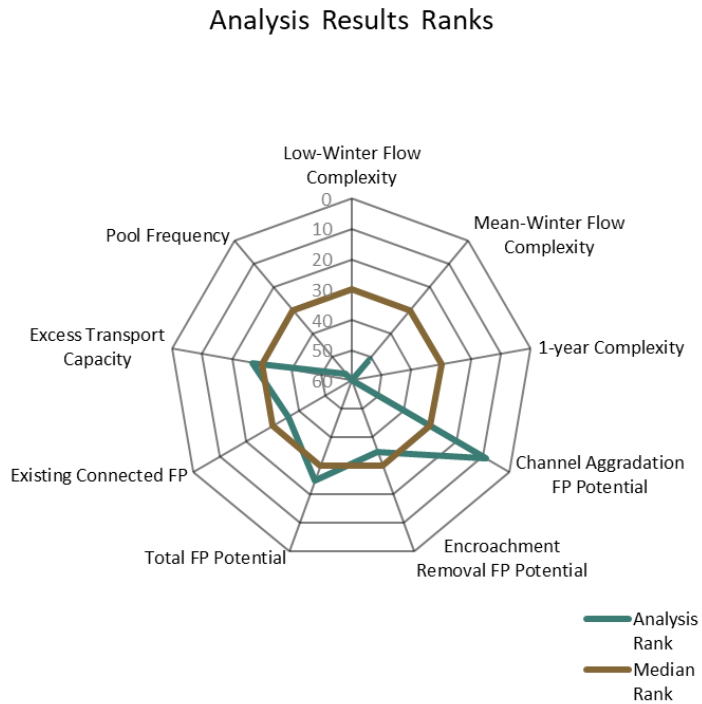
Summary of Restoration Opportunities Identified

- Gravel augmentation
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

Long-Term Opportunities in this Project Area

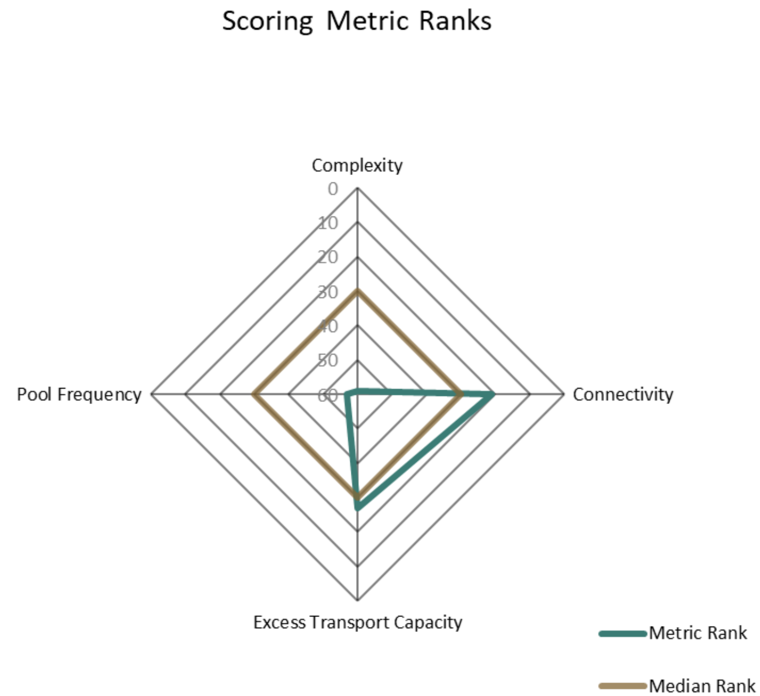
- Set back road against left valley wall for more floodplain connection and channel migration area.

PA 17.1 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

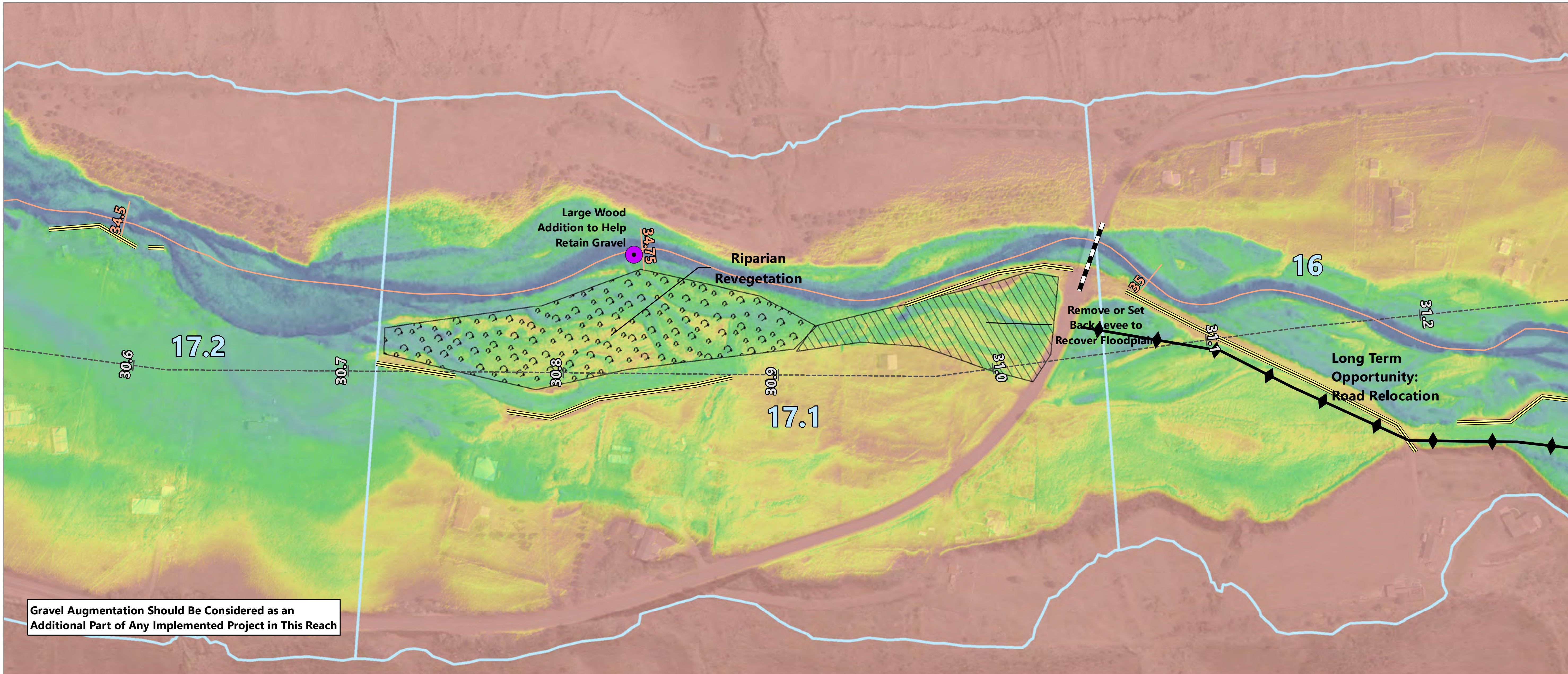
PA 17.1 Scoring Metric Ranks

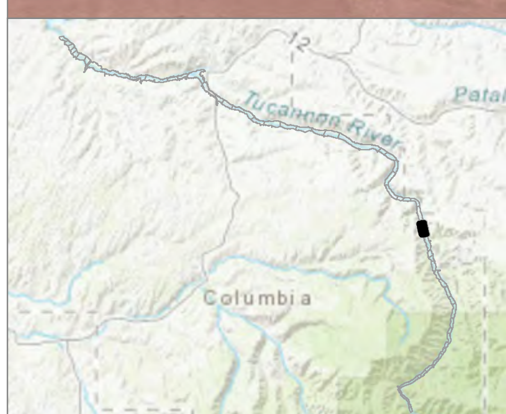


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 17.1 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.067	60	40%	Complexity	0.086	59	90% to 100%	5 of 5	0	40%	1.4	40	3	Untreated	25	3
Mean-Winter Flow Complexity	0.115	51	40%													
1-year Complexity	0.067	60	20%													
Channel Aggradation FP Potential	0.305	9	40%	Connectivity	0.219	21	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.050	35	40%													
Total FP Potential	0.383	25	20%													
Existing Connected FP	0.617	36	0%													
Excess Transport Capacity	0.06	27	100%	Excess Transport Capacity	1.000	27	30% to 52%	3 of 4	1	20%						
Pool Frequency	2.91	57	100%	Pool Frequency	0.075	57	90% to 100%	5 of 5	0	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential
- Long Term: Relocate Road
- Riparian Enhancement

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 34.62
RIVER MILE END: 34.97
VALLEY MILE START: 30.71
VALLEY MILE END: 31.05

0 500
Feet

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ANCHOR QEA

Project Area 17.1
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 17.2 Description

Project Area 17.2 begins at VM 30.45 and extends upstream to VM 30.71. The 2017 RM length is 0.31 mile. Field observations for PA 17.2 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

The channel through PA 17.2 is characterized as a single-thread, plane-bed channel with local deep, rapid sections that contain little hydraulic complexity. Resistant fine-grained material is located along much of the left bank. The channel is wide and plane-bed with some deeper areas adjacent to the resistant bank. The 2011 assessment noted a few minor side channels that were wetted at the time of field observation.

In 2011, floodplain connectivity in this project area was poor to moderate. There was little low-lying floodplain on the left bank of the river due to natural alluvial fan deposits. Much of the right floodplain was composed of remnant alluvial fan and hillslope deposits that were reworked during the 1996/1997 flooding. These surfaces were covered in cobble and supported little vegetation. Some remnant spoils and armor material were observed on the floodplain, which limited the channel from naturally migrating and expanding into the low areas of the floodplain. Channels observed in the floodplain were largely dry; some standing water was observed in the right floodplain.

Project Area 17.2
Photograph taken from the 2011 prioritization showing a plane-bed section of the channel that flows along the base of a high terrace (right bank).

Project Area 17.2 Reach Characteristics

VM Start (mi)	30.45
VM Length (mi)	0.27
Valley Slope	1.31%
RM Start (mi)	34.32
RM Length (mi)	0.31
Average Channel Slope	1.06%
Sinuosity	1.15
Connected FP (ac/VM)	24.72
Encroachment Removal (ac/VM)	3.06
Channel Aggradation (ac/VM)	9.99
Total FP Potential (ac/VM)	14.23
Encroaching Feature Length (ft)	268.70
Connected FP Rank	9

The 2011 assessment noted that the riparian zone adjacent to the channel was generally in a moderately healthy condition, with some local areas that had been degraded by development, historic flooding, or poor hyporheic connection with the channel.

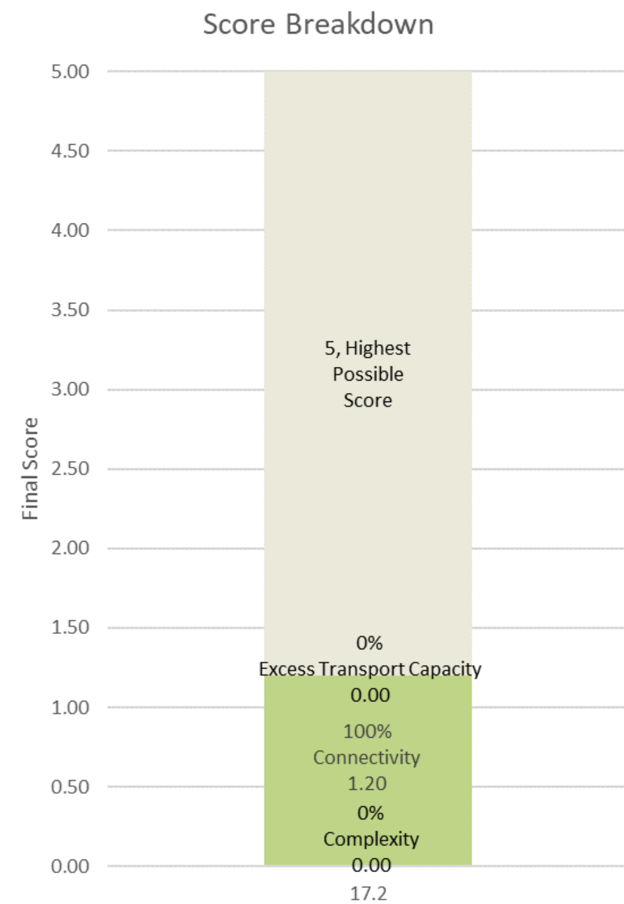
Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows a large amount of deposition has occurred for almost the entire PA 17.2 reach. While PA 17.2 is a short reach, the extent of this depositional area is unique in the geomorphic change analysis for this basin. At the upstream end, deposition in the main channel has caused only minor split flows and avulsions (box 1). At the downstream end, several large split flows and side channels have formed as a result of the deposition and channel aggradation in the main channel (box 2). It should be noted that the complexity seen as a result of the deposition in this reach is the representative of the desired outcome of the channel aggradation and gravel augmentation restoration strategies discussed in other parts of this assessment.

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 17.2 receives its entire prioritization score from a moderate score in the Connectivity metric, which is above average in the 50th to 75th percentile. This score is primarily driven by the Channel

PA 17.2 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

Aggradation analysis result, which ranks above average, although the Encroachment Removal analysis result ranks around average as well. The potential area for connection by channel aggradation is located at the upper end of the project area on the left bank, in what is currently occupied by residential lawns and property. Similarly, a narrow, low-lying area is disconnected on the left bank near the middle of the reach. Connecting these two areas through pilot channel cuts and high bank or encroachment removal, along with the addition of instream wood, should be the primary restoration strategy for this reach, although this may be difficult given the residential nature of the area, and full reconnection is unlikely.

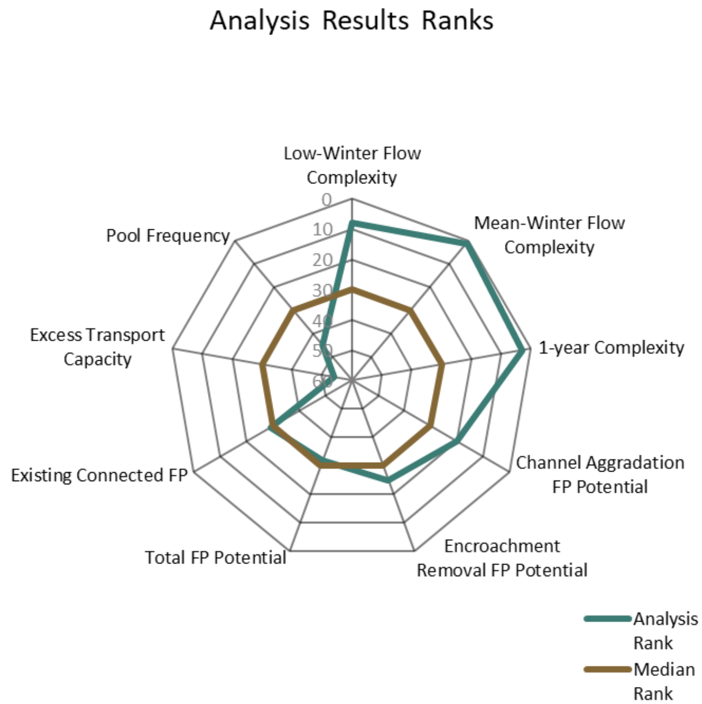
PA 17.2 ranks highly in the Complexity metric and falls in the 90th to 99th percentile, a range which has been identified as needing no further restoration for complexity. This is likely due in large part to the depositional nature of the reach. The riparian buffer in this reach is thin in many places, although the beginnings of riparian enhancement restoration effort are evident on the right bank. A primary restoration strategy should also be to improve the riparian vegetation on both banks to provide a thicker riparian buffer.

Finally, the pool frequency in this reach scores below average, which might reflect the fact that the deposition in this reach has occurred recently. Maintaining the high sediment load, as well as adding some instream wood either naturally through recruitment or artificially through restoration, should continue to create the conditions that will promote complexity and form pools.

Summary of Restoration Opportunities Identified

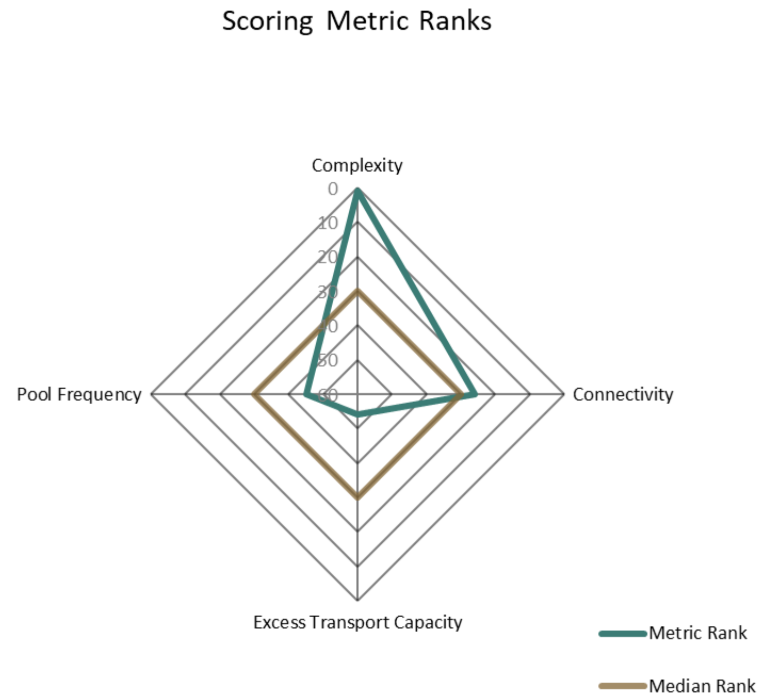
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

PA 17.2 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

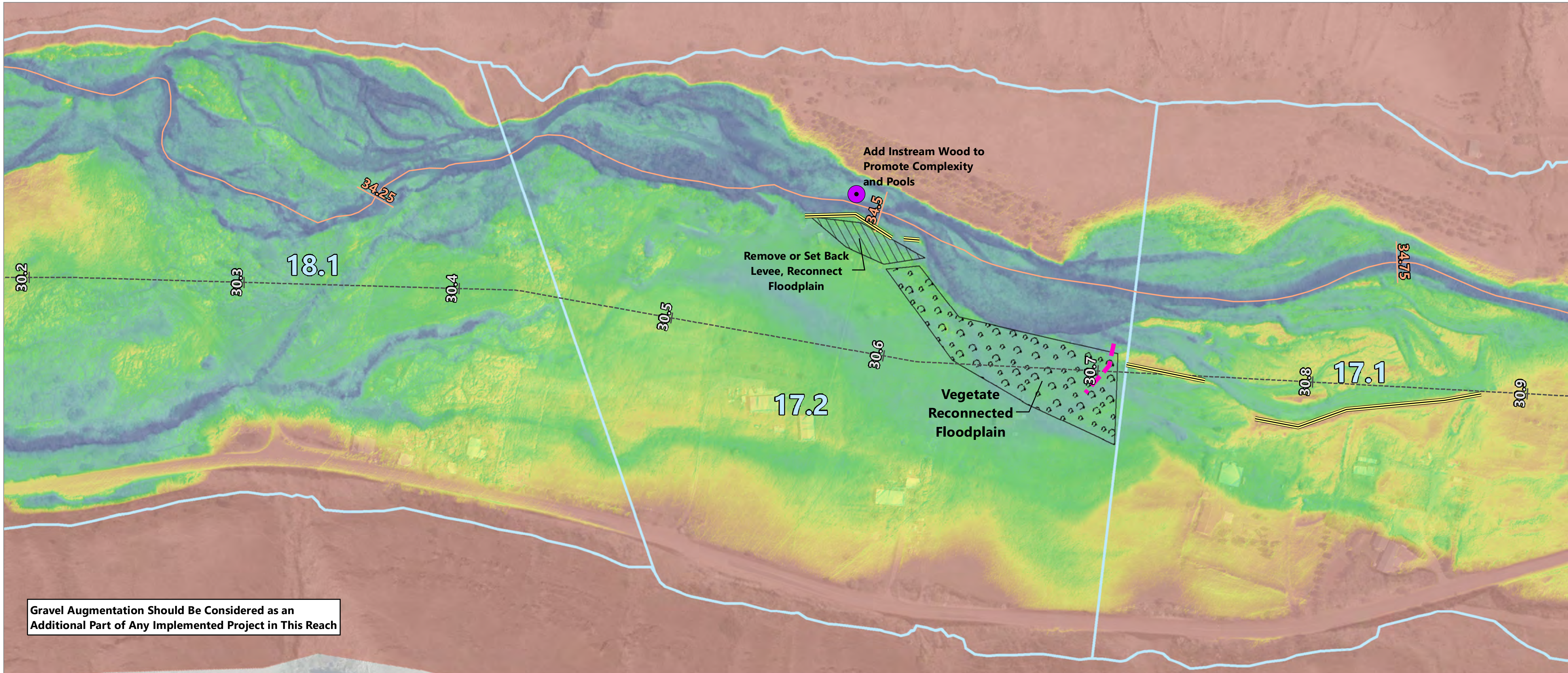
PA 17.2 Scoring Metric Ranks

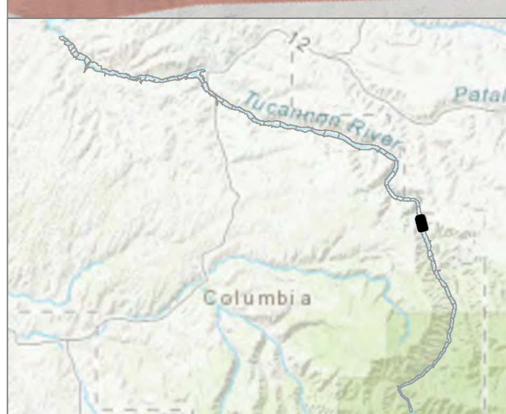


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 17.2 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.309	8	40%	Complexity	0.630	1	1% to 10%	1 of 5	0	40%	1.2	47	3	Untreated	27	3
Mean-Winter Flow Complexity	0.882	1	40%													
1-year Complexity	0.769	3	20%													
Channel Aggradation FP Potential	0.256	20	40%	Connectivity	0.207	26	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.079	25	40%													
Total FP Potential	0.365	32	20%													
Existing Connected FP	0.635	29	0%													
Excess Transport Capacity	-0.17	54	100%	Excess Transport Capacity	0.000	54	52% to 100%	4 of 4	0	20%						
Pool Frequency	6.53	45	100%	Pool Frequency	0.168	45	60% to 90%	4 of 5	1	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential
- Riparian Enhancement

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 34.32
RIVER MILE END: 34.62
VALLEY MILE START: 30.45
VALLEY MILE END: 30.71

0 500
Feet

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ANCHOR QEA

Project Area 17.2
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 21 Description

Project Area 21 begins at the bridge crossing of Tucannon Road at VM 26.85 and extends upstream to VM 27.91. The 2017 RM length is 1.05 miles. Field observations for PA 21 were conducted on October 29, 2018, when flow at the Starbuck gage was approximately 110 cfs.

PA 21 is largely characterized by moderate confinement with several levee sections and high banks on the left bank and the valley wall on the right bank. This moderate confinement does allow more floodplain than typically seen behind levees on the Tucannon River, and there are large pockets of mature deciduous riparian vegetation on the left and right banks.

For the first upstream 1,500 feet of the channel, the left bank does not have a well-defined levee, but several high spots suggest older levee remnants still disconnecting a large, low area and several side channel opportunities. Near the downstream end of this section, a large debris jam has forced flow onto the limited floodplain and caused decent channel complexity. There are large side channels in this area disconnected by levee remnants.

At VM 27.44, an access road and irrigation pump on the left bank bisects a significant side channel that is already disconnected by an old levee. Downstream from this access road, the left bank levee becomes much more well defined with large riprap.

Project Area 21
Looking downstream towards the location of a major avulsion. The former channel is a plane-bed gravel bar with little vegetation. The flow now goes through a confined steep section as shown on the right side of the photograph.

Project Area 21 Reach Characteristics

VM Start (mi)	26.85
VM Length (mi)	1.06
Valley Slope	1.00%
RM Start (mi)	30.41
RM Length (mi)	1.05
Average Channel Slope	1.03%
Sinuosity	0.99
Connected FP (ac/VM)	8.73
Encroachment Removal (ac/VM)	0.45
Channel Aggradation (ac/VM)	2.00
Total FP Potential (ac/VM)	2.83
Encroaching Feature Length (ft)	2,908.22
Connected FP Rank	55

At VM 27.3, the defined levee ends and a large avulsion has occurred towards the right bank. The main flow now is funneled into a narrow channel between a high spot on the left bank and the valley wall on the right. The abandoned channel was dry with no vegetation at the time of the site visit but appears to receive regular higher flows. Downstream of this abandoned channel, several flow paths split off from the main abandoned flow path and meander through forested floodplain for several hundred feet.

Downstream, the channel again becomes more confined and is generally a straight, plane-bed, and uniform channel. Several rock weirs were noted throughout this reach, each with large, deep scour pools.

Bed material in this reach is relatively large with mostly cobbles and small boulders; some patches of gravel deposits were observed but not in any significant amounts. Instream wood was lacking with only one notable large log jam at the top of the reach. Due to the confined nature of this reach, it is likely that it serves as a transport reach for both sediment and wood, although the healthy riparian area could provide a good source for future wood recruitment.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows several minor geomorphic changes in PA 21 have occurred since the last assessment. Near the middle of the reach, a log jam has triggered a meander bend to be cut off although the former main channel still has some flow. A depositional bar has formed on the right bank in this area as well (box 1).

Further downstream, a major channel avulsion has occurred and the main channel has had massive deposition. During the field investigation, this area was an open gravel bar and all flow had been forced into a narrow channel on the right bank floodplain where some erosion was evident (box 2).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 21 receives the highest possible score in the Excess Transport Capacity metric, and a low score in the Complexity metric, both of which combine to make up the entire prioritization score. The low Complexity score indicates that this project area falls below average in the 10th to 40th percentile, which is a range that has been identified as having some small existing complexity but would likely require a large restoration effort to achieve higher levels.

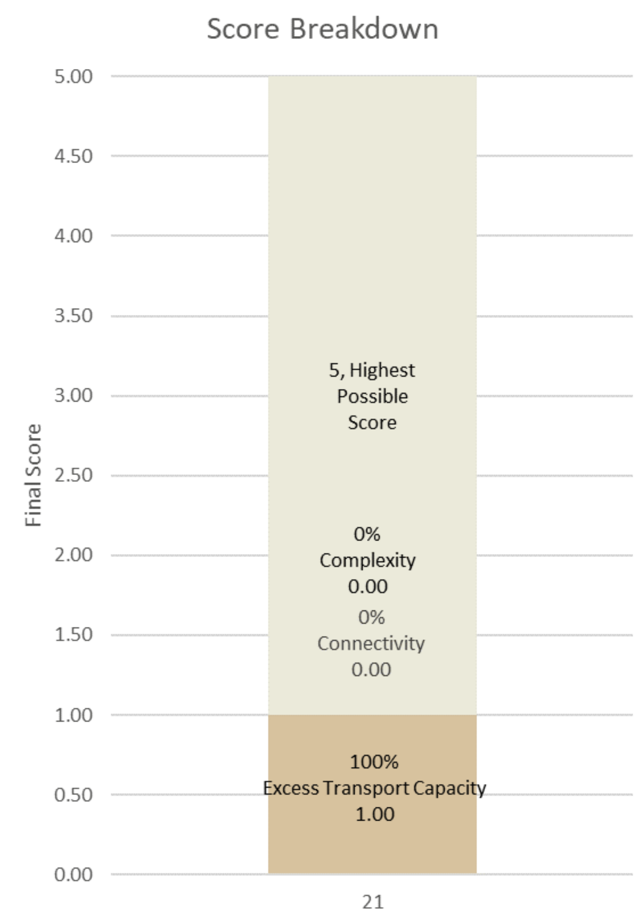
PA 21 is highly confined and leveed for most of the reach between the valley wall on the right bank and the levees on the left bank. The high Excess Transport Capacity score reflects this fact and addressing this should be a primary restoration target. Fortunately, many of these levees appear to be good opportunities for setback levee locations because there is some riparian area behind many of them. Widening the floodplain through removal and setback of levees and floodplain benching should increase complexity and connectivity in this reach. After addressing the confinement, the restoration focus should be on adding instream wood and gravel augmentation to promote in-channel complexity as well as more split flows and side channels in the newly available floodplain. A combination of levee setbacks, adding instream wood, and gravel augmentation should be the primary restoration strategies for this reach.

PA 21 scores very poorly in pool frequency, likely due to the confined nature and lack of geomorphic change in this reach. The identified restoration strategies of widening the floodplain, adding instream wood, and providing gravel augmentation should allow more complexity to form and create the conditions that will allow pools to form more regularly through natural geomorphic processes.

Summary of Restoration Opportunities Identified

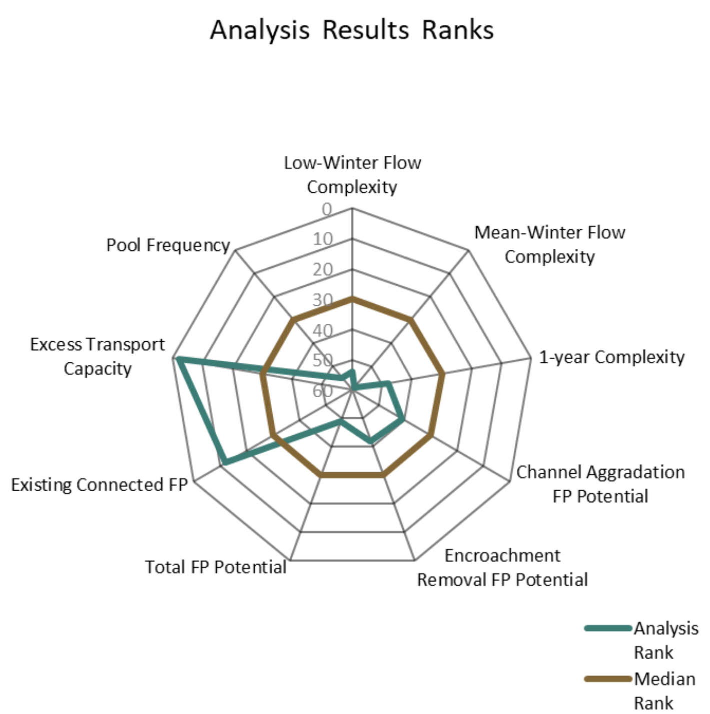
- Gravel augmentation
- Address encroaching features
- Add instream structure (LWD)

PA 21 Score Breakdown



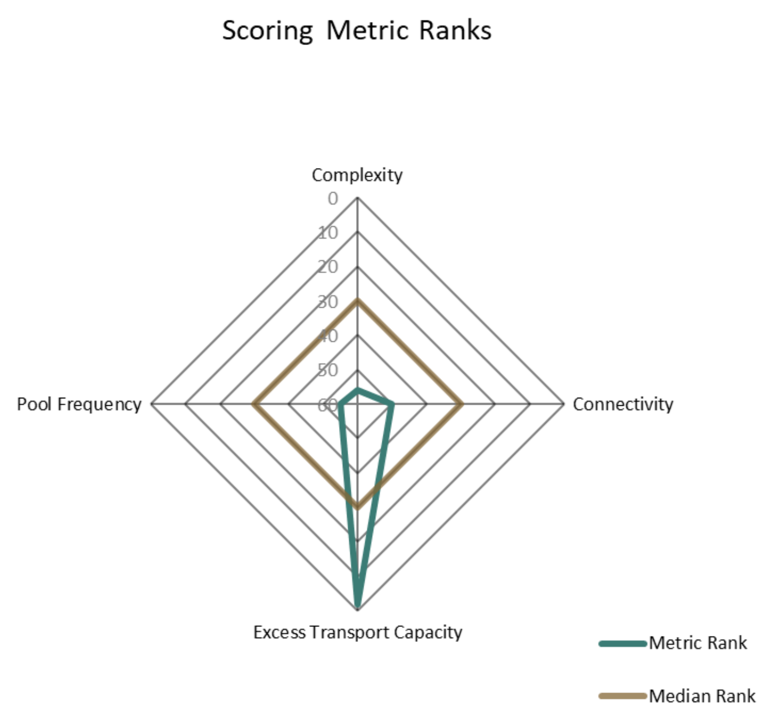
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 21 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

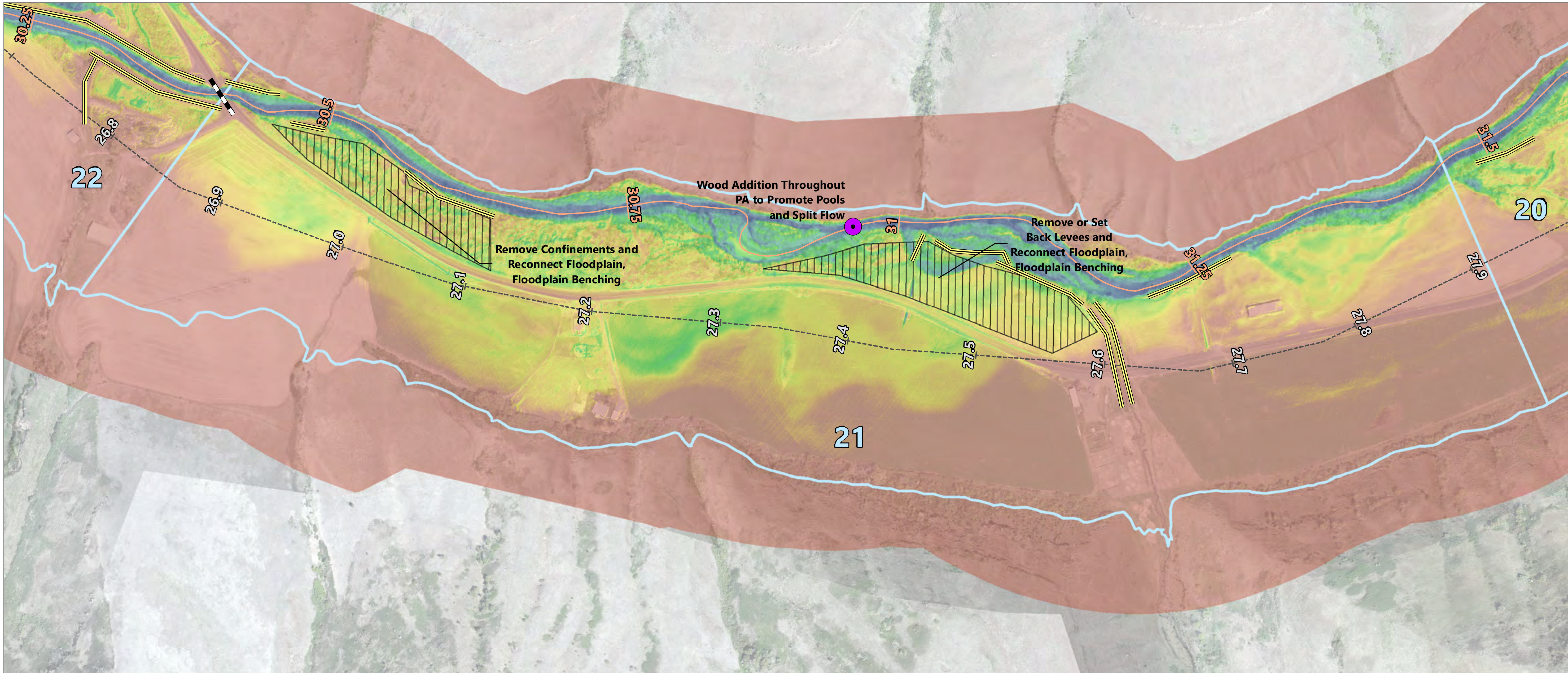
PA 21 Scoring Metric Ranks

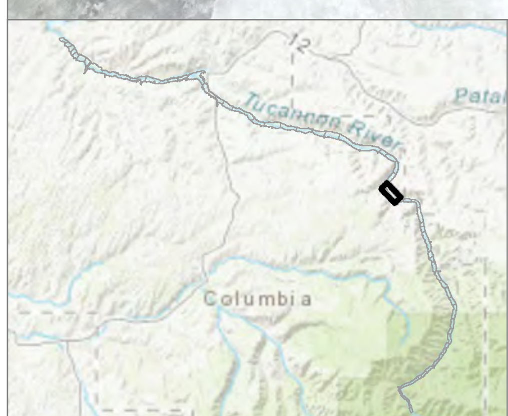


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 21 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.089	54	40%	Complexity	0.094	56	90% to 100%	5 of 5	0	40%	1.0	51	3	Untreated	31	3
Mean-Winter Flow Complexity	0.075	59	40%													
1-year Complexity	0.140	48	20%													
Channel Aggradation FP Potential	0.173	41	40%	Connectivity	0.134	50	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.039	42	40%													
Total FP Potential	0.245	49	20%													
Existing Connected FP	0.755	12	0%													
Excess Transport Capacity	0.32	2	100%	Excess Transport Capacity	5.000	2	1% to 10%	1 of 4	5	20%						
Pool Frequency	3.80	55	100%	Pool Frequency	0.098	55	90% to 100%	5 of 5	0	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 30.41
RIVER MILE END: 31.46
VALLEY MILE START: 26.85
VALLEY MILE END: 27.91

0 500
Feet

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ANCHOR QEA

Project Area 21
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 30 Description

Project Area 30 begins at VM 15.54 and extends upstream to the Brines Road bridge crossing at VM 16.37. The 2017 RM length is 1.01 miles. Field observations for PA 30 were conducted on October 10, 2018, when flow at the Starbuck gage was approximately 115 cfs.

PA 30 is a unique reach on the Tucannon River. At the time of the site visit, the channel width throughout the reach was 2 or 3 times wider than channel widths for nearby reaches. There is a large amount of gravel material in this reach with a moderate amount of instream wood. However, there is almost no riparian vegetation established throughout the reach, and large gravel bars are exposed to full sun. These gravel bars form multiple side channels and any piece of wood is forcing split flows; however, the split flows have almost no cover and are likely extremely transient.

At the upstream end of the project area, some sections have good mature riparian vegetation on the right bank, but it appears this portion of the river has had cattle grazing and very few young trees or undergrowth are present. There are several side channel opportunities in the wooded area that could be reconnected to move flow out of the large exposed gravel bar area.

Just downstream of this wooded right bank, the channel enters an approximately half-mile reach that has almost no riparian

Project Area 30
Looking downstream. The channel has complex flow but exposed gravel bars with little vegetation or instream wood structure, making the current conditions geomorphically unstable.

Project Area 30 Reach Characteristics

VM Start (mi)	15.54
VM Length (mi)	0.83
Valley Slope	0.99%
RM Start (mi)	17.62
RM Length (mi)	1.01
Average Channel Slope	0.82%
Sinuosity	1.22
Connected FP (ac/VM)	18.70
Encroachment Removal (ac/VM)	2.05
Channel Aggradation (ac/VM)	8.06
Total FP Potential (ac/VM)	9.05
Encroaching Feature Length (ft)	2,213.87
Connected FP Rank	18

vegetation and is eroding into loess banks in several locations. It should be noted that this site was visited by Anchor QEA staff again in April of 2019, and significant erosion has occurred in several of these meander bends. Very little of the complexity apparent at the low flow was visible during a higher flow.

Near the downstream end of the reach at VM 15.8, a large rock berm extrudes into the active channel to push water into an irrigation channel on the right bank. Just downstream of here, a large log jam is forcing erosion into the left bank before the irrigation ditch returns to the river.

In general, this reach has decent instream wood, but with few riparian trees to hold it in place, much of this wood will likely be flushed downstream within the next few high flows. Bed material is a good mix of gravels, cobbles, and boulders, and geomorphic pools and planforms seem to form relatively easily. The apparent complexity of this reach appears to be transient in nature, though, and the very poor riparian vegetation makes this likely poor juvenile salmonid habitat despite the complexity.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows geomorphic changes in PA 30 that occur on a large scale and occupy large portions of the reach. PA 30 has been noted to have very large riparian vegetation in the lower portion of the reach, which likely contributes to the scale in which geomorphic changes are occurring in this reach.

In the upstream end where both banks still have some riparian vegetation, a large log jam in the middle of the channel has caused split flows and side channels with associated deposition behind the log jam and erosion in the main channel (box 1).

The primary change pattern in the reach occurs for the entire downstream section of PA 30, where little mature woody vegetation on the banks has made the channel highly susceptible to erosion. Large areas of erosion into alternating banks are forming five distinct meander bends as the channel erodes into the banks over approximately 2,000 feet of channel length. Large areas of the bank have eroded, and it is likely this process will continue given that there is little vegetation to hold banks and resist erosion (box 2).

Geomorphic Characteristics and Restoration Strategies

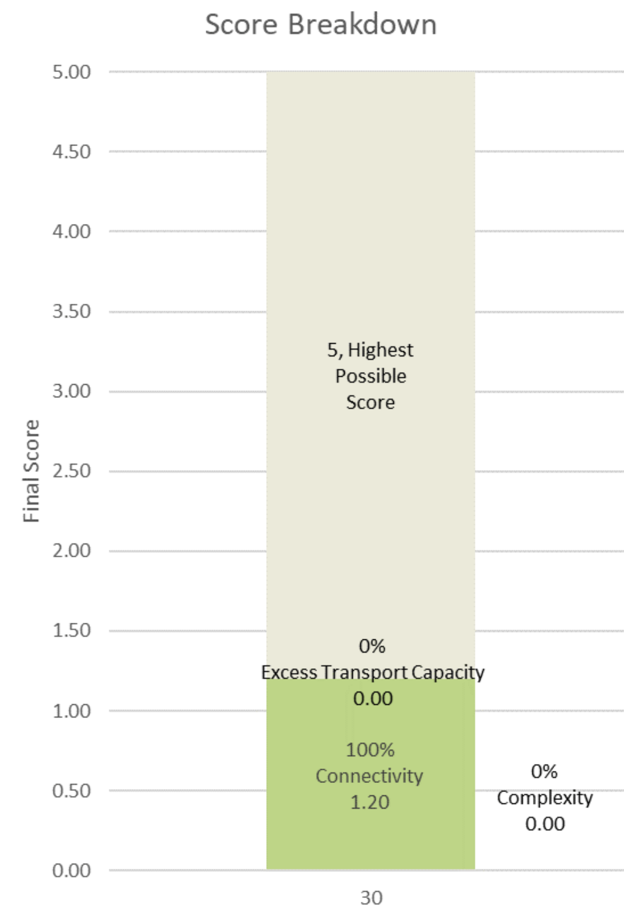
As shown in the following graphs and table, PA 30 receives its entire prioritization score from a moderate score in the Connectivity metric, which indicates that PA 30 ranks above average in the 50th to 75th percentile for floodplain connectivity potential. This ranking is almost entirely driven by an above average rank in the Channel Aggradation analysis result. Much of this area exists as expansion of the boundaries of the existing 2-year floodplain as well as several channels in the right bank floodplain that appear to be disconnected even at the 2-year event.

PA 30 scores no points in the Complexity metric because it ranks at the top of the assessment in the 90th to 99th percentile range. While this range receives no score because it has been identified as likely needing no further complexity from restoration work, PA 30 is a special case. The complexity in this reach is driven by large gravel islands completely bare of vegetation. This type of complexity is extremely transient and does not provide the same habitat benefits that complexity through a healthy riparian area does. For example, major channel changes occurred between the LiDAR flight in fall 2017 and the aerial imagery in spring 2018. Given the instability of the reach, it is likely that significant changes like this happen with yearly flows.

The primary restoration strategies for this reach should be to add instream wood and cut pilot channels to connect the channel identified as providing potential connectivity. These strategies will add connected floodplain and should be targeted for perennial flow to increase complexity. Because most of these areas are in the portion of the reach with a somewhat intact riparian zone, this should provide a stable habitat and beneficial boost to complexity.

For the downstream portion of the reach, the primary restoration strategy should be to aggressively add instream structure and

PA 30 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

wood to stabilize gravel bars, along with intense riparian vegetation plantings on the floodplain and on the bars if possible. This should help to stabilize the complex flow paths and hopefully provided better habitat through these areas as well.

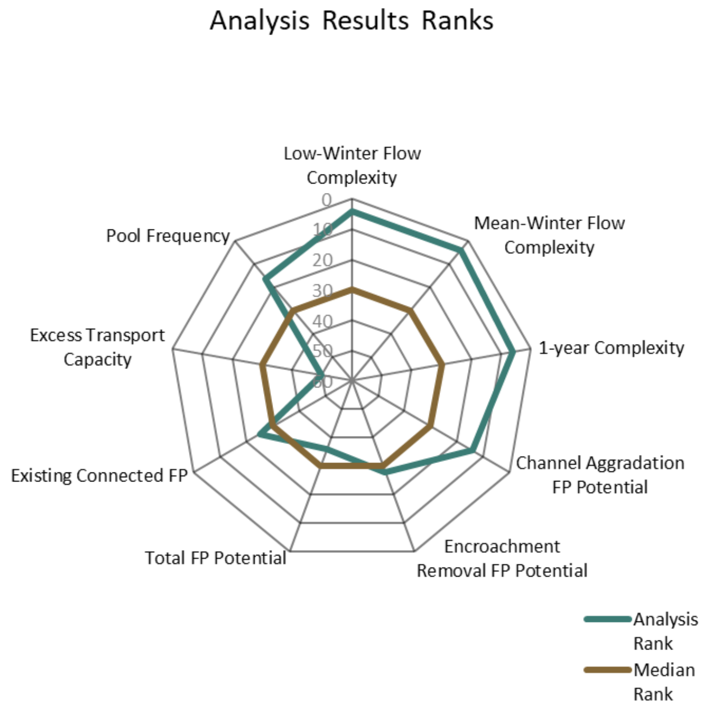
Because this reach could benefit from channel aggradation, gravel augmentation should be considered after this reach has been treated with the above restoration strategies to promote more stable complexity that can trap and store some of the incoming sediment.

Finally, PA 30 ranks well above average in the Pool Frequency metric, indicating a high amount of pools per river mile. However, due to the lack of riparian vegetation, these pools may not actually be providing good habitat. The restoration strategies of adding instream structure and wood, along with riparian zone enhancement, should promote conditions where pools are likely to be maintained and provide better habitat benefit with shade, cover, and complexity.

Summary of Restoration Opportunities Identified

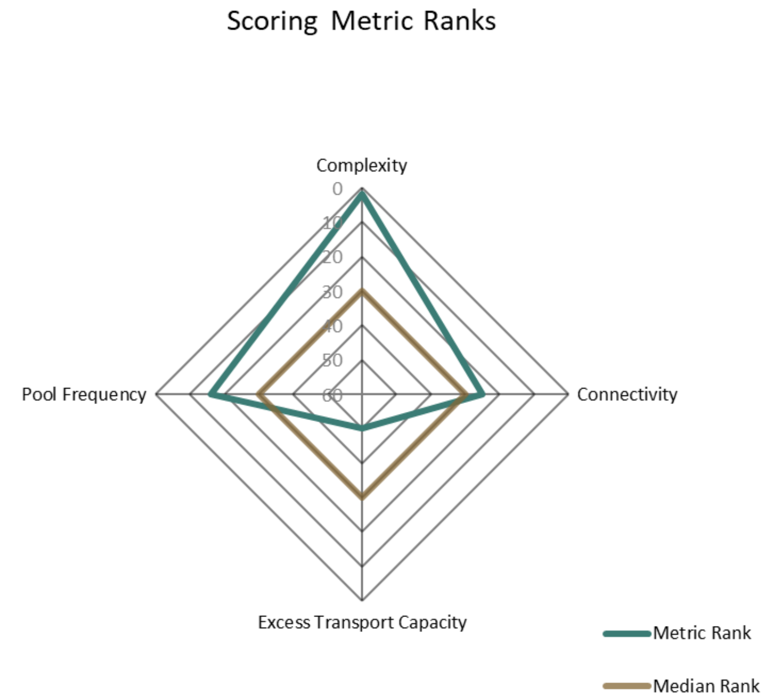
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)
- Riparian zone enhancement

PA 30 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

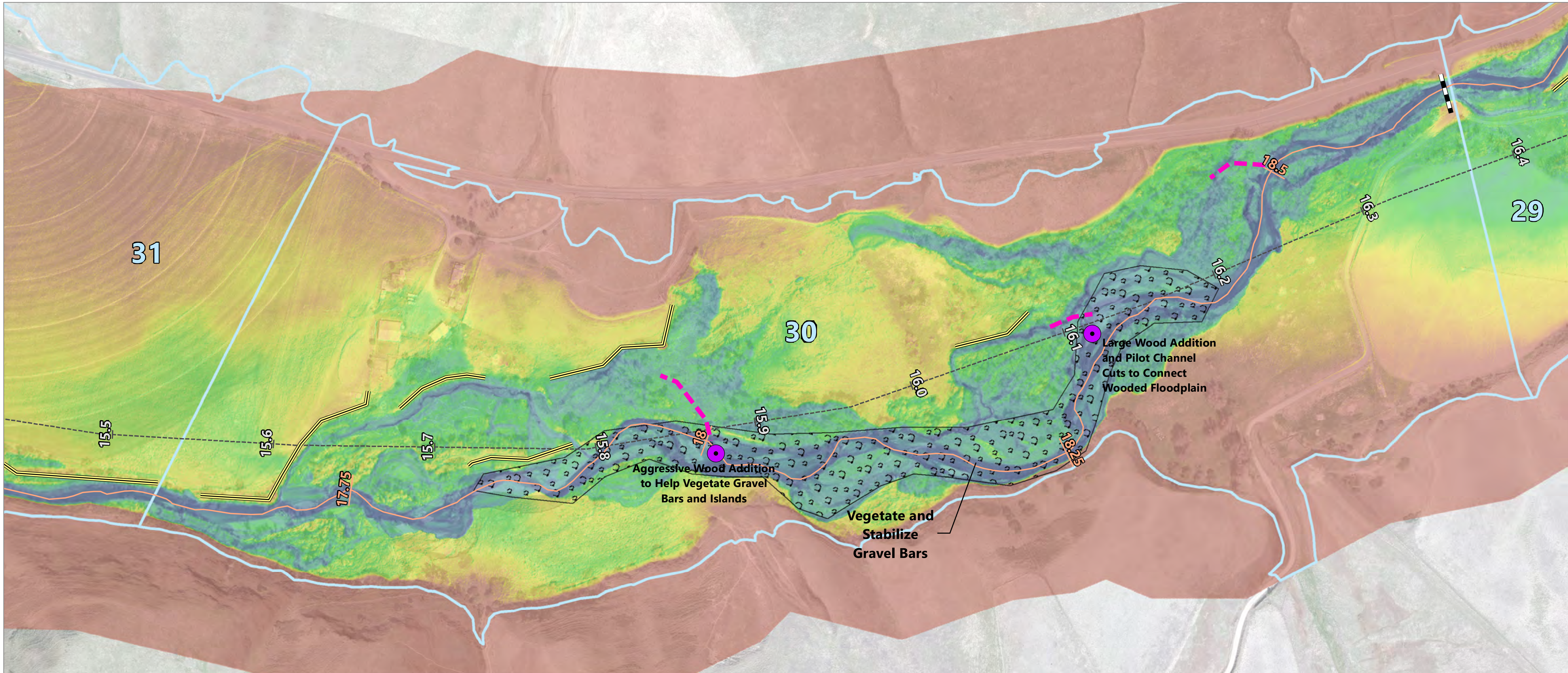
PA 30 Scoring Metric Ranks

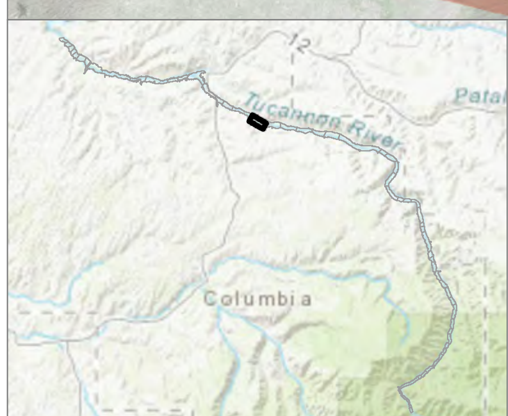


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 30 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.369	4	40%	Complexity	0.500	2	1% to 10%	1 of 5	0	40%	1.2	48	3	Untreated	28	3
Mean-Winter Flow Complexity	0.559	4	40%													
1-year Complexity	0.645	6	20%													
Channel Aggradation FP Potential	0.290	14	40%	Connectivity	0.211	25	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.074	28	40%													
Total FP Potential	0.326	36	20%													
Existing Connected FP	0.674	25	0%													
Excess Transport Capacity	-0.13	50	100%	Excess Transport Capacity	0.000	50	52% to 100%	4 of 4	0	20%						
Pool Frequency	15.88	16	100%	Pool Frequency	0.408	16	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Riparian Enhancement

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 17.62
RIVER MILE END: 18.63
VALLEY MILE START: 15.54
VALLEY MILE END: 16.37

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Feet

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ANCHOR QEA

Project Area 30
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 33 Description

Project Area 33 begins at the Territorial Road bridge at VM 14.11 and extends upstream to the Highway 12 bridge at VM 15.54. The 2017 RM length is 1.49 miles. Field observations for PA 33 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

Within PA 33, the river is largely confined and incised within a relatively straight, single-thread channel. The 2011 assessment noted that some portions of the channel had cut down to expose historical compacted alluvium along the banks and LWD had been unburied. The channel was primarily a transport reach with a low volume of temporary sediment storage and low volume of wood material. In the upper project, occasional bedrock outcrops were located in the channel bed, which forced local pools and rapids and likely contributed to holding the channel grade. A majority of the upper reach was confined by riprap and unarmored levees. A significant bedrock sill was located along the left bank and in the channel. The bedrock sill area contained split flow, a large log jam, and active migration of the channel into the right floodplain (which was a field at the time of the 2011 assessment). The lower portion of the project reach was primarily a plane-bed channel with local forced pools where the channel was located along the toe of the bedrock valley wall, and sporadic LWD pools. The right bank contained

Project Area 33
Photograph taken from 2011 prioritization showing a bedrock sill (left) and plane-bed channel conditions.

Project Area 33 Reach Characteristics

VM Start (mi)	11.71
VM Length (mi)	1.12
Valley Slope	0.72%
RM Start (mi)	13.43
RM Length (mi)	1.22
Average Channel Slope	0.66%
Sinuosity	1.09
Connected FP (ac/VM)	7.76
Encroachment Removal (ac/VM)	0.11
Channel Aggradation (ac/VM)	1.71
Total FP Potential (ac/VM)	1.87
Encroaching Feature Length (ft)	3,629.84
Connected FP Rank	57

sporadic riprap, and an armored and unarmored access road prism at a decommissioned pump and ditch site.

In 2011, instream habitat conditions were generally characterized by a lack of LWD and cover, low hydraulic complexity, and poor bedload sediment distribution. The existing bedrock pools were likely providing good adult holding habitat, but the overall quantity of pools was low. In general, there was a low amount of potential spawning area. No significant side channels or off-channel areas for high-flow refuge or juvenile rearing areas were observed.

The riparian zone was in generally poor health. The riparian corridor was very narrow and not well connected to the water table. Riparian trees were predominantly mature alders and cottonwoods. In some exposed sections of the channel, regenerating locusts or other invasive plants were dominant. Shade was poor to moderate. Understory vegetation was dominated by invasive groundcover including several thick patches of poison hemlock.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows several locations of significant geomorphic change in this project area. PA 33 also shows long stretches of erosion in locations where the channel has not moved. These have not been highlighted because it is possible that these are false indicators based on the differences in ability of the 2017 LiDAR to detect bathymetry compared to the 2010 LiDAR. However, PA 33 is a straight and confined reach where incision and downcutting would be expected, so it is not impossible that some of this is real change.

The first notable location of change comes at the upstream end of the project area, where the channel has migrated slightly into the right bank floodplain, and then more drastically towards the left bank, where it now runs against the valley wall (box 1).

Immediately downstream, the channel has formed a split flow and erosion is evident in the side channel and main channel. Past the bend, more erosion is evident on the right bank along with some deposition on the left bank bar (box 2).

Finally, near the downstream end of the reach, the channel has again migrated toward the left bank and is now completely up against the valley wall (box 3).

Geomorphic Characteristics and Restoration Strategies

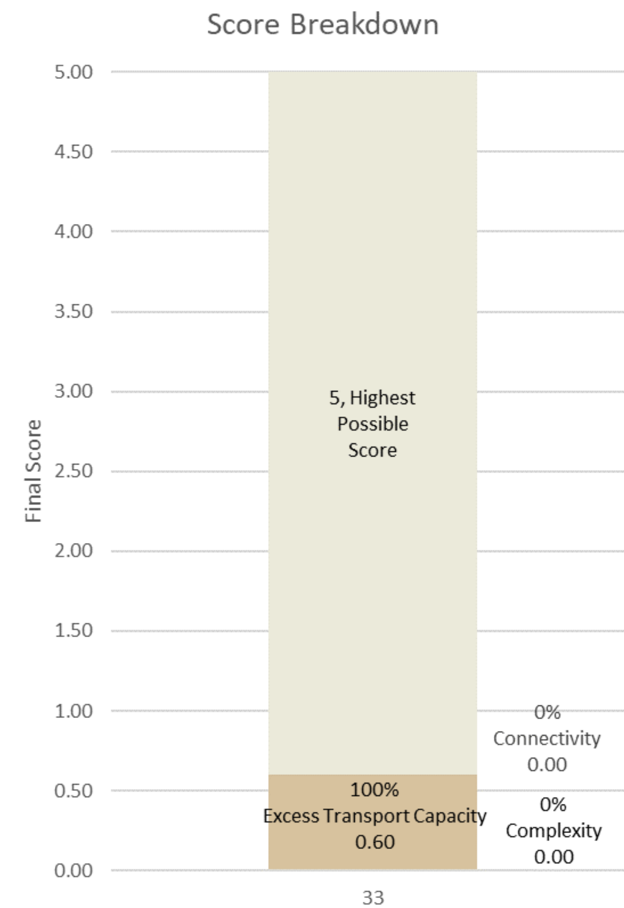
As shown in the following graphs and table, PA 33 receives a moderate score in the Excess Transport Capacity metric, which makes up the entirety of its prioritization score. PA 33 is highly confined and ranks in the bottom 10% and bottom 25% for Complexity and Connectivity, respectively. The moderate Excess Transport Capacity score is likely due to this confinement, which appears to be due to mostly incision because no well-defined levees are evident on the relative elevation map. The primary restoration target for this reach should be to reverse some of this incision through channel aggradation and adding a large amount of instream wood to trap and store sediment in the main channel. However, floodplain reconnection may be difficult to achieve through channel aggradation and floodplain benching may provide more immediate habitat gains in the short term, although this would likely require a large amount of effort.

Pool frequency in PA 33 is slightly above average despite what would be expected in a reach that is starved of sediment supply and severely confined. The identified restoration strategies of widening the floodplain, adding instream wood, and providing gravel augmentation should greatly benefit the natural processes of complexity and connectivity that will maintain pool formation in this reach.

Summary of Restoration Opportunities Identified

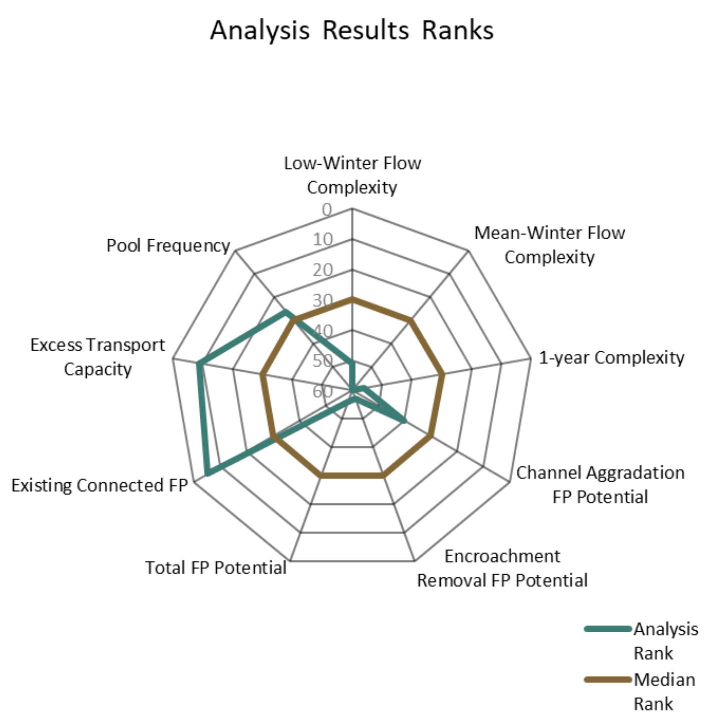
- Gravel augmentation
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

PA 33 Score Breakdown



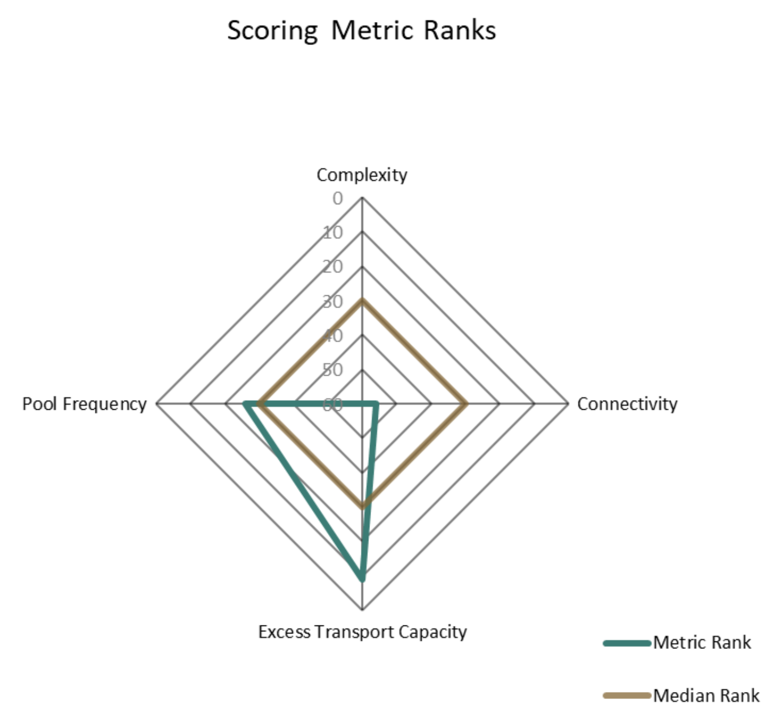
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 33 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

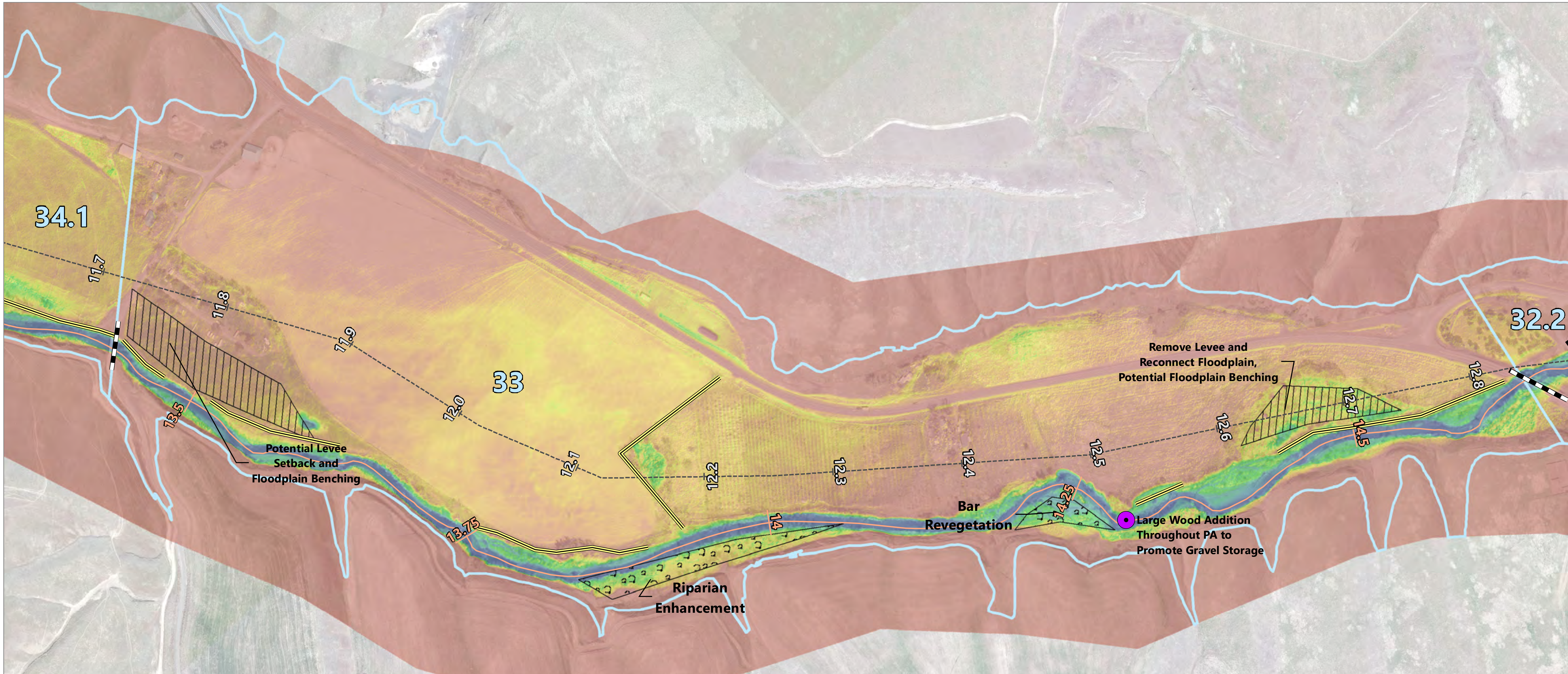
PA 33 Scoring Metric Ranks

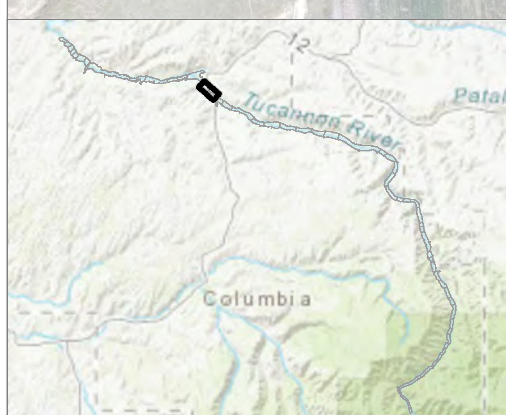


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 33 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.094	51	40%	**Complexity**	0.084	60	90% to 100%	5 of 5	0	40%	0.6	58	3	Untreated	36	3
Mean-Winter Flow Complexity	0.075	60	40%													
1-year Complexity	0.085	56	20%													
Channel Aggradation FP Potential	0.177	40	40%	**Connectivity**	0.114	56	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.011	57	40%													
Total FP Potential	0.194	56	20%													
Existing Connected FP	0.806	5	0%													
Excess Transport Capacity	0.18	9	100%	**Excess Transport Capacity**	3.000	9	10% to 30%	2 of 4	3	20%						
Pool Frequency	12.28	26	100%	**Pool Frequency**	0.315	26	40% to 60%	3 of 5	5	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential
- Riparian Enhancement

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 13.43
RIVER MILE END: 14.65
VALLEY MILE START: 11.71
VALLEY MILE END: 12.84

0 500
Feet

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ANCHOR QEA

Project Area 33
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 37 Description

Project Area 37 begins at VM 6.86 and extends upstream to VM 7.83. The 2017 RM length is 1.10 miles. Field observations for the upper portion of PA 37 were conducted on November 30, 2018, when flow at the Starbuck gage was approximately 110 cfs.

PA 37 is mostly defined by extreme channel confinement and disconnection from the surrounding floodplain. At the time of the site visit, the reach contained a minimal amount of large woody material and almost no geomorphic forced pools or plan forms.

The Smith Hollow Road bridge crosses the river mid-reach at VM 7.21, and a U.S. Geological Survey gage is located shortly downstream of the bridge. The channel confinement continues downstream, with only a thin strip of riparian vegetation and large riprap observed on both banks.

PA 37 likely functions as a pure transport reach with almost no gravel side sediment observed in the bed material and very little instream wood. The few pools observed in this reach were forced by large angular rock or the bridge abutments.

Geomorphic Changes

Analysis of the difference between the 2010 and 2017 LiDAR data shows only two minor locations of notable geomorphic change in PA 37. PA 37 also shows long stretches of erosion in

Project Area 37
Looking upstream. The reach is a straight, uniform channel that is highly confined by levees and high banks.

Project Area 37 Reach Characteristics

VM Start (mi)	6.86
VM Length (mi)	0.97
Valley Slope	0.58%
RM Start (mi)	8.01
RM Length (mi)	1.10
Average Channel Slope	0.50%
Sinuosity	1.13
Connected FP (ac/VM)	10.85
Encroachment Removal (ac/VM)	0.18
Channel Aggradation (ac/VM)	2.55
Total FP Potential (ac/VM)	3.11
Encroaching Feature Length (ft)	4,656.68
Connected FP Rank	43

locations where the channel has not moved. These have not been highlighted because it is possible that these are false indicators based on the differences in ability of the 2017 LiDAR to detect bathymetry compared to the 2010 LiDAR. However, PA 37 is a straight and confined reach where incision and downcutting would be expected, so it is not impossible that some of this is real change.

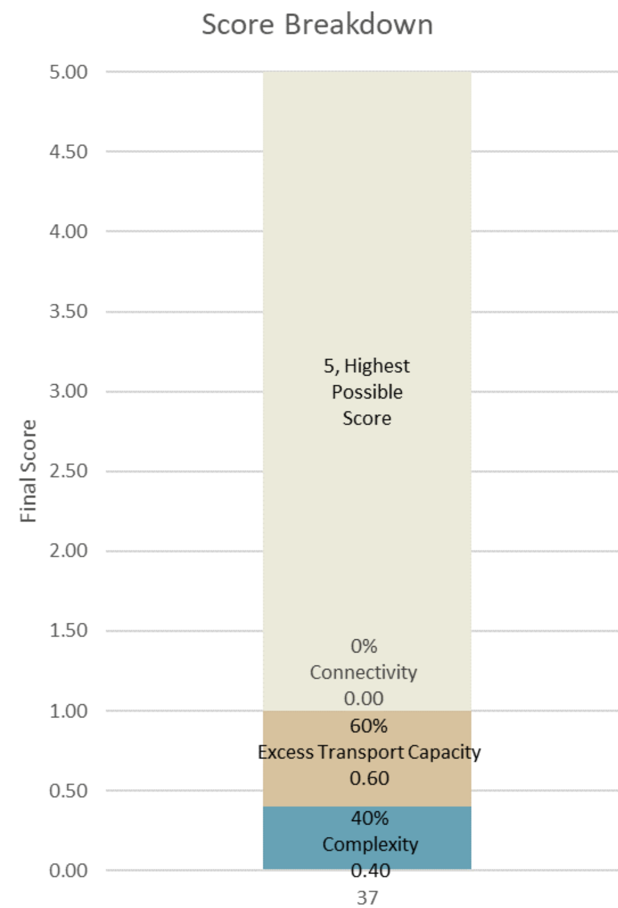
At the upstream end of the reach, a large amount of deposition has occurred on the left and right bank floodplains, followed by a small erosional area on the left bank. It is possible the noted deposition on the right bank may not be natural because it coincides closely with the levee in that location (box 1).

Immediately downstream, a long stretch of deposition has occurred in the main channel and on the left bank floodplain and pushed the channel towards the left bank further downstream. Erosion is evident on both the left and right banks in this location (box 2).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 37 receives a moderate score in the Excess Transport Capacity metric and a low score in the Complexity metric, which combine to account for the entire prioritization score for this project area. The low Complexity score indicates that this project area falls below average in the 10th to 40th percentile, which is a range that has

PA 37 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

been identified as having some small existing complexity but would likely require a large restoration effort to achieve higher levels. Almost all of the existing complexity comes from the upstream end of this reach where some mid-channel bars and small side channels have formed.

The primary restoration strategy for this reach should be to add instream wood and structure to promote in-channel complexity and better habitat conditions. There are several small side channel connection opportunities in the immediate floodplain evident on the relative elevation map that could be connected via the addition of instream wood and pilot channel cuts. Gravel augmentation could also be considered a restoration strategy that would allow more pools and in-channel complexity to form. However, it will be difficult to retain sediment in this reach because of the higher-than-average score in the Excess Transport Capacity metric, so wood loading should be aggressive if gravel augmentation is considered.

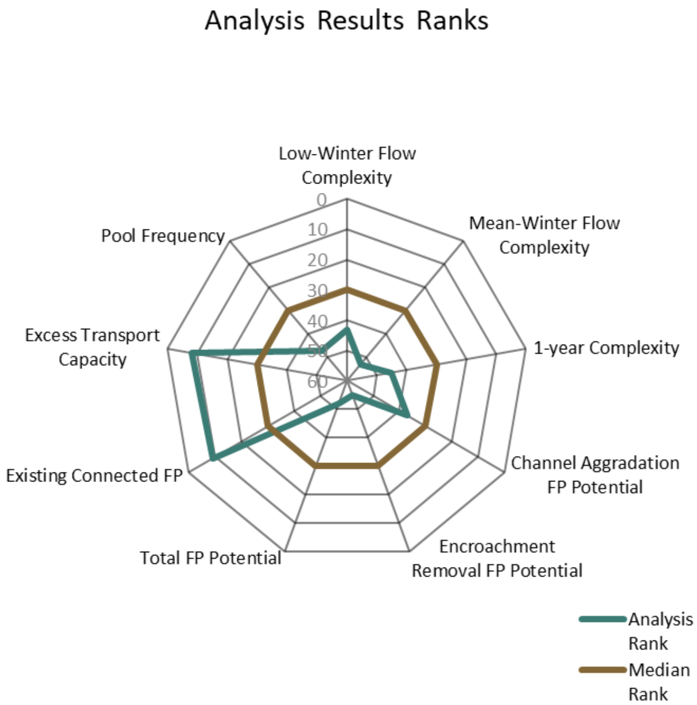
Real habitat benefits in this reach will likely only be gained by widening the floodplain to provide more available area for connection and connectivity. However, this would likely require a massive effort because incision is severe for most of the reach and often includes large rock.

Finally, PA 37 scores very poorly in pool frequency, likely due to the confined nature of this reach. The identified restoration strategies of adding instream wood and gravel augmentation should allow more complexity to form and create the conditions that will allow pools to form more regularly through natural geomorphic processes.

Summary of Restoration Opportunities Identified

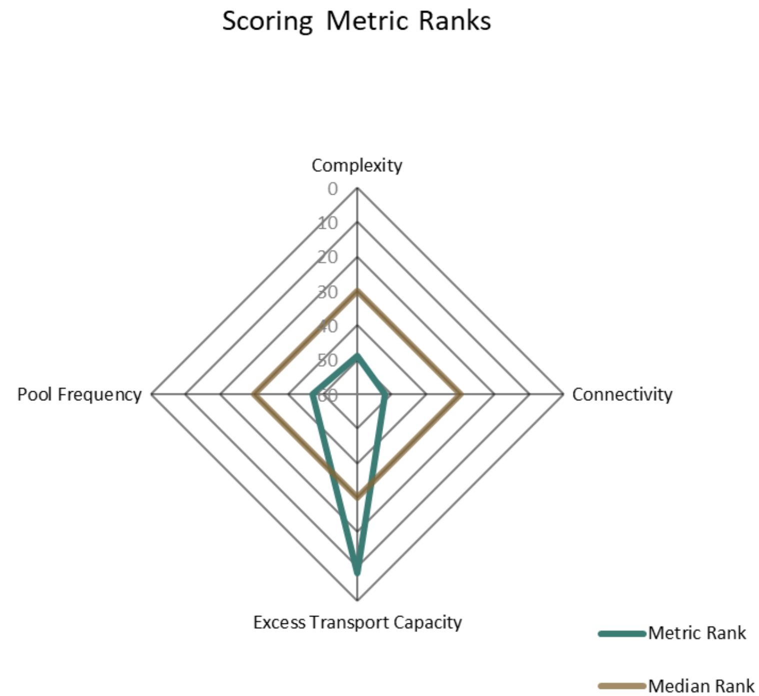
- Gravel augmentation
- Address encroaching features
- Add instream structure (LWD)
- Modify or remove obstructions

PA 33 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

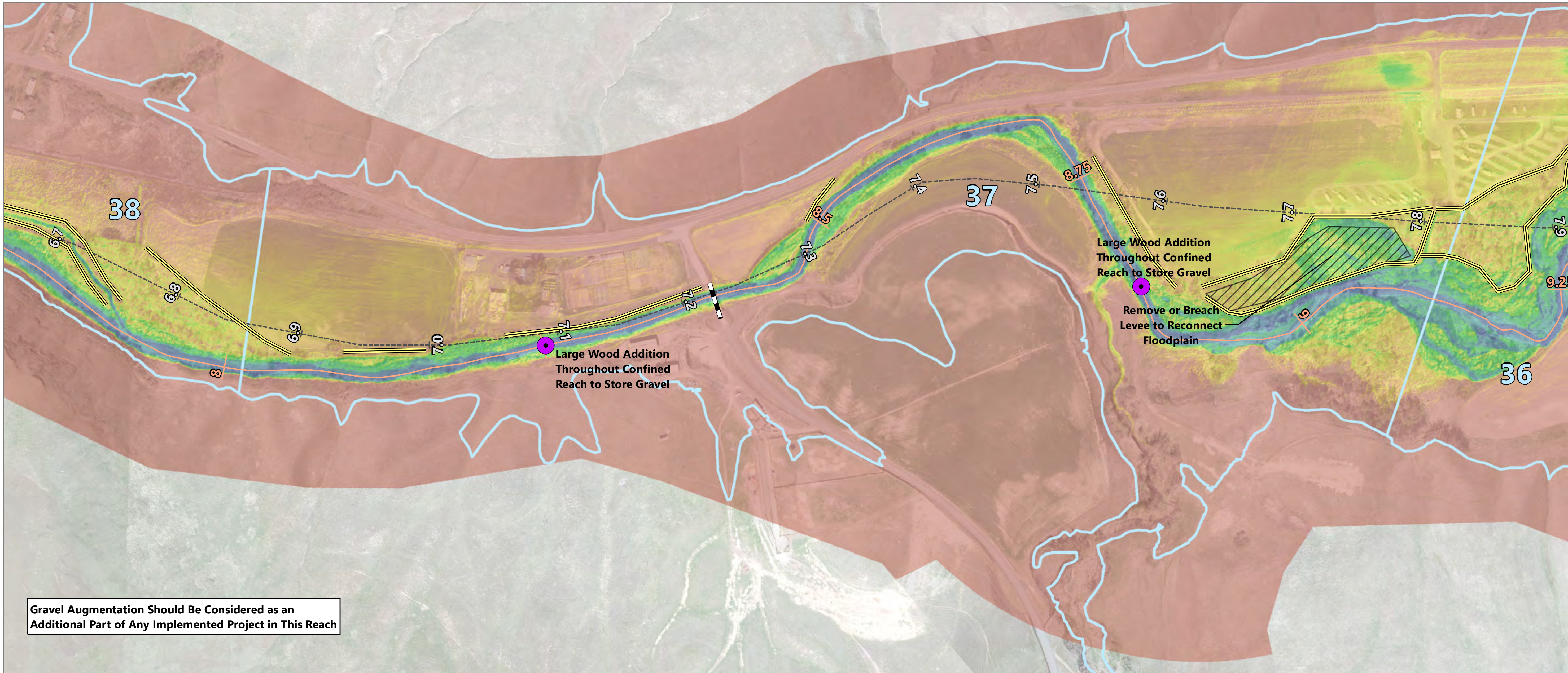
PA 33 Scoring Metric Ranks

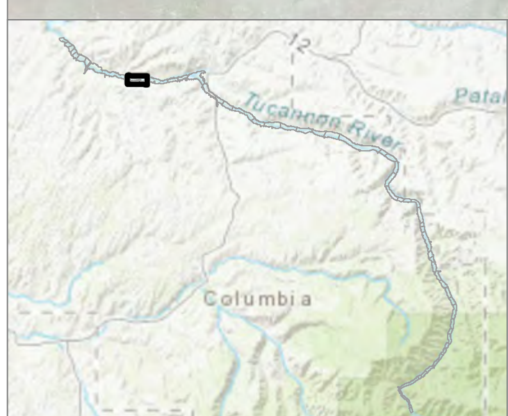


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 37 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.105	43	40%	Complexity	0.121	49	60% to 90%	4 of 5	1	40%	1.0	52	3	Untreated	32	3
Mean-Winter Flow Complexity	0.113	53	40%													
1-year Complexity	0.172	45	20%													
Channel Aggradation FP Potential	0.183	37	40%	Connectivity	0.123	52	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.013	55	40%													
Total FP Potential	0.223	52	20%													
Existing Connected FP	0.777	9	0%													
Excess Transport Capacity	0.18	8	100%	Excess Transport Capacity	3.000	8	10% to 30%	2 of 4	3	20%						
Pool Frequency	5.46	47	100%	Pool Frequency	0.140	47	60% to 90%	4 of 5	1	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 8.01
RIVER MILE END: 9.11
VALLEY MILE START: 6.86
VALLEY MILE END: 7.83

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ANCHOR QEA

Project Area 37
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 39.2 Description

Project Area 39.2 begins at VM 3.40 and extends upstream to VM 4.00, which is just upstream of the large lateral Starbuck levee. The 2017 RM length is 0.33 mile. Field observations for PA 39.2 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization.

The river through PA 39.2 is a single-thread channel downstream of the Kellogg Hollow Road bridge and flows along the base of the Starbuck levee on the right bank. One large pool the Starbuck Swimming Hole) is located downstream of the Kellogg Hollow Road bridge at the bedrock outcrop located along the left bank.

The 2011 assessment noted that there was limited floodplain within the project area and the channel was highly confined due to the alignment of the Starbuck levee. The levee extends along the right bank throughout the entire project area, limiting channel migration and floodplain development along the right bank. This levee protects the town of Starbuck from high flood waters during peak flows. Along the left bank is a bedrock outcrop that limits floodplain connectivity and channel migration along the left bank. Some overbank area exists along the left bank immediately downstream of the Kellogg Hollow Road bridge. Along with the confluence with Kellogg Creek.

Project Area 39.2
Photograph taken from the 2011 prioritization showing the main channel just downstream of the Kellogg Road bridge with the Starbuck levee along the right bank. View is looking downstream.

Project Area 39.2 Reach Characteristics

VM Start (mi)	3.68
VM Length (mi)	0.31
Valley Slope	0.71%
RM Start (mi)	4.61
RM Length (mi)	0.33
Average Channel Slope	0.66%
Sinuosity	1.05
Connected FP (ac/VM)	10.22
Encroachment Removal (ac/VM)	0.00
Channel Aggradation (ac/VM)	2.48
Total FP Potential (ac/VM)	2.52
Encroaching Feature Length (ft)	1,791.59
Connected FP Rank	47

In 2011, the riparian zone through the project area was generally in poor to moderate health. Riparian vegetation along the right bank was limited due to the presence of the Starbuck levee. Recent vegetation removal of trees on the levee face was evident. U.S. Army Corps of Engineers levee requirements limit the diameter size of vegetation allowed to grow on the face and levee toe. Because of the limited riparian zone, channel shading is lacking throughout most of the project area.

Geomorphic Changes

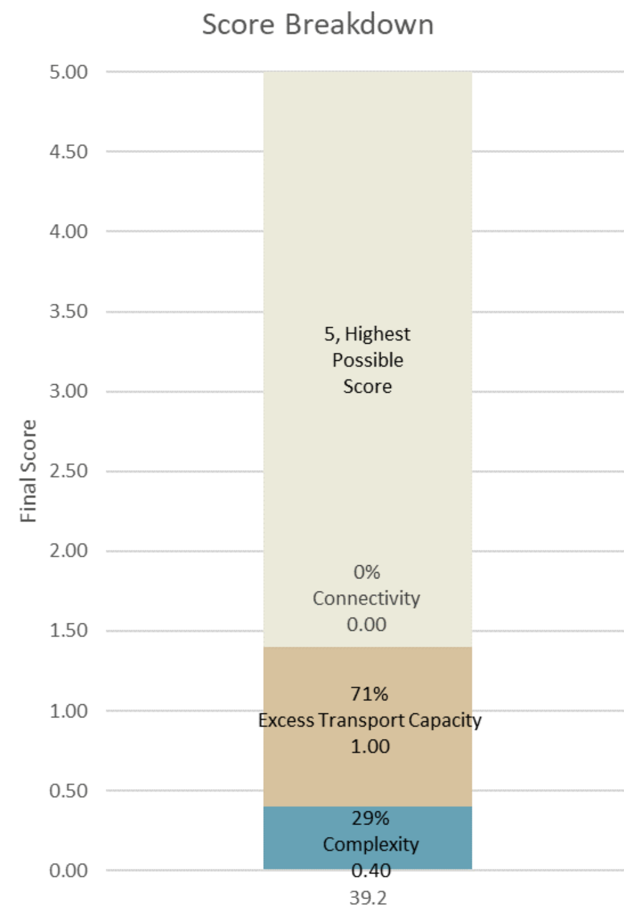
Analysis of the difference between the 2010 and 2017 LiDAR data shows two locations of significant geomorphic change. At the very upstream end of the project area, there is a depositional area on the left bank, and associated erosion on the right bank. This area is likely geomorphically associated with the major bank erosion occurring just upstream in PA 39.1 (box 1).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 39.2 receives the majority of its score from the Excess Transport Capacity metric. PA 39.2 receives no points for Connectivity and ranks in the bottom 25% of all project areas.

PA 39.2 receives a high score in the Excess Transport Capacity metric, indicating that this reach might have more transport capacity than average for the basin. This reach is highly confined by the levee for the town of Starbuck and there is

PA 39.2 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

likely little opportunity to widen the floodplain and decrease the transport capacity Therefore, the restoration strategy of adding instream wood should be considered if possible to slow flows and reduce transport capacity.

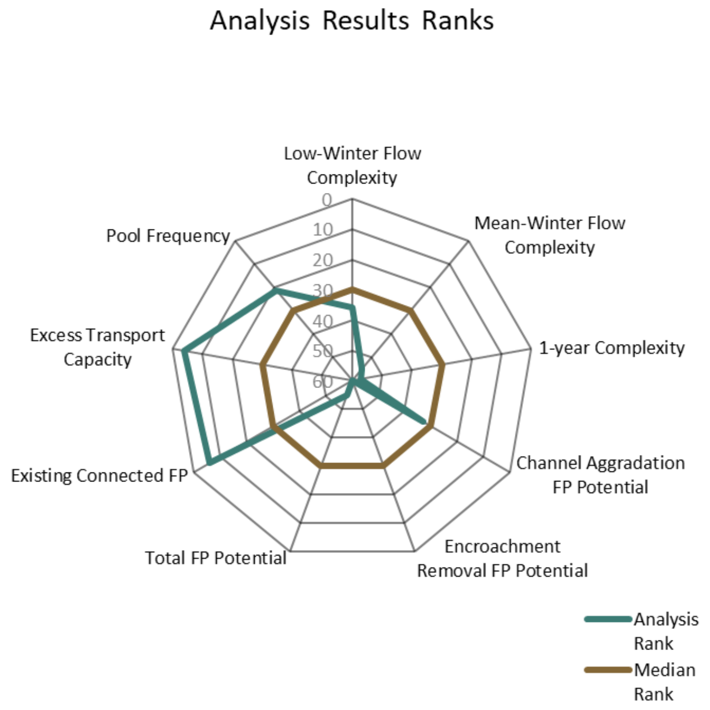
PA 39.2 ranks in the 10th percentile for Complexity, much lower the most of the other project areas. This range has been identified as having some complexity but would be difficult to achieve more. Because most of the reach is behind the levee for the town of Starbuck, adding side channels and split flows would be difficult or impossible. The most likely restoration strategy for this reach would be to add some instream wood as habitat features and in-channel complexity.

Finally, PA 39.2 ranks slightly above average among project areas in the Pool Frequency metric. Adding instream wood and gravel augmentation will promote changes towards an increase in channel complexity, promoting the formation of pools. These restoration strategies should be employed to target maintaining and increasing pool frequency in the reach.

Summary of Restoration Opportunities Identified

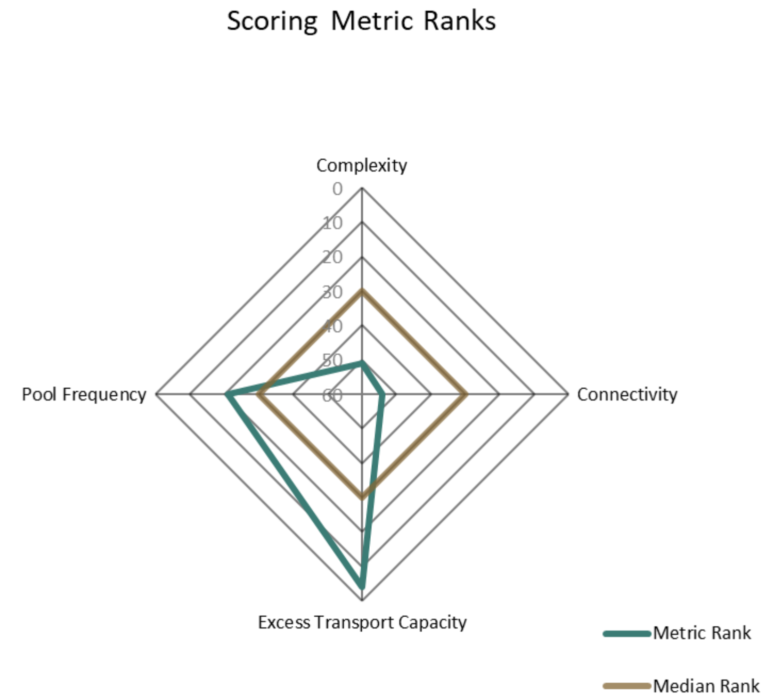
- Add instream structure (LWD)

PA 39.2 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

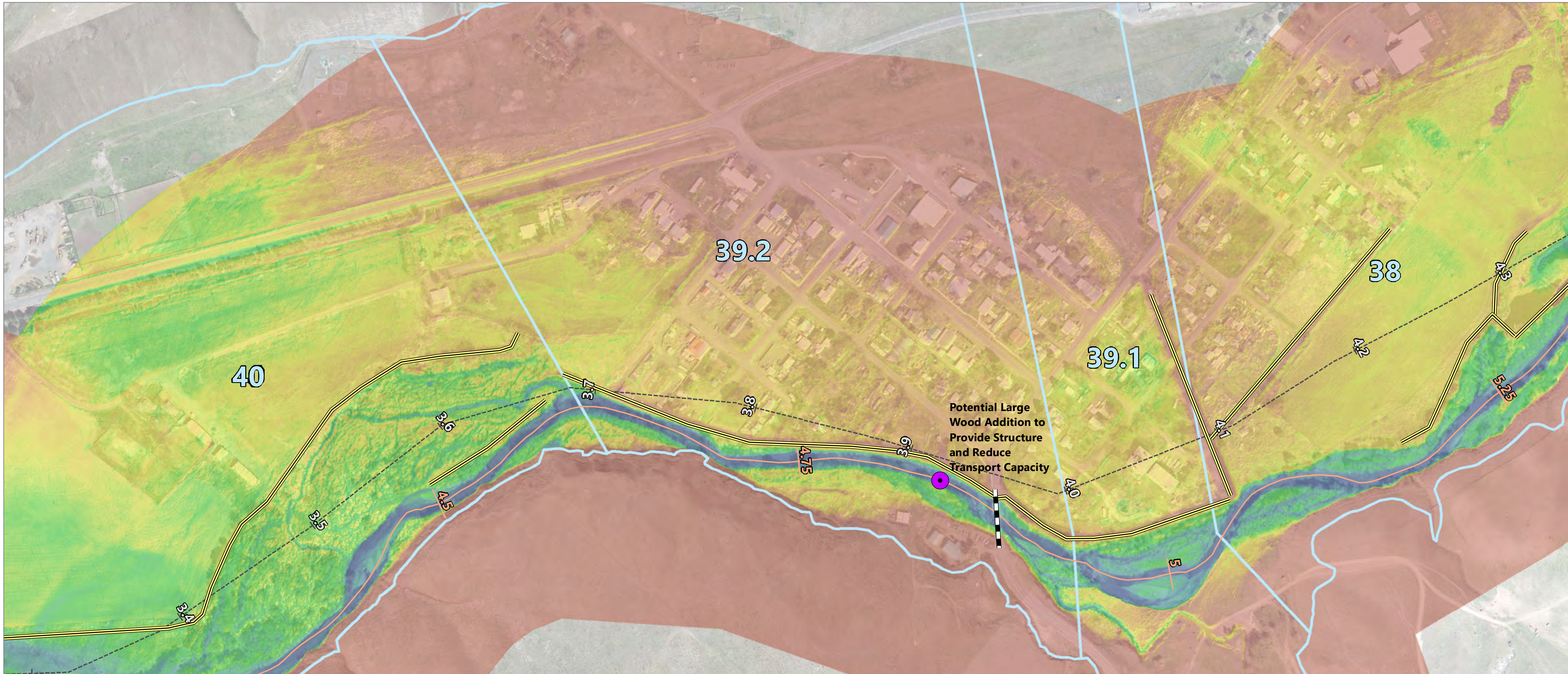
PA 39.2 Scoring Metric Ranks



This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 39.2 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.128	36	40%	Complexity	0.108	51	60% to 90%	4 of 5	1	40%	1.4	43	3	Untreated	26	3
Mean-Winter Flow Complexity	0.101	55	40%													
1-year Complexity	0.084	57	20%													
Channel Aggradation FP Potential	0.194	33	40%	Connectivity	0.117	54	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.000	60	40%													
Total FP Potential	0.198	55	20%													
Existing Connected FP	0.802	6	0%													
Excess Transport Capacity	0.29	4	100%	Excess Transport Capacity	5.000	4	1% to 10%	1 of 4	5	20%						
Pool Frequency	14.39	21	100%	Pool Frequency	0.369	21	10% to 40%	2 of 5	3	0%						



LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 4.61
RIVER MILE END: 4.94
VALLEY MILE START: 3.68
VALLEY MILE END: 4

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Feet

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ANCHOR QEA

Project Area 39.2
Conceptual Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 45 Description

Project Area 45 begins at the first bridge crossing for the Tucannon Road at VM 1.58 and extends upstream to the Powers Road bridge at VM 2.01. The 2017 RM length is 0.52 mile. Field observations for PA 45 were not conducted in 2018 as part of this assessment update, and the following description of the reach is based on the 2018 aerial imagery.

PA 45 is the most downstream project area in the assessment, and the remainder of the Tucannon River is highly influenced by the water surface elevation of the Snake River. The channel here is highly sinuous and runs through a riparian corridor of mostly grass, reeds, and small trees.

At the upstream end at the Powers Road bridge, the riparian vegetation is sparse, particularly on the left bank that borders an agricultural field. The channel through this reach meanders from the edges of the riparian corridor several times. When the channel is on the left bank edge of the riparian corridor, it borders the nearby agricultural field and pasture. On the right bank, it borders the old railway grade, which was noted to be heavily riprapped in upstream reaches. The riparian corridor in general seems to have adequate mature vegetation, and where the channel meanders from one side to the other there is relatively good vegetative cover. Midway through the reach, the channel becomes more confined by a levee on the left bank and the railway line on the right bank, and the floodplain

Project Area 45
No site photograph available.

Project Area 45 Reach Characteristics

VM Start (mi)	1.58
VM Length (mi)	0.43
Valley Slope	0.46%
RM Start (mi)	1.96
RM Length (mi)	0.52
Average Channel Slope	0.38%
Sinuosity	1.23
Connected FP (ac/VM)	25.05
Encroachment Removal (ac/VM)	4.10
Channel Aggradation (ac/VM)	3.91
Total FP Potential (ac/VM)	13.48
Encroaching Feature Length (ft)	3,183.31
Connected FP Rank	7

continues to narrow until reaching the bridge opening at Tucannon Road.

Geomorphic Changes

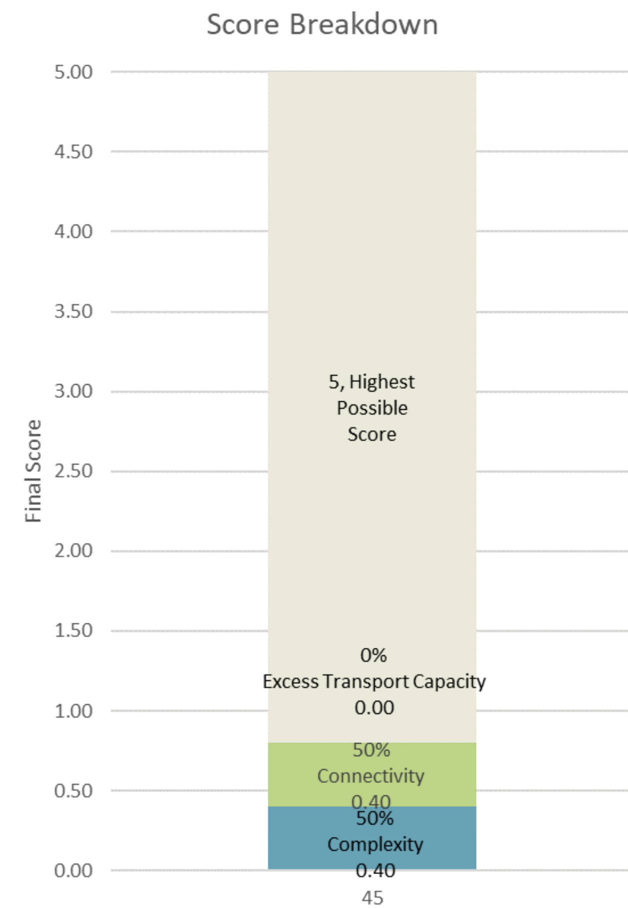
Analysis of the difference between the 2010 and 2017 LiDAR data shows several locations of significant geomorphic change. At the upstream end of the reach, a large depositional area has occurred on the left bank forming a point bar. On the opposite bank, erosion is occurring as the channel moves that way. Immediately downstream, erosion has occurred on the left bank and a slight meander bend may be forming here (box 1).

After the next bend downstream, erosion is occurring on the right bank and deposition is forming another point bar on the left bank as the channel moves closer to the old railway grade (box 2).

Geomorphic Characteristics and Restoration Strategies

As shown in the following graphs and table, PA 45 receives the majority of its score from a moderate score in the Connectivity metric. This score indicates that PA 45 ranks above average in the 50th to 75th percentile of all project areas for Connectivity potential. However, this rank is driven almost entirely by a high rank in the Encroachment Removal analysis result due to an area that may be difficult to reconnect. On the right bank, a large, low-lying area is disconnected from the active channel by

PA 45 Score Breakdown



This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

the old railway grade. This railway line acts as a large levee and is heavily reinforced with riprap in many locations. On the left bank, a large portion of the bordering agricultural field is disconnected by a levee as well. The primary restoration strategy for this reach should be to remove or breach these levees to reconnect this floodplain area, along with the addition of instream and gravel augmentation to promote geomorphic change into these new areas. Riparian vegetation enhancement will also be necessary in these areas because the current vegetation is grass and agricultural fields.

Should removal of these levees not be possible, the alternate restoration strategy should be to promote complexity. PA 45 receives a low score in the Complexity metric, indicating it ranks below average in the 10th to 40th percentile of project areas. This typically indicates that additional complexity could be difficult to achieve through restoration. However, PA 45 presents several opportunities for restoration in the form of disconnected side channels in the 2-year floodplain. The channels exist primarily on the left bank floodplain between the river and levee midway through the reach. Additionally, a long side channel on the right bank floodplain is currently connected at the 1-year flow but not at the two lower flows. This is reflected in the analysis results that have the 1-year flow ranked much higher than the two lower flows. Connecting these side channels to perennial flow would boost complexity across the entire reach. The primary restoration strategies for complexity should be to cut pilot channels to these side channels and add instream wood to promote geomorphic change in these locations. Gravel augmentation should also be considered to promote more frequent geomorphic change and to raise the channel bed and allow for easier connection of side channels.

Finally, PA 45 ranks very highly in the Pool Frequency metric, indicating a high amount of pools per river mile. The identified restoration strategies of adding instream structure and wood should promote geomorphic change towards more in-channel complexity and conditions where pools are likely to be maintained and continue to form with the natural processes of the reach.

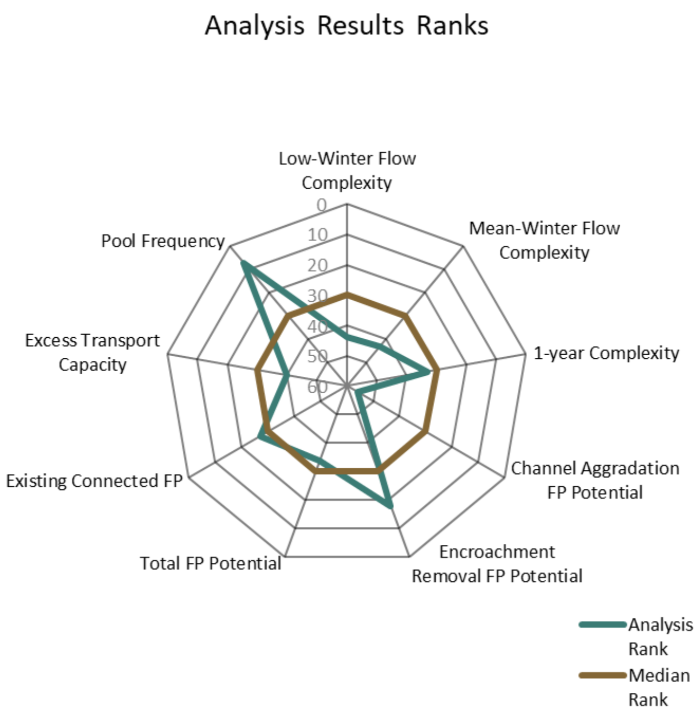
Summary of Restoration Opportunities Identified

- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

Long-Term Opportunities in this Project Area

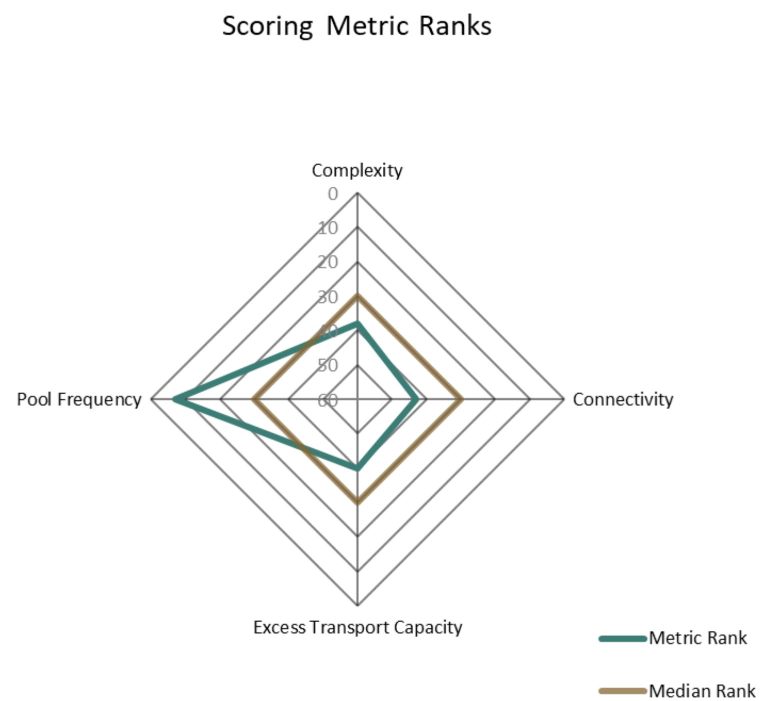
- Remove railroad grade, reconnect floodplain.

PA 45 Analysis Results Ranks



This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

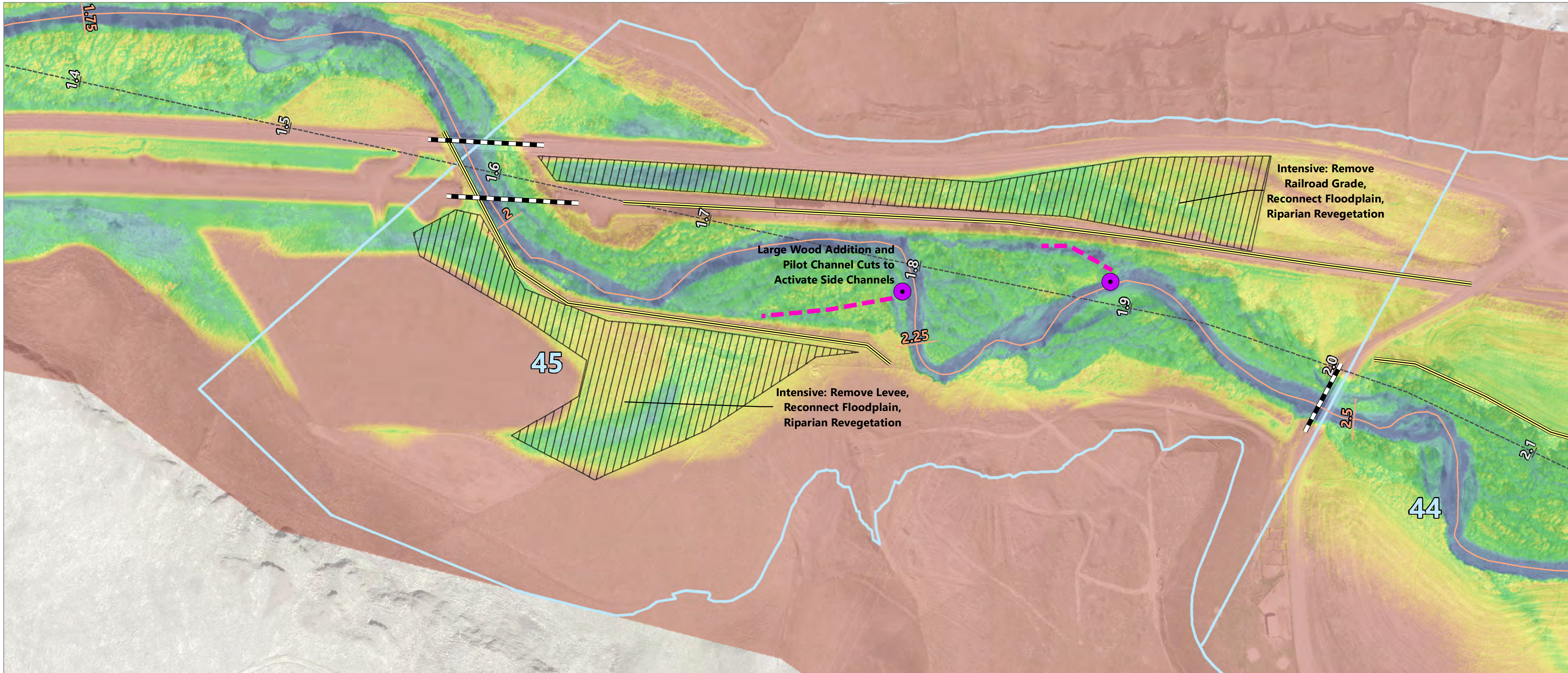
PA 45 Scoring Metric Ranks

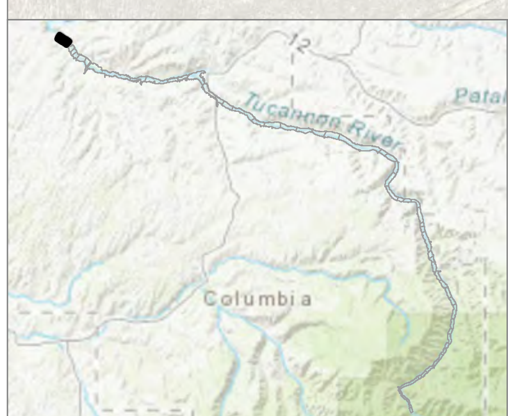


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project area. The median rank is highlighted in brown for comparison.

PA 45 Prioritization Ranking

Analysis	Analysis Result	Analysis Rank	Metric Weight	Metric	Metric Score	Metric Rank	Top Percent Range	Metric Class	Metric Class Score	Prioritization Weight	Final Score	Overall Rank	Overall Tier	Status	Status Rank	Status Tier
Low-Winter Flow Complexity	0.100	44	40%	**Complexity**	0.158	38	60% to 90%	4 of 5	1	40%	0.8	54	3	Untreated	33	3
Mean-Winter Flow Complexity	0.147	43	40%													
1-year Complexity	0.295	33	20%													
Channel Aggradation FP Potential	0.101	56	40%	**Connectivity**	0.153	43	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.106	18	40%													
Total FP Potential	0.350	34	20%													
Existing Connected FP	0.650	27	0%													
Excess Transport Capacity	-0.08	40	100%	**Excess Transport Capacity**	0.000	40	52% to 100%	4 of 4	0	20%						
Pool Frequency	26.73	7	100%	**Pool Frequency**	0.686	7	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Wood Addition Throughout Project Area
- Reconnect Side Channel
- Reconnect Floodplain or Levee Setback Potential

Relative Elevation in Feet

High : 15

Low : -0

NOTES:

1. Horizontal datum is WA State Plane South, NAD83, U.S. Feet.
2. Vertical datum is North American Vertical Datum of 1988, feet.
3. Aerial Imagery provided by GeoTerra. Flown April 19, 2018.
4. LiDAR elevation data provided by QSI (2018).
5. The conditions and opportunities in this map are based on LiDAR and aerial imagery from 2018. Flood events and geomorphic changes have occurred since then and may have changed the topography relative to what is shown.

RIVER AND VALLEY MILE DATA:

RIVER MILE START: 1.96
RIVER MILE END: 2.49
VALLEY MILE START: 1.58
VALLEY MILE END: 2.01

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Feet

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Project Area 45
Conceptual Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration