LIST OF PROJECT AREAS

Tier 1

Project Area 1.1 2
Project Area 3.2 9
Project Area 6 16
Project Area 9 24
Project Area 14.2 32
Project Area 23 40
Project Area 26 47
Project Area 40 56

Tier 2

Project Area 8 64
Project Area 10.3 72
Project Area 14.1 79
Project Area 15.2 87
Project Area 18.1 94
Project Area 28.2 102
Project Area 28.3 109

Tier 3

Project Area 10.1 117
Project Area 10.2 123
Project Area 11.1 130
Project Area 11.2 137
Project Area 15.1 145
Project Area 22 152
Project Area 24 159
Project Area 29 166

ABBREVIATIONS

ac/VM	acres per valley mile
AEM	airborne electromagnetics
cfs	cubic feet per second
CHaMP	Columbia Habitat Monitoring Program
FP	floodplain
GIS	Geographical Information Systems
LiDAR	Light Detection and Ranging
LWD	large woody debris
mi	mile
NF	National Forest (road)
PA	Project Area
RM	river mile
USFS	U.S. Forest Service
VM	valley mile
WDFW	Washington Department of Fish and Wildlife

APPENDIX J.1
TIER 1: TREATED PROJECT AREAS

Project Area 1.1 Description

Project Area 1.1 begins at VM 44.02 and extends upstream to the bridge crossing at Tucannon Road at VM 44.52. The 2017 RM length is 0.55 mile. Field observations for PA 1.1 were conducted on September 27, 2018, when flow at the Starbuck gage was approximately 82 cfs.

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.

PA 1.1 is characterized by several long side channels with flow even at some of the lowest flows during the year. At the upstream end of the project area, and just downstream of the bridge, a side channel into the right bank floodplain runs for approximately 650 feet. At the time of the site visit, the side channel had relatively low flow but a high amount of gravel material allowed instream wood to form multiple pools. In the main channel opposite this first channel, flow was relatively uniform. It was noted that this reach could use more instream wood to promote some in-channel complexity, although several structures were noted to be just disengaged at this low-flow level.

At approximately VM 44.41, there is a large side channel opportunity that is disconnected at the upstream end on the left bank floodplain. At VM 44.34, a side channel splits off into

Project Area 1.1
Engineered log jam with large wood recruits at the upstream end of PA 1.

Project Area 1.1 Reach Characteristics

VM Start (mi)	44.02
VM Length (mi)	0.50
Valley Slope	1.69%
RM Start (mi)	49.63
RM Length (mi)	0.55
Average Channel Slope	1.52%
Sinuosity	1.10
Connected FP (ac/VM)	11.01
Encroachment Removal (ac/VM)	1.20
Channel Aggradation (ac/VM)	4.60
Total FP Potential (ac/VM)	7.43
Encroaching Feature Length (ft)	213.18
Connected FP Rank	41

the right bank floodplain where it runs through young alders and ponderosa and may possibly drown them in the near future. This flow continues right along the road embankment on the right bank, which has been stabilized with large log poles. This side channel runs for approximately a quarter of a mile through well-established riparian vegetation. In the main channel in this section, a large channel-spanning log jam has created a backwater effect that is likely contributing to the amount of water in the right bank side channel. This reach of the mainstem has better instream wood than the upstream portion of this project area but could still benefit from more as it runs along the left bank valley wall.

At the downstream end of the project area, just past where the side channel rejoins the main channel, an old weir is providing grade control to the reach and a very large log jam on the right bank was mostly disengaged from flow at the time of the site visit. This structure was intended to backwater flow over the weir. Based on the site observations, it should be evaluated whether or not this structure is still functioning as intended.

Vegetation in the immediate riparian area of the channel is relatively good with large ponderosas and even some larger cottonwoods on some of the islands. Younger willows are being established on gravel bars and very few invasive species were noted. However, both of the large islands created by the side channels are very high compared to the water surface and are disconnected from the floodplain. The vegetation on these islands mostly consists of upland species such as ponderosa pines, often without any large woody vegetation at all. Both islands also seem to be composed of fine gravel alluvium that is easily transportable on a regular basis in the Tucannon River.

Restoration Actions and Geomorphic Changes

In 2014, restoration work in PA 1.1 included placing 38 log jams using 231 key logs within the channel and side channels, as well as excavating two side channel pilot cuts to activate about 0.3 mile of side channel habitat and reducing a WDFW campsite located on river right floodplain from 3.3 acres to 1.2 acres. Restoration in this project area had the objective of floodplain connectivity and channel complexity, including increasing perennial side channels and increasing pool frequency. A detailed as-built map of the project in pre/post conditions can be viewed in the Webmap.

Analysis of the difference between the 2010 and 2017 LiDAR data shows very little geomorphic change in PA 1.1, with five minor areas highlighted in this assessment. At the upstream end of the project area, a log jam on the left bank shows up as aggradation, and the pilot channel shows up as erosion in the right bank side channel (box 1). Where the side channel returns to the main channel, there is some minor erosion on the left bank and aggradation on the right bank that may result from a downstream log jam (box 2).

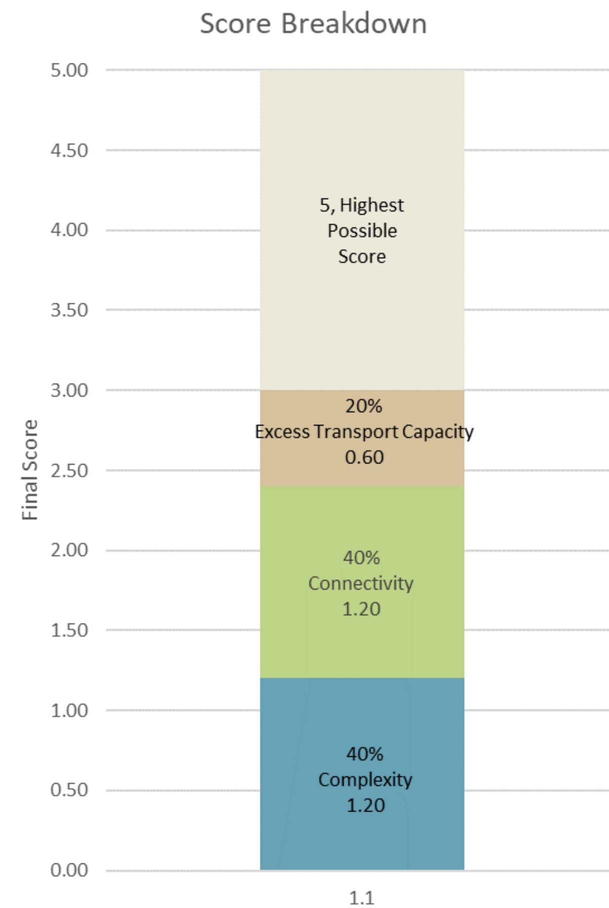
Where the second side channel splits off from the main channel, the log jam and pilot channel are again evident with some minor aggradation on the right bank (box 3). Further down on the main channel, a large bank barb shows a small scour pool off the front (box 4). Finally, a log jam in the downstream side channel has caused some erosion on the right bank (box 5).

Overall, this reach has experienced almost no geomorphic change compared to other treated reaches in this assessment. This is at least partially to be expected because this project area is the furthest upstream in the watershed, where the valley width is generally smaller and sediment sizes are generally larger and less easily transported. However, with large structures like those installed in this project area, more geomorphic change would be expected and more transportable material may be necessary to precipitate this change. A small pilot channel was cut as part of the restoration efforts in this project area, but it was likely too small to register on the LiDAR.

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 1.1 received the highest score possible in the Connectivity metric and moderate scores for both Complexity and Excess Transport Capacity metrics. PA 1.1 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; this project area may need some additional restoration work to reach that

PA 1.1 Score Breakdown



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

mark. The moderate Excess Transport Capacity score indicates that this reach has a higher transport capacity than would be expected for a reach with this average slope.

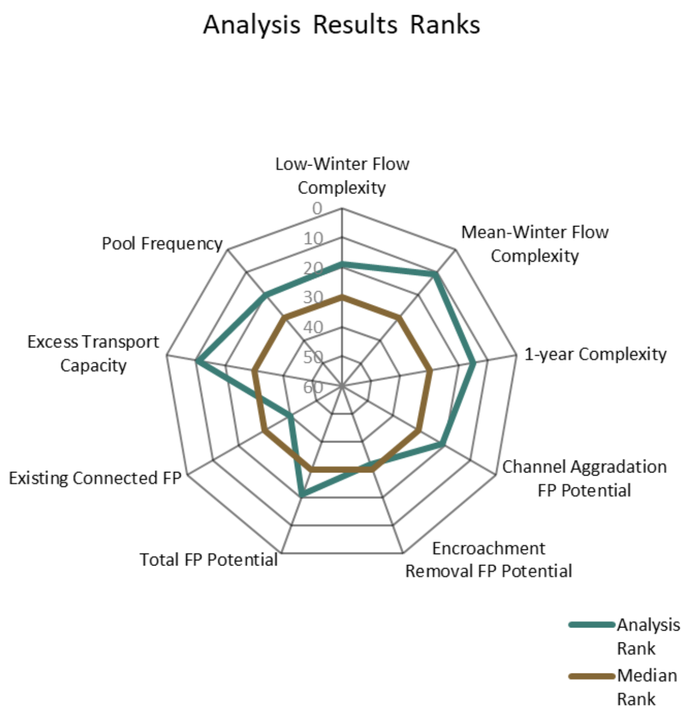
Side channel connection in PA 1.1 has been achieved moderately well; both side channels that were targeted in the restoration work were flowing during field observations. However, the main channel lacks significant mid-channel bars or split flow and is generally plane-bed with little instream complexity. There are also several additional side channel opportunities, visible on the relative elevation map, which have not been connected during low-winter, mean-winter, or 1-year flows. The primary enhancement strategy for this reach should be to develop instream structure through wood placement. The relative lack of geomorphic change in this reach is likely due in part to the lack of easily transportable gravel and cobble material in this reach. Augmenting the enhancement strategy of wood placement with gravel augmentation could help to develop instream complexity and habitat features on a more advanced timetable. It should be noted that PA 1.1 appears to have excess transport capacity relative to its average slope, and any gravel augmentation in this reach will be significantly more effective after more instream structure has been added to the channel. Field observations also noted that many of the abandoned floodplain terraces, particularly on the island formed by the side channels, appeared to be composed of the easily transportable material that would be ideal for gravel augmentation. A combined effort of floodplain benching and gravel augmentation may be an efficient use of resources in this area.

Much of the connectivity potential in this reach appears to be in the areas surrounding the existing 2-year floodplain, which could be activated through gravel augmentation and hopefully channel aggradation. The rest of the floodplain connectivity potential area is located in and around side channel opportunities, and reconnecting these side channels through pilot cuts and adding wood structure should be a secondary enhancement strategy for this reach. It is important to note that the downstream side channel, which was flowing during low-flow field observations, appears to be disconnected at the 2-year event. This side channel was initiated by an upstream structure and pilot channel. With consistent flows, and as long as the side channel forcing log jam does not wash out, enough geomorphic change in this channel should occur over time to lower it below the 2-year event elevation.

Summary of Restoration Opportunities Identified

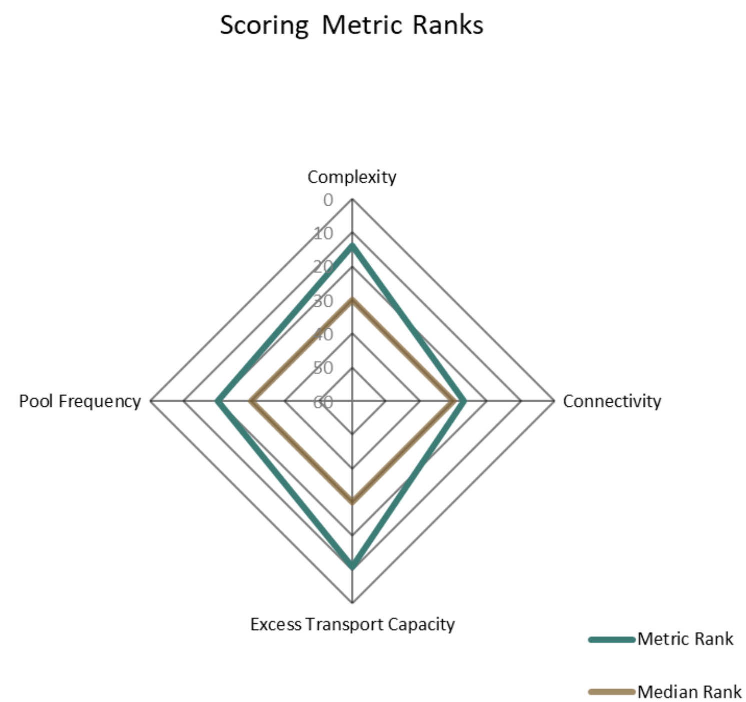
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure and wood loading (LWD)

PA 1.1 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.

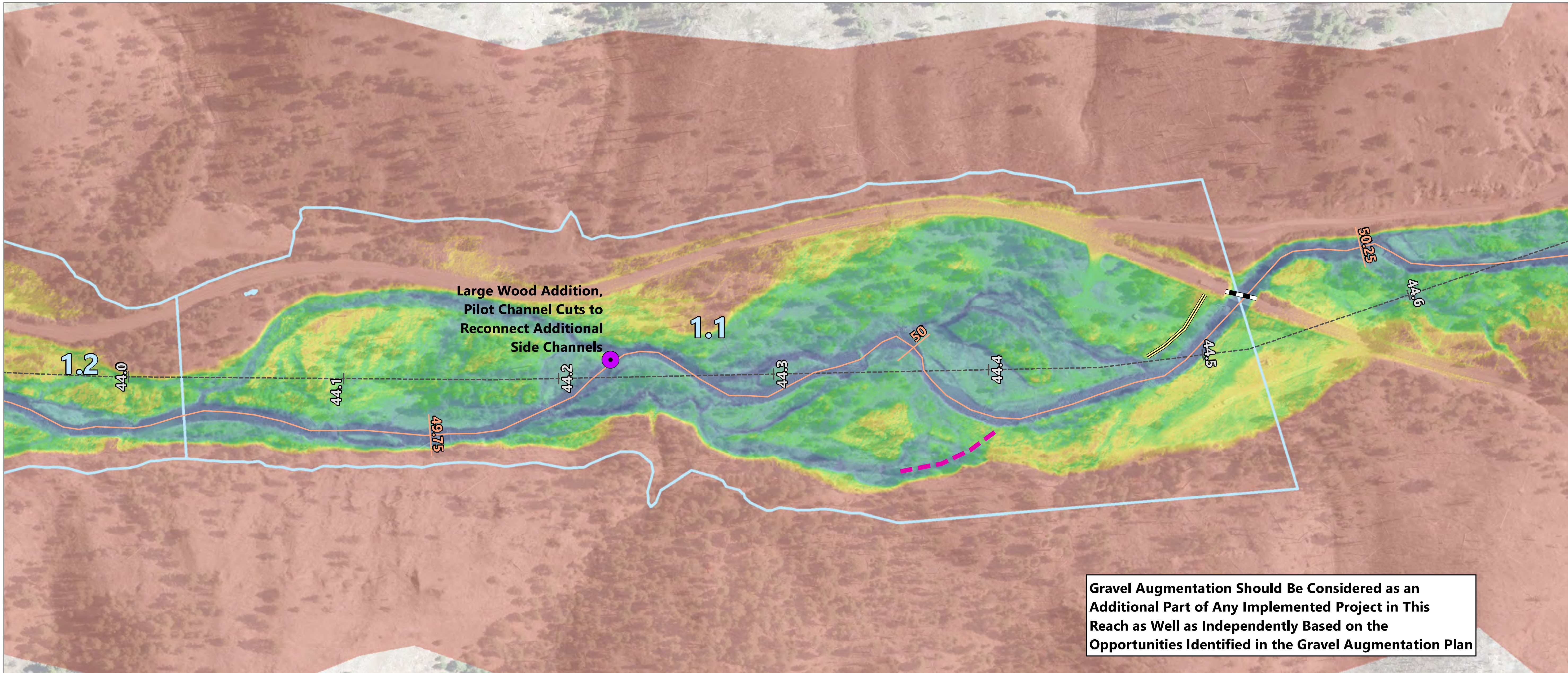
PA 1.1 Prioritization Scoring Summary

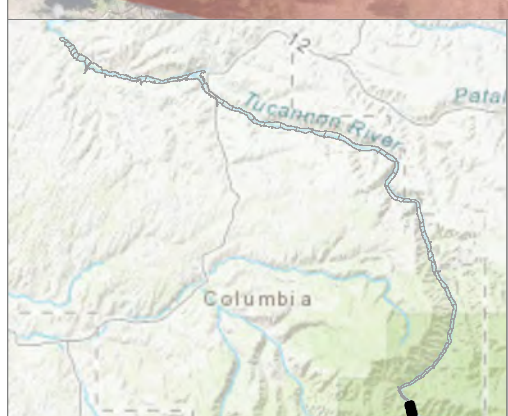


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 1.1 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	0.241	19	40%	Complexity	0.364	14	10% to 40%	2 of 5	3	40%	3.0	13	1	Treated	4	1
Mean-Winter Flow Complexity	0.423	11	40%													
1-year Complexity	0.491	15	20%													
Channel Aggradation FP Potential	0.249	21	40%	Connectivity	0.206	27	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.065	32	40%													
Total FP Potential	0.403	21	20%													
Existing Connected FP	0.597	40	0%													
Excess Transport Capacity	0.16	11	100%	Excess Transport Capacity	3.000	11	10% to 30%	2 of 4	3	20%						
Pool Frequency	14.55	20	100%	Pool Frequency	0.373	20	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
- 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: 49.63
RIVER MILE END: 50.18
VALLEY MILE START: 44.02
VALLEY MILE END: 44.52

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Feet

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ANCHOR QEA

Project Area 1.1
Conceptual Adaptive Management and Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 3.2 Description

Project Area 3.2 begins at VM 41.44 and extends upstream to VM 42.73. The 2017 RM length is 1.44 miles. Field observations for PA 3.2 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 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. Since the 2011 assessment, this reach has undergone a restoration project in 2014 with additional wood loading in 2018, based in part on the opportunities identified in the 2011 prioritization. However, restoration actions in this project area were very recent and occurred after the raw data for this report were collected in 2017, and this project description may be out of date.

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. Only a few side channels were observed that appeared to provide minimal habitat benefit.

The availability and quality of instream habitat was limited by lack of complexity and hydraulic conditions that prevented the

Project Area 3.2
Post-project photograph taken May 7, 2019, post high flow. The log jams placed in 2018 captured disconnected floodplain channels.

Project Area 3.2 Reach Characteristics

VM Start (mi)	41.44
VM Length (mi)	1.29
Valley Slope	1.61%
RM Start (mi)	46.79
RM Length (mi)	1.44
Average Channel Slope	1.44%
Sinuosity	1.12
Connected FP (ac/VM)	13.21
Encroachment Removal (ac/VM)	0.30
Channel Aggradation (ac/VM)	4.81
Total FP Potential (ac/VM)	5.07
Encroaching Feature Length (ft)	1,344.17
Connected FP Rank	35

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 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.

Restoration Actions and Geomorphic Changes

Restoration in PA 3.2 was conducted in both 2014 and 2018. In 2014, the goal was to return a roughly 1.3-mile reach of the river located within the Washington Department of Fish and Wildlife WT Wooten Wildlife Area property closer to its historical, naturally functioning state, and increase river complexity and floodplain connectivity. The 2014 restoration had the following specific short-term objectives: 1) conduct wood loading within the bankfull channel and on the floodplain to increase channel complexity, channel migration, and floodplain connectivity; 2) add 271 LWD key log pieces to increase reach LWD densities to be greater than two pieces per bankfull width; 3) place LWD in 42 strategic locations to increase channel habitat and river channel complexity; and 4) place two structures with the dual purpose of providing habitat cover and acting as a “catcher’s mitt” to help prevent LWD from mobilizing from the project reach.

In 2018, the goal was to return a roughly 1.58-mile reach of the river located within the Washington Department of Fish and Wildlife WT Wooten Wildlife Area property closer to its historical, naturally functioning state, and increase river complexity and floodplain connectivity. The 2018 restoration had the following specific short-term objectives: 1) conduct wood loading within the bankfull channel and on the floodplain to increase channel complexity, channel migration, and floodplain connectivity; 2) place log jams in 58 predetermined locations (using 633 key LWD pieces greater than 6 meters long and 0.3 meter in diameter) to increase channel complexity and habitat cover; and 3) place 10 floodplain structures in currently disconnected flow paths in anticipation of flood flows.

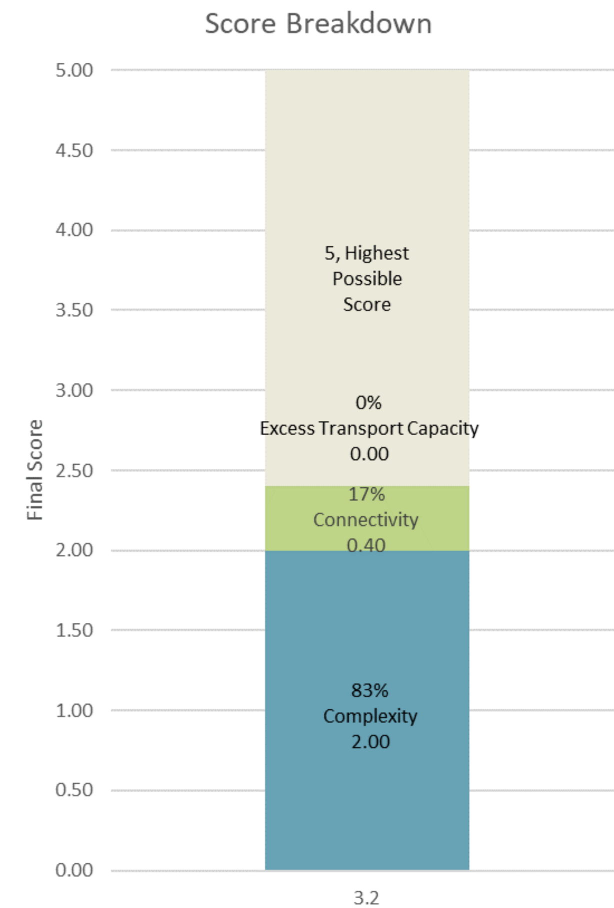
In addition, the 2018 restoration effort had the following specific long-term objectives: 1) strategically place LWD log jams to reconnect floodplain and disconnected side channel and off-channel habitats; 2) connect between 1,175 and 4,460 feet of additional side channel habitat; 3) increase the River Complexity Index value from the 2017 value of 35.09 to potentially 46.16 to 68.91; and 4) capture approximately 12 acres of disconnected floodplain.

Analysis of the difference between the 2010 and 2017 LiDAR data shows relatively minor and localized geomorphic change in PA 3.2; however, any changes resulting from the 2018 restoration efforts will not be reflected in this analysis. All of the highlighted change locations in this project area are relatively similar geomorphic reactions to instream wood. Aggregation and deposition is seen behind the large woody material and some small amount of erosion is seen on the outside of the bed adjacent to the wood. In boxes 3, 5, and 7, there is an associated new split flow with the minor geomorphic change, along with some deposition on the resulting island. These changes are all possibly due to the instream wood restoration efforts in 2014. The fact that changes have been relatively minor could indicate that bedload material in this reach is too large for geomorphic changes to occur after only 4 years.

Geomorphic Characteristics and Management and Enhancement Strategies

The management and enhancement opportunities identified here are based on the 2018 LiDAR and aerial imagery data. However, it should be noted that the restoration actions in this

PA 3.2 Score Breakdown



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

reach occurred shortly after the data were collected and geomorphic response may not have occurred yet and is not yet reflected in the prioritization score.

As shown in the following graphs and table, PA 3.2 scores almost all of its points in complexity, ranking near average in the 40th to 60th percentile, which is the range in which reaches have the most potential for improving complexity. A small amount of points were received for floodplain connectivity potential, mostly from the channel aggradation potential portion, and no points were received for excess transport capacity because PA 3.2 falls below the average transport capacity that would be expected for a project area with similar slope, and may be more depositional in nature then surrounding reaches.

Interestingly, the complexity score is driven by pockets of side channels that exist throughout the project area. At the low flow, only a few of these side channels are currently being activated and are mostly being driven by the split flows and minor geomorphic changes promoted by instream wood. Both the mean-winter and 1-year flows show significant increases to complexity as several longer and more significant side channels are activated. The primary restoration strategy for this reach, which was already implemented in 2018 but not reflected by the data in this assessment, is to improve the connection frequency of these mean-winter or 1-year flow side channels so that they flow perennially. This was accomplished by adding instream structure and LWD and cutting pilot channels when possible. This was the described goal and primary actions taken in the 2018 restoration efforts, which are not reflected in these data, so more time should be given to allow those efforts to cause geomorphic change. However, it should be noted this reach shows only very minor geomorphic change from the 2014 restoration actions of adding instream wood. Contributing factors could include that no significant flows were seen between this restoration and 2017 when the data were collected. It may also indicate that this reach is starved of easily transportable material that allows geomorphic changes to occur on a regular basis. If this is the case, gravel augmentation upstream of this project area may be necessary to jumpstart geomorphic processes in this project area.

Finally, the pool frequency in this reach appears to be slightly below average for the basin. More pools are likely to form as a result of the recent restoration actions. However, similar to complexity, should these changes not occur, gravel augmentation will allow for more frequent pool formation around any instream structure.

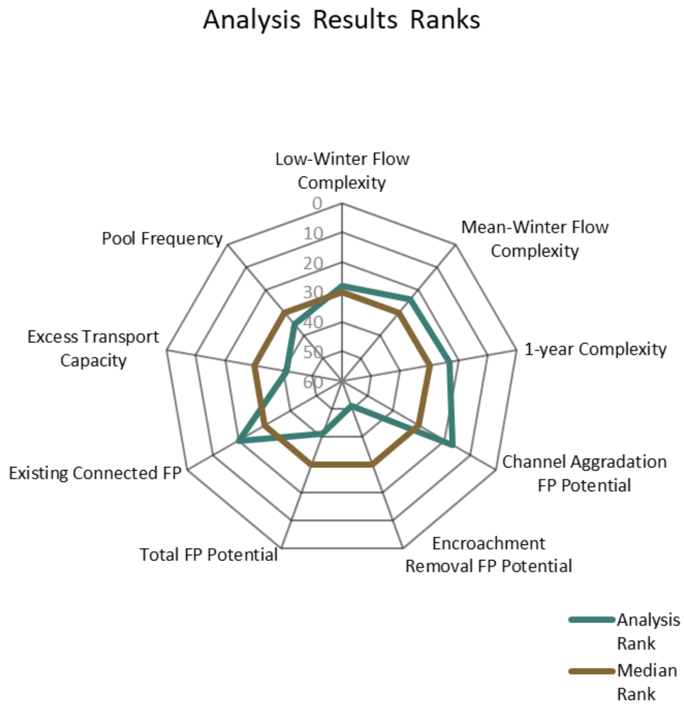
Summary of Restoration Opportunities Identified

- Gravel augmentation
- Reconnect side channels and disconnected habitats

Long-Term Opportunities in this Project Area

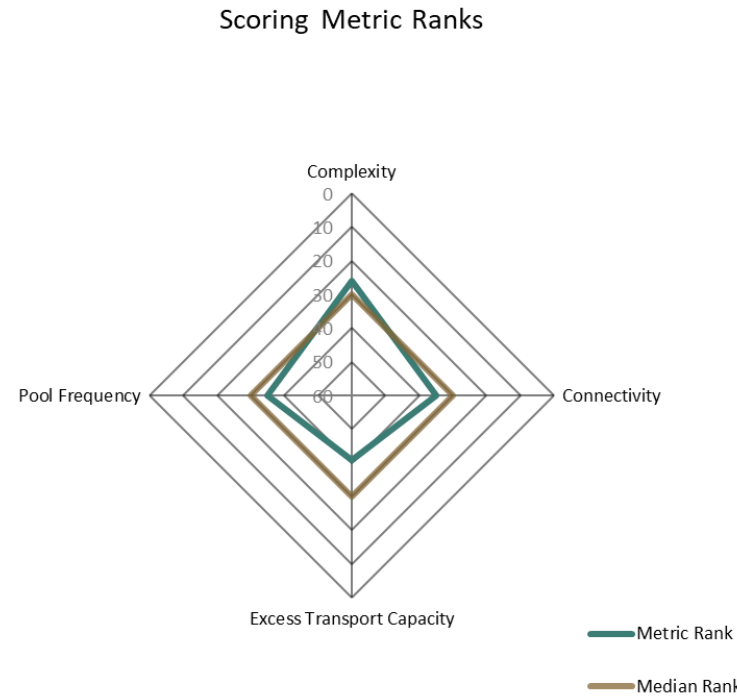
Reconfigure lake at Camp Wooten to reconnect floodplain and consider decommissioning and removing if ever feasible.

PA 3.2 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.

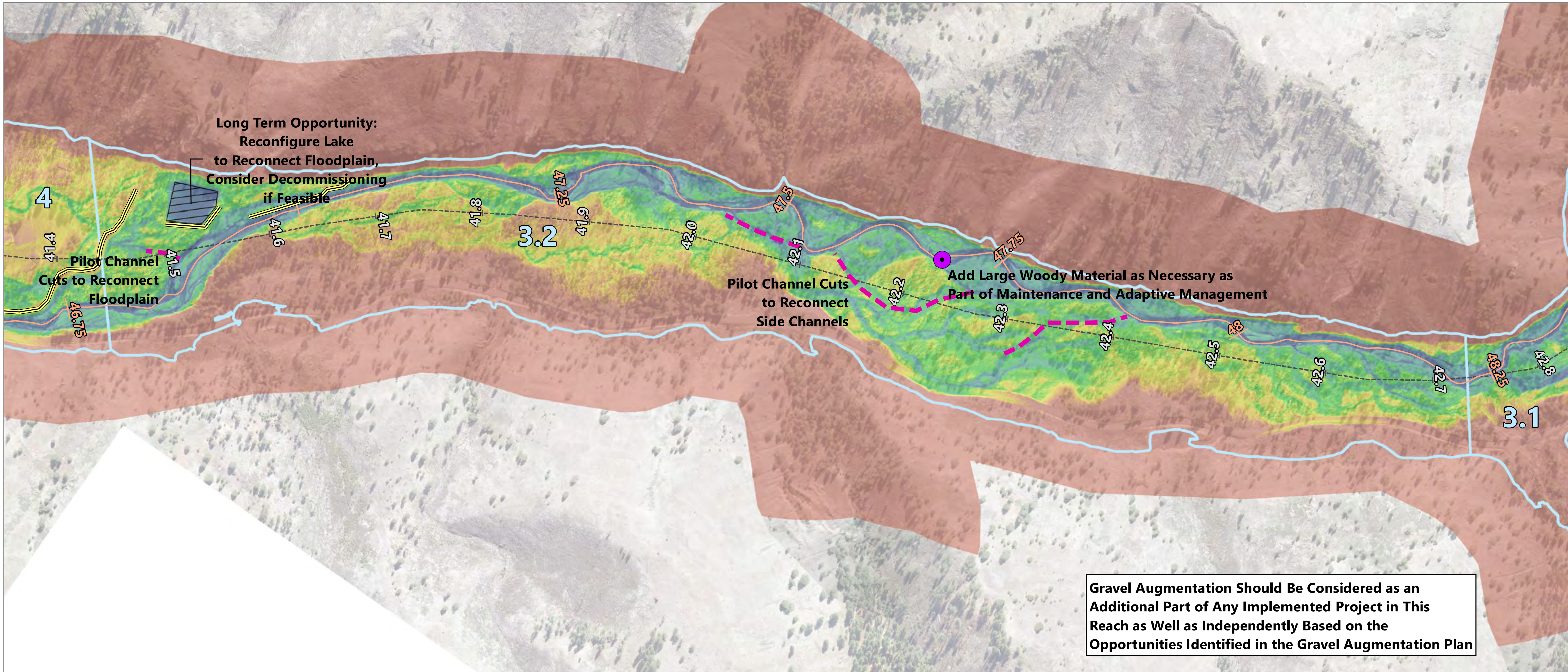
PA 3.2 Scoring Metric Ranks



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 3.2 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	0.164	28	40%	**Complexity**	0.256	26	40% to 60%	3 of 5	5	40%	2.4	20	1	Treated	7	1
Mean-Winter Flow Complexity	0.293	24	40%													
1-year Complexity	0.369	23	20%													
Channel Aggradation FP Potential	0.263	17	40%	**Connectivity**	0.167	35	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.017	51	40%													
Total FP Potential	0.277	41	20%													
Existing Connected FP	0.723	20	0%													
Excess Transport Capacity	-0.08	41	100%	**Excess Transport Capacity**	0.000	41	52% to 100%	4 of 4	0	20%						
Pool Frequency	10.42	35	100%	**Pool Frequency**	0.267	35	40% to 60%	3 of 5	5	0%						



LEGEND:

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

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: 46.79
RIVER MILE END: 48.23
VALLEY MILE START: 41.44
VALLEY MILE END: 42.73

0 500
Feet

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ANCHOR QEA

Project Area 3.2
Conceptual Adaptive Management and Restoration Opportunities

Project Area 6 Description

Project Area 6 begins at VM 40.16 and extends upstream to the NF-160 bridge crossing at VM 40.80. The 2017 RM length is 0.74 mile. Field observations for PA 6 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization. Since the 2011 assessment, this reach has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization. However, restoration actions in this Project Area were implemented very recently (July 2017) and occurred just before the raw data for this report were collected in 2017.

In the upper portion of the project area, the channel is a single-thread, plane-bed channel with little complexity. Two vortex weirs mid-reach were placed by the USFS to maintain and hold the channel grade for the Camp Wooten and USFS Tucannon Camp Ground. The 2011 assessment noted that this portion of the channel contained very little LWD or other hydraulic complexity, other than the pools at the weirs, which was also the observation in 2019 habitat survey conducted by the Programmatic. There continued to be very little suitable habitat for juvenile fish except near the channel margins. Habitat conditions are also affected in the summer months by recreational use related to the adjacent campground.

Project Area 6
Engineered log jam placed by helicopter 2 years following construction in 2017.

Project Area 6 Reach Characteristics

VM Start (mi)	40.16
VM Length (mi)	0.64
Valley Slope	1.69%
RM Start (mi)	45.35
RM Length (mi)	0.74
Average Channel Slope	1.44%
Sinuosity	1.17
Connected FP (ac/VM)	11.76
Encroachment Removal (ac/VM)	6.48
Channel Aggradation (ac/VM)	2.80
Total FP Potential (ac/VM)	11.86
Encroaching Feature Length (ft)	476.89
Connected FP Rank	40

About 0.25 river mile downstream, the channel was more complex in 2011, with a multi-channel configuration with forced pools and riffles at LWD and along the bedrock valley wall. Instream habitat conditions in the main channel were generally good, due to the presence of large LWD that retained additional mobile wood and forced deep pools. Two large side channels met the main river near the middle and downstream end of the reach, providing good off-channel rearing habitat with ample cover, depth, and low velocities. The large natural log jam that had existed in 2011 at this site had become undercut by the summer of 2017, reducing the number of side channels and complexity within the reach. In July 2017, a new channel-spanning jam was constructed to aid in reforming the initial natural jam's function (Webmap VM 40.5).

Floodplain connectivity in this project area was adversely affected by the presence of the NF-140 bridge and campground, which cut off approximately half of the low floodplain area. A major former channel position along the southeast valley wall was separated from the river by the campground area. Floodplain connectivity was less impacted for the last tenth of a mile at the downstream end of the project area, where no infrastructure was present. A short portion of the floodplain was somewhat naturally confined by remnant alluvial fan and hillslope deposits from the northwest side of the valley.

Hixon Creek joins with the mainstem at VM 40.48, about midway through the reach. However, Hixon Creek enters the Tucannon River valley at VM 41 in Project Area 5, and runs parallel to the mainstem for just over half a mile through the bottom half of PA 5 and the upper half of PA 6. For this distance, Hixon Creek is separated from the mainstem by Camp Wooten, the USFS Tucannon campground, and associated infrastructure. Hixon Creek has fish access from the mainstem up into the Tucannon Campground where it is disconnected by two undersized culverts in the campground access road.

At the upper end of the project area, riparian vegetation is reported as some of the older growth following the fires of 2006. Larger deciduous trees were present, including red alder, flowering dogwood, and vine maple. The understory was in moderate health but provided little overhanging vegetation.

Towards the downstream end of the project area, the riparian zone was in moderately healthy condition. Riparian trees were mixed coniferous and deciduous. Understory vegetation included groundcover, shrubs, and small trees that provided overhanging vegetation along the banks.

Restoration Actions and Geomorphic Changes

Restoration actions in 2017 began approximately 800 feet downstream of the upper project boundary and ended about 700 feet upstream of the downstream boundary, with a measured treatment length of 0.55 mile. Treatment actions involved placing 40 log jams using 255 key log pieces. The number of key LWD pieces increased from 0.52 key pieces per bankfull width to 3.79 key pieces per bankfull. Additionally, a small side channel pilot channel was excavated to reconnect about 0.22 mile of high-flow channels and floodplain at the lower end of Hixon Creek. Goals for restoration work on PA 6 included increasing pool frequency to greater than 50% increase in pools, which equates to about 10 to 20 pools; increasing channel complexity by increasing secondary channels from 0.24 mile total length to greater than 0.51 mile; and increasing floodplain connectivity.

This assessment assumes that restoration work and geomorphic changes are, for the most part, unrelated due to the timing of the restoration work, which occurred in 2017 shortly before the LiDAR data were collected for this assessment. With so little elapsed time, it is not expected that any geomorphic changes resulting from the restoration project would be apparent in the LiDAR or aerial imagery data. Additionally, a flow event in spring 2018 occurred shortly before the aerial imagery was captured.

The first change occurs at approximately VM 40.65 where significant erosion shows up on the left bank. There are several large channel-spanning log jams just downstream of here apparent in the 2018 aerial imagery and these, along with the upstream erosion, are associated with aggradation behind the log jam and on several bars, along with split flow that did not appear to exist in 2011 (box 1).

Just downstream of this location, there has been aggradation in the main channel and a mid-channel bar is apparent in the 2018 aerial imagery. This aggradation is associated with several large pieces of instream wood and several side channel erosional areas are apparent as a result (box 2). This area represents a good example of how channel aggradation can promote complexity with the addition of instream wood even in the upper reaches of this assessment area.

Several hundred feet downstream, a large channel-spanning log jam has triggered aggradation on the left bank as a bar is built on the inside of a bend. Just downstream of here, another bar is being built on the inside of a bend and minor erosion exists on the outside of the bend (box 3). Immediately downstream of this area, the final area shows a split flow with aggradation on the mid-channel bar forming from the nearby LWD. A significant erosional area is apparent on the bank side of the LWD and it appears that high flows may be cutting behind the log jam.

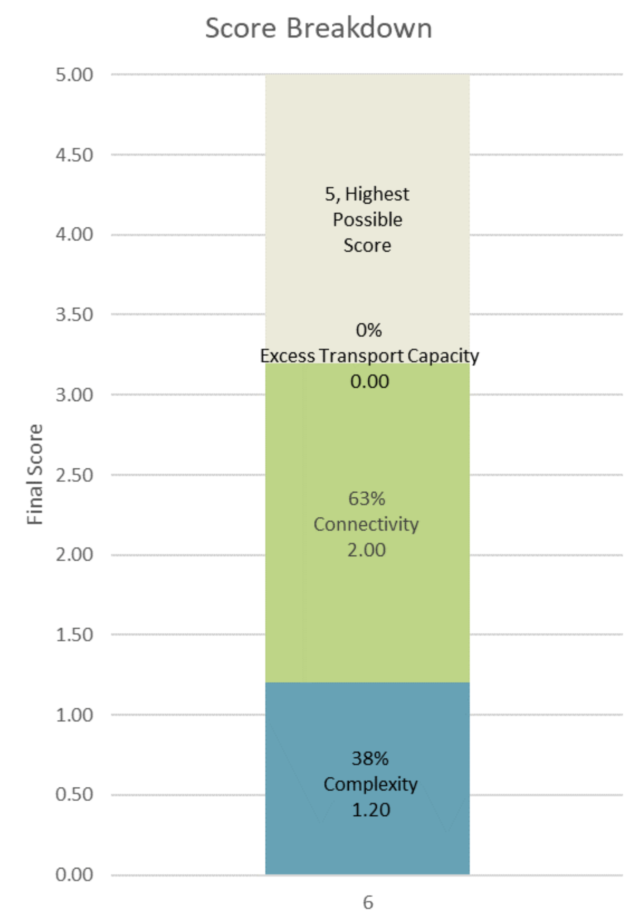
Geomorphic Characteristics and Management and Enhancement Strategies

The management and enhancement opportunities identified here are based on the 2018 LiDAR and aerial imagery data. However, it should be noted that the restoration actions in this reach occurred shortly before the data were collected and geomorphic response had not yet occurred and may not yet be reflected in the prioritization score.

PA 6 receives moderate scores in both Complexity and Connectivity metrics, with a small score for the Excess Transport Capacity metric. The Complexity for this reach is ranked above average in the 60th to 90th percentile, a range that still shows moderate complexity but does not place it in the top 10% of project areas; this project area likely only needs a little restoration work to reach that mark.

The Connectivity score is defined primarily by a high rank in the Encroachment Removal analysis result and is driven by a large low-lying area on the right bank floodplain at the downstream end of the Hixon Creek tributary. Hixon Creek and its associated floodplain runs parallel to the Tucannon River for nearly 0.5 mile, but is separated first by the road for Camp Wooten, and then by the USFS Tucannon campground for about 0.4 mile of this distance. The last 0.1 mile of this tributary and its low-lying floodplain though is what drives the connectivity metric in this project area. This area is disconnected by significant high banks, and the pilot channel cut as part of the restoration action appears to allow 2-year and a small amount of 1-year flow into this area. A primary enhancement strategy for this reach should be to cut pilot channels to reconnect this area at a more frequent rate and add wood structure to promote geomorphic change near where the pilot channels have been cut.

PA 6 Score Breakdown



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

The complexity score is moderate but shows that only a little work is necessary to reach the highest level of complexity for the assessment. As noted in the sections above, restoration actions were completed in 2017, just before these data were collected, and there seems to already have been significant geomorphic response. If the entire tributary was deemed unobtainable, the identified management strategy would be to let the restoration actions in this reach develop. Should geomorphic processes stop, and side channels begin to deactivate at perennial flow, a gravel augmentation plan to jumpstart the geomorphic processes should be considered.

Finally, the pool frequency in this reach appears to be slightly below average for the basin. More pools are likely to form as a result of the recent restoration actions. However, similar to complexity, should these changes not occur, gravel augmentation will allow for more frequent pool formation around any instream structure.

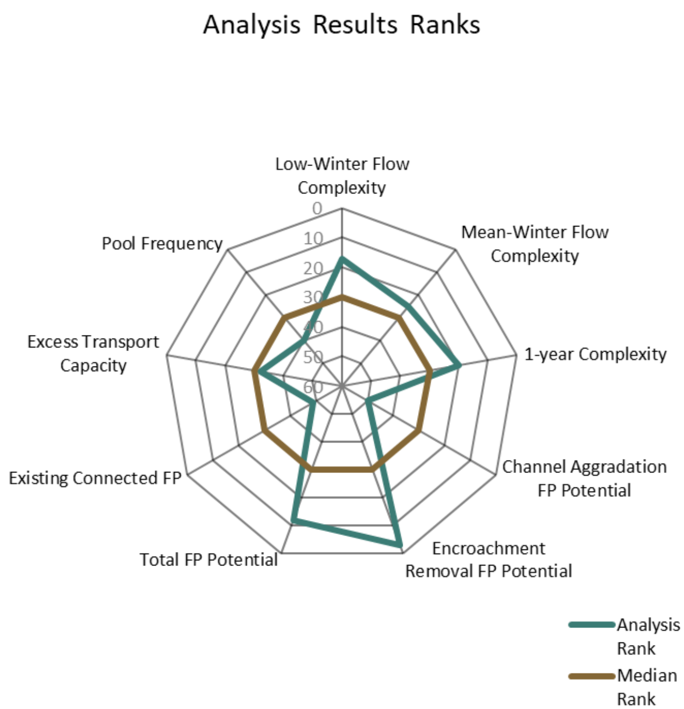
Summary of Restoration Opportunities Identified

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

Long-Term Opportunities in this Project Area

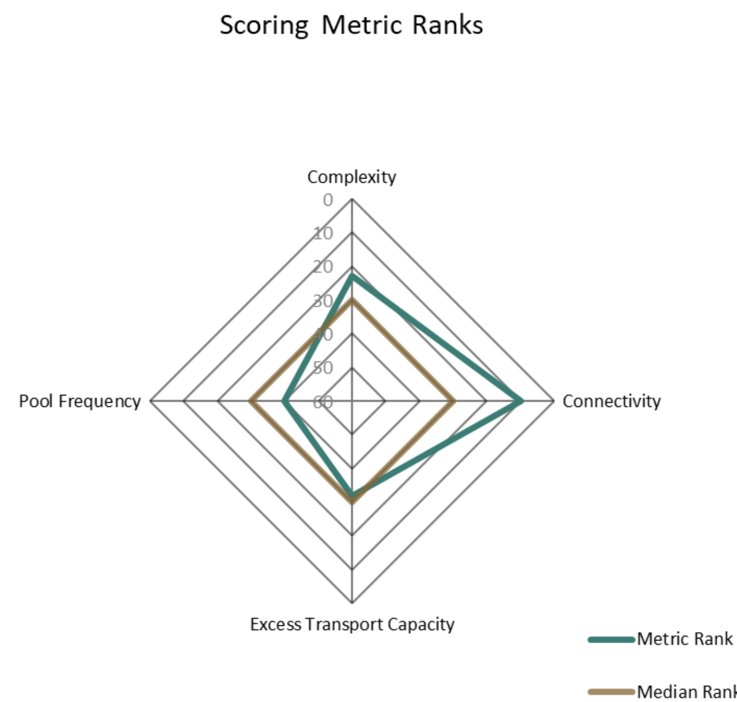
- Set back road against left valley wall for more floodplain connection and channel migration area.
- Relocate or reconfigure access bridge to Camp Wooten upstream, and enlarge the culvert.

PA 6 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.

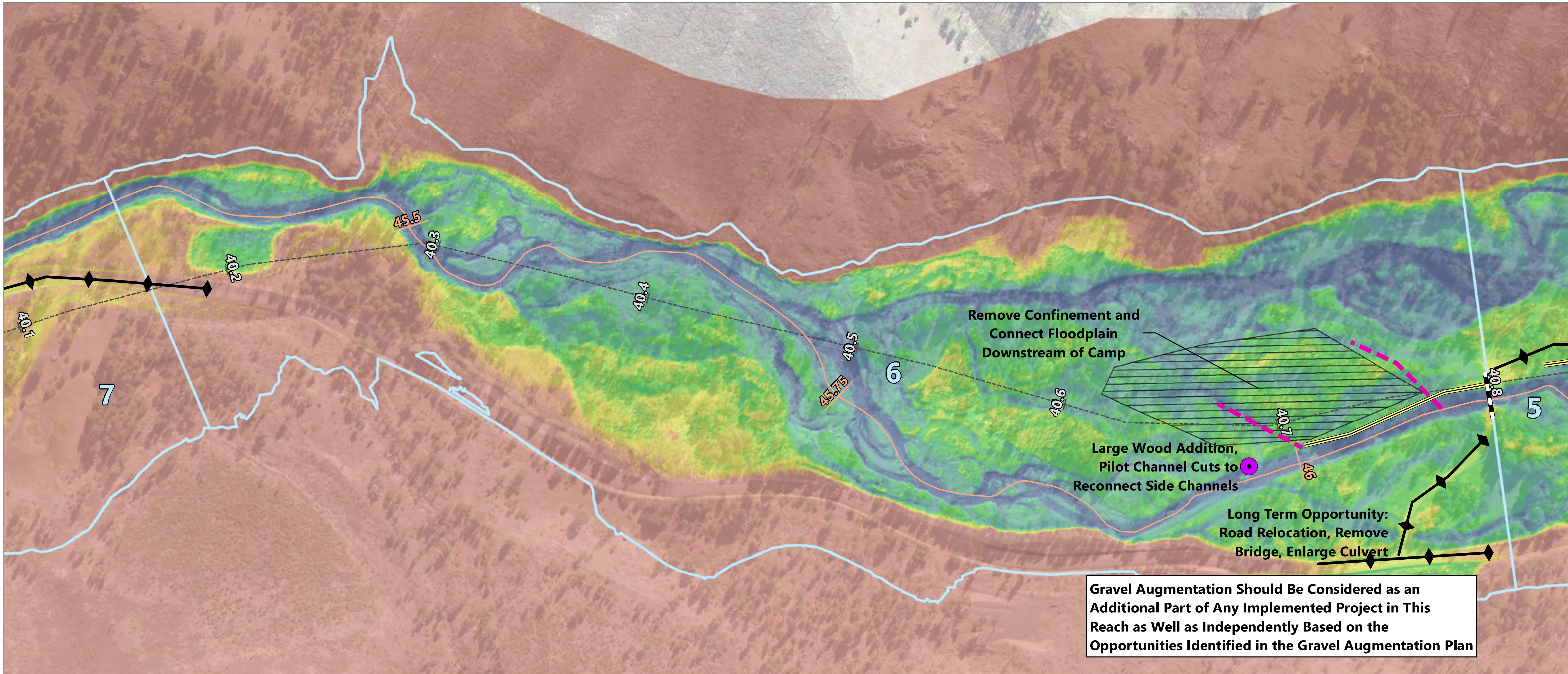
PA 6 Prioritization Scoring Summary

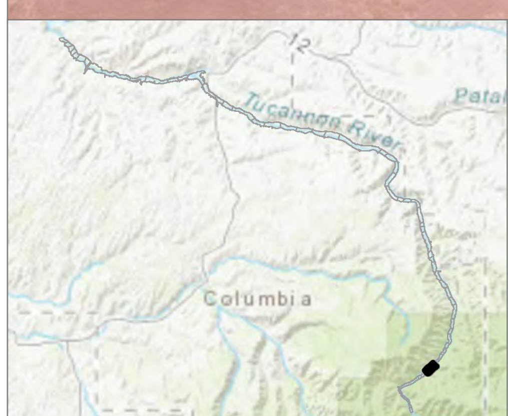


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 6 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	0.245	17	40%	Complexity	0.292	23	10% to 40%	2 of 5	3	40%	3.2	8	1	Treated	2	1
Mean-Winter Flow Complexity	0.291	25	40%													
1-year Complexity	0.387	20	20%													
Channel Aggradation FP Potential	0.118	50	40%	Connectivity	0.258	10	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.275	3	40%													
Total FP Potential	0.502	12	20%													
Existing Connected FP	0.498	49	0%													
Excess Transport Capacity	0.01	32	100%	Excess Transport Capacity	0.000	32	52% to 100%	4 of 4	0	20%						
Pool Frequency	8.07	40	100%	Pool Frequency	0.207	40	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
- Reconnect Side Channel
- Reconnect Floodplain
- 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: 45.35
RIVER MILE END: 46.09
VALLEY MILE START: 40.16
VALLEY MILE END: 40.8

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Feet

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ANCHOR QEA

Project Area 6
Conceptual Adaptive Management and Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 9 Description

Project Area 9 begins at VM 38.92 and extends upstream to VM 39.33. The 2017 RM length is 0.4 mile. Field observations for PA 9 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization or observations based on habitat surveys made in 2019 by the Programmatic partners. Since the 2011 assessment, this reach has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization.

Throughout PA 9, the river is characterized by multiple-channel pathways containing a variety of hydraulic conditions caused by the presence of LWD, including several pools and secondary flow paths. The 2011 assessment noted that local channel expansion was occurring in the project area from just upstream, as evidenced by bank erosion and multiple-flow path development, recently recruited trees in the channel and side channels, and high amounts of temporary sediment storage. A levee is located along the right bank in PA 8 for a short distance at the diversion structure to Big Four Lake. The structure is composed of rock armoring and some rootwads along the toe. The channel adjacent to the levee was wide, shallow, and relatively well-armored due to locally high velocities. A straight, plane-bed stretch of channel adjacent to Big Four Lake had a well-armored bed lined with large cobbles. In general, the project area has good side channel connectivity

Project Area 9
Channel-spanning ELJ placed using a helicopter in July 2017; photograph taken in September 2017.

Project Area 9 Reach Characteristics

VM Start (mi)	38.92
VM Length (mi)	0.41
Valley Slope	1.39%
RM Start (mi)	44.05
RM Length (mi)	0.40
Average Channel Slope	1.38%
Sinuosity	0.98
Connected FP (ac/VM)	13.20
Encroachment Removal (ac/VM)	7.56
Channel Aggradation (ac/VM)	3.03
Total FP Potential (ac/VM)	15.34
Encroaching Feature Length (ft)	1,586.02
Connected FP Rank	36

and contains a variety of side channel types from perennial to high-flow pathways.

The complex sections of channel within this project area provide a variety of hydraulic conditions, including a relatively high amount of off-channel habitat, that provide preferred habitat throughout different life stages over the water year. In 2010, instream habitat conditions in the main channel were generally good in these complex sections due to the presence of large LWD that retained additional mobile wood, forced deep pools, formed side channels, and provided cover and hydraulic refuge. These areas had several well-connected side channels and a wide, active channel and floodplain, which has allowed the channel to migrate. However, the plane-bed sections of the project area lack sufficient volume and size of LWD necessary for instream complexity, which has led to wide, shallow conditions during low flows and high velocities during seasonal high flows. The LWD observed in these reaches did not appear substantial enough to persist and retain additional LWD over time, and by 2016 detreating conditions prompted WDFW to design a wood loading project funded through the Programmatic and implemented in July 2017 five months prior to the collection of LiDAR data in December 2017.

This project area is characterized by a large, active channel area but infrastructure disconnects and prevents connection or channel development in this reach. The floodplain surface is relatively high above the channel bed with a small amount of low floodplain area throughout the valley. The right bank Big Four Lake levee and infrastructure has likely prevented channel migration, but it did not cut the channel off from any significant low areas of the floodplain (within the 5-year water surface elevation). Big Four Lake is approximately two-thirds of the width of the valley, confining the potential width of the floodplain corridor. A large amount of low floodplain exists on the downstream side of the lake, which contained flowing water at the time of field observations that was likely sourced from lake seepage or tributary flow. The current position of the lake prevents an upstream surface water connection to this area. The lake itself accounts for more than 5 acres of floodplain, and its conversion to connected floodplain could be the target of an aggressive restoration project.

The riparian zone was generally in moderate health, with some local areas that had been highly disturbed by fire. Riparian trees were predominantly mature ponderosa pines and young dogwoods and alders. The understory was in moderate health dominated by emergent vegetation that provided little overhang. There were few mature trees and intermediate-sized plants and poor vegetation diversity in several areas. The upstream end of the severe burn zone from the 2005 School Fire begins at the downstream end of the project area.

Restoration Actions and Geomorphic Changes

In 2017, restoration work in PA 9 included placing 50 LWD log jams using 252 key LWD pieces to increase the number per bankfull width from 0.85 to 6.14. (Seven of the LWD log jams placed during this restoration work were downstream of the PA 9 boundary, covering approximately 800 feet of the upper PA 10.) The LWD was placed to promote channel avulsion and inundation during modest mean-winter flows to reconnect 0.44 mile and enhance flow into 0.18 mile of side channel.

This updated assessment assumes that restoration work and geomorphic changes are unrelated due to the timing of the restoration work, which occurred in 2017 shortly before the LiDAR data were collected for this assessment. With so little elapsed time, it is not expected that any geomorphic changes resulting from the restoration project would be apparent in the LiDAR or aerial imagery data.

At the upstream end of PA 9, a large split flow has formed from a mid-channel log jam located in PA 8, and the resulting mid-channel bar in PA 9 is apparent as aggradation in the change analysis. This has caused some minor bank erosion as well on the left bank in this area (box 1). 400 feet downstream of this split flow, additional deposition is apparent in the floodplain that appears to be associated with a channel split flow, indicating that this side channel receives higher flows during flood events to allow sediment to deposit (box 2).

Immediately downstream is the most significant change in the reach in the form of a large amount of aggradation in the main channel. This depositional reach extends for several hundred feet and appears to be associated with a large amount of instream wood seen in the 2018 aerial imagery. Based on local knowledge, the channel began to carve a meander into the gravel bar on river right until the flow undercut a large pine on the left bank, which recruited as a spanner. The plunge pool can be seen in the 2018 aerial imagery near the bottom of box 3. The spanner began to be cut around by 2017 and was augmented with additional materials as part of the PA 9 treatment (box 3).

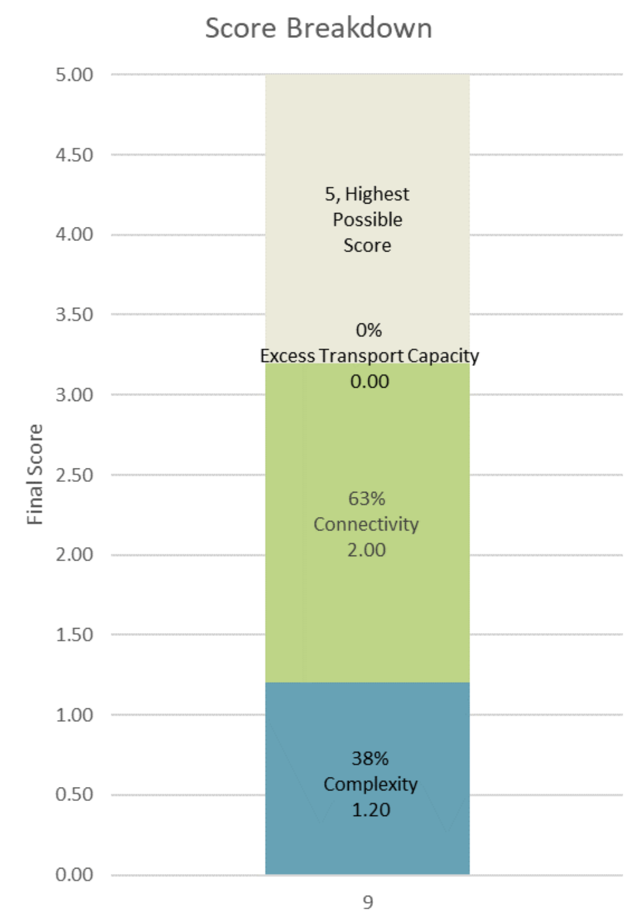
Because the restoration occurred in 2017, less than a year before these data were collected, it is difficult to attribute any of the geomorphic changes to the restoration efforts. However, the 2018 aerial imagery shows the restored project area after at least one major flow event (in the winter of 2017/2018), and there does appear to be some additional split flow and complexity resulting from the added instream wood.

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 9 receives a high score in the Connectivity metric and a moderate score in the Complexity metric. The high Complexity score indicates that this project area already ranks above average in the 60th to 90th percentile of project areas, a range that still shows moderate complexity but does not place it in the top 10% of project areas; this project area likely only needs a little restoration work to reach that mark. The high Connectivity score indicates this project area ranks near the top in the 75th to 99th percentile of all project areas. This high score is almost entirely driven by the Encroachment Removal analysis result, which ranks near the top, while the Channel Aggradation analysis result ranks near the bottom. The potential area to be reconnected exists almost entirely on the right bank, downstream of the Big Four Lake located in the floodplain of this project area. This area is a series of low-lying channels that could be relatively easily reconnected at the 2-year event. However, the largest benefit to the floodplain would be the decommission and reconnection of the lake itself, which would provide more than 5 acres of reconnected floodplain itself. The removal of this lake and associated levees would be a very large restoration project and would require additional restoration strategies such as riparian planting and addition of LWD. The levees from the lake present a possible opportunity for gravel augmentation, and the nearby fishing access parking lot presents a possible location for gravel augmentation. This project area has already been treated with a large amount of instream wood, so the primary enhancement strategy should be to reconnect this right bank area via pilot channel cuts or larger removal of the high right bank separating this area.

Additionally, if this area can be connected at the mean-winter flow or lower, this would also be a significant boost to the complexity in this reach by adding a long and potentially complex side channel. It should be noted that, while the main channel was heavily treated with instream wood, none of this additional potential area was treated on the floodplain, and adding wood to

PA 9 Score Breakdown



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

this area should be a primary enhancement strategy should this area be targeted for reconnection.

This project area was only treated shortly before the LiDAR data were collected and likely needs more time to respond to the large amount of instream wood added. However, should significant geomorphic changes not occur, gravel augmentation may be necessary to provide more easily transportable material to the reach and should be considered a management strategy for the restoration actions already implemented.

The pool frequency in this reach appears to be slightly below average for the basin. More pools are likely to form as a result of the recent restoration actions. However, should these changes not occur, gravel augmentation will allow for more frequent pool formation around any instream structure.

Finally, it should be noted that the Big Four Lake occupies a large portion of the floodplain in this project area. Reconfiguration of this lake, as discussed in the Wooten Floodplain Management Plan, should be considered to increase the floodplain connectivity in this area. Additionally, while decommissioning and removing this lake would require a specific set of circumstances to be possible, as well as a large effort, it would provide the largest benefit to both the floodplain connectivity and complexity of this project area.

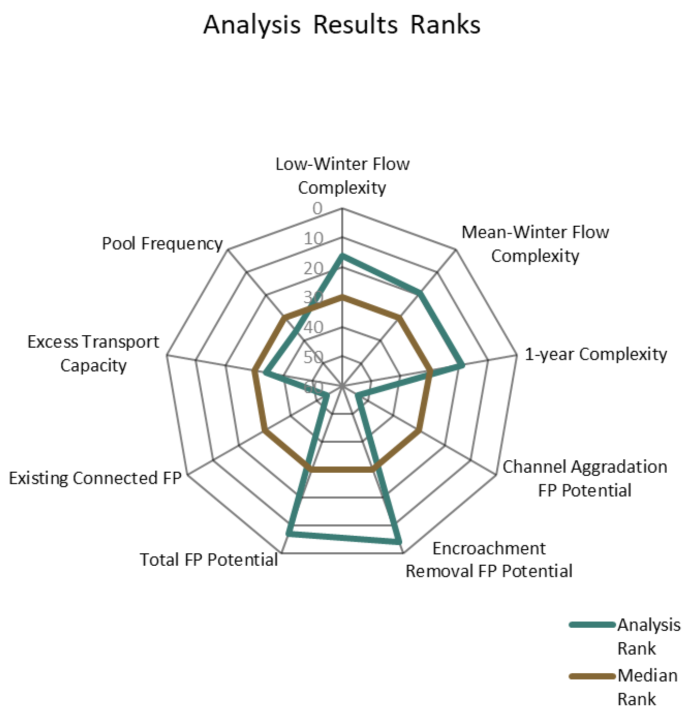
Summary of Restoration Opportunities Identified

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

Long-Term Opportunities in this Project Area

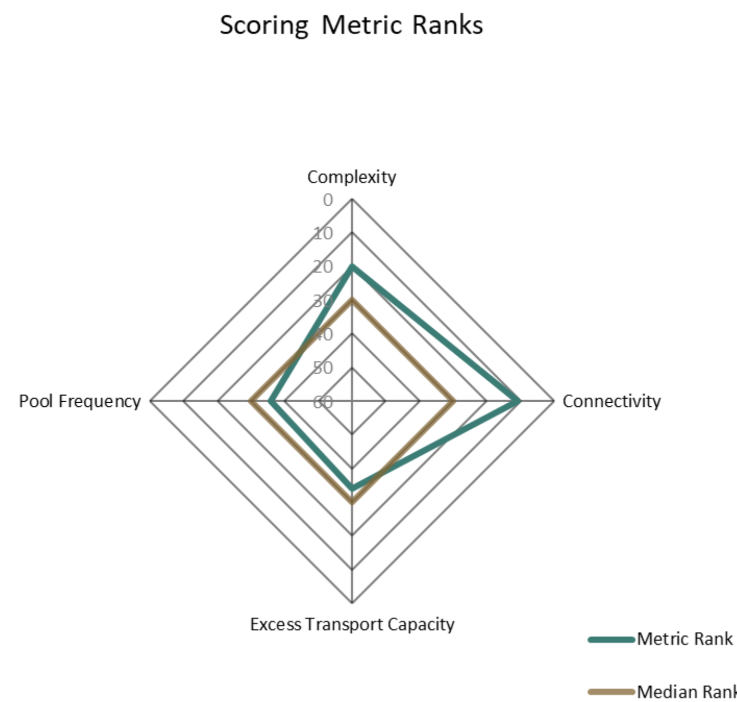
- Reconfigure Big Four Lake to reconnect floodplain and consider decommissioning and removing if ever feasible.

PA 9 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.

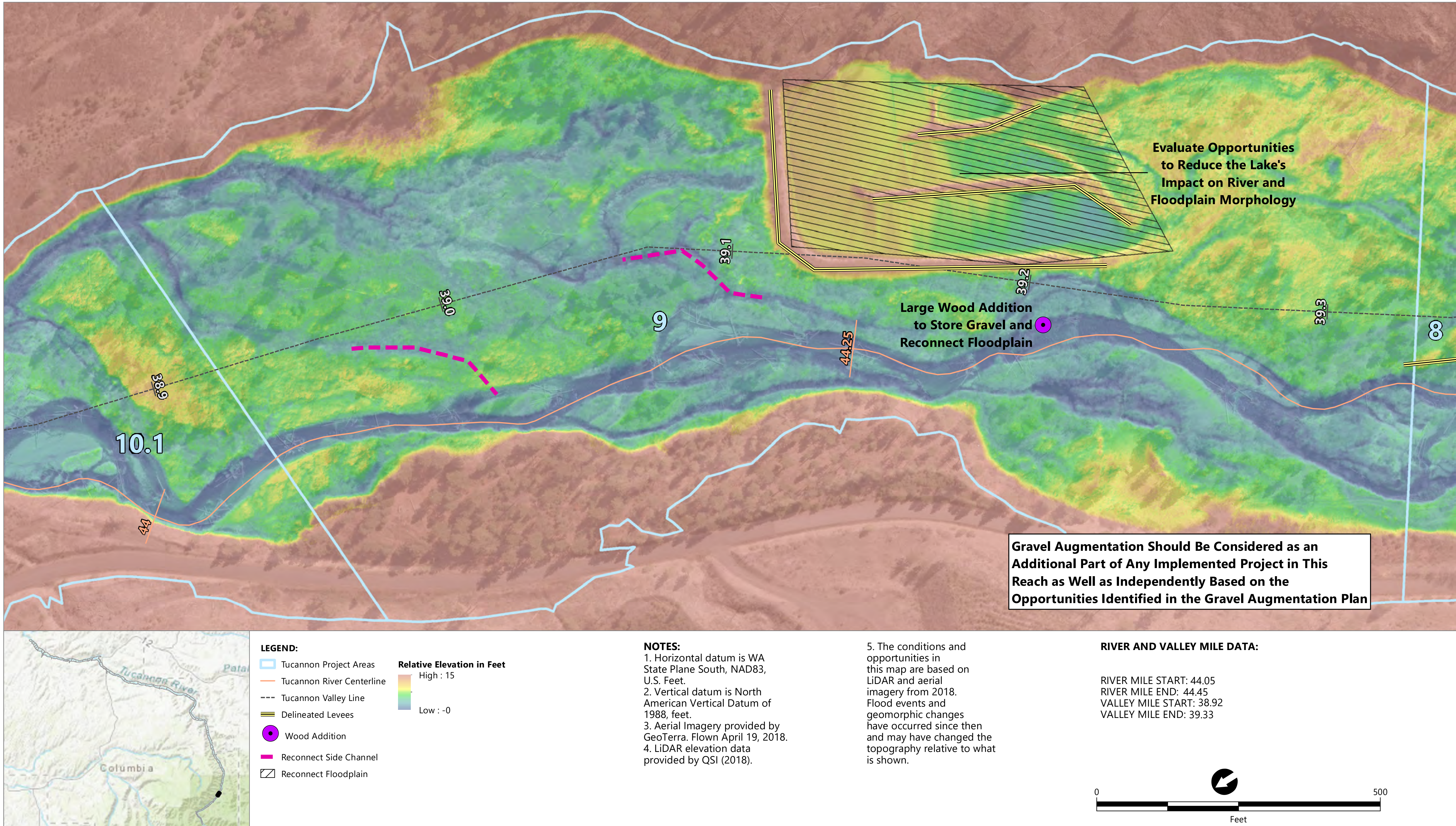
PA 9 Prioritization Scoring Summary



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 9 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	0.261	16	40%	**Complexity**	0.310	20	10% to 40%	2 of 5	3	40%	3.2	9	1	Treated	3	1
Mean-Winter Flow Complexity	0.315	19	40%													
1-year Complexity	0.401	19	20%													
Channel Aggradation FP Potential	0.106	54	40%	**Connectivity**	0.256	11	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.265	4	40%													
Total FP Potential	0.538	7	20%													
Existing Connected FP	0.462	54	0%													
Excess Transport Capacity	-0.03	34	100%	**Excess Transport Capacity**	0.000	34	52% to 100%	4 of 4	0	20%						
Pool Frequency	9.99	36	100%	**Pool Frequency**	0.256	36	40% to 60%	3 of 5	5	0%						



LEGEND:

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

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: 44.05
RIVER MILE END: 44.45
VALLEY MILE START: 38.92
VALLEY MILE END: 39.33

0 — 500
Feet

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ANCHOR QEA

Project Area 9
Conceptual Adaptive Management and Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 14.2 Description

PA 14.2 begins at a bridge crossing for the Tucannon Road at VM 33.64 and extends upstream to VM 34.26. The 2017 RM length is 0.82 mile. Field observations for PA 14.2 were conducted on September 27, 2018, when flow at the Starbuck gage was approximately 82 cfs.

For this assessment update, PA 14 as defined in the 2011 prioritization was separated into three project areas (PA 14.1, PA 14.2, and PA 14.3). In 2014, the upper sections of this project area (PA 14.1 and PA 14.2) were the subject of a restoration project, while PA 14.3 has remained untreated. PA 14.1 and PA 14.2 represent distinct parts of the restoration project and were therefore separated for distinct analysis.

At the upstream end of PA 14.2 is a sharp meander bend with a deep pool with overhanging cover. On the left bank behind this pool, the immediate floodplain is high, but approximately 200 feet along the meander bend is the start of a side channel that at the downstream end has water flowing, likely from groundwater. It is possible this side channel could cut off the large meander bend and become the main channel if it cuts through the left bank.

After this first sharp meander bend, the channel runs along the right bank valley wall for a long reach. It was noted during site observations that this reach had very little instream wood because it was not treated due to difficulty in access, except for

Project Area 14.2
Engineered log jam with channel-spanning recruits likely from upstream structure losses.

Project Area 14.2 Reach Characteristics

VM Start (mi)	33.64
VM Length (mi)	0.61
Valley Slope	1.56%
RM Start (mi)	37.88
RM Length (mi)	0.82
Average Channel Slope	1.13%
Sinuosity	1.34
Connected FP (ac/VM)	8.81
Encroachment Removal (ac/VM)	0.51
Channel Aggradation (ac/VM)	2.49
Total FP Potential (ac/VM)	3.37
Encroaching Feature Length (ft)	640.77
Connected FP Rank	54

a large structure on the right bank that is causing erosion on the left bank and creating several split flows.

After the reach along the valley wall, at approximately VM 34.13, a large apex jam has accumulated a lot of wood recruits and is forcing a split flow onto the left bank. Just downstream, there are several individual wood pieces and the side channel from the pool at the upstream end of the reach returns in a low swampy area on the left bank.

Downstream of the swampy area, a very large ponderosa pine log has fallen in and is spanning the channel. This tree is relatively well entrenched, and scour and erosion are occurring on the left bank at this location. Just above this ponderosa pine, the right bank is beginning to cut off the meander with a side channel running down to the next meander.

The channel goes through another straight, uniform stretch with little instream wood until VM 34.01 where the channel goes through another sharp meander bend. A large apex jam here is causing split flow and erosion on the right bank, followed closely by a massive channel-spanning log jam and a bank barb jam on the left bank as the channel makes a sharp turn close to the road. The channel-spanning log jam is creating good complexity with deeper pools and multiple side channels. The bank barb jam appears to have collected a lot of wood recruits and is also creating good complexity.

Between VM 34 and VM 33.89, the channel is straight and uniform with little instream wood except for a few small engineered bank barbs that appeared to be mostly disconnected at the time of the site visit.

At VM 33.89, a large log is controlling the grade with a large drop-off, which could make the structure a possible fish impediment, but a large V-notch has been cut into the center of the log to allow a low-flow path over the log.

At VM 33.87 and 33.77, there are two large channel-spanning log jams that are creating good complexity but apparently with relatively little geomorphic change.

At the downstream end of the project area, Cummings Creek joins the Tucannon River and was flowing during the site visit. The area just downstream of Cummings Creek appears to have some of the most dynamic channel forms in the reach, with several side channels and split flows through the trees.

For almost all of the log jams through this reach, there is some localized geomorphic change, but very few have deep scour pools and, given the size of the log jams, the amount of geomorphic change occurring seems relatively low. The bed material through this reach is relatively large, with mostly large cobbles and boulders and very little transportable gravel. This may be an important factor in the lack of deep scour pools and complexity around these large log jams.

Riparian vegetation through the bottom half of the reach is relatively poor up until the area around Cummings Creek, consisting of mostly mature coniferous species with some undergrowth, but large stretches of grassy upland areas. At the upstream end, the riparian vegetation provides more cover and woody material. After the first bend on the upstream side, the left bank and the second bend on the right bank are large wetland complexes with younger deciduous tree stands and large areas of canary grass.

Restoration Actions and Geomorphic Changes

In 2014, restoration work in PA 14.2 included placing 34 LWD structures within the reach using 303 key LWD pieces. The restoration project targeted connecting approximately 1,700 feet of ephemeral side channels. The goal for this reach was to increase channel complexity and floodplain connectivity at a 2-year level and less.

Analysis of the difference between the 2010 and 2017 LiDAR data shows multiple locations of significant geomorphic change, many of which were likely caused by the restoration actions in the reach. At the beginning of the reach, a large erosional area in a sharp bend has formed a deep pool and is associated with bar building on the right bank. This change does not appear to be forming as a result of a restoration structure (box 1).

Near the middle of the reach, a large mid-channel engineered log jam has caused a large depositional area both immediately upstream of the log jam and downstream on the left bank. A small area of bank erosion likely from scour is located on the left bank next to the log jam (box 2). This log jam is one example of several mid-channel structures in this reach that have caused localized geomorphic change, not all of which have been highlighted for this narrative.

Immediately downstream of here, a bank barb type structure on the left bank has cause some localized erosion on the left bank and a depositional bar building on the right bank (box 3). The next highlighted area occurs around the next bend, and includes another mid-channel log jam, but this time with a large depositional area immediately upstream. On the bank immediately behind this log jam in the same area, erosion has occurred in the start of a floodplain side channel (box 4).

At VM 34, a series of channel-spanning log jams and a left bank log jam has caused bank erosion on the right bank and deposition on the left bank. Some minor bar building has occurred immediately downstream of these log jams on the right bank and is associated with erosion on the left bank (box 5). The next channel-spanning jam has also caused erosion and a minor avulsion to the right bank (box 6).

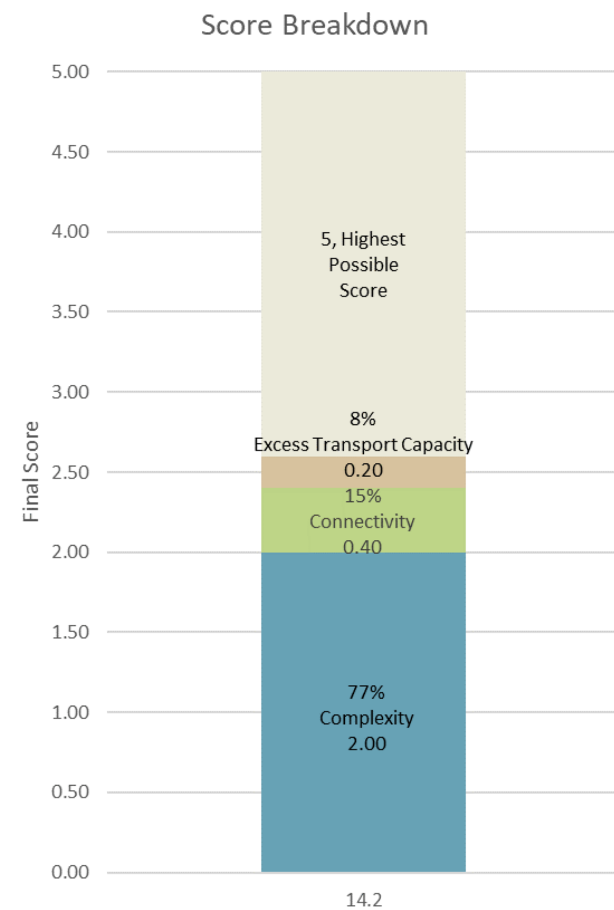
Finally, at the downstream end of the reach and downstream of Cummings Creek, two large engineered log jams have caused a major avulsion towards the right bank (box 7).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 14.2 receives most of its prioritization score from the Complexity prioritization metric. The Complexity metric for PA 14.2 ranks within the 40th to 60th percentile of project areas, a range which receives the highest score for this metric. Project areas in this range have been identified as having moderate complexity and have the most opportunity for improvement. This complexity score is driven mostly by moderate ranks in complexity for all three flows. At the low-winter flow, complexity comes in the form of several mid-channel bars, almost exclusively the result of placed wood structures. At the mean-winter and 1-year flows, an additional side channel is connected mid-reach, providing slightly higher complexity scores. This channel has been reported as being perennially connected in recent years.

However, based on the relative elevation map, several side channel opportunities exist between the bends in these reaches. While wood structure has already been added to this reach, it was noted during field observations that several long stretches could benefit from more wood structure. The primary enhancement strategy for this reach should be to connect

PA 14.2 Score Breakdown



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

these side channels, by strategically placing wood structures in conjunction with pilot channel cuts. Adding wood structure will also contribute to more in-channel complexity.

This project area does not receive any prioritization points for floodplain connectivity, but the Channel Aggradation Floodplain Potential analysis result is ranked near the middle of all reaches. Furthermore, while side channel opportunities appear accessible on the relative elevation map, it may be possible that channel-forming flows do not reach elevations sufficient to allow erosion and flow down these channels. Channel aggradation through gravel augmentation would allow these side channels to be more regularly inundated and achieve some of the floodplain potential indicated through the Channel Aggradation Floodplain Potential analysis result. Gravel augmentation should be pursued as an additional restoration strategy in this reach. The Excess Transport Capacity metric ranks well above average but still falls in a range where the transport capacity is not significantly more than would be expected of the slope, and thus receives a low prioritization score. Adding some wood structure will help to store and maintain any sediment added through gravel augmentation.

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

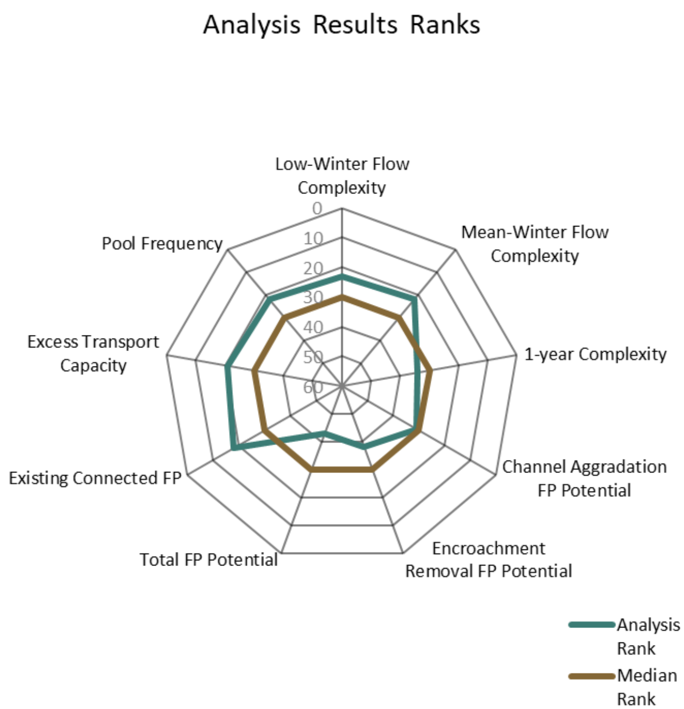
Summary of Restoration Opportunities Identified

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

Long-Term Opportunities in this Project Area

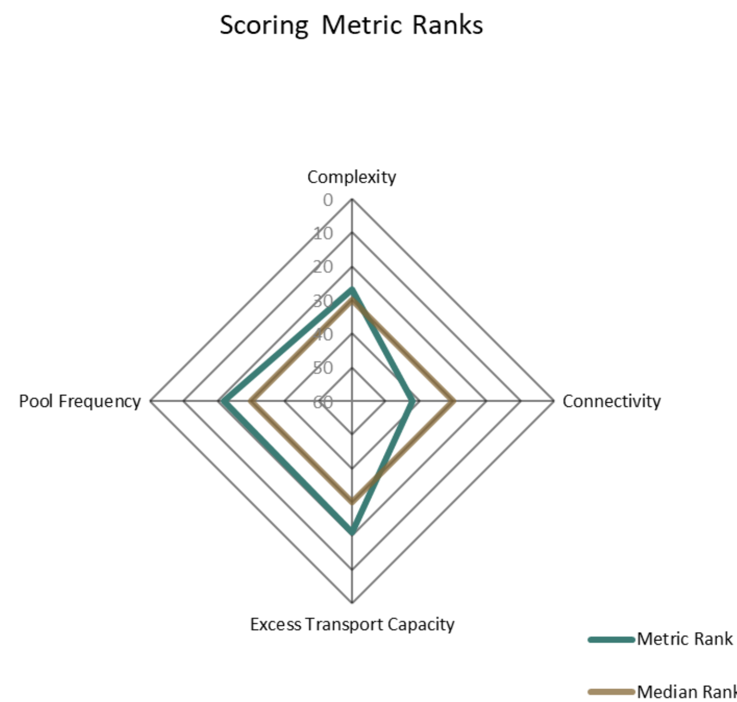
- Set back road and relocate parking areas out of left floodplain for more floodplain connection and channel migration area.

PA 14.2 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.

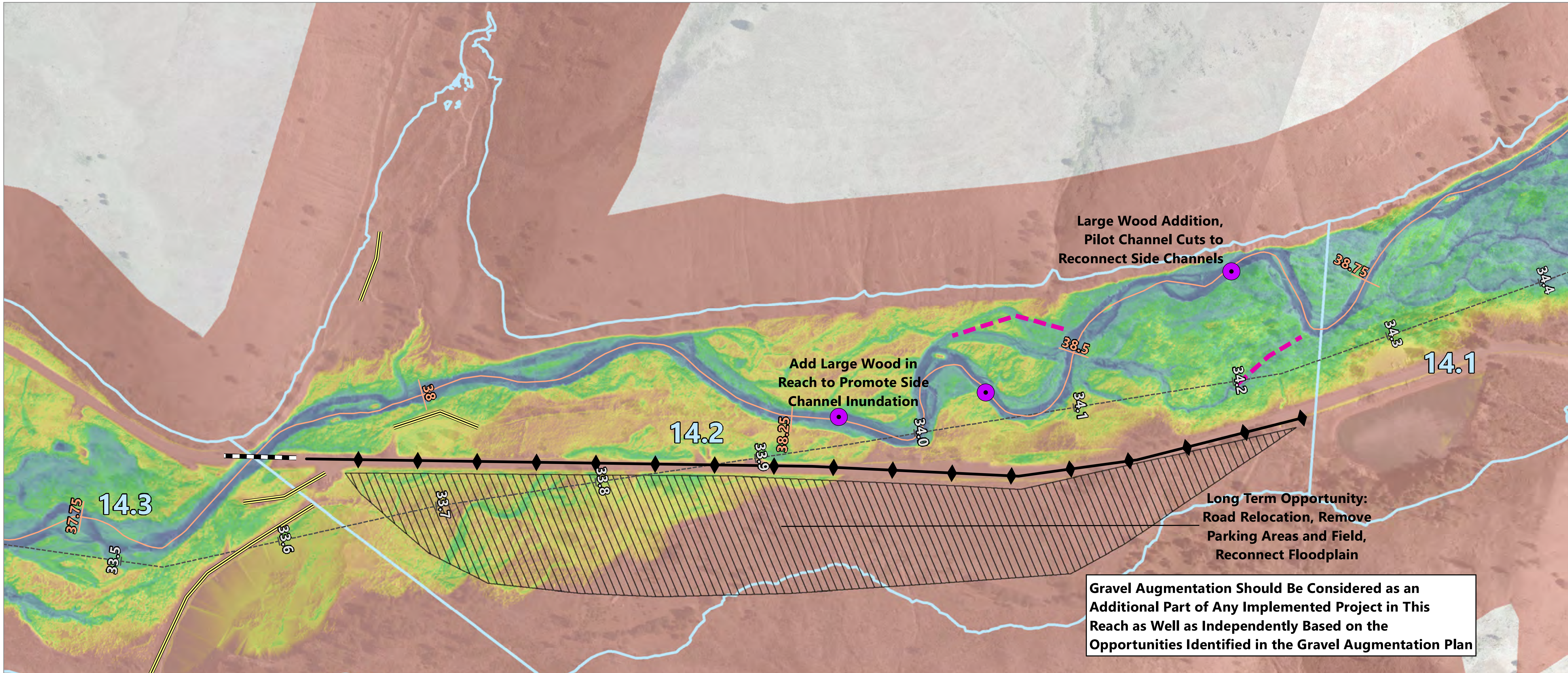
PA 14.2 Scoring Metric Ranks

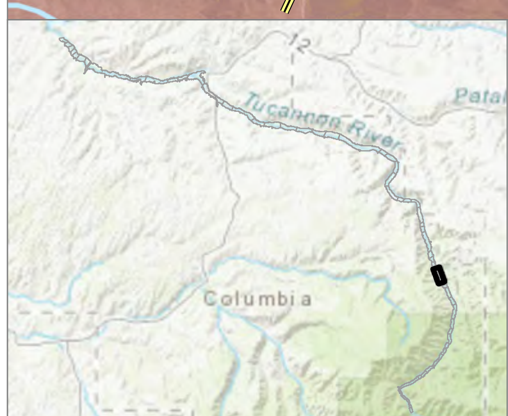


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 14.2 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	0.202	23	40%	Complexity	0.255	27	40% to 60%	3 of 5	5	40%	2.6	18	1	Treated	6	1
Mean-Winter Flow Complexity	0.294	22	40%													
1-year Complexity	0.280	34	20%													
Channel Aggradation FP Potential	0.205	31	40%	Connectivity	0.154	42	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.042	38	40%													
Total FP Potential	0.277	43	20%													
Existing Connected FP	0.723	18	0%													
Excess Transport Capacity	0.11	21	100%	Excess Transport Capacity	1.000	21	30% to 52%	3 of 4	1	20%						
Pool Frequency	13.38	22	100%	Pool Frequency	0.343	22	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
- Reconnect Side Channel
- Reconnect Floodplain
- 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: 37.88
RIVER MILE END: 38.71
VALLEY MILE START: 33.64
VALLEY MILE END: 34.26

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Feet

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ANCHOR QEA

Project Area 14.2
Conceptual Adaptive Management and Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 23 Description

Project Area 23 begins at VM 25.06 and extends upstream to VM 25.87. The 2017 RM length is 1.05 miles. Field observations for PA 23 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization. Since the 2011 assessment, this reach has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization.

The channel through PA 23 is a single-thread, plane-bed channel that is highly confined to a straight alignment between infrastructure and the valley wall. Levees and spoil piles confine the upper quarter-mile of the project area, and much of the right bank downstream of this point is lined by levees. Approximately 0.7 mile from the upstream end, a series of rock barbs are located along the bank, followed by a large rock weir after another 0.15 mile. Levees confine the channel between the weir and the downstream end of the project area. One small spring or tributary is present in the left floodplain near VM 25.76, and a small alcove is present at the downstream end of this area. The low-lying floodplain area is disconnected from the channel at the upstream end by a large armored levee along the left bank that constricts the channel to a tight bend at VM 25.14.

Project Area 23
No site photograph available.

Project Area 23 Reach Characteristics

VM Start (mi)	25.06
VM Length (mi)	0.81
Valley Slope	1.16%
RM Start (mi)	28.28
RM Length (mi)	1.05
Average Channel Slope	0.89%
Sinuosity	1.29
Connected FP (ac/VM)	10.28
Encroachment Removal (ac/VM)	1.23
Channel Aggradation (ac/VM)	5.60
Total FP Potential (ac/VM)	9.76
Encroaching Feature Length (ft)	4,900.44
Connected FP Rank	46

The quality and availability of instream habitat in this reach is limited by lack of complexity and hydraulic conditions that prevent the retention of sufficient volumes of LWD and sediment. The channel is wide and shallow with little complexity except at rock placements that provide some pool habitat for adult fish. Field observations noted very little LWD and little opportunity for cover except for some overhanging vegetation and undercut root masses along the channel margins. The project area lacks an adequate quantity of secondary flow paths and off-channel areas that are preferred by juvenile fish. The straight, confined channel likely has high instream velocities during spring runoff and floods. Very few opportunities were identified for fish to seek refuge.

Floodplain connectivity is poor and highly impacted by infrastructure. Relative to upstream project areas, the amount of low-lying floodplain in PA 23 is relatively high and the channel is less incised. Approximately half a mile of the reach is low lying and much of this area is currently used as a horse pasture and contains many wetland plants.

The riparian zone is in poor to moderate health. Riparian trees are predominantly deciduous species, including dogwood, alder, willow, and cottonwood. Some mature trees are present in the floodplain near the upstream end with a moderately diverse understory. The remainder of the project area mostly contains smaller trees, with many patches of immature trees in poor health and a sparse understory dominated by groundcover. Along the levees at the downstream end of the project area, there is little shading except for willows that have been planted along the banks.

Restoration Actions and Geomorphic Changes

In 2015, restoration work in PA 23 included placing a total of 12 LWD structures using 54 LWD key pieces, and removing 520 feet of levee and associated riprap. The expected response was to include increased channel complexity such as pools, gravel bar development, floodplain inundation, side channel development, and reduced incision.

Analysis of the difference between the 2010 and 2017 LiDAR data shows significant geomorphic change, much of which is a direct result of restoration actions in the reach. To begin with, at the upstream end of the reach, the levee removal as part of the restoration actions is clearly evident on the left bank (box 1).

Near the middle of the reach, the channel has avulsed and caused erosion toward the right bank, deposition has occurred in the main channel in this area, and a large patch of trees has fallen into the main channel (box 2). Immediately downstream, the left bank has experienced some minor but consistent erosion (box 3).

Near the downstream end of the reach, some significant erosion has occurred along the valley wall, on the outside of a sharp meander bend, and a side channel appears to be forming that cuts off the meander bend in this location (box 4). Erosion at the downstream end of the side channel area is also evident along with deposition due to several large log jams (box 5).

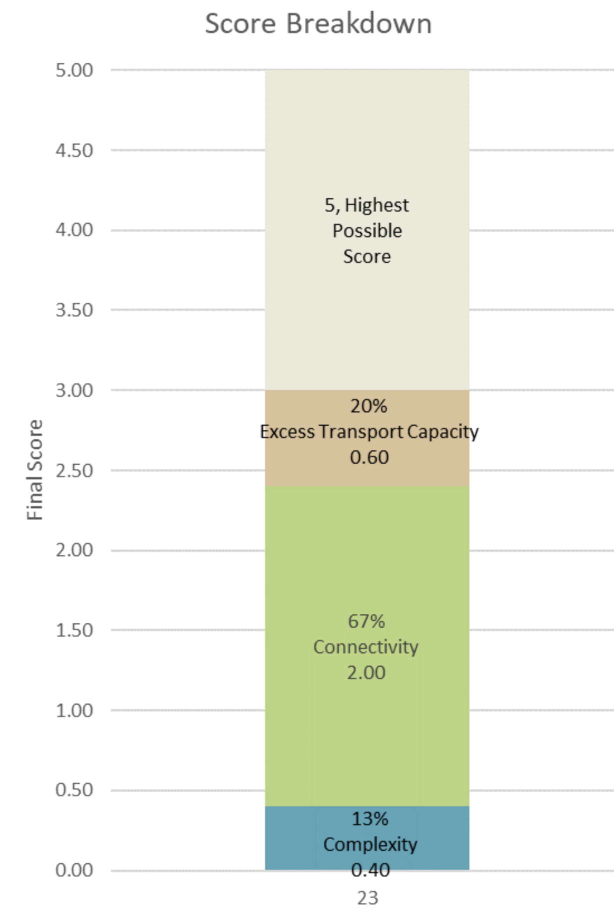
Finally, at the very downstream end of the reach just before and continuing into PA 24, significant deposition has occurred in the main channel and on the left bank floodplain (box 6).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 23 receives equal low scores in the Connectivity and Complexity metrics, and a moderate score in the Excess Transport Capacity metric. The low score in Complexity indicates that PA 23 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. The low score in the Connectivity metric indicates that PA 23 ranks below average in the 25th to 50th percentile of project areas for connectivity potential.

This connectivity score is driven mostly by the Channel Aggradation score, which ranks near the average for project areas, although the Total Floodplain Potential analysis result ranks PA 23 very highly. This indicates that there is some floodplain that can be accessed through channel aggradation, but there is also a good amount of floodplain that can only be

PA 23 Score Breakdown



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

accessed through both channel aggradation and encroachment removal. Based on the GIS layer for connectivity, most of the Channel Aggradation Floodplain Potential is located in pockets of floodplain near the middle and bottom of the reach. The Total Floodplain Potential area is mostly driven by a long side channel and narrow floodplain area on the left bank floodplain that is disconnected at the upstream and downstream end. There is some additional disconnected area in the left bank pasture area that appears to be associated with a spring or runoff area. The primary restoration strategy for this reach should be to reconnect the pockets of floodplain through channel aggradation and gravel augmentation, along with added instream structure and wood. The moderate score in the Excess Transport Capacity metric indicates that this reach transports sediment more easily than others in the assessment area, likely because the channel is mostly straight and moderately confined. The addition of instream wood should be aggressive and dense to ensure sediment material from gravel augmentation is trapped and maintained in the reach.

While it may be initially difficult to achieve more complexity, opening these floodplain areas should give room for the channel to form more complexity. Pilot channel cuts should be considered an additional enhancement action to adding wood and gravel augmentation in order to open these reconnected floodplains to more perennial flows.

Finally, PA 23 ranks slightly below the average in the Pool Frequency metric, indicating a moderate amount of pools per valley mile. The enhancement actions of adding instream structure and gravel augmentation should promote geomorphic change towards more in-channel complexity and conditions where pools are forced more frequently with the natural processes of the reach.

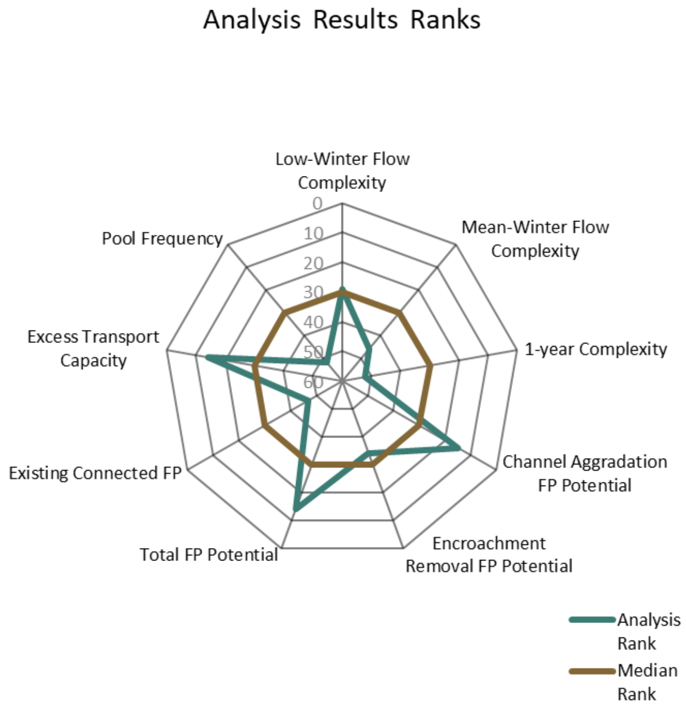
Summary of Restoration Opportunities Identified

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

Long-Term Opportunities in this Project Area

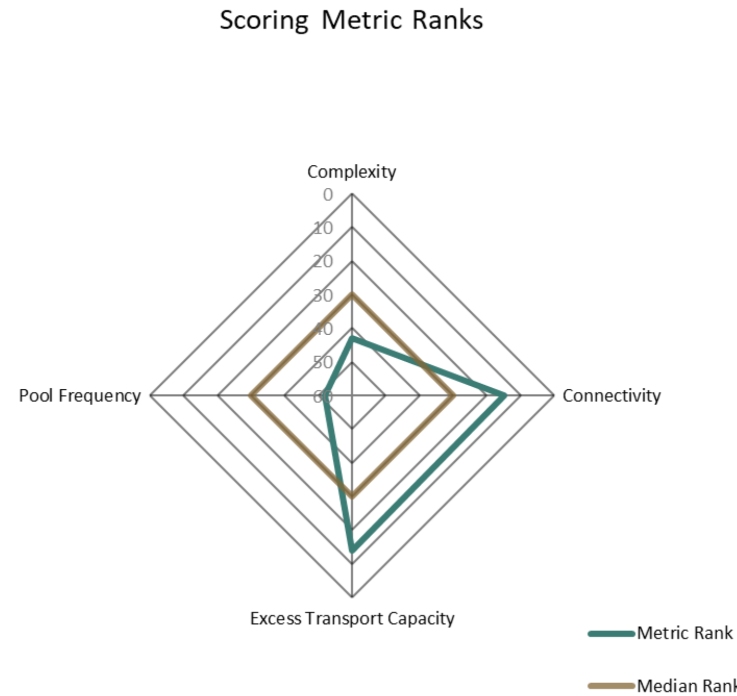
- Large-scale road setback project to relocate road onto right valley wall. The road crosses the river twice in quick succession here and relocating the road would allow both bridges to be removed, and necessitate less channel confinement, increasing floodplain connection and channel migration area through this reach.

PA 23 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.

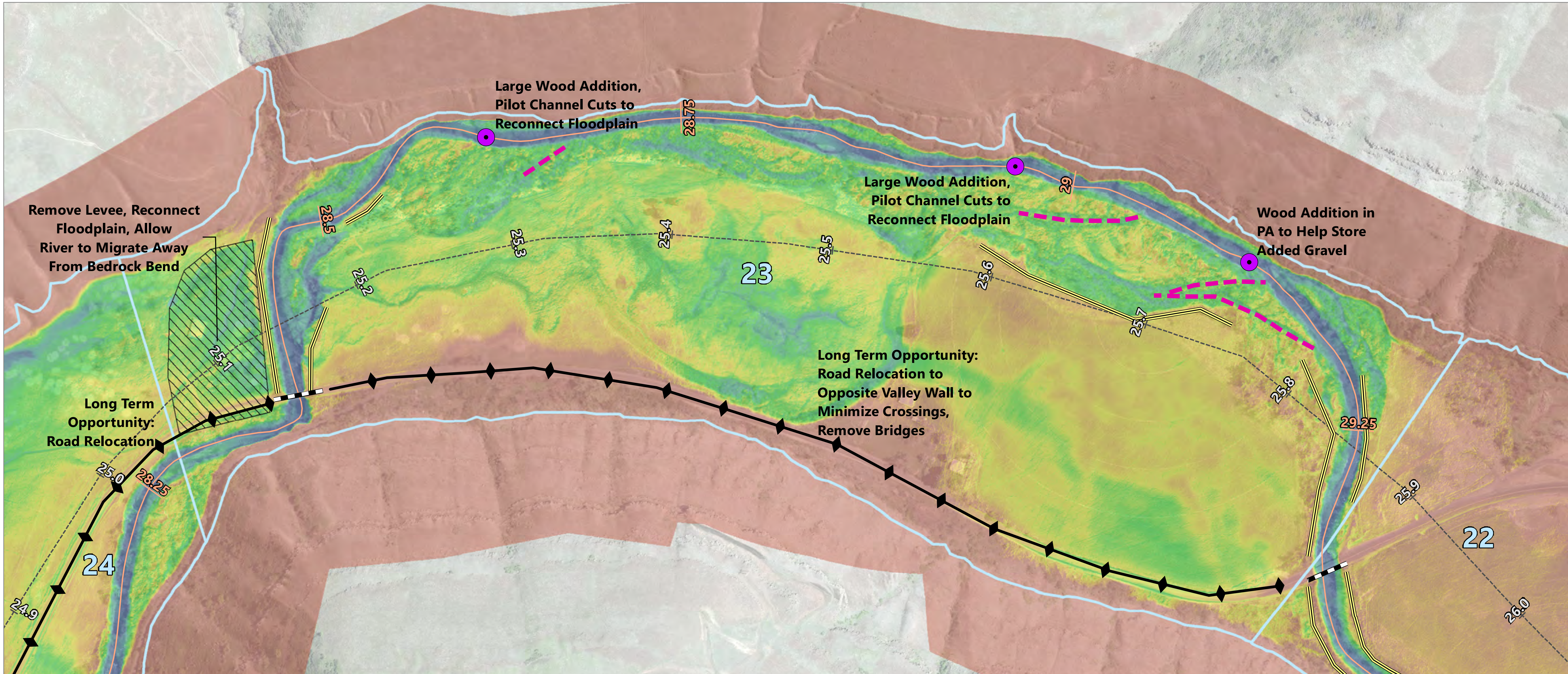
PA 23 Scoring Metric Ranks



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 23 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	29	40%	Complexity	0.144	43	60% to 90%	4 of 5	1	40%	3.0	15	1	Treated	5	1
Mean-Winter Flow Complexity	0.135	46	40%													
1-year Complexity	0.128	52	20%													
Channel Aggradation FP Potential	0.279	15	40%	Connectivity	0.234	15	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.061	34	40%													
Total FP Potential	0.487	14	20%													
Existing Connected FP	0.513	47	0%													
Excess Transport Capacity	0.14	14	100%	Excess Transport Capacity	3.000	14	10% to 30%	2 of 4	3	20%						
Pool Frequency	4.75	52	100%	Pool Frequency	0.122	52	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
- Reconnect Side Channel
- Reconnect Floodplain
- 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: 28.28
RIVER MILE END: 29.33
VALLEY MILE START: 25.06
VALLEY MILE END: 25.87

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ANCHOR QEA

Project Area 23
Conceptual Adaptive Management and Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 26 Description

Project Area 26 begins at VM 21.11 and extends upstream to the Turner Road bridge at VM 23.90. The 2017 RM length is 2.99 miles. Field observations for PA 26 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization. Since the 2011 assessment, this reach has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization.

The channel through PA 26 contains sections of dynamic and complex channel networks as well as wide, plane-bed stretches with little complexity. In the upper portion of the project area, the river is confined to a single-thread, plane-bed channel against the valley wall by bank armoring and levees. The levee materials are typically composed of angular armor rock, as well as a rock/wood revetment just downstream of the Turner Road bridge. Three large vortex rock weirs mid-reach control the channel grade.

Downstream the active channel becomes wider and less confined, except for a short section where the channel contains multiple rock weirs and barbs that control the grade and planform. Within this portion of the channel, the 2011 assessment noted that there was a higher amount of temporary sediment storage in the form of islands and gravel bars, multiple-channel pathways, and active channel migration. This

Project Area 26
Looking downstream near the upper end of the 3-mile project area in July 2019. Note mobile gravel material forming the mid-channel bar.

Project Area 26 Reach Characteristics

VM Start (mi)	21.11
VM Length (mi)	2.79
Valley Slope	1.00%
RM Start (mi)	23.99
RM Length (mi)	2.99
Average Channel Slope	0.92%
Sinuosity	1.07
Connected FP (ac/VM)	18.61
Encroachment Removal (ac/VM)	1.02
Channel Aggradation (ac/VM)	5.20
Total FP Potential (ac/VM)	6.07
Encroaching Feature Length (ft)	14,586.28
Connected FP Rank	19

was confirmed by recent CHaMP and AEM surveys, which noted change in gravel movement and pool formation. Multiple rock placements and restoration features were also observed through this section. For approximately a half mile, the channel becomes wide and shallow where it is lined on either bank by a large levee. Multiple rock weirs and rock barbs control the grade throughout this section.

The channel is braided with many channel pathways and a high amount of sediment deposition. The river makes a tight bend around a resistant fine-grained deposit and is confined against the valley wall by a levee. Downstream, the main channel flows parallel to the valley wall but has a wide, aggrading active channel area. The 2011 assessment noted that moderate to high LWD was present in this section where wood was being recruited in the channel. Several deep alcove pools were present along the margins of the channel, as well as pools that had scoured out at fallen LWD and root masses of standing trees.

For a half mile the river is characterized as a highly dynamic, meandering, forced pool-riffle channel. The 2011 assessment noted that the channel had multiple secondary flow paths and side channels and contained many deep pools at LWD and along the outside of meander bends. Remnant alluvial fans and terraces, which are relatively resistant to erosion compared to the recent alluvium in the active channel, had created tight bends in the channel planform.

Instream habitat conditions in the main channel were generally good in the dynamic portions of the channel due to the presence of large recruited LWD, active channel migration, and the availability of side channels. Ample deep holding pools were present at LWD and along eroding bends. The riffles formed between the pools and sediment deposits in the lee provided good spawning areas. The alcoves and side channels are preferred habitat for juvenile fish, and field observations noted several juvenile fish using these areas.

The plane-bed and confined sections of the project area have limited complexity and, therefore, poor habitat quality. Deep pools were typically only present at rock weirs and fallen riprap boulders. The confined conditions of the channel likely result in high-velocity conditions during spring runoff and high flows that may scour redds and flush small fish downstream. These areas have very few off-channel areas for juvenile rearing and high-flow refuge. There was little LWD or other forms of cover noted during the 2011 assessment.

Restoration Actions and Geomorphic Changes

In 2011, restoration work in PA 26 included removing or breaching and setting back 8,305 feet of river levee, with the purpose of connecting about 120 acres of disconnected low floodplain. In 2013, 17 LWD structures were placed within the reach using 84 key pieces.

The purpose of removing and setting back river levees and berms in this project area was to increase river access to disconnected floodplain while protecting existing landowner infrastructure. LWD structures were intentionally delayed to observe river response following levee removal. In 2013, a limited number of engineered log jam structures were placed to encourage gravel deposition, pool formation, and floodplain connectivity.

Analysis of the difference between the 2010 and 2017 LiDAR data shows a relatively large amount of geomorphic change, with nine major locations highlighted in this assessment along with multiple minor locations. The levee removals conducted in 2011 are identified in boxes 1, 2, and 5. Geomorphic change behind these levee removals has been mixed. At the upstream end, the high-flow channel behind the short section of levee removal has experienced some scour and erosion, which could indicate that high flows are reaching this part of the floodplain and could cause more significant change (box 1). The next portion of levee removal has almost no change associated with it, although this does not mean high flows are not passing it, only that no significant erosional or depositional change has occurred (box 2). The third identified levee removal location is by far the longest and, interestingly, there appears to have been some floodplain deposition behind it, although this is unconfirmed by field observations, which would indicate that high flows do pass the levee. The area should be watched to ensure a natural high bank does not form in place of the levee (box 5). It should be noted that the setback levees put in place as part of the restoration work in this project area are easily visible in the LiDAR change analysis but are not included in this discussion.

In addition to the three locations of levee removal, several areas of natural geomorphic change were noted, as well as multiple others that are too small to describe here. Before the most downstream levee removal location a significant split flow has occurred, mid-channel, and appears to be the result of a log jam, with aggradation on the center bar and erosion to either side (box 3).

Just upstream of, and partially coinciding with, the major levee removal, a large channel avulsion has occurred towards the right bank, with aggradation seen in the former main channel and erosion on the right bank floodplain. The new channel appears to return to the old channel location just as the levee removal starts, and in the future this channel migration could be working its way into the area where the levee has been removed, which could provide additional floodplain connection (box 4).

Just downstream of the major levee removal, two former meander bends have been cut off, with the new channel location going straight between them. A large amount of sediment has been deposited in these former channels, which is visible on the 2018 aerial imagery. Despite this there appears to have been some meander migration at the downstream end before the channel cut off the meanders, and a side channel off the right bank of the most downstream meander appears to still be in place (box 6). Along the most downstream setback levee, the reach has experienced a large amount of floodplain deposition along the right bank; within this area there are several areas of channel avulsion with the channel initially moving left towards the valley wall. There also appears to be a new split flow and side channel forming seen in the aerial imagery. Google images show that the channel-spanning jam led to channel aggradation and then to floodplain deposition, which killed the alder trees on the floodplain. In 2017, the spanning jam failed and the channel cut back to its current configuration. This is a good example of what geomorphic change can occur on the Tucannon River, as well as how unstable alder LWD can be (box 7).

Immediately downstream of this area, a quarter-mile-long channel avulsion into the right bank floodplain has occurred likely as a result of several large log jams that appear to be a combination of engineered and natural recruits. Large amounts of sediment have been deposited in the abandoned channel and it appears to be mostly disconnected at low flows. Multiple split flows and side channels exist in the new main channel and there is a high degree of in-channel complexity. At the downstream end of this avulsion, a large erosional area is occurring on the right bank into the forest floodplain and could be the source of much of the wood in this reach. Immediately downstream of the erosional area, the channel has aggraded and there are signs of flow onto the surrounding floodplain. This is an excellent example of channel dynamics releasing sediment stored in the floodplain and causing downstream geomorphic change (box 8).

Finally, at the very downstream end of the project area, a large split flow and side channel has been pushed into the left bank floodplain, possibly by a log jam, and another split flow has occurred right at the project area boundary and extends into PA 27 (box 9).

The downstream half of PA 26 has had a large amount of geomorphic change and appears to be responding to the additional wood placement, as well as a supply of easily transportable material. In contrast, on the upstream end where levee removals have occurred, not much geomorphic change has occurred in the newly accessible floodplain. However, it appears that higher flow events have accessed these areas, but field observations suggest this has not happened in recent years.

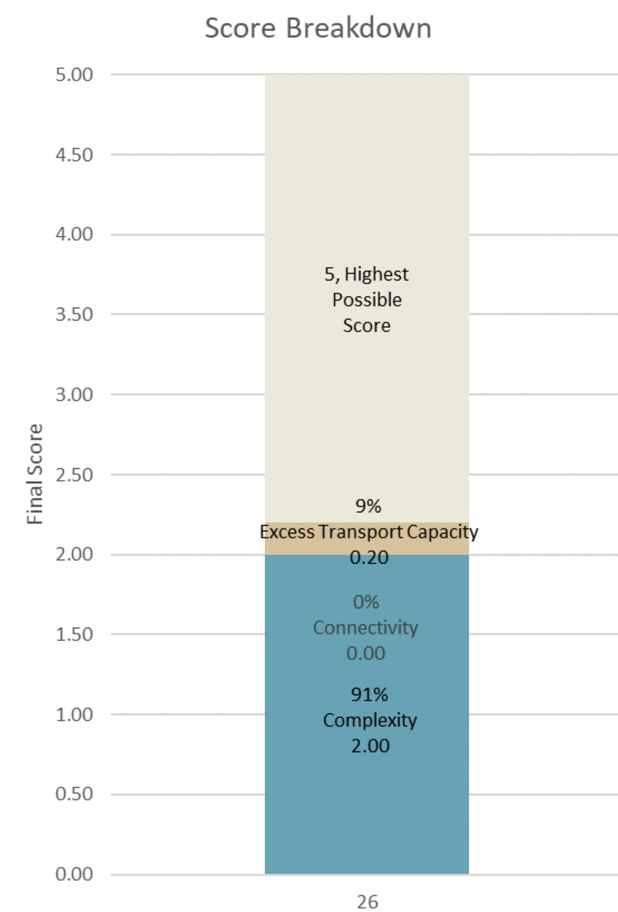
Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 26 received the highest possible scores in both the Connectivity and Complexity metrics, but a low score for the Excess Transport Capacity metric. PA 26 ranks near the average in the 40th to

60th percentile for Complexity, which is the range that has been identified as having the most potential for restoration focused on complexity. This score is reflected across all three flows of the complexity analysis results, ranking near the average across the assessment area for each flow. Both Encroachment Removal and Channel Aggradation analysis results rank PA 26 highly for floodplain connectivity potential, with a slightly higher rank in Encroachment Removal.

The levee removals have had moderate success in this project area, particularly the levee removed just upstream of VM 23, which appears to have connected most of the low-lying floodplain at the 2-year event. The levee removal at VM 22.5 appears to need some channel aggradation before the floodplain behind it can be accessed at the low-winter flow event, and the levee breach at the top of the project has not yet allowed flows behind it in order for that area to be connected. However, the primary potential for additional floodplain connection is a right bank low-lying area just downstream of the levee removal at VM 22.4. This low-lying area is behind a high right bank at the upstream end, that is too high for the 2-year flow to inundate, as well as a small levee at the downstream end. Management and enhancement strategies should include attempting to raise the channel bed in this area through upstream gravel augmentation, along with some strategic breaches or removal of the high right bank coinciding with existing wood structures, to promote geomorphic change in the areas were encroachments have

PA 26 Score Breakdown



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

been removed. There is some additional potential for connection of this floodplain area via high bank breaches or channel aggradation at the location of the 2011 levee removal at VM 22.4. Several other encroachments exist through the project area, and removing or breaching these may connect some floodplain at the 2-year event but will also serve to allow an increase in complexity in these areas.

Several pockets of high complexity are spread throughout the entire project area. However, there are also long stretches with little to no complexity such as at VM 22 and upstream of VM 23. Enhancement strategies should include adding instream structures to these long, straight reaches to help create bars and split flow to create more instream complexity. Several of these sections have floodplain channel opportunities that should be targeted with pilot channel cuts and strategic placement of large wood structures to promote geomorphic change. Gravel augmentation in this reach does not appear to be necessary because the complex pockets and locations of geomorphic change should be causing sufficient geomorphic change to release transportable material, as long as enough instream structure is available to store and trap sediment moving downstream.

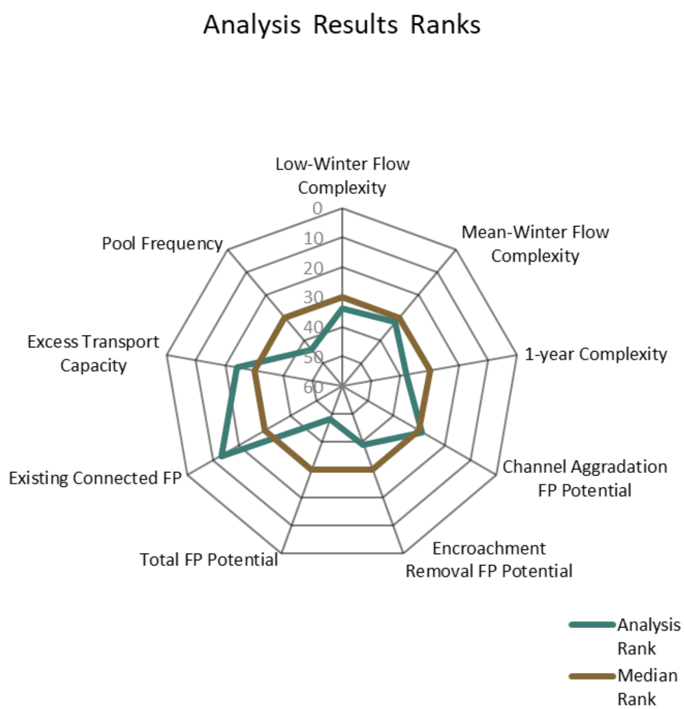
Some of the targeted floodplain area is currently vegetated with only riparian grasses and small shrubs, so riparian vegetation enhancement will be an additional necessary enhancement strategy in these areas.

Finally, the pool frequency in this reach appears to be well below average for the basin. More pools are likely to form as a result of the recent restoration actions. However, similar to complexity, should these changes not occur, gravel augmentation will allow for more frequent pool formation around any instream structure.

Summary of Restoration Opportunities Identified

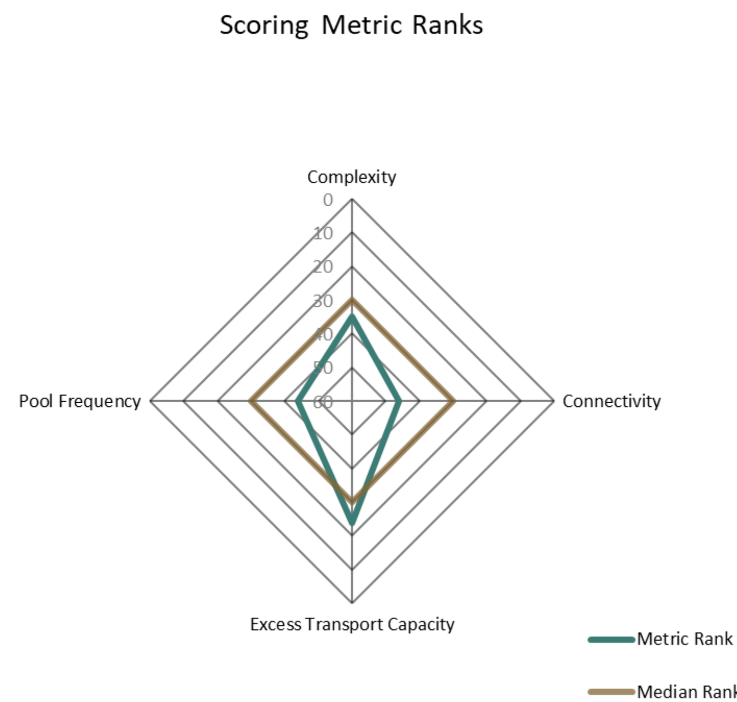
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

PA 26 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.

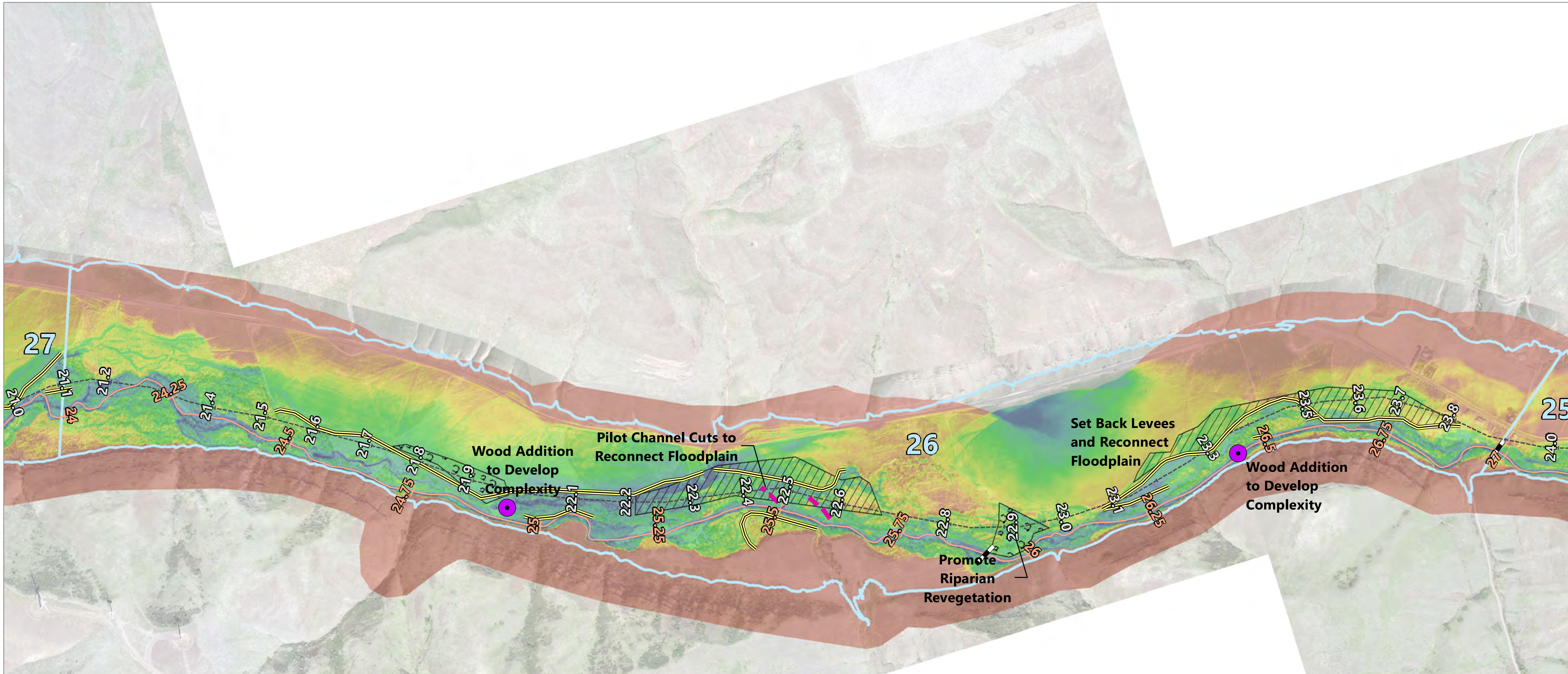
PA 26 Prioritization Scoring Summary



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 26 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	0.138	34	40%	Complexity	0.180	35	40% to 60%	3 of 5	5	40%	2.2	27	2	Treated	8	1
Mean-Winter Flow Complexity	0.204	32	40%													
1-year Complexity	0.215	38	20%													
Channel Aggradation FP Potential	0.211	29	40%	Connectivity	0.150	46	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.041	39	40%													
Total FP Potential	0.246	48	20%													
Existing Connected FP	0.754	13	0%													
Excess Transport Capacity	0.08	24	100%	Excess Transport Capacity	1.000	24	30% to 52%	3 of 4	1	20%						
Pool Frequency	6.70	44	100%	Pool Frequency	0.172	44	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
- Reconnect Side Channel
- Reconnect Floodplain
- 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: 23.99
RIVER MILE END: 26.98
VALLEY MILE START: 21.11
VALLEY MILE END: 23.9

0 500
Feet

Publish Date: 2021/01/25, 3:50 PM | User: mgieschen
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ANCHOR QEA

Project Area 26
Conceptual Adaptive Management and Restoration Opportunities

Project Area 40 Description

PA 40 begins at VM 3.16 and extends upstream to VM 3.68. The 2017 RM length is 0.57 mile. Field observations were conducted on October 10, 2018, when flow at the Starbuck gage was approximately 115 cfs. Since the 2011 assessment, this reach has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization.

PA 40 is a short project area at only 0.57 mile long and can be largely characterized as one reach. Near the upstream end of the project area, the restoration work of the large levee removal and setback is evident, resulting in a split flow and the beginning of a meander bend. This levee was removed in 2015 as part of the PA 40 project to increase channel complexity and floodplain connectivity.

In the middle of the reach, the entire left bank is exposed to the nearby agricultural field and has only a few patches of trees at the upstream and downstream ends and in places is heavily riprapped. The right bank is the inside of a meander bend and is forested with alder stands and a few cottonwoods with heavy undergrowth. The levee remnants on the right bank are from a levee that was removed and set back as part of the restoration project in this reach, which connected several side channels. However, some of these side channels may have been blocked and several additional side channel opportunities exist in this area.

Project Area 40
Side channel opened up as part of PA 40 project, no flow was present at time of site walk but would be connected at a slightly high-flow stage.

Project Area 40 Reach Characteristics

VM Start (mi)	3.16
VM Length (mi)	0.52
Valley Slope	0.55%
RM Start (mi)	4.03
RM Length (mi)	0.57
Average Channel Slope	0.48%
Sinuosity	1.10
Connected FP (ac/VM)	30.61
Encroachment Removal (ac/VM)	4.76
Channel Aggradation (ac/VM)	16.06
Total FP Potential (ac/VM)	22.14
Encroaching Feature Length (ft)	4,686.38
Connected FP Rank	4

A high-flow channel splits off on the right bank in a location where the old levee has been breached. At the head of this channel is a large rootwad structure that has accumulated some debris and sediment that is partially blocking the side channel. While this channel was not flowing at the time of the site visit, it likely sees slightly higher flows than what were noted when the 2017 aerials were taken in April. This channel runs along another old levee on the right bank that separates it from another low spot in the floodplain before reaching the new, well-maintained levee that currently protects the field on the right bank. There is a large amount of in-channel wood, structures, and channel complexity when there is flow. This channel has been opened up to high flows, but more floodplain on the right bank is available for access.

Bed material through this reach is a mix of cobbles and boulders with little transportable material. It should be noted that just downstream of this project area, in the upper reach of PA 41, a large avulsion and debris jam has trapped large amounts of gravel material, and it is likely the material had simply been transported quickly through PA 40 to this area. PA 40 has very little instream wood or structure in the main channel, and placing this structure could serve to trap some of this gravel material and cause geomorphic change to the right bank floodplain.

Restoration Actions and Geomorphic Changes

In 2014, the main river in PA 40 between RM 4.5 and RM 4 was treated by removing 1,335 feet of confining gravel berms, reconnecting a disconnected flow path that was approximately 0.32 mile long to perennial flow, and placing 52 structures to maintain stability and provide complexity within the side channel. Although the river levees and gravel berms were removed, only one structure was placed within wetted channel to maintain a split flow into the reconnected side channel. The geomorphic goal was to increase side channel length and complexity as well as increase floodplain connectivity through levee and berm removal.

Analysis of the difference between the 2010 and 2017 LiDAR data shows only a few locations of geomorphic change in PA 40, which is a short reach. The most notable change is not natural geomorphic change, but the setback levee installed as part of the restoration project is easily recognizable, along with the apparent bar deposition at the downstream end on the right bank (box 1).

The right bank side channel that was reconnected during restoration has seen significant erosion in the channel, which indicates it is likely seeing a large portion of flow during higher flow events. There is also a depositional area in the floodplain surrounding the side channel part of the way down the channel that could be a result of high flows (box 2).

At the downstream end of the reach, there is a large depositional area in the left and right floodplains along with the beginnings of a channel avulsion that occurs in PA 41. While this change is driven by processes just downstream in PA 41, the aggradation and deposition in this reach could cause some backwater effect allowing more side channels and floodplain to be accessed (box 2).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 40 received the highest possible score for floodplain connectivity potential, indicating it is in the top 25% of all project areas. This project area also has a moderate score for the Complexity metric, indicating it falls in the 60th to 90th percentile of project areas. This is a range that still shows moderate complexity but does not place it in the top 10% of project areas; this project area likely only needs a little restoration work to reach that mark. PA 40 also received a moderate score for Excess Transport Capacity.

The potential indicated by the Connectivity metric for PA 40 exists entirely within the low-lying area of two agricultural fields that border the active floodplain terrace on the left and right bank floodplains. However, much of the available area on the right bank floodplain is behind the setback levee installed during the 2014 restoration effort and may not be desirable for additional connection. On the left bank, the low-lying

PA 40 Score Breakdown

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

floodplain is behind a large levee, and a targeted enhancement strategy to activate this area should be to breach or remove this levee and install wood structure to promote geomorphic change into the floodplain. It should be noted that the left bank of the river is currently running along this levee and has almost no vegetation cover. Active erosion is happening here and the pivot is nearly undercut by the river at this point. Enhancing the riparian vegetation on the left bank should be a targeted enhancement strategy but will be especially necessary if the left bank floodplain is reconnected.

The opening to the side channel established during the last restoration effort was observed to be partially blocked during the 2018 site visit. To address the complexity in this project area, a management strategy should be to ensure that this side channel allows perennial flows. In addition, the island created by this side channel contains several low-winter flow paths easily visible in the relative elevation model. Some high banks may need to be removed to establish perennial connection. Reconnecting these side channels through pilot cuts and adding instream wood to push flow into these channels should be a targeted enhancement strategy. Finally, the main channel through PA 40 is plane-bed and uniform with very little in-channel structure. Regardless of other restoration enhancement strategies that may be pursued, adding instream structure and LWD should be the primary restoration enhancement strategy pursued in this project area.

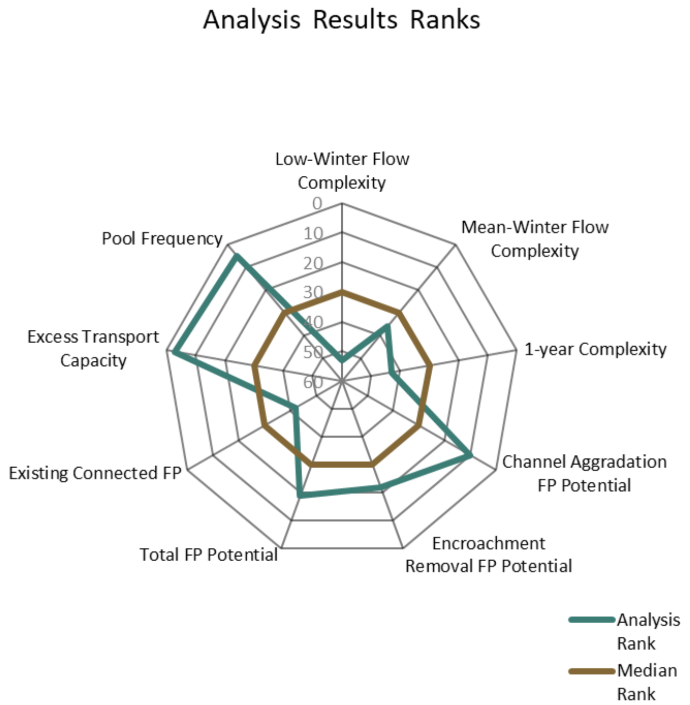
Gravel augmentation can be considered in this reach should the above enhancement strategies not have the desired effect in a timely manner. The addition of easily transportable material should allow geomorphic changes to occur more rapidly and effectively. However, it should be noted that because this area has such high excess transport capacity, a large amount of wood and instream structure should be added to maintain and store this sediment.

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

Summary of Restoration Opportunities Identified

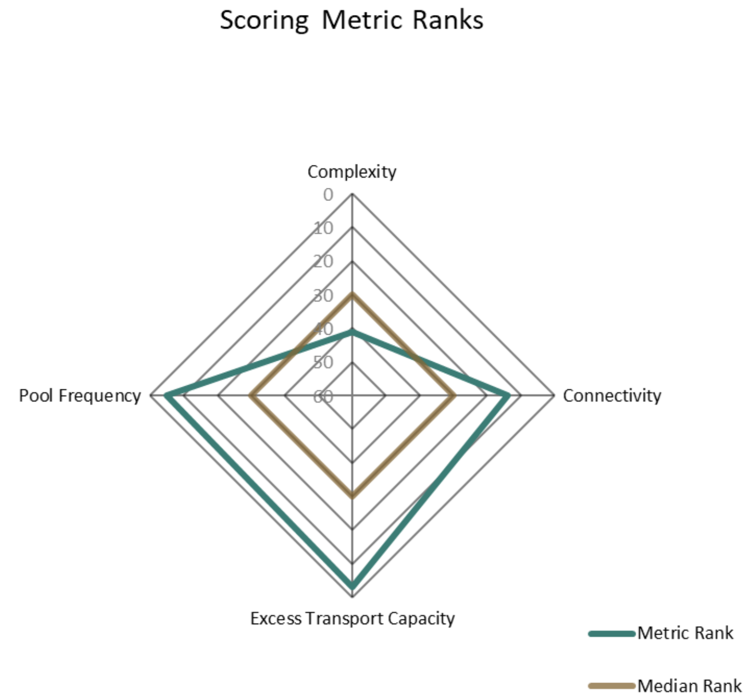
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)
- Riparian zone enhancement

PA 40 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.

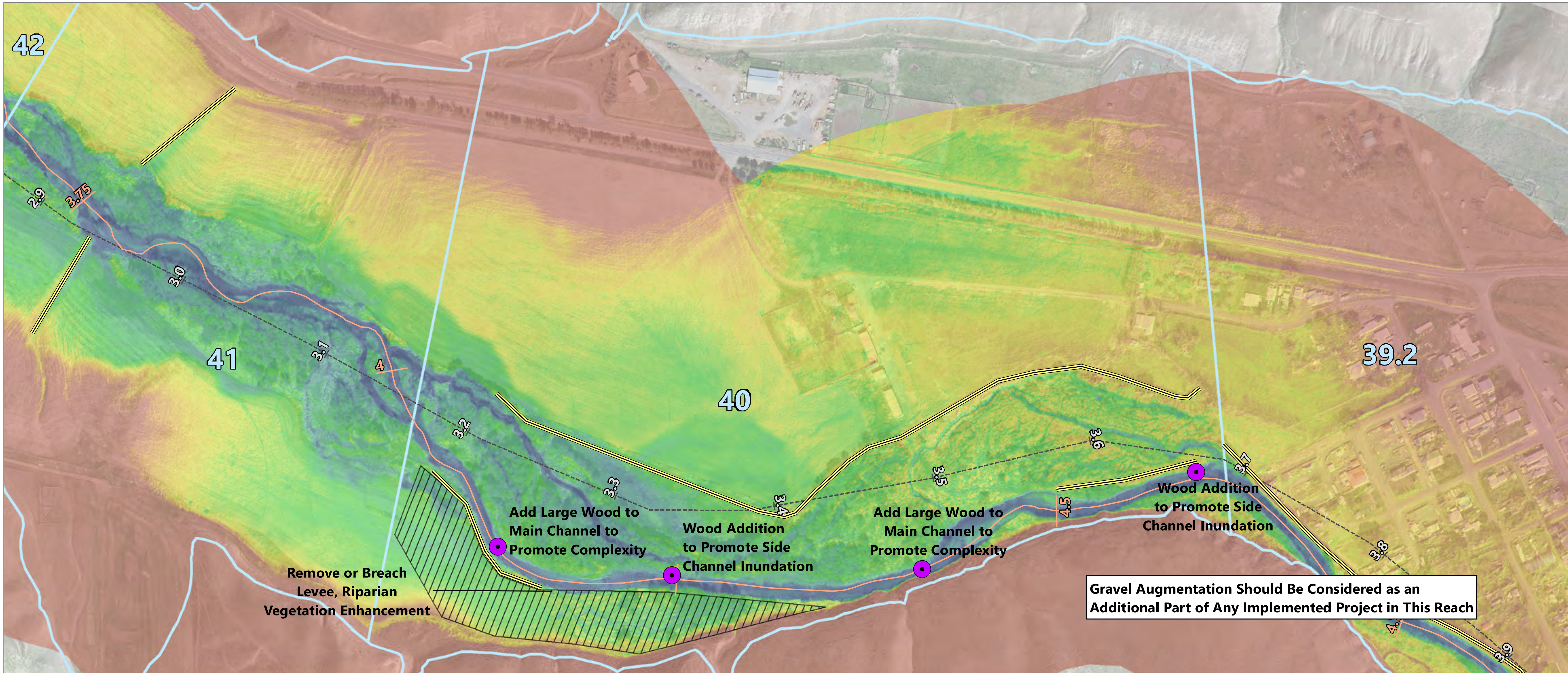
PA 40 Prioritization Scoring Summary

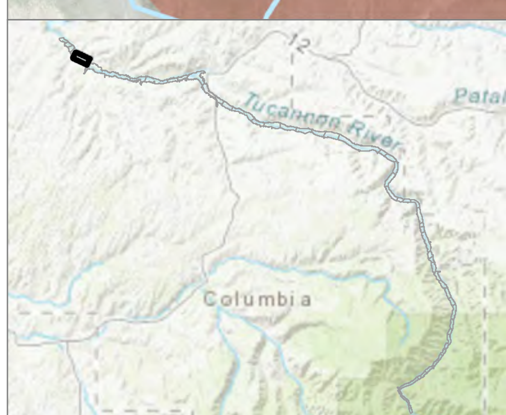


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 40 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	0.091	53	40%	Complexity	0.148	41	60% to 90%	4 of 5	1	40%	3.4	5	1	Treated	1	1
Mean-Winter Flow Complexity	0.181	36	40%													
1-year Complexity	0.195	43	20%													
Channel Aggradation FP Potential	0.304	10	40%	Connectivity	0.242	14	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.090	22	40%													
Total FP Potential	0.420	19	20%													
Existing Connected FP	0.580	42	0%													
Excess Transport Capacity	0.31	3	100%	Excess Transport Capacity	5.000	3	1% to 10%	1 of 4	5	20%						
Pool Frequency	28.71	5	100%	Pool Frequency	0.737	5	1% to 10%	1 of 5	0	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition
- Reconnect Floodplain

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: 4.03
RIVER MILE END: 4.61
VALLEY MILE START: 3.16
VALLEY MILE END: 3.68

0 500
Feet

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ANCHOR QEA

Project Area 40
Conceptual Adaptive Management and Restoration Opportunities

APPENDIX J.1
TIER 2: TREATED PROJECT AREAS

Project Area 8 Description

Project Area 8 begins at VM 39.33 and extends upstream to VM 39.74. The 2017 RM length is 0.45 mile. Field observations for PA 8 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization. Since the 2011 assessment, this reach has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization.

Throughout the project area, the single-thread channel is typically wide, shallow, and plane-bed. A few local high-velocity areas occur along the toe of the bedrock valley wall. Levees are present along much of the left bank, confining the active channel and low floodplain to the far side of the valley. No side channels or secondary flow paths were identified. A large engineered log jam is present on the right bank and provides some cover and pool habitat. The channel contains little other LWD except small, transient material. Although juvenile fish may use the shallow margins of the channel, the lack of cover, complexity, and pools results in generally poor habitat conditions throughout this section of the river.

Floodplain connectivity in this project area is poor due the incised condition of the channel and the presence of infrastructure that confines and disconnects the channel from a majority of the low-lying floodplain. A narrow corridor of low floodplain is present from approximately the upstream end of

Project Area 8
Large engineered log jams interacting with flow at the upstream end of PA 8.

Project Area 8 Reach Characteristics

VM Start (mi)	39.33
VM Length (mi)	0.41
Valley Slope	1.30%
RM Start (mi)	44.45
RM Length (mi)	0.45
Average Channel Slope	1.08%
Sinuosity	1.09
Connected FP (ac/VM)	13.23
Encroachment Removal (ac/VM)	0.53
Channel Aggradation (ac/VM)	4.01
Total FP Potential (ac/VM)	5.72
Encroaching Feature Length (ft)	2,926.19
Connected FP Rank	34

the project area to the Curl Lake outfall, but it is cut off from the channel by levees. A groundwater spring located near VM 39.41 appears to originate west of Tucannon Road, where several wetland plants were observed but no flowing water. East of the road, the spring becomes a surface water channel, eventually flowing into a wetland. The channel is lined with ferns, sedges, and rushes that provide good shading and cover. The spring flows into a portion of the disconnected low floodplain, consisting of a muddy to ponded wetland area vegetated with rushes, sedges, ferns, and cattails. Several dead or dying trees are present in this area. The spring channel has a poor downstream connection with the river and no fish were observed in the channel.

Adjacent to Curl Lake, another disconnected floodplain area is present that is fed by seepage through the lake berm. The water accumulates into a small side channel and meets the river, providing a minor amount of off-channel habitat. Downstream of Curl Lake, a ponded wetland dominated by cattails and grasses makes up a majority of the floodplain. Trees and other cover or shading is sparse.

In general, the riparian zone is in a moderately healthy condition, but conditions adjacent to the main channel provide little cover or shading. Few mature riparian trees are present along the channel margins.

Restoration Actions and Geomorphic Changes

In 2017, restoration work in PA 8 included placing LWD in the downstream 1,200 feet of PA 7 and all of PA 8. Treatment actions involved the placement of 26 LWD structures within approximately 0.55 stream miles using 153 key pieces of LWD. This action increased LWD volumes from 1.4 key pieces per bankfull width to 3.6 key pieces.

LWD structures were placed to capture approximately 0.3 mile of new side channel. Objectives for the project included increasing channel complexity to increase pool frequency and increasing side channel complexity and floodplain connectivity.

Analysis of the difference between the 2010 and 2017 LiDAR data shows that even though these restoration actions took place shortly before the LiDAR data for this reach were collected, several of the targeted responses have occurred. Just downstream of Curl Lake, a mid-channel log jam has triggered a split flow and bar, although it is unclear if the bar-forming material is natural deposition or was placed as part of the restoration actions (box 1).

A large log jam has caused a split flow towards the left bank, where bank erosion has occurred as the channel pushes into the left bank floodplain. Before the side channel confluence, a mid-channel bar has formed with noticeable deposition. Just downstream of the confluence, a channel-spanning log jam has promoted substantial erosion on the right bank and deposition on the left (box 2).

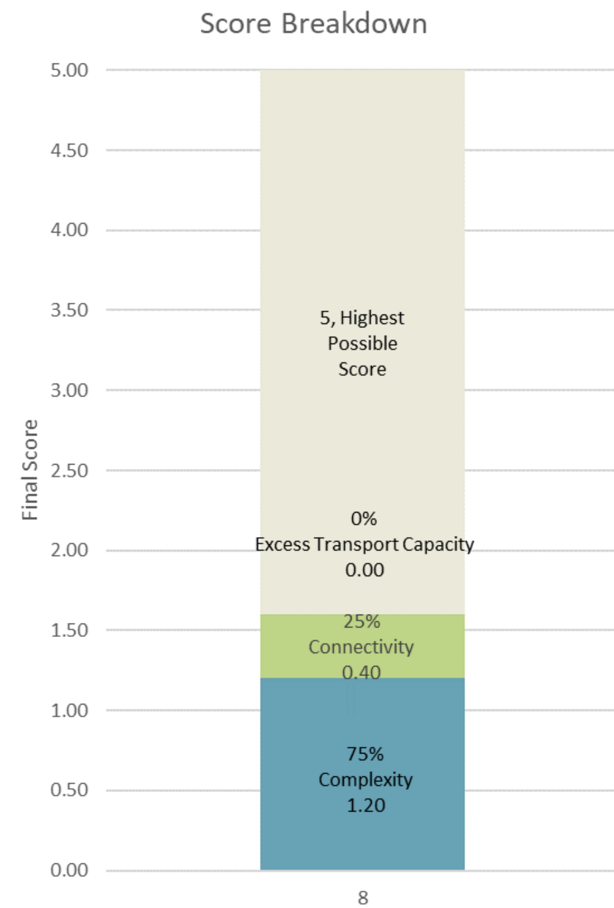
Finally, just before the downstream boundary of the reach, deposition has occurred in the left bank floodplain where there appears to be a side channel that starts upstream near box 2. This deposition area continues into PA 9, and appears to have pushed a side channel into the right bank floodplain (box 3).

It should be noted that, while many large log jams evident from the 2018 aerial imagery were placed throughout the project area, no significant geomorphic change has occurred in the reach above or coincident with Curl Lake within this project area. This reach is highly confined by the left bank levee for Curl Lake and the right bank valley wall, and is downstream of the diversion structure for Curl Lake. It is possible this reach has geomorphically resistant bed material, although gravel material was reportedly placed as part of restoration actions in the area in an effort to increase spawning area.

Geomorphic Characteristics and Management and Enhancement Strategies

The management and enhancement opportunities identified here are based on the 2018 LiDAR and aerial data. However, it should be noted that the restoration actions in this reach occurred shortly before the data were collected and geomorphic response may not have occurred yet and may not yet be reflected in the prioritization score.

PA 8 Score Breakdown



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

As shown in the following graphs and table, the Complexity metric makes up the majority of the score for PA 8, placing this project area in the 60th to 90th percentile for complexity. This range still shows moderate complexity but does not place it in the top 10% of project areas; this project area may only need some minor additional restoration work to reach that mark.

This good complexity is spread out across the analyzed flow regime, ranking highest in low-winter and mean-winter flows, with a slightly lower ranking in complexity for the 1-year flow. Complexity across all three flows is driven by several split flows and side channels downstream of Curl Lake. Upstream and coincident with Curl Lake, only a minor split flow at the low-winter flow adds complexity to the reach. Because restoration actions have already added a large amount of wood to this reach, more time may be required to see significant geomorphic change. However, should geomorphic changes not begin to happen, a gravel augmentation plan should be considered as a primary enhancement strategy. More transportable material will allow geomorphic changes to form at regular flow events, forcing in-channel and floodplain complexity.

The Connectivity score, while overall relatively low, is almost entirely driven by the Channel Aggradation Potential analysis result. Based on this and the connectivity GIS layers, most of this potential immediately surrounds the active channel and existing 2-year floodplain. A restoration strategy of gravel augmentation should help raise the average channel bed elevation through this reach and allow 2-year flood events to access more of the floodplain.

Because a large amount of wood has already been added to this reach, and floodplain potential is available via channel aggradation, gravel augmentation should be considered as a primary enhancement strategy. The reach has a low Excess Transport Capacity score, indicating that gravel material added here is likely to be retained with little additional wood added.

The pool frequency in this reach appears to be around average for the basin. More pools are likely to form as a result of the recent restoration actions. However, similar to complexity, should these changes not occur, gravel augmentation will allow for more frequent pool formation around any instream structure.

Modification of Big Four lake is another potential long-term opportunity in PA 8 and PA 9. A lot of the right floodplain area on the lower end of PA 8 is blocked by a riprap levee and diversion structure to the impoundment. Long-term restoration should target removal of this diversion structure to reconnect the floodplain.

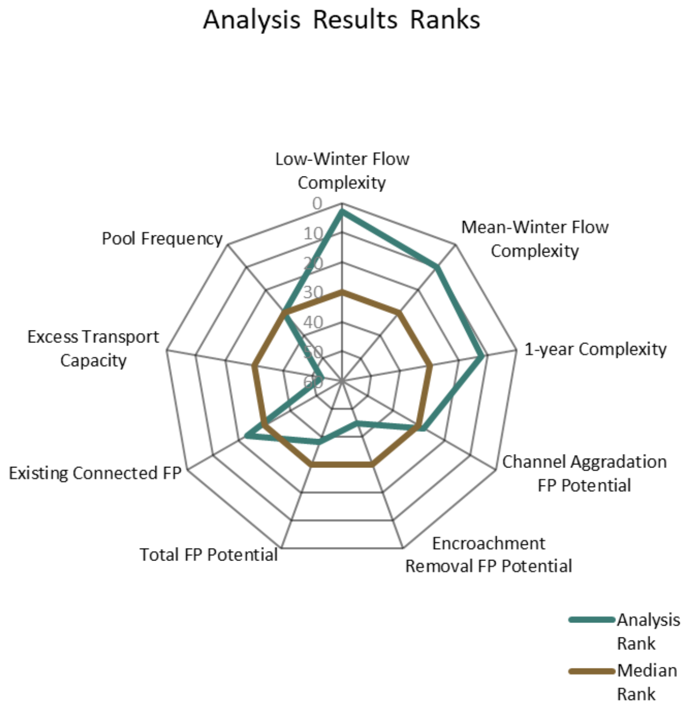
Summary of Restoration Opportunities Identified

- Gravel augmentation
- Reconnect side channels and disconnected habitats

Long-Term Opportunities in this Project Area

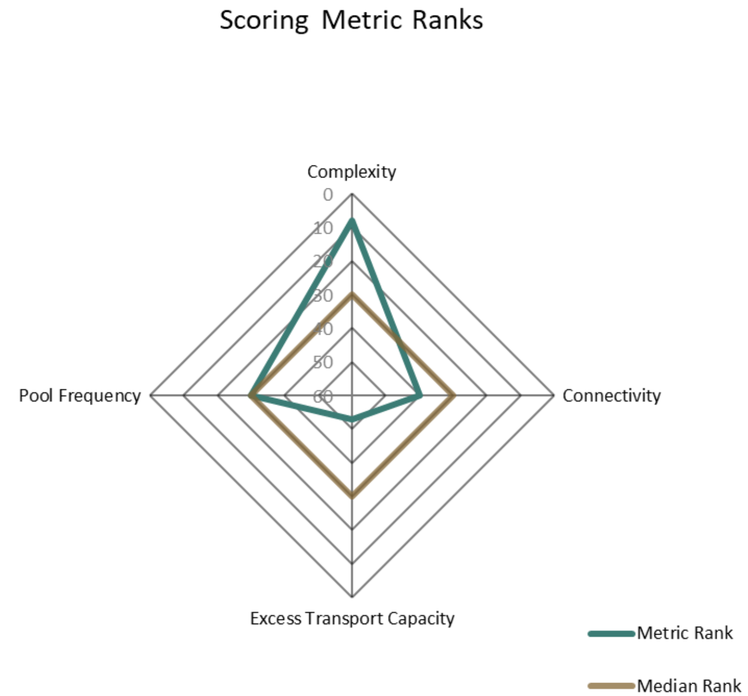
- Remove or reconfigure Big Four Lake diversion structure and levee.
- Reconfigure Curl Lake to reconnect floodplain and consider decommissioning and removing if ever feasible.

PA 8 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.

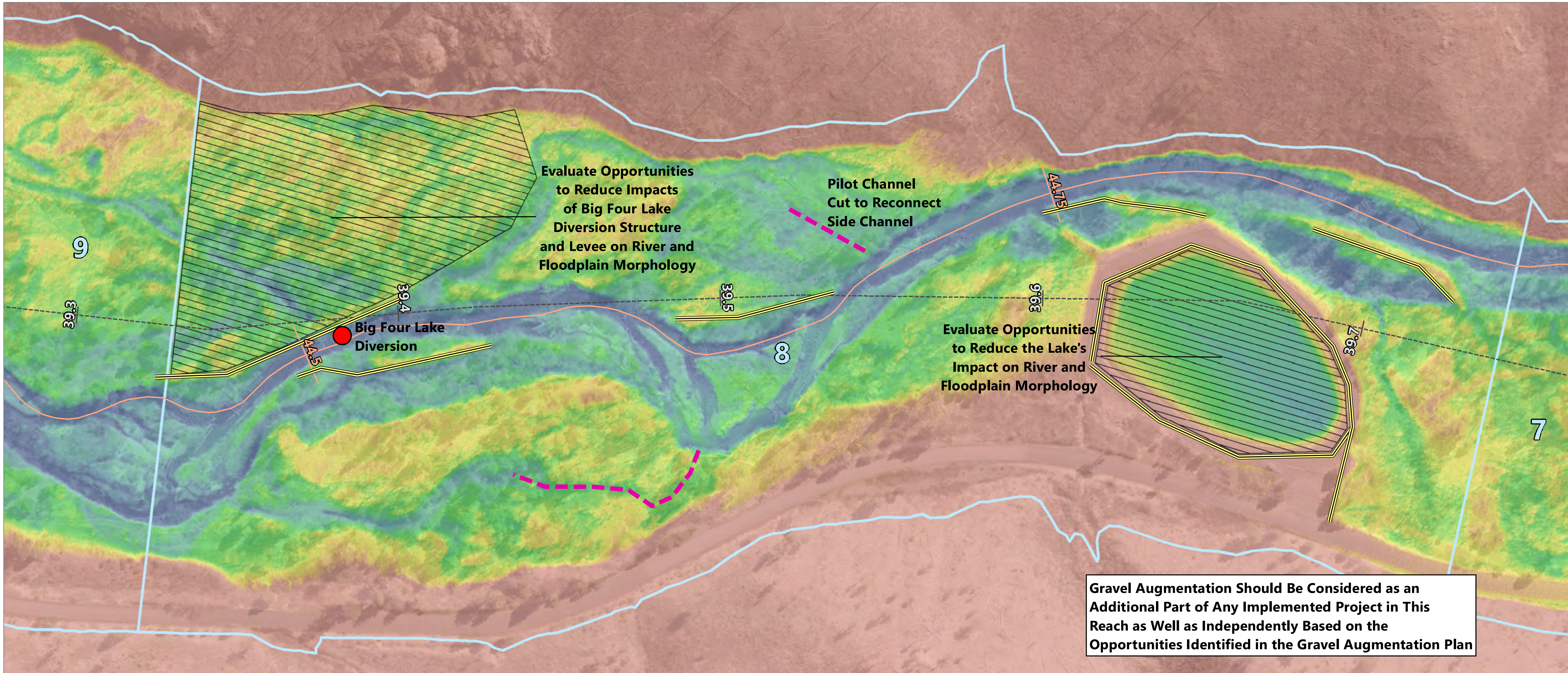
PA 8 Scoring Metric Ranks

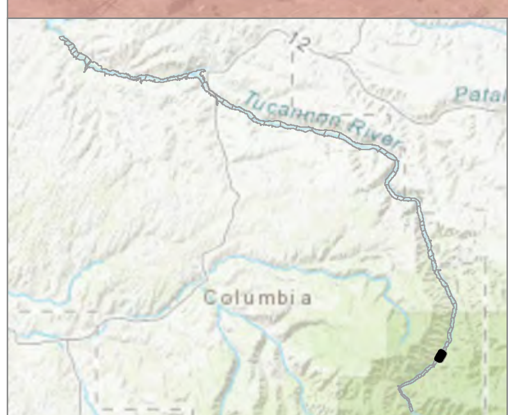


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 8 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	0.376	3	40%	**Complexity**	0.424	8	10% to 40%	2 of 5	3	40%	1.6	37	2	Treated	14	2
Mean-Winter Flow Complexity	0.433	10	40%													
1-year Complexity	0.501	12	20%													
Channel Aggradation FP Potential	0.212	28	40%	**Connectivity**	0.156	40	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.028	45	40%													
Total FP Potential	0.302	38	20%													
Existing Connected FP	0.698	23	0%													
Excess Transport Capacity	-0.17	53	100%	**Excess Transport Capacity**	0.000	53	52% to 100%	4 of 4	0	20%						
Pool Frequency	11.10	30	100%	**Pool Frequency**	0.285	30	40% to 60%	3 of 5	5	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Reconnect Side Channel
- Reconnect Floodplain
- 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: 44.45
RIVER MILE END: 44.9
VALLEY MILE START: 39.33
VALLEY MILE END: 39.74

0 500
Feet

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ANCHOR QEA

Project Area 8
Conceptual Adaptive Management and Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 10.3 Description

Project Area 10.3 begins at VM 37.51 and extends upstream to VM 37.89. The 2017 RM length is 0.41 mile. Field observations for PA 10.3 were conducted on September 28, 2018, when flow at the Starbuck gage was approximately 80 cfs.

The defining characteristic of PA 10.3 is the nearly half-mile-long side channel on the right bank floodplain. This side channel starts at the top of the reach and returns at the bottom of the reach, with a maximum distance from the main channel of 500 feet. At the start of the reach, a massive channel-spanning log jam, which appears to be engineered with multiple additional log recruits, serves to backwater the channel and direct water into the side channel.

At the time of the site visit, the side channel was not flowing, although evidence of recent flow was abundant with several pools still holding small fish. It is likely that this side channel flows the majority of the year. The side channel has multiple large engineered structures with a mix of bank and apex structures. Large pools have formed on the sides of many of these structures, and it is evident that this side channel receives a large portion of the flow at higher flows. Bed material through the side channel is mostly gravel and fine sands with occasional cobbles and boulders mixed in.

In the main channel downstream of the large channel-spanning log jam, the channel becomes more plane-bed and uniform.

Project Area 10.3
Floodplain structure near the upstream end of the long side channel that was reconnected as part of restoration work in PA 10.3.

Project Area 10.3 Reach Characteristics

VM Start (mi)	37.51
VM Length (mi)	0.38
Valley Slope	1.70%
RM Start (mi)	42.45
RM Length (mi)	0.41
Average Channel Slope	1.53%
Sinuosity	1.09
Connected FP (ac/VM)	16.62
Encroachment Removal (ac/VM)	0.27
Channel Aggradation (ac/VM)	5.23
Total FP Potential (ac/VM)	6.14
Encroaching Feature Length (ft)	0.00
Connected FP Rank	21

There is much less instream wood in the main channel compared to the side channel. An apex log jam near VM 37.72 splits the flow for about 200 feet and is the most complex feature on the mainstem. Bed material in the main channel is a mix of cobbles and boulders with some amount of transportable gravel material mixed in, and may be resistant to geomorphic change.

This project area was heavily affected by the 2005 School Fire, and mature riparian vegetation through this reach is extremely sparse. A few coniferous species make up the majority of large vegetation, but dense stands of young to middle-aged alders, dogwoods, and cottonwoods populate much of the immediate riparian area and the island formed by the long side channel. Based on the floodplain characteristics described in the previous report (Anchor QEA 2011), it is likely the vegetation in this reach is in the process of recovering.

Restoration Actions and Geomorphic Changes

In 2012, restoration work in PA 10.3 included placing a total of 14 LWD structures in the channel, with the three structures at the downstream end being catcher mitt configuration. The furthest upstream structure was designed to be a porous channel plug, which would allow bed load over it during high flow to allow gravel to accumulate in the downstream incised channel. The channel plug aimed to reconnect approximately 0.42 mile of side channel. The three segments of this project focused on more than 5,000 feet of side channel and approximately 5.8 acres of floodplain.

Analysis of the difference between the 2010 and 2017 LiDAR data shows several major changes as a direct result of the restoration actions. The side channel targeted by the restoration actions in this reach begins at the upstream end and runs for the majority of PA 10.3. This porous channel plug log jam shows up in the 2018 aerial imagery, and there appears to be channel aggradation and deposition in this area, which would be expected even despite the porous design. The side channel shows some minor erosion and downcutting at the head of the channel in this area as well (box 1). This side channel shows almost no other geomorphic change besides some sediment deposition at log jams at the very downstream end of the side channel (box 4).

In the main channel, some wood structures are visible and have minor geomorphic change associated with them. The most significant of these occurs mid-reach and has a small area of sediment deposition behind it (box 3).

Finally, at the confluence with the side channel, a split flow has formed and a large area of sediment deposition is forming an island around the log jam located there. Some additional minor erosion has occurred at the outside of the bend on the left bank behind a bank barb style jam (box 4).

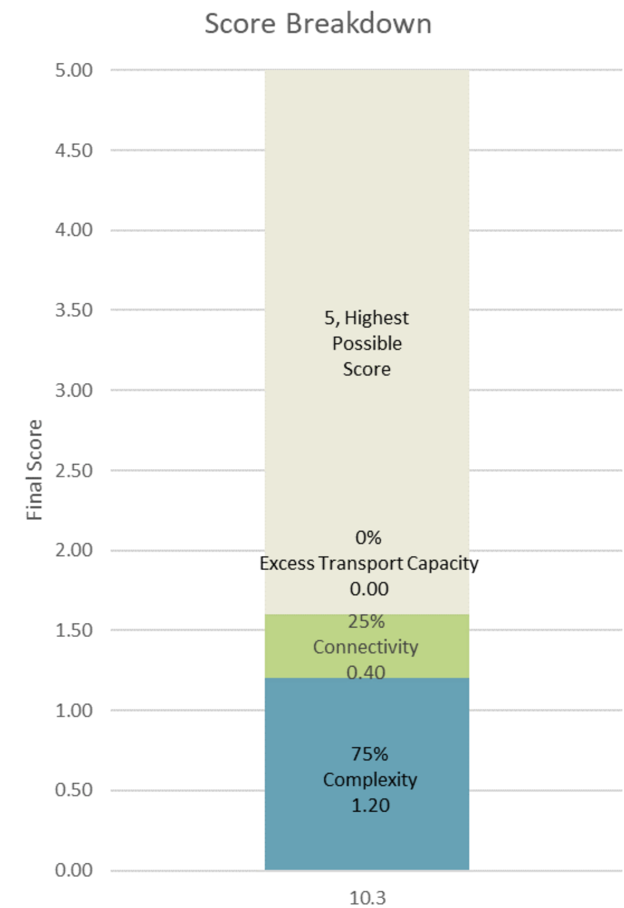
Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, Complexity makes up most of the score for PA 10.3, placing this project area in the top 25% of project areas. PA 10.3 scores 0.4 in the Connectivity metric, which makes up 25% of its total score. Excess Transport Capacity for this project area scores 0 and therefore does not receive prioritization points either.

The Connectivity potential metric in this reach is driven almost entirely by the Encroachment Removal Potential ranking near the top in this analysis result and the Channel Aggradation Potential ranking near the bottom. A large disconnected floodplain area on the right bank floodplain at the top of the reach drives this high ranking. This area is connected at the downstream end to the main side channel in this project area, and likely receives some backwater during the 2-year flow event but appears to be disconnected at the upstream end. The primary enhancement strategy should be to reconnect this area by adding instream wood and cutting pilot channels or removing the high right bank in general. Field observations also indicate more floodplain may be available on the left bank. Flow paths there remain wet into the summer some years and may originate in PA 10.2. Identifying and reconnecting these channels should be target of restoration.

The project area already ranks higher than average in the Pool Frequency metric and this is not a primary enhancement target.

PA 10.3 Score Breakdown



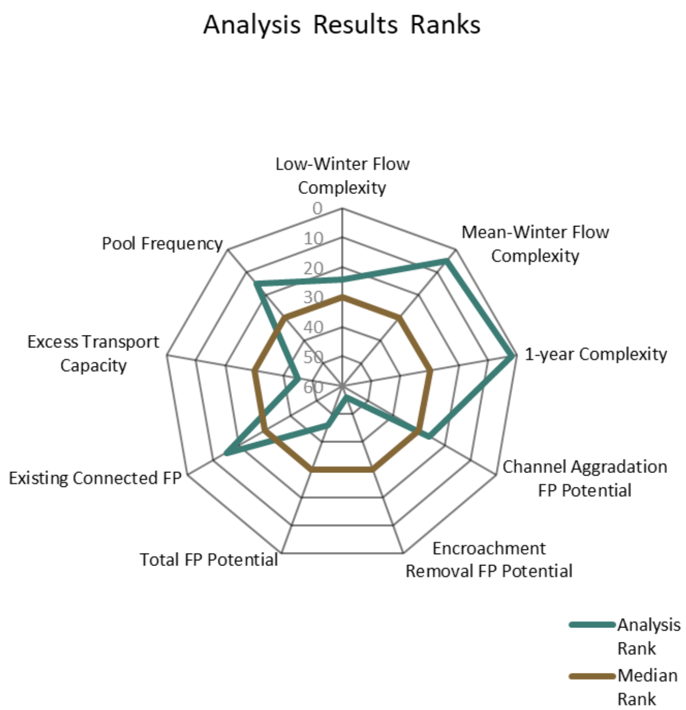
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

However, adding more instream structure and wood will help to maintain and increase the frequency of pools in the reach.

Summary of Restoration Opportunities Identified

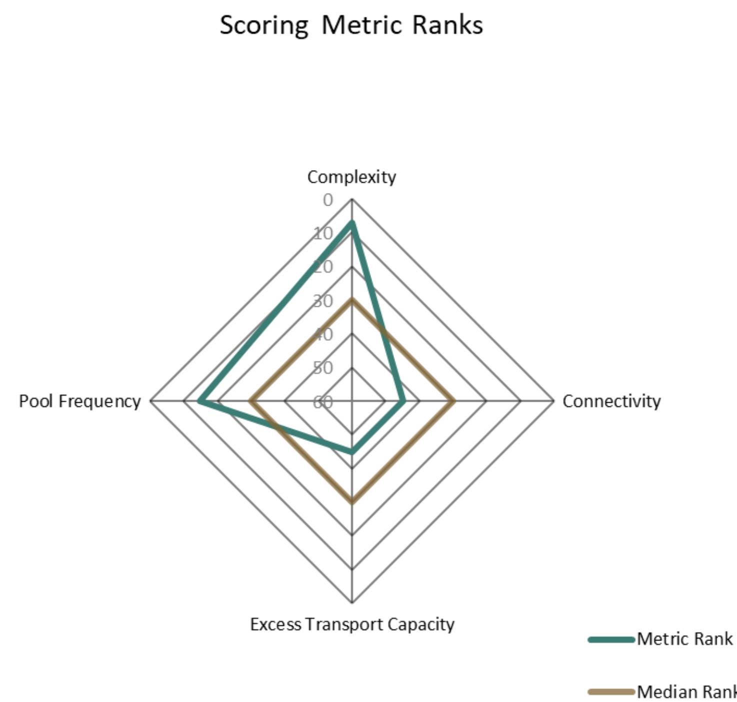
- Reconnect side channels and disconnected habitats
- Gravel augmentation
- Add instream structure (LWD)

PA 10.3 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.

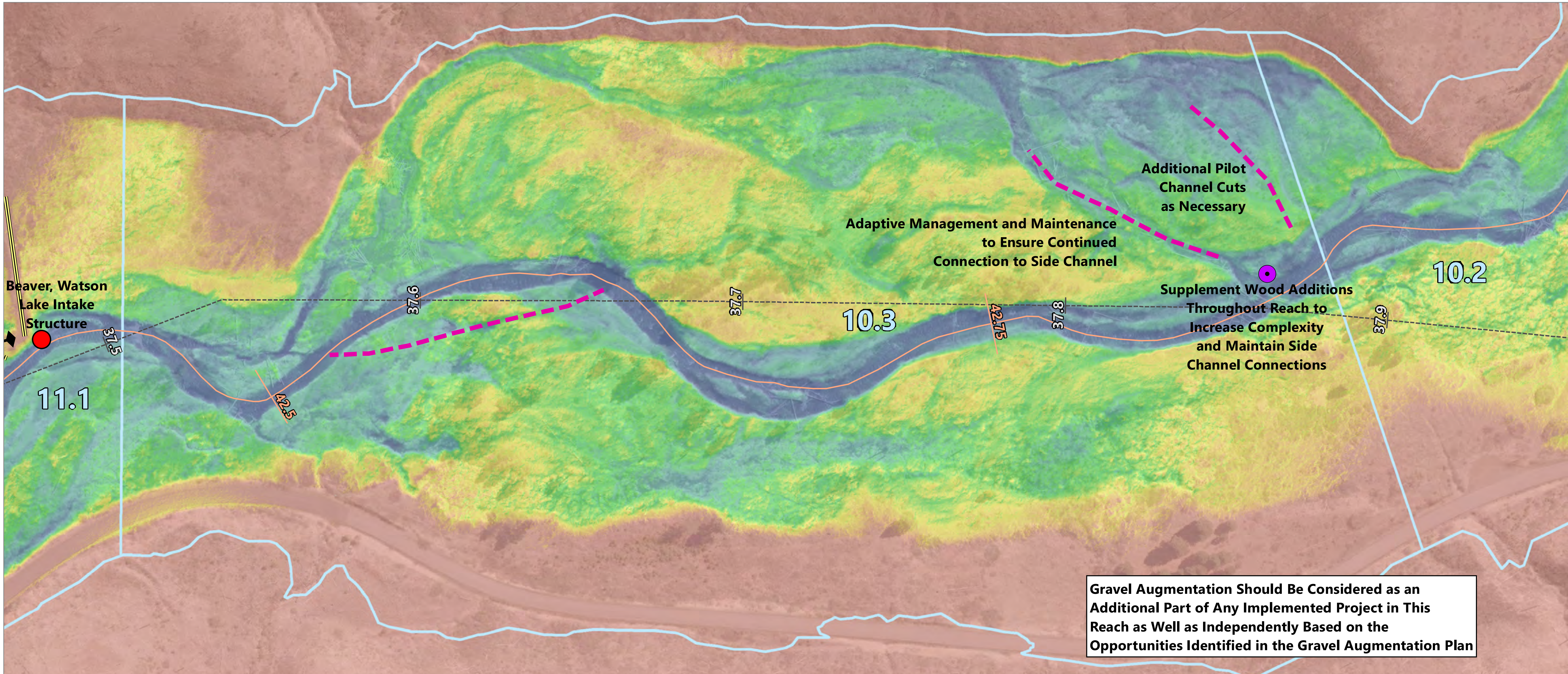
PA 10.3 Scoring Metric Ranks

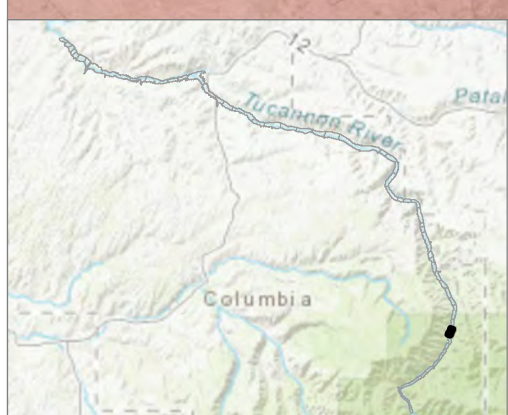


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 10.3 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	0.199	24	40%	Complexity	0.459	7	10% to 40%	2 of 5	3	40%	1.6	38	2	Treated	15	2
Mean-Winter Flow Complexity	0.518	5	40%													
1-year Complexity	0.863	2	20%													
Channel Aggradation FP Potential	0.230	26	40%	Connectivity	0.151	45	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.012	56	40%													
Total FP Potential	0.270	46	20%													
Existing Connected FP	0.730	15	0%													
Excess Transport Capacity	-0.11	45	100%	Excess Transport Capacity	0.000	45	52% to 100%	4 of 4	0	20%						
Pool Frequency	16.87	15	100%	Pool Frequency	0.433	15	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition
- Reconnect Side Channel
- 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: 42.45
RIVER MILE END: 42.86
VALLEY MILE START: 37.51
VALLEY MILE END: 37.89

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Feet

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ANCHOR QEA

Project Area 10.3
Conceptual Adaptive Management and Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 14.1 Description

PA 14.1 begins at VM 34.26 and extends upstream to the Rainbow Lake Road bridge at VM 34.81. The 2017 RM length is 0.61 mile. Field observations for PA 14.1 were conducted on September 27, 2018, when flow at the Starbuck gage was approximately 82 cfs.

For this assessment update, PA 14 as defined in the 2011 prioritization was separated into three project areas (PA 14.1, PA 14.2, and PA 14.3). In 2014, the upper sections of this project area (PA 14.1 and PA 14.2) were the subject of a restoration project, while PA 14.3 has remained untreated. PA 14.1 and PA 14.2 represent distinct parts of the restoration project and were therefore separated for distinct analysis.

At the time of the site visit, the first engineered log jam at VM 34.71 had split flow as was designed, but accumulated woody material prevented any significant flow on one side. The side channel at VM 34.68 carries perennial flow. However, at VM 34.65, a side channel that was intended to be inundated for most of the year was completely dry and did not appear to be inundated during yearly flow events. A log jam on the right bank just downstream from this side channel opportunity was noted to be disengaged from the channel at this flow level but was close enough that it would likely be engaged during higher flow events.

Project Area 14.1
Looking downstream at an apex engineered log jam, a small amount of flow is present on the right side of the structure but has been partially blocked by woody material.

Project Area 14.1 Reach Characteristics

VM Start (mi)	34.26
VM Length (mi)	0.56
Valley Slope	1.35%
RM Start (mi)	38.71
RM Length (mi)	0.61
Average Channel Slope	1.23%
Sinuosity	1.10
Connected FP (ac/VM)	12.77
Encroachment Removal (ac/VM)	0.46
Channel Aggradation (ac/VM)	3.31
Total FP Potential (ac/VM)	5.15
Encroaching Feature Length (ft)	1,021.04
Connected FP Rank	38

Further downstream, a long, uniform section stretches for approximately 400 feet before the next major log jam. This section also includes a protected right bank for hatchery infrastructure. The bed material through the reach is relatively large with only small amounts of easily transportable gravel material, which may explain the lack of geomorphic pools around some of these log jams.

The next major log jam at VM 34.56 had several large pieces of woody material, and the channel had aggraded on the left side, disconnecting it at this flow. However, groundwater still seeped through to the alcove on the bank side of the log jam. The next log jam just downstream was splitting flow as designed at the time of the site visit, although reports indicate that this channel does disconnect at low flows. A 2019 rapid habitat survey indicates that this channel had reduced to subsurface flow. This may be due to the fact that the log jam has deteriorated from design conditions and is not adequately splitting flow.

For the next tenth of a mile, the channel goes through another uniform stretch to the next set of large log jams near where the hatchery return flow joins with the river at VM 34.46. The large channel-spanning log jam just downstream is providing good complex flow with the rootwads providing cover, but pool depths were not as deep as would be expected with this kind of structure.

PA 14.1 ends near where the parking lot for Blue Lake is located in the left bank floodplain. The channel goes through a major horseshoe bend into PA 14.2 where cut-off side channels might be expected on the right bank. These channels appear to be slowly eroding with higher flows but do not currently convey flow. The structure on the left bank here was noted to be disengaged from flow at the time of the site visit. Also, on the left bank is the location where the upstream side channels should be returning to the main flow; this area was low, wet, and swampy, indicating some groundwater flow or possibly seepage from Blue Lake across the road. Estimates are that 0.5 cfs of flow comes from Blue Lake and 2 to 3 cfs from the upstream side channel.

Floodplain vegetation in this reach is a good mix of conifers and deciduous species with many large ponderosas in the riparian area. Some canary grass was noted in this reach, particularly around the hatchery return flow, and there are several stretches with no good riparian cover.

Bed material in the channel consists of mostly large cobbles and boulders in this reach. This may be due in part to the reach’s location just downstream of the dam on PA 13, which likely is a sediment transport barrier.

Restoration Actions and Geomorphic Changes

In 2014, restoration work in PA 14.1 included placing 51 LWD structures within the reach using 396 key log pieces. About

2,709 feet of perennial and 1,272 feet of ephemeral side channels were reconnected through pilot cuts and LWD was placed in the main channel to redirect flow. The goal for this reach was to increase channel complexity and floodplain connectivity at a 2-year level and less.

Analysis of the difference between the 2010 and 2017 LiDAR data shows four areas of significant geomorphic change in PA 14.1. At the upstream end of the project area, a large apex engineered log jam has caused a small amount of erosion into the left bank, along with some wood accumulation at the front of the structure (box 1).

Downstream, another large apex engineered log jam has caused some bar building and sediment deposition on the left bank and some minor erosion on the right bank. The sediment deposition on the right bank appears to be blocking a flow path towards one of the targeted pilot cuts, which was not flowing during field observations (box 2).

Further downstream is the area with the most significant geomorphic change in this reach: engineered log jams on the left bank have triggered significant erosion on the right bank. Just downstream of this area is a split flow around a large log jam that comes together again at a large, channel-spanning log jam. The area between the erosion and channel-spanning log jam has seen some aggradation, especially in the former main channel, which likely is a driving factor behind the split flow in this location. This area is a good example of channel dynamics releasing sediment stored in the floodplain and forcing downstream geomorphic change and complexity. Much of the rest of the reach is likely starved of transportable matter, because only this log jam has caused significant change when some transportable material is available (box 3).

Finally, an apex engineered log jam has caused a split flow along with a small area of erosion on the left bank near the downstream end of the project area. This is the type of log jam and location where more geomorphic change would be expected (box 4). In general, PA 14.1 has seen very little geomorphic change for the amount of wood structure installed, and pilot side channels have not been eroded further into the floodplain as expected. It was noted during field observations that sediment sizes in this reach are too large to be easily transportable; the geomorphic change analysis supports the idea that more change would occur with a supply of transportable material.

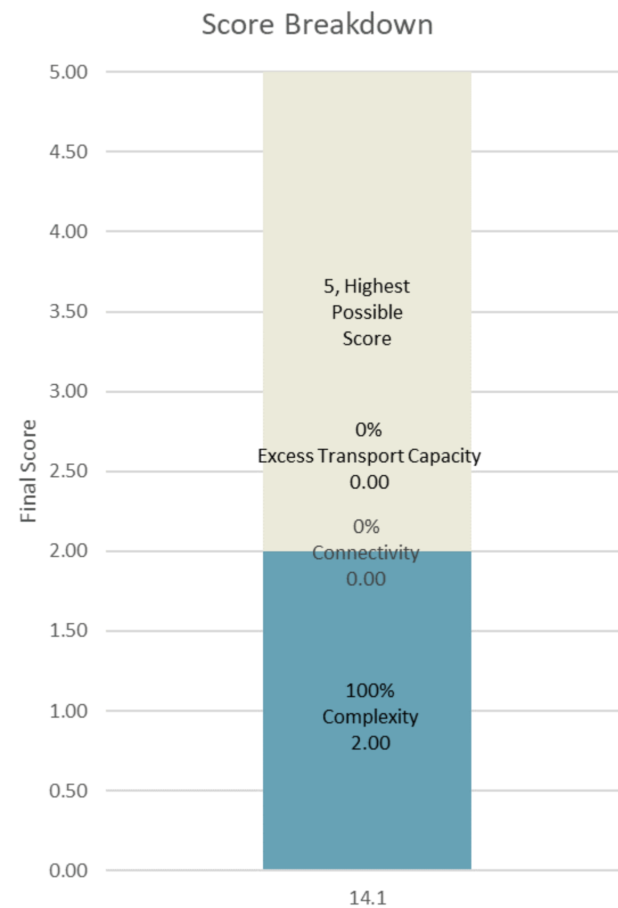
Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 14.1 received the highest possible scores in the Complexity metric, but scored 0 for the Excess Transport Capacity metric. PA 14.1 ranks in the 40th to 60th percentile for Complexity, which is the range in which reaches have the most potential for improving complexity. This score is reflected across all three flows of the complexity analysis results, ranking near the average across the assessment area for each flow.

Complexity in this reach is entirely driven by the in-channel bars and split flows formed by the apex and channel-spanning log jams in this reach. While this type of complexity does provide some habitat benefit, the more ideal situation would be for these log jams to promote geomorphic change in the floodplain, causing longer side channels, floodplain flow, and recruiting additional wood. This should be the primary goal for enhancing the complexity of restoration features in this reach. Since the lack of transportable material is likely the primary reason why these changes are not occurring, gravel augmentation in this reach should be a high priority for restoration management and enhancement. Wood structures could be added to help gravel augmentation by providing additional sediment storage.

Finally, PA 14.1 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 14.1 Score Breakdown



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

Summary of Restoration Opportunities Identified

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

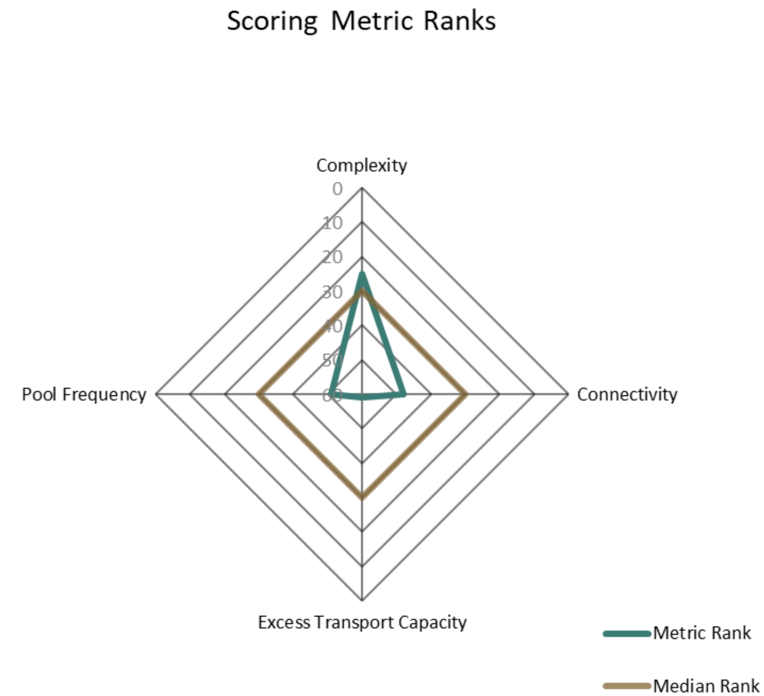
Long-Term Opportunities in this Project Area

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

PA 14.1 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.

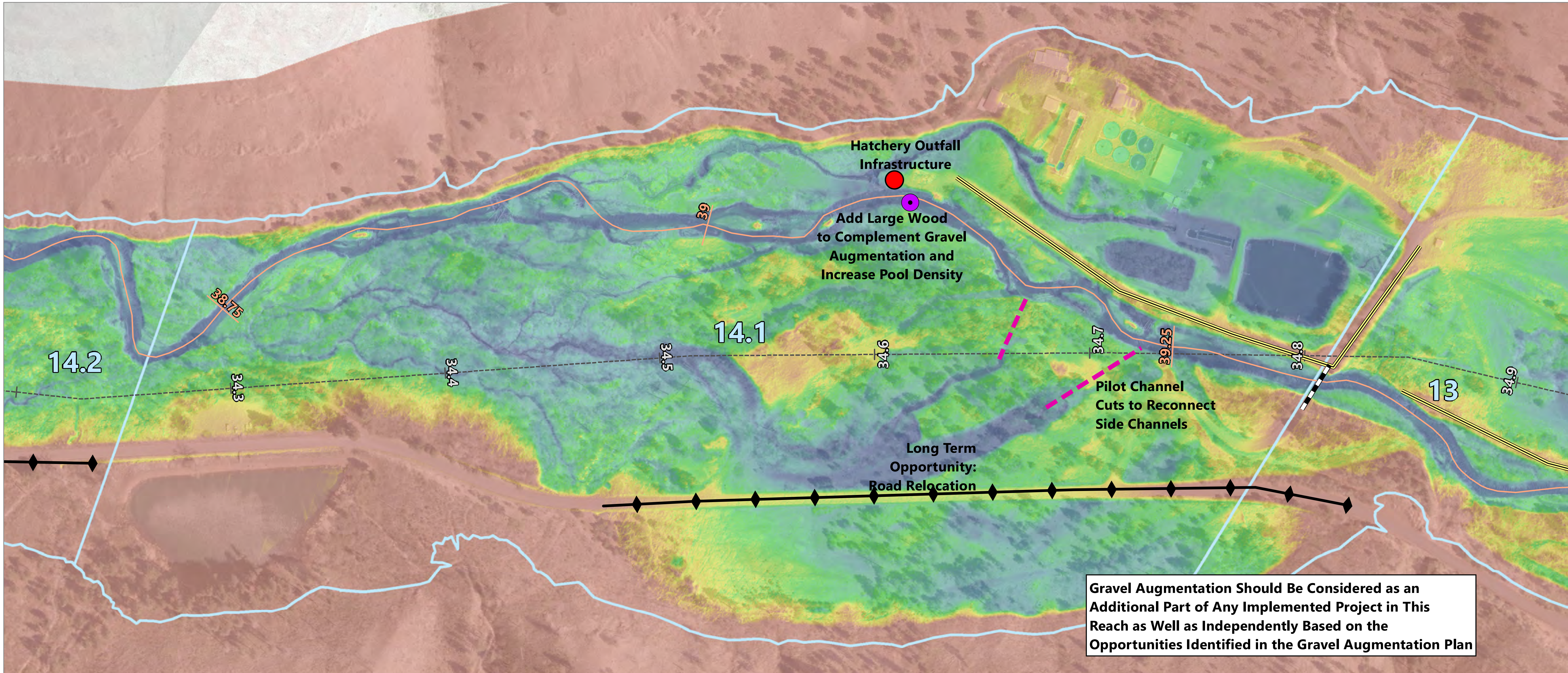
PA 14.1 Prioritization Scoring Summary

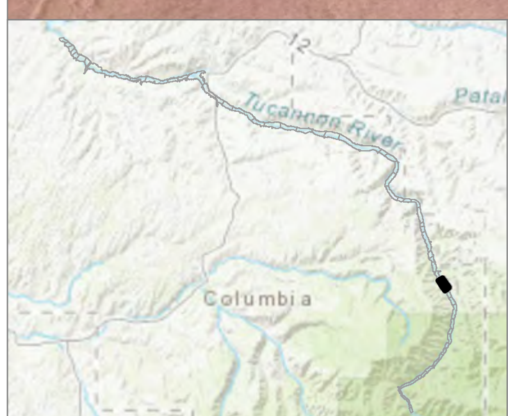


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 14.1 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	0.219	21	40%	**Complexity**	0.259	25	40% to 60%	3 of 5	5	40%	2.0	28	2	Treated	9	2
Mean-Winter Flow Complexity	0.272	27	40%													
1-year Complexity	0.315	31	20%													
Channel Aggradation FP Potential	0.185	36	40%	**Connectivity**	0.142	48	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.026	46	40%													
Total FP Potential	0.287	39	20%													
Existing Connected FP	0.713	22	0%													
Excess Transport Capacity	-0.32	59	100%	**Excess Transport Capacity**	0.000	59	52% to 100%	4 of 4	0	20%						
Pool Frequency	4.91	51	100%	**Pool Frequency**	0.126	51	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
- Reconnect Side Channel
- 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: 38.71
RIVER MILE END: 39.32
VALLEY MILE START: 34.26
VALLEY MILE END: 34.81

0 500
Feet

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ANCHOR QEA

Project Area 14.1
Conceptual Adaptive Management and Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 15.2 Description

Project Area 15.2 begins at VM 32.29 and extends upstream to VM 32.68. The 2017 RM length is 0.42 mile. Field observations for PA 15.2 were not conducted in 2018, but the majority of the reach was viewed from a lookout point on the road on September 26, 2018, when flow at the Starbuck gage was approximately 80 cfs. The remainder of this site description reflects observations made from the lookout point as well as information from the 2011 prioritization.

For this assessment update, PA 15 as defined in the 2011 prioritization was separated into two project areas (PA 15.1 and PA 15.2) for distinct analysis. Since the 2011 assessment, PA 15.2 has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization.

PA 15.2 is largely characterized by having a uniform plane-bed channel with a large, left bank floodplain and multiple large apex engineered log jams.

The upstream end of the reach begins just below the large side channel in PA 15.1 and has little instream complexity until the first large apex engineered log jam at VM 32.60, which appears to be causing a shallow scour pool and alcove on the left bank. Further downstream, the channel is mostly plane-bed and uniform, with one small split flow and bar, until the next apex engineered log jam at VM 32.48.

Project Area 15.2
Apex engineered log jams in PA 15.2, as seen from a nearby high vantage point.

Project Area 15.2 Reach Characteristics

VM Start (mi)	32.29
VM Length (mi)	0.39
Valley Slope	1.31%
RM Start (mi)	36.36
RM Length (mi)	0.42
Average Channel Slope	1.18%
Sinuosity	1.08
Connected FP (ac/VM)	9.83
Encroachment Removal (ac/VM)	1.17
Channel Aggradation (ac/VM)	4.94
Total FP Potential (ac/VM)	5.69
Encroaching Feature Length (ft)	415.50
Connected FP Rank	51

At VM 32.38, two large apex engineered log jams are forcing large split flow and erosion into the left bank. The majority of geomorphic activity for this reach is occurring here. The channel through this section borders the valley wall on the right bank but has a large floodplain area on the left bank with mature vegetation. The vegetation in this area has been affected by a recent fire but many of the large trees still remain, including a mix of cottonwoods and coniferous species.

The bed material for the whole reach was not noted during field observations, but at the upstream end the bed material was mostly cobble and boulder with little gravel and transportable material.

Restoration Actions and Geomorphic Changes

In 2015, restoration work in PA 15.2 included placing 24 engineered log jams and single logs using 181 key LWD pieces. Restoration work also included removing 190 feet of rock levee/berm and placing LWD to increase flooding into that area. The goal of the restoration work in this reach is to increase channel complexity and over time connect floodplain.

Analysis of the difference between the 2010 and 2017 LiDAR data shows several significant locations of geomorphic change, many of which are likely a direct result of the restoration efforts in the reach.

The first two locations of significant geomorphic change are related to the two large engineered log jams located in the main channel. Both log jams exhibit deposition in the wake of the structure and scour erosion along the sides. There are other examples of this type of change but not all have been noted in this narrative (boxes 1 and 2).

Downstream of here, more geomorphic change has occurred as a direct result of restoration efforts. Two engineered log jams have triggered a channel avulsion towards the left bank by the downstream log jam. Near the upstream log jam, there is some erosion and deposition on the left bank floodplain that indicates high flows are being pushed onto the floodplain. Additional deposition has occurred in the wake of the structures as well (box 3).

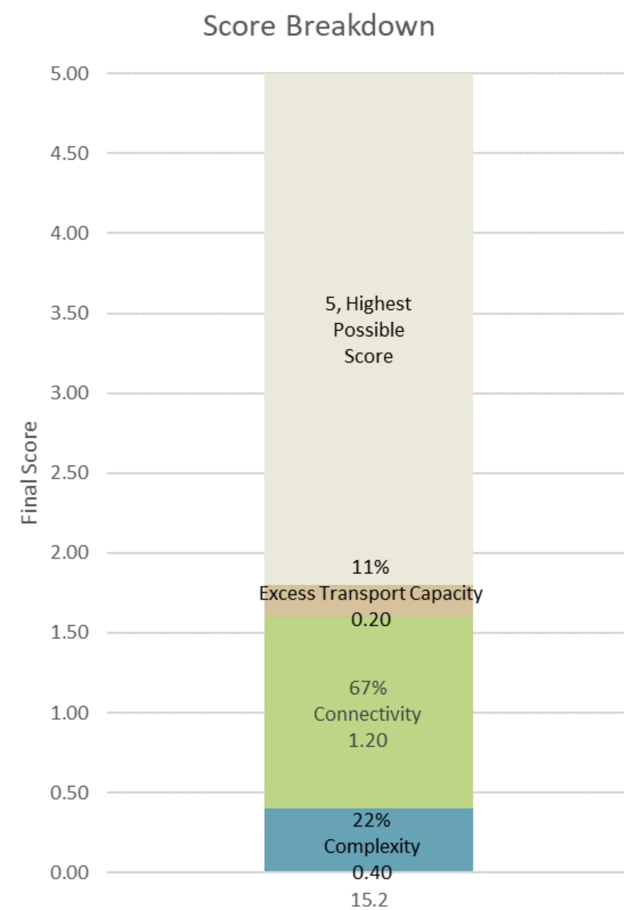
Finally, the last geomorphic change noted for this narrative occurs at the downstream end of the reach and does not appear to be a direct result of restoration efforts. A meander pattern is starting to form with first erosion on the left bank and bar building deposition on the right bank followed downstream by deposition on the left bank (box 4).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, Connectivity makes up the majority of the score for PA 15.2; this project area ranks near the top for Channel Aggradation and just below average for Encroachment Removal, which contribute to the overall score as well. Based on the floodplain mapping, this potential for connectivity comes mostly from a low-lying former channel or side channel on the left bank floodplain. Some of this area is low enough to be connected at the 2-year event, but a large additional amount of area could be connected given a rise in channel bed elevation. Enhancement strategies in this reach should target connecting this side channel area through strategic pilot channel cuts and wood placement to reconnect the low-lying area. Channel aggrading techniques such as gravel augmentation and strategic wood placement should also be considered as enhancement techniques to target the additional potential area to be connected. PA 15.2 receives a low score in Excess Transport Capacity, indicating that the shear stress is only slightly above the slope predicted value, and any gravel augmentation in this reach is likely to be easily stored and maintained with the addition of instream wood.

PA 15.2 receives a low score in the Complexity metric, indicating that the existing complexity in this reach is low enough that achieving additional complexity through restoration might be difficult. However, connecting the low-

PA 15.2 Score Breakdown



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

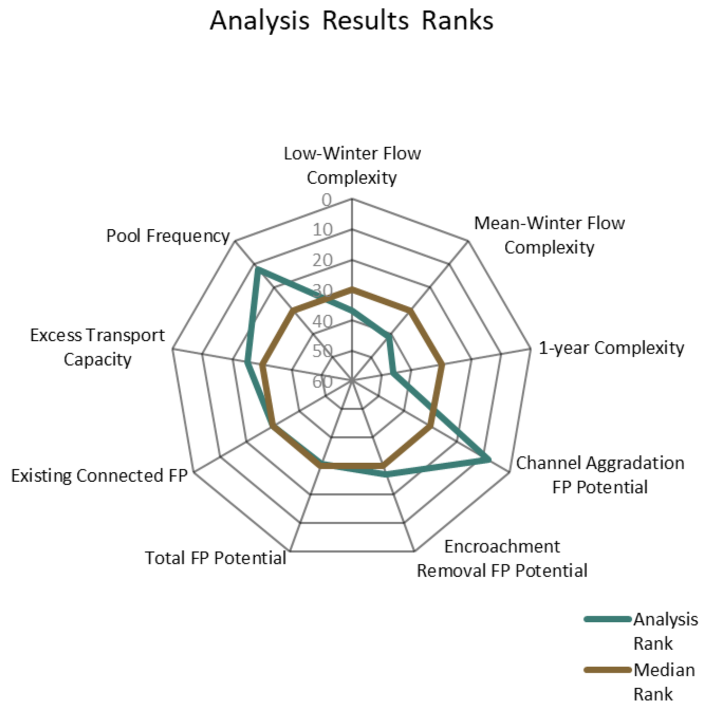
lying area targeted for floodplain connectivity could present a good opportunity to increase complexity as well. Cutting pilot channels low enough that perennial flow can access this area as well as adding instream wood should be considered as an enhancement strategy to increase complexity in this reach.

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

Summary of Restoration Opportunities Identified

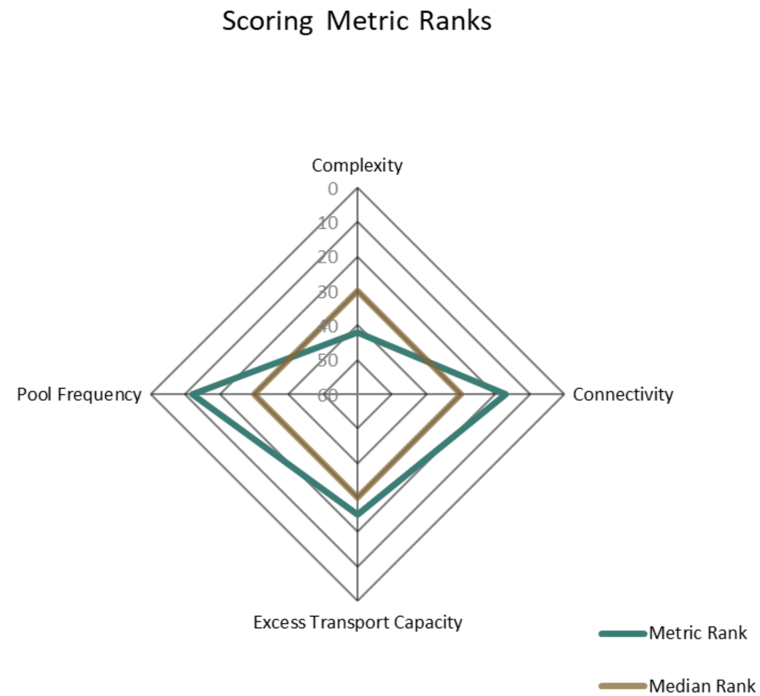
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)

PA 15.2 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.

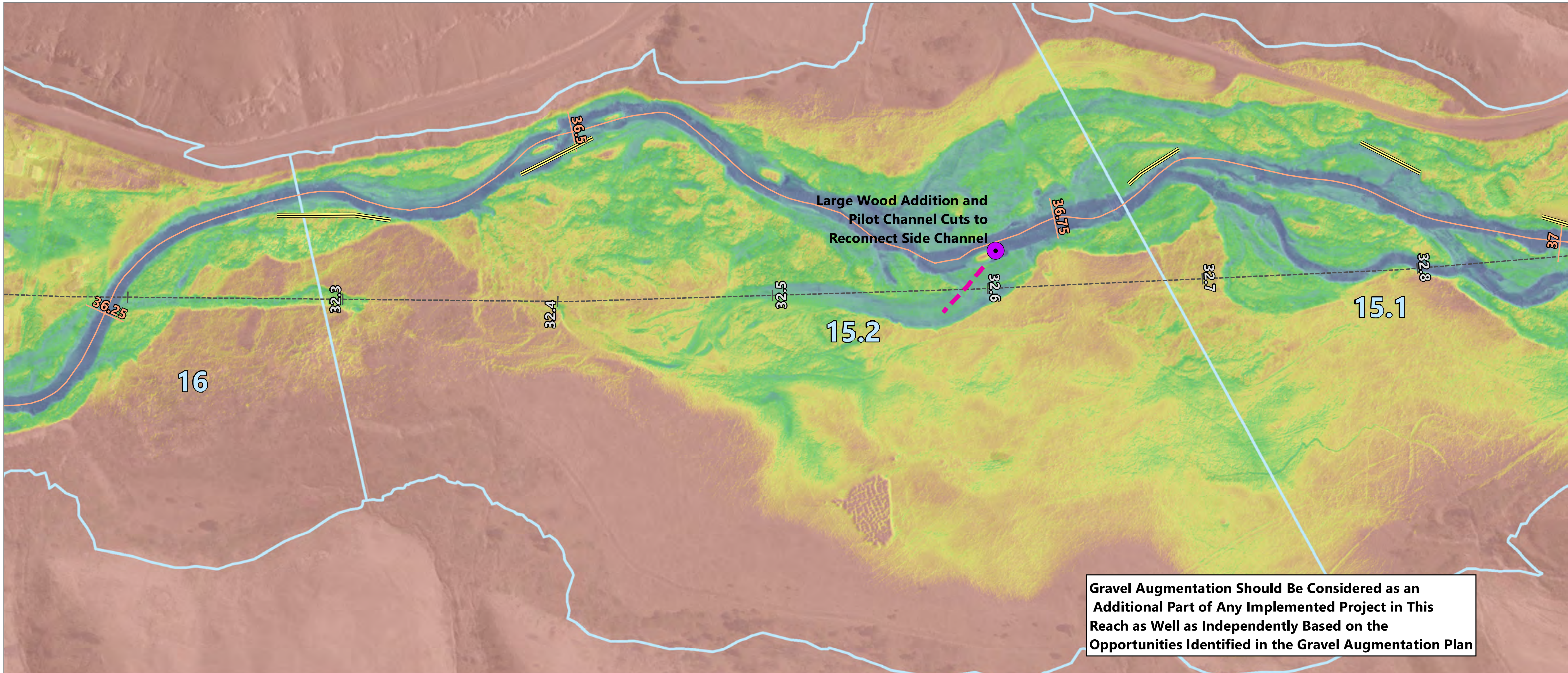
PA 15.2 Scoring Metric Ranks

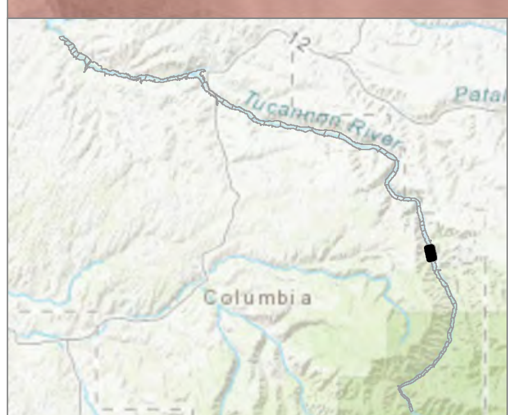


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 15.2 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	0.127	37	40%	Complexity	0.147	42	60% to 90%	4 of 5	1	40%	1.8	31	2	Treated	11	2
Mean-Winter Flow Complexity	0.154	41	40%													
1-year Complexity	0.172	46	20%													
Channel Aggradation FP Potential	0.318	8	40%	Connectivity	0.231	17	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.075	27	40%													
Total FP Potential	0.367	31	20%													
Existing Connected FP	0.633	30	0%													
Excess Transport Capacity	0.06	25	100%	Excess Transport Capacity	1.000	25	30% to 52%	3 of 4	1	20%						
Pool Frequency	18.90	12	100%	Pool Frequency	0.485	12	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition
- 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: 36.36
RIVER MILE END: 36.78
VALLEY MILE START: 32.29
VALLEY MILE END: 32.68

0 500
Feet

Publish Date: 2021/01/25, 3:48 PM | User: mgieschen
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ANCHOR QEA

Project Area 15.2
Conceptual Adaptive Management and Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 18.1 Description

Project Area 18.1 begins at the bridge crossing at Tucannon Road at VM 29.48 and extends upstream to VM 30.45. The 2017 RM length is 1.08 miles. Field observations were conducted on September 26, 2018, when flow at the Starbuck gage was approximately 80 cfs.

For this assessment update, PA 18 as defined in the 2011 prioritization was separated into two project areas (PA 18.1 and PA 18.2) for distinct analysis because only PA 18.1 was treated; this project area also exists entirely above the Tucannon Road bridge. Since the 2011 assessment, this reach has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization. However, restoration actions in this project area were very recent and occurred just before the raw data for this report were collected in 2017.

During field observations, the project area was accessed via the left bank floodplain near the upstream end. A floodplain spring has been reconnected from near the upstream end of the project area and was flowing at the time of field observations. Large woody material has been added to these side channels and is interacting with flow. Vegetation in the area of this side channel is primarily canary grass.

The channel itself was accessed near a point that had obviously recently aggraded. Surface flow is evident on much of the

Project Area 18.1
Recently installed rootwad logs and large woody debris structures interacting with flow.

Project Area 18.1 Reach Characteristics

VM Start (mi)	29.48
VM Length (mi)	0.96
Valley Slope	1.25%
RM Start (mi)	33.24
RM Length (mi)	1.08
Average Channel Slope	1.12%
Sinuosity	1.12
Connected FP (ac/VM)	20.45
Encroachment Removal (ac/VM)	0.50
Channel Aggradation (ac/VM)	8.78
Total FP Potential (ac/VM)	9.54
Encroaching Feature Length (ft)	3,201.32
Connected FP Rank	16

floodplain and multiple side channels are beginning to flow through the trees.

Downstream of this area on the main channel, a large amount of instream wood has been added to the channel. It appears the wood is a mix of single log placements and larger structures, which are secured with a mix of large boulder and roper, or piles. A side channel is flowing through the riparian area on the left bank, and at the time of the site visit, the outfall had significant flow.

Bed material throughout the reach is a mix of transportable gravel material and cobbles and boulders. Gravel material locations are patchy at times, and it appears that some upstream avulsion or event has recently transported material into the reach.

Because of this recent avulsion, the geomorphic reaction to many of the structures has been mixed. Several structures have deep scour pools even around single log placements, often associated with a stretch of gravel bed material. Other structures have been placed on cobble and boulder material and have not caused much pooling. Because restoration work was so recent, it is possible that there has not been enough time or enough transport flow events to have caused significant change.

Several redds from a recent spawning survey were noted in this project area, especially in the reaches where gravel material is more prevalent.

Mid-reach, a large channel-spanning log jam has recruited several additional pieces of woody material, and the channel begins to be confined on the right bank by the bedrock valley wall before returning to the center of the floodplain. Bank scour and erosion are evident on both banks and multiple natural wood recruits have fallen into the channel.

Near the downstream end of the reach, several return flows are on the left bank. On the right bank, multiple rootwad logs have been keyed into the long bridge levee that is confining the river on that side. There appears to be additional low-lying area behind the levee that is not being accessed. In this area, multiple very large pile structures are preventing wood recruits or lost structure wood from moving any further downstream.

Throughout this reach, vegetation around the channel is relatively dense, with large stands of alders and some cottonwoods with a few conifers mixed in. The riparian buffer around the stream is large in most places with several hundred feet of forest area on either side of the stream, except for where the channel runs along the valley wall on the right bank. Near the bridge at the downstream end of the project area, overhanging vegetation is slightly sparser.

Between this riparian area and the road is a large grass field where the side channel from the downstream end of the project area is mostly located.

Restoration Actions and Geomorphic Changes

In 2017, restoration work in PA 18.1 included placing 49 structures within the wetted width and 29 floodplain structures using 590 key LWD pieces. Additionally, 41 single log structures were incorporated into the wetted width. A 146-foot river levee was removed and used as gravel and cobble supplementation. Three side channels were cut and LWD structures were added to reconnect 1.66 miles of side channel and enhance 0.66 mile. The targeted geomorphic response focused on reconnecting large portions of the existing 5-year floodplain to a greater than 2-year flood interval (approximately 300 cfs) floodplain by removing confining features, connecting side channels, and placing high density LWD structure to increase bank erosion and stream bed deposition.

This assessment assumes that restoration work and geomorphic changes are unrelated due to the timing of the restoration work, which occurred just before the raw data were collected for this assessment. With so little elapsed time, it is not expected that any geomorphic changes resulting from the restoration project would be apparent in the LiDAR or aerial imagery data, which occurred shortly after construction.

At the upstream end of the project area, a large mid-channel bar is building on the right bank and associated erosion is evident on the left bank (box 1). Just downstream, areas of major deposition are evident in a location that was noted during field observations to be extremely complex even at the low-winter flow. Deposition in the main channel appears to be associated with the presence of LWD and has allowed flow onto the floodplain where several side channels are evident in the 2018 aerial imagery (box 2).

At VM 30.11, meander bends are beginning to form as first the left bank and then the right bank have experienced major erosion since 2010. No associated inside bar formation is apparent but may form eventually as the meander wavelength increases. LWD is apparent in these locations and could be forcing some of this change, but it is likely this process had begun before the 2017 restoration effort (box 3).

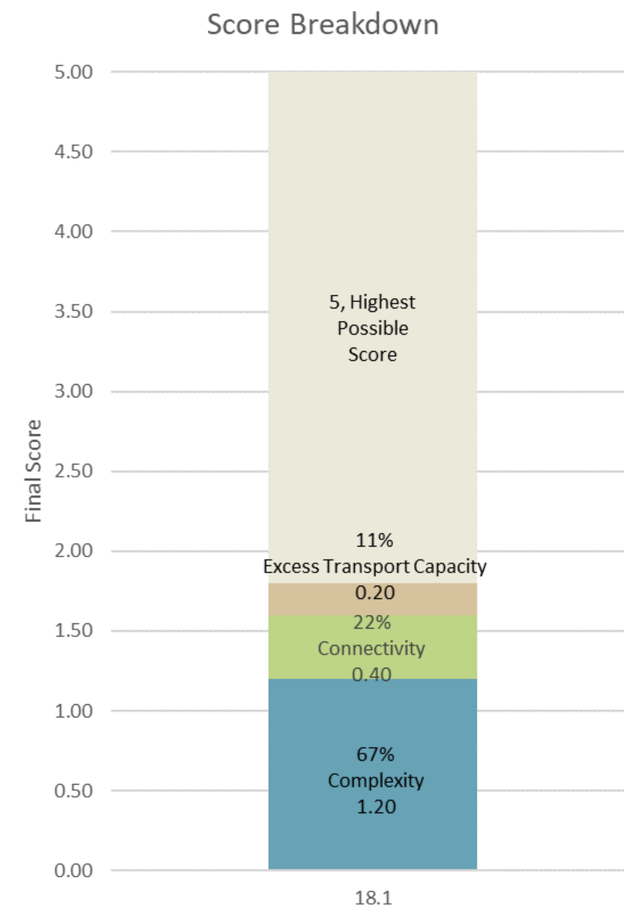
At VM 29.96, there appears to be some erosion associated with the downstream end of a side channel, along with deposition immediately to the side of the erosion. The source of the deposition was a gravel berm removal used as gravel augmentation as well as backfill for an apex ELJ upstream (box 4). Just downstream of here, a large amount of erosion on the left bank is apparent just upstream of a side channel, although this may just indicate inundation from backwatering. The side channel has evident elevational loss that were side channel cuts performed in the restoration effort, and it appears this side channel is connected at most flows (box 5).

Further downstream on the main channel, there is erosion on the right bank as well as significant erosion in the unnamed tributary. (box 6). The next reach immediately downstream shows apparent erosion on first the left bank and then the right bank over a long stretch. There is LWD in this area, but it is not clear whether this has caused these erosional stretches. Field observations suggest gravel materials were deposited in spring 2017 and subsequently mobilized following wood placement in fall 2017. However, because some of this area is within the area of the channel in 2010, it is possible some of these apparent changes may be an error due to the differences in the 2010 LiDAR and the 2017 blue/green LiDAR. See the Geomorphic Assessment for a more detailed explanation of this effect (box 7). The final reach of note shows a similar effect but with more area outside of the former channel and some evidence of increasing channel meander (box 8).

Geomorphic Characteristics and Management and Enhancement Strategies

The management and enhancement opportunities here are based on the 2018 LiDAR and aerial imagery data. However, it should be noted that the restoration actions in this reach occurred shortly before the data were collected and geomorphic response may not have occurred yet and may not yet be reflected in the prioritization score.

PA 18.1 Score Breakdown



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

As shown in the following graphs and table, PA 18.1 receives moderate scores in both the Complexity and Connectivity metrics, with a small score for the Excess Transport Capacity metric. The Complexity in this reach ranks above average in the 60th to 90th percentile, a range that still shows moderate complexity but does not place it in the top 10% of project areas; this project area likely only needs a little restoration work to reach that mark.

The floodplain area that drives the Connectivity score is a large low-lying area on the left bank floodplain. While the connectivity analysis shows that this area is disconnected by a by high bank floodplain, field observations noted flow in this area during low flow. This area does have a spring connection as well, and a 2019 field survey indicates that this area is inundated already at very low flow (75 cfs). A few other side channel areas are shown as disconnected, but all appear to have been targeted during restoration in 2017. The identified enhancement strategies for this reach would be to monitor the reconnection of disconnected side channels and low floodplain and supplement woody material to the main channel and side channels if needed. Because these actions match the restoration that was performed just before these data were collected, this area should be monitored for future changes. Should the reach respond to the restoration actions and the channel bed is raised, more disconnected floodplain area may become available and should be targeted.

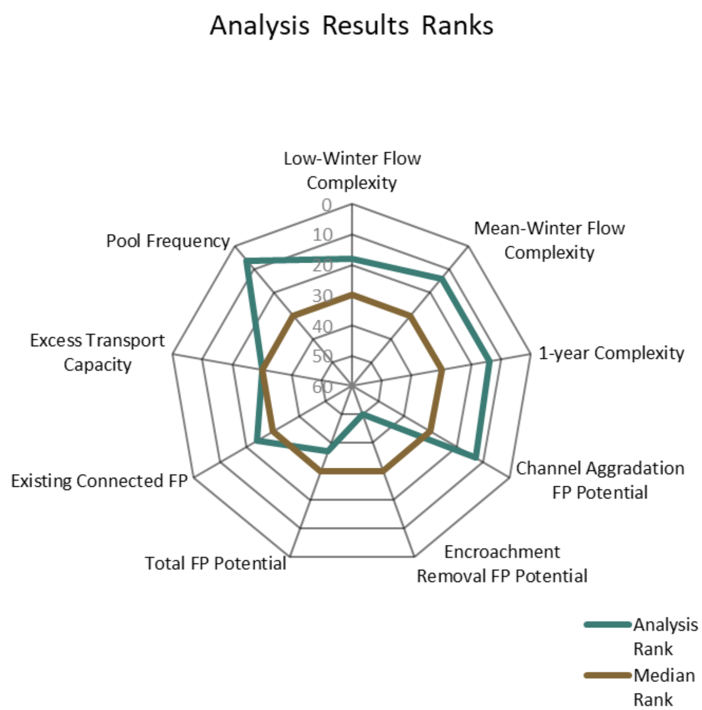
Finally, this project area already ranks higher than average in the Pool Frequency metric and this is not a primary enhancement target. The number, size, and frequency of pools should be monitored to ensure that geomorphic processes continue to exist that will force and maintain pools.

The complexity in this reach scores very close to the top 10% of project areas and, considering the amount of geomorphic response already noted in this reach, that complexity target should be easily reached. Management strategies for this reach should be to monitor the geomorphic response to the addition of wood and gravel augmentation already performed. Should the channel begin to disconnect from some side channels, it is possible that additional gravel augmentation could be warranted.

Summary of Restoration Opportunities Identified

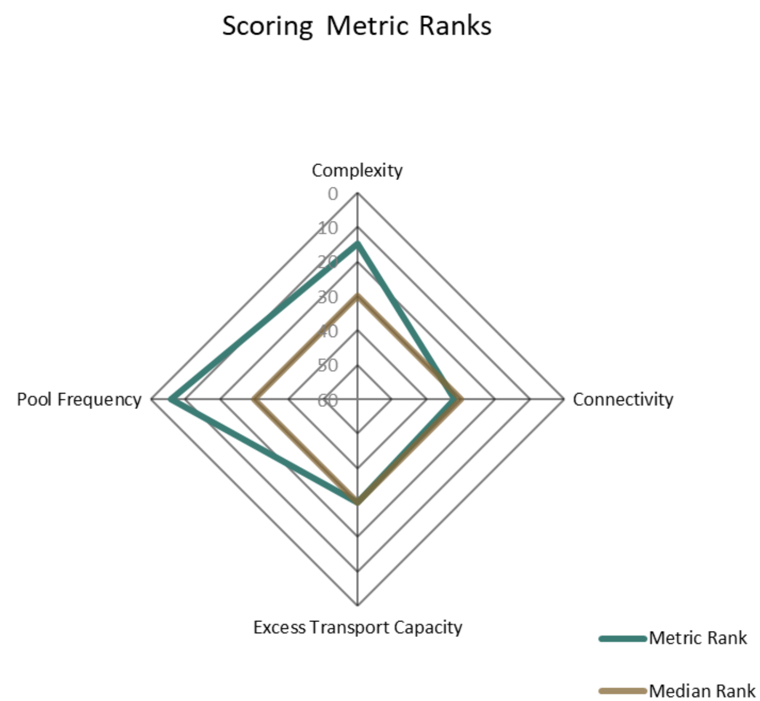
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features

PA 18.1 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.

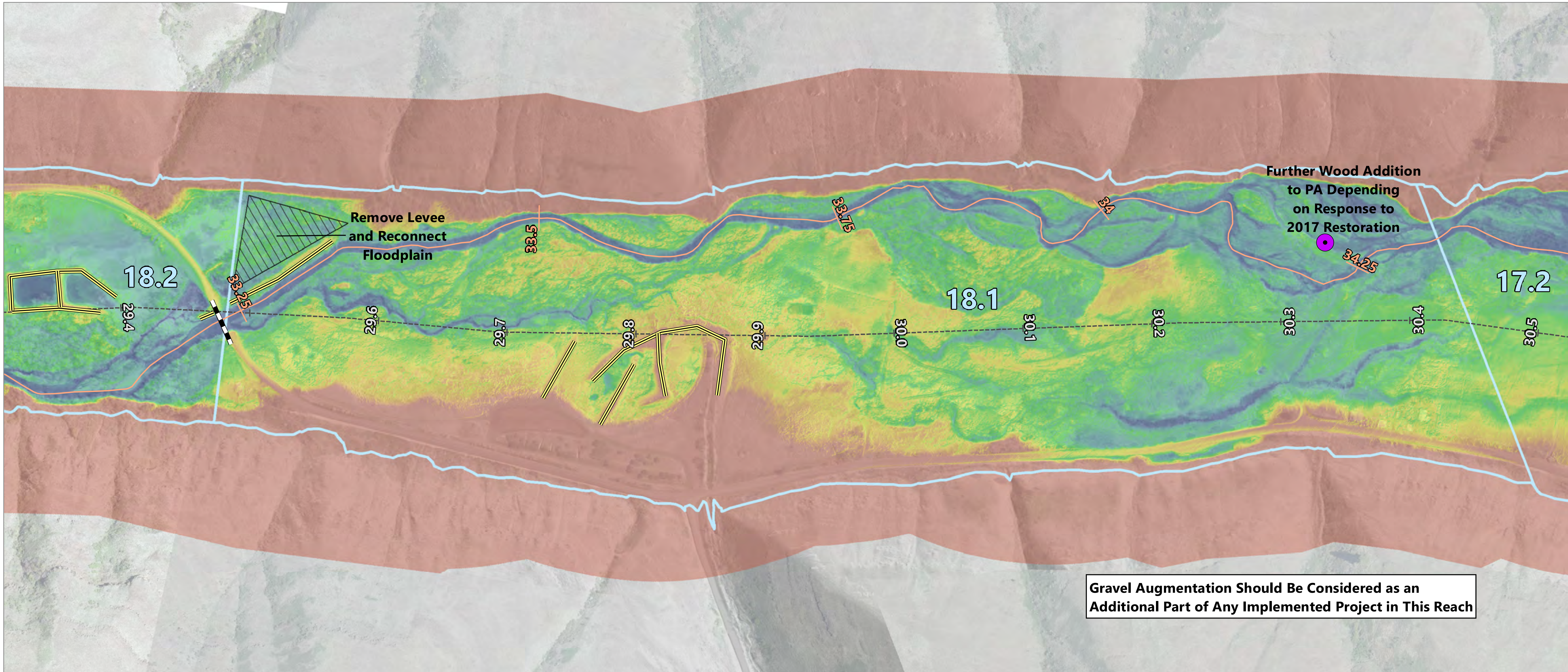
PA 18.1 Prioritization Scoring Summary

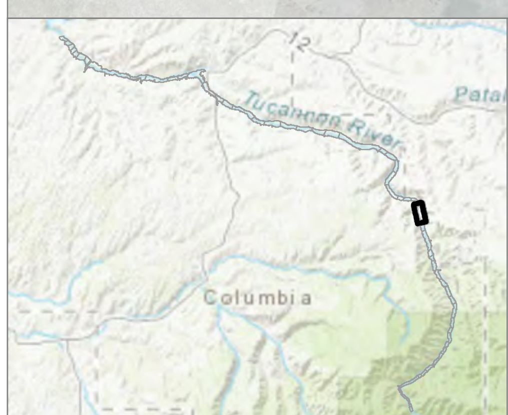


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 18.1 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	0.243	18	40%	Complexity	0.376	13	10% to 40%	2 of 5	3	40%	2.6	14	1	Treated	7	1
Mean-Winter Flow Complexity	0.422	13	40%													
1-year Complexity	0.549	11	20%													
Channel Aggradation FP Potential	0.169	38	40%	Connectivity	0.214	25	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.143	17	40%													
Total FP Potential	0.444	18	20%													
Existing Connected FP	0.556	43	0%													
Excess Transport Capacity	0.02	29	100%	Excess Transport Capacity	1.000	29	30% to 52%	3 of 4	1	20%						
Pool Frequency	26.83	6	100%	Pool Frequency	0.689	6	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
- Reconnect Floodplain

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: 33.24
RIVER MILE END: 34.32
VALLEY MILE START: 29.48
VALLEY MILE END: 30.45

0 500
Feet

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ANCHOR QEA

Project Area 18.1
Conceptual Adaptive Management and Restoration Opportunities

Project Area 28.2 Description

Project Area 28.2 begins at VM 18.41 and extends upstream to VM 19.42. The 2017 RM length is 1.17 miles. Field observations for PA 28.2 were conducted on September 25, 2018, when flow at the Starbuck gage was approximately 85 cfs.

For this assessment update, PA 28 as defined in the previous assessment (Anchor QEA 2011) 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 upstream 0.25 mile of PA 28.2 was not walked but appears from the LIDAR and aerial imagery to be mostly confined by a levee on the right bank and the valley wall on the left bank.

At VM 19.17, a small, complex flow area with several log jams is pushing some flow out through the trees, making it unclear where the main channel is. At about VM 18.96, a large, complex area with several engineered and natural log jams was forcing flow into several side channels and floodplain flow at the time of the site walk. These side channels flow for a long way through the forested floodplain and create extremely complex juvenile habitat for nearly half a mile to the end of the reach.

Project Area 28.2
Complex flow around an engineered log jam near the upstream end of PA 28.2.

Project Area 28.2 Reach Characteristics

VM Start (mi)	18.41
VM Length (mi)	1.01
Valley Slope	0.91%
RM Start (mi)	20.91
RM Length (mi)	1.17
Average Channel Slope	0.78%
Sinuosity	1.16
Connected FP (ac/VM)	23.53
Encroachment Removal (ac/VM)	5.02
Channel Aggradation (ac/VM)	15.67
Total FP Potential (ac/VM)	24.11
Encroaching Feature Length (ft)	5,120.78
Connected FP Rank	10

Throughout these side channels and the floodplain, there are multiple log and debris jams that often are forcing large scour pools and in-channel complexity. The main channel on the left bank runs mostly along the valley wall and has less wood and complexity than the side channels, with a few plane-bed uniform sections. Near the end of the main channel, a large, constructed log jam is creating multiple split flows and complexity.

At VM 18.51, all of the floodplain side channels rejoin the main channel and there are several more log jams forcing deep pools, particularly where the largest side channel rejoins the main channel.

This reach is defined by excellent complexity in the floodplain. Bed material is difficult to characterize but the side channels appear to have a good amount of gravel material that is easily transported, and geomorphic pools are forced easily.

Riparian vegetation through this reach is very good because the large floodplain area has many large deciduous trees throughout. One side channel does border the right bank levee closely where there is an abundance of reed canary grass and little other overhanging cover.

Restoration Actions and Geomorphic Changes

In 2016, VM 19 downstream was treated with 22 structures and 4 single logs using 135 key LWD pieces. In 2017, an additional 10 structures were added using 62 LWD key pieces, and 11 floodplain structures using 22 LWD key pieces were added to a reconnected high-flow channel. A 120-foot gravel berm was removed to help reconnect the floodplain. LWD structures were placed in two strategic locations to reconnect 2,400 feet of side channel as perennial channel and 690 feet to be captured as annual high-flow side channel. Restoration work included connecting approximately 22 acres of low floodplain that had been isolated by incision.

The geomorphic goal was to encourage increased flooding on an annual basis (approximately 300 cfs). This was attempted using LWD structures to capture gravel and create bars, as well as reduce channel capacity to cause flooding and side channel development. It is anticipated that with this restoration the number of pools would double and the perennial length of the channels would double as well.

Analysis of the difference between the 2010 and 2017 LiDAR data shows that PA 28.2 has seen some of the most significant change in the Tucannon River basin over the last 7 years. Much of the change discussed here can be attributed to the removal of levees as part of restoration efforts, as well as a large amount of sediment deposited throughout the reach.

At the upstream end, several log jams have promoted sediment deposition and several split flows causing complex flow throughout the floodplain (box 1). It is possible this avulsion could be the source of some of the sediment seen deposited downstream.

The next highlighted location marks a long section of sediment deposition in the main channel. Part way through this depositional reach, a split flow has formed a long side channel that continues on for the remainder of the reach forming multiple islands and very complex flow. It should be noted that this deposition and change is a good example of the type of response targeted with the gravel augmentation plan included as part of this prioritization (box 2).

Downstream of here, another depositional reach occurs in one of the channels as well as on the floodplain on both sides. Split flows and side channels have formed as a result and there are several erosional areas where new side channels have formed in this area, creating very complex flow (box 3).

Finally, a large channel-spanning log jam and engineered apex jams have allowed deposition in the floodplain to either side of the log jam in one of the channels. Additionally, scour pools and erosional areas can be seen behind the two main log jams. (box 4). It should be noted this reach has a large amount of geomorphic change, not all of which is discussed as part of this narrative. For a complete picture of the geomorphic change analysis, see the GIS layers provided as part of this assessment.

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 28.2 receives very high scores in the Connectivity metric. PA 28.2 ranks within the 90th percentile for complexity, indicating that it is one of the most complex project areas and therefore receives a Complexity score of 0. Management strategies should work to ensure that complexity in this reach remains and does not degrade. While the low-winter, mean-winter, and 1-year flow complexity analysis results all rank PA 28.2 very highly, the 1-year complexity is slightly lower, which is not necessarily undesirable. PA 28.2 has seen very recent deposition and complex flow formation and the slightly lower 1-year flow complexity could indicate that some island and gravel bars are being "washed out" and inundated at the 1-year flow event. One management strategy to the restoration already completed in this reach should be to continue wood loading over time to maintain existing islands and split flows to ensure complexity at low flows does not wash out at the higher flows.

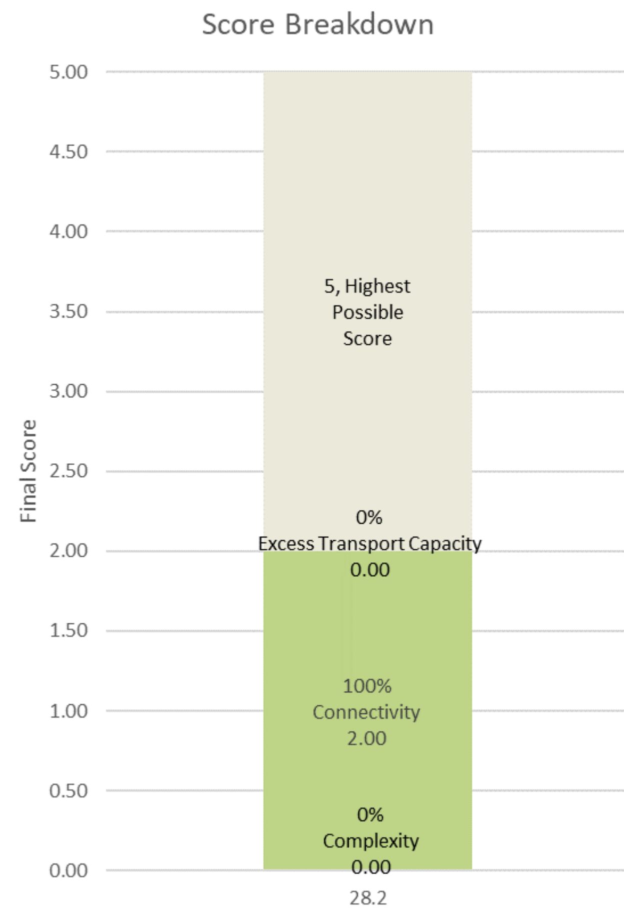
PA 28.2 also receives a moderate score for Connectivity, indicating that it falls within the 50th to 75th percentile of all project areas. This score is driven primarily by a large, low-lying area in the upstream end of the left bank floodplain. There is additional disconnected area in several former channels and meanders just upstream of this low-lying area. These areas could be reconnected with strategic pilot channel cuts and placement of instream wood near the heads of these new channels to promote geomorphic change. Placing instream wood and cutting pilot channels to connect these areas should be the primary enhancement strategies for this reach, in addition to the management strategies suggested for complexity.

Finally, the Pool Frequency analysis result indicates that this project area ranks relatively high for number of pools per valley mile. The management strategies of adding instream wood, if necessary, should help to ensure this number of pools is maintained in the future. Should the depositional trend in this reach ever reverse, adopting gravel augmentation may be necessary to maintain the high number of pools in the reach.

Summary of Restoration Opportunities Identified

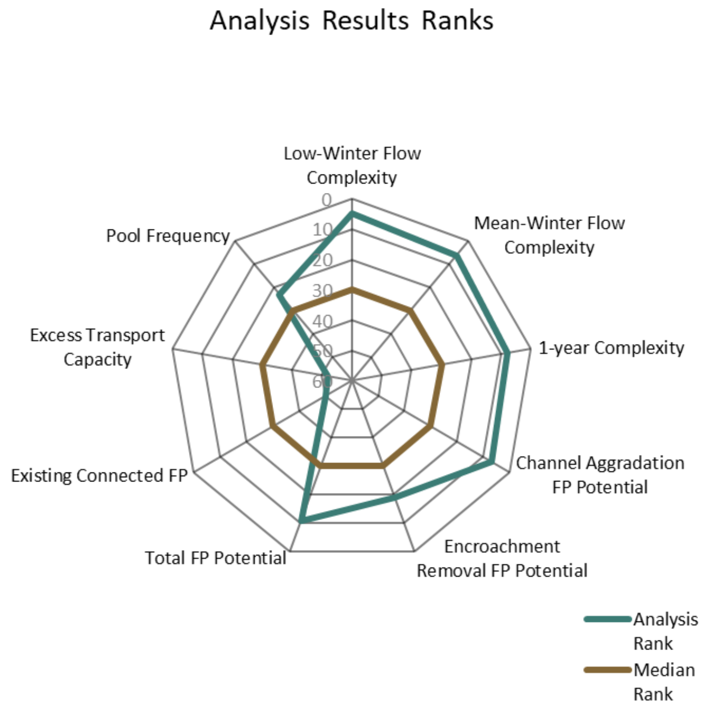
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)

PA 28.2 Score Breakdown



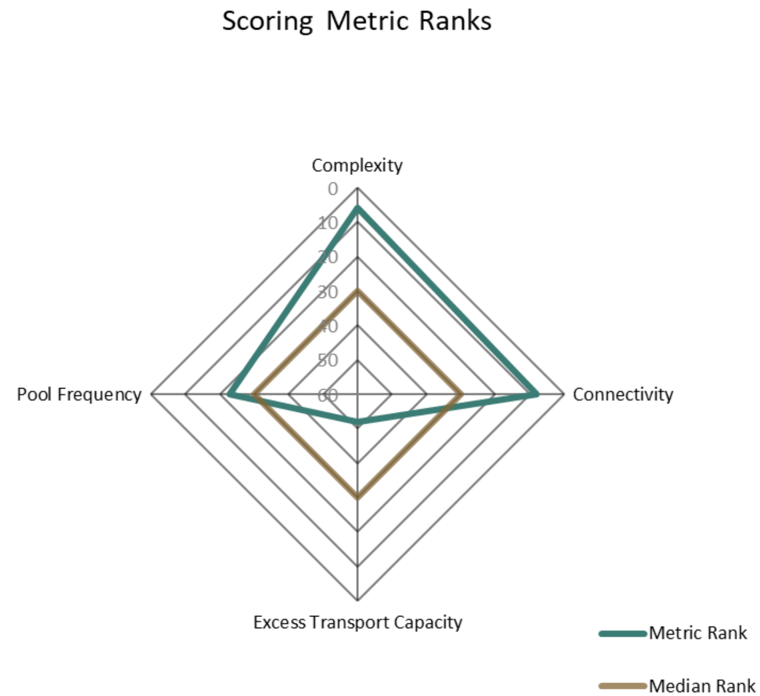
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 28.2 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.

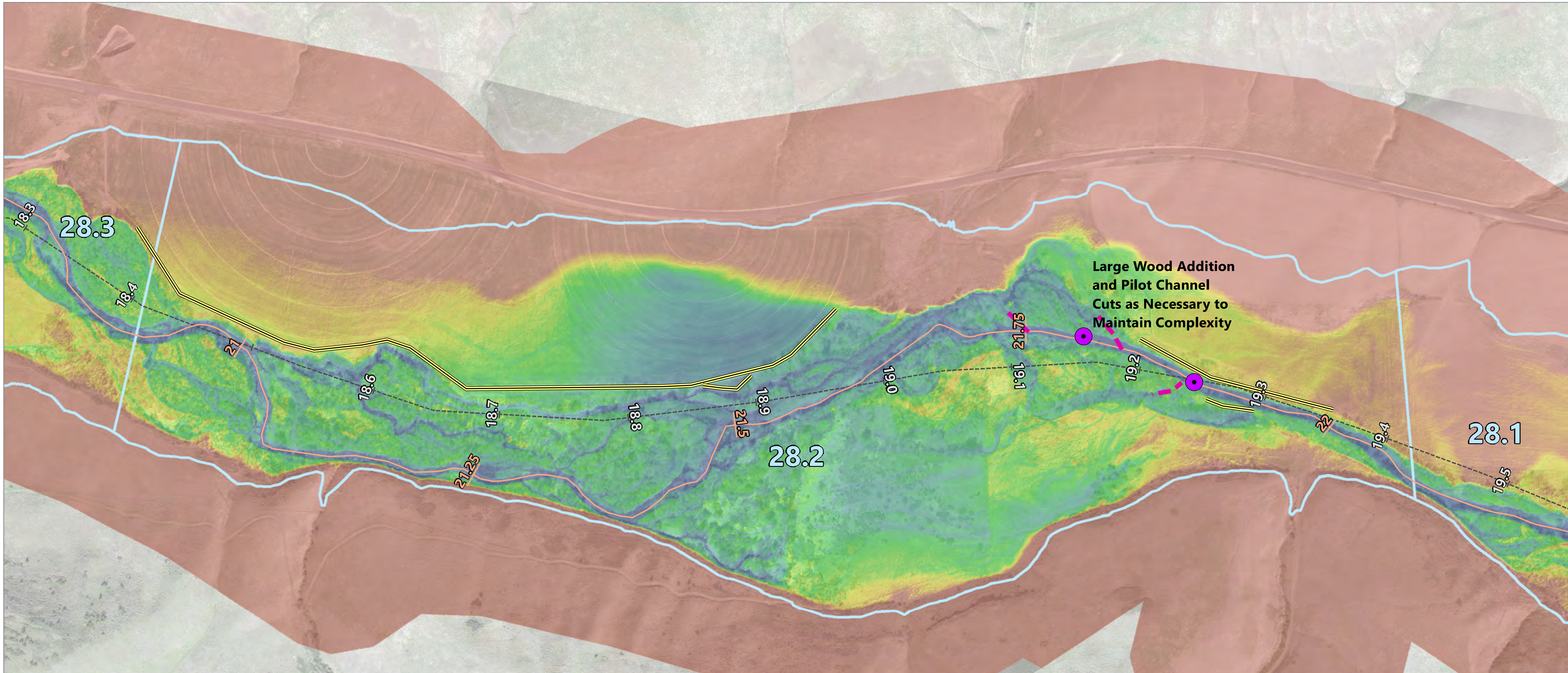
PA 28.2 Scoring Metric Ranks

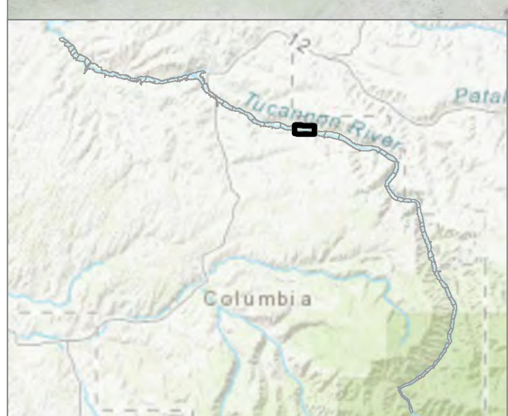


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 28.2 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	0.333	5	40%	Complexity	0.460	6	1% to 10%	1 of 5	0	40%	2.0	29	2	Treated	10	2
Mean-Winter Flow Complexity	0.500	6	40%													
1-year Complexity	0.635	8	20%													
Channel Aggradation FP Potential	0.329	7	40%	Connectivity	0.275	8	1% to 25%	1 of 4	5	40%						
Encroachment Removal FP Potential	0.105	19	40%													
Total FP Potential	0.506	11	20%													
Existing Connected FP	0.494	50	0%													
Excess Transport Capacity	-0.16	52	100%	Excess Transport Capacity	0.000	52	52% to 100%	4 of 4	0	20%						
Pool Frequency	12.85	23	100%	Pool Frequency	0.330	23	10% to 40%	2 of 5	3	0%						





LEGEND:
- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition
- 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: 20.91
RIVER MILE END: 22.08
VALLEY MILE START: 18.41
VALLEY MILE END: 19.42

0 500
Feet

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ANCHOR QEA

Project Area 28.2
Conceptual Adaptive Management and Restoration Opportunities
Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 28.3 Description

Project Area 28.3 begins at VM 17.38 and extends upstream to VM 18.41. The 2017 RM length is 1.16 miles. Field observations for PA 28.3 were conducted on September 25, 2018, when flow at the Starbuck gage was approximately 85 cfs.

For this assessment update, PA 28 as defined in the previous reports was separated into three project areas (PA 28.1, PA 28.2, and PA 28.3). In 2017 and 2018, 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.

PA 28.3 is characterized by a mostly single-thread channel with some planform complexity. Several sections along this reach have a bedrock bottom, and there is a small bedrock falls at VM 17.78. The bedrock continues upstream and downstream of this point for some distance.

At the upstream end of the project area, there are multiple log jams on either bank of the channel. At about VM 18.33, an apex jam creates a split flow and protects an island with some established vegetation.

For the next 0.23 mile, the river is mostly a uniform plane-bed channel with good instream wood in the form of log jams on alternating banks. At VM 18.1, a large channel avulsion has

Project Area 28.3
Alternating engineered bank structures in a confined section of PA 28.3.

Project Area 28.3 Reach Characteristics

VM Start (mi)	17.38
VM Length (mi)	1.03
Valley Slope	1.01%
RM Start (mi)	19.75
RM Length (mi)	1.16
Average Channel Slope	0.90%
Sinuosity	1.13
Connected FP (ac/VM)	18.92
Encroachment Removal (ac/VM)	0.40
Channel Aggradation (ac/VM)	10.88
Total FP Potential (ac/VM)	11.30
Encroaching Feature Length (ft)	830.19
Connected FP Rank	17

occurred on the right bank and multiple trees have naturally fallen in the river, creating a deep scour pool. At VM 18, large woody material jam is protecting a location with right bank erosion, and a short distance downstream a side channel is visible on the relative elevation map.

At the time of the site visit, the next section was straight and plane-bed with alternating engineered log jam bank structures. This entire location has very little vegetation and the entire left bank is steep bank field. At the bend at the end of this section, large log jams have been placed near the left bank to push flow off of a fine sand material bank with little vegetative cover.

Immediately downstream of this bend, the channel bottom becomes mostly bedrock and goes over the small bedrock falls. At the downstream end of the falls, multiple locations show evidence of avulsions through the trees that are scouring to bedrock. The channel here is confined by a large, high-elevation area on the right bank. The remainder of the channel is mostly straight and uniform but with alternating structures placed on the left and right banks to increase channel complexity to the downstream end of the reach.

Bed material near the downstream end of the reach consists of mostly cobbles and boulders, which are resistant to being transported, as might be expected just downstream of a bedrock falls. Upstream, moderately more gravel material has allowed some scour pools to form near structures, but this reach could definitely benefit from more easily transportable material.

Vegetation in this reach is also mixed, with pockets of well-established trees in the riparian areas including cottonwood and alder, and long stretches of exposed areas with sparse, large, overhanging vegetation, particularly near the middle of the project area. The very downstream end of the project area has mature vegetation in a narrow band of riparian vegetation on either side of the channel.

Restoration Actions and Geomorphic Changes

Between 2017 and 2018, restoration work in PA 28.3 included placing 30 LWD structures using 328 LWD key pieces and 55 floodplain structures using 55 key pieces. Two side channel pilot cuts totaling 150 feet were excavated to reconnect 0.98 mile of high-flow channel. Two channel-spanning structures were placed to backwater the falls near the downstream end of the project area. The goal was to connect more than 5 acres of poorly connected floodplain at a less than 2-year flood and connect 14 acres disconnected floodplain at a less than 2-year flood. Over time it is anticipated the 0.98 mile of connected flow paths will improve riparian growth and increase perennial length. The long-term goal is to increase floodplain connectivity and channel complexity.

Analysis of the difference between the 2010 and 2017 LiDAR data shows several areas of significant geomorphic change in

PA 28.3. However, given that some restoration actions occurred just before or after these raw data were collected, it is unlikely that these changes are a result of restoration efforts and there may have been other significant changes that were not a result of the restoration efforts. However, restoration actions performed in 2017 have reportedly responded very quickly and are likely reflected in these results. Reports indicated that a significant amount of change occurred in 2018 after the data collection and the floodplain may be inundated after RM 20 at the yearly event.

The first area of significant change is located at VM 18.33 where a significant split flow has occurred around a vegetated island. The island appears to be a depositional area, with erosion occurring in the main and side channel to either side. A small log jam at the head of the island, visible in the 2018 aerial imagery, may have propagated this split flow (box 1).

The next significant location occurs just downstream at VM 18.13 where a major channel avulsion has occurred and left a large meander scar in the nearby agricultural field along with deposition on the island in between. The 2018 aerial imagery shows an engineered log jam has been placed at the head of this meander scar, although the log jam does not appear to have caused the meander scar because it was placed to encourage flow into that channel but not to let it capture the channel. Immediately downstream of this area, bank erosion has occurred on the right bank and LWD has fallen and caused the channel to migrate towards the left bank where there has been significant erosion, and sediment has been deposited in the former channel bed. This channel migration appears to have put extra erosional pressure on the right bank of the meander bend downstream where a significant bank erosion has occurred along with bar building inside of the bend. The 2018 aerial imagery shows large woody material recruited in this erosional bank area (box 2).

Finally, at VM 17.6 the channel trace comparison from 2010 to 2018 shows an avulsion towards the left bank. However, based on the LiDAR differencing it appears that since then the channel has migrated back towards its original position with erosion on the right bank and bar building on the left bank (box 3).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 28.3 receives the majority of its prioritization score from a moderate score in the Connectivity metric. PA 28.3 also receives a low score in both the Excess Transport Capacity metric and the Complexity metric, which make up its entire prioritization score. The high Connectivity score consists of high ranks in both the Channel Aggradation and Encroachment Removal analysis results, both of which are defined by two primary areas.

The channel aggradation potential comes from an area mid-reach that is connected at the 5-year event but not the 2-year event. An avulsion in this area was noted as having been reinforced with large woody material as part of recent restoration actions and may help to connect this area given more time for geomorphic change. Reports indicate that some of this change has occurred; however, if the ELJs begin to fail or disintegrate, remediation actions should be taken to maintain this inundation.

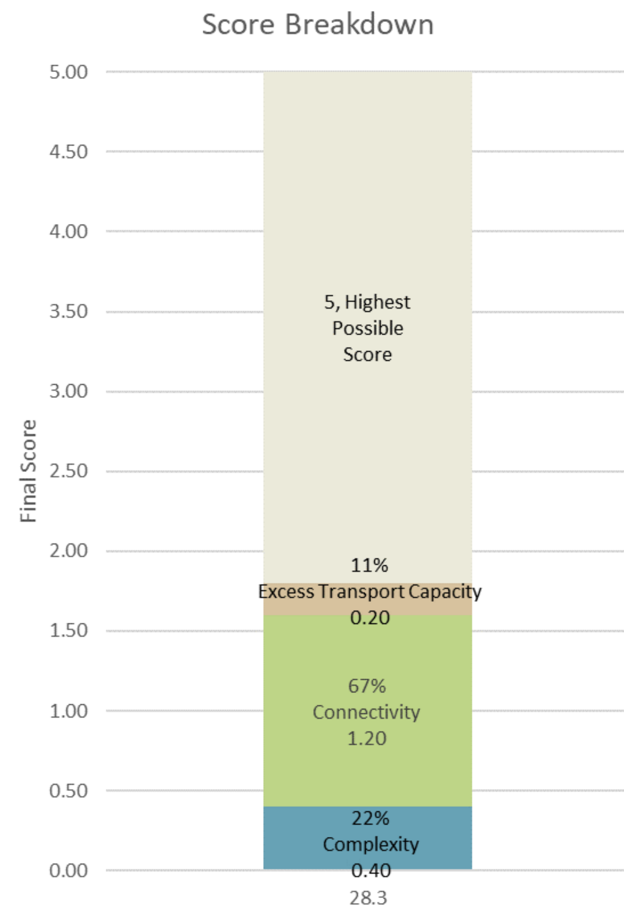
The encroachment removal potential is driven by a very large floodplain area disconnected on the right bank. There appears to be several connected side channels that do not quite reconnect this area. Restoration actions have occurred near this area and reports indicate that they are connected semiannually. However, should this area begin to become disconnected at the 2-year event, it should be targeted with pilot channel cuts and adding instream wood to reconnect the side channels that feed this large floodplain area.

Finally, the Pool Frequency analysis result indicates that this project area ranks relatively high for number of pools per valley mile. The management strategies of adding instream wood, and gravel augmentation if necessary, should help to ensure the number of pools is maintained in the future.

Summary of Restoration Opportunities Identified

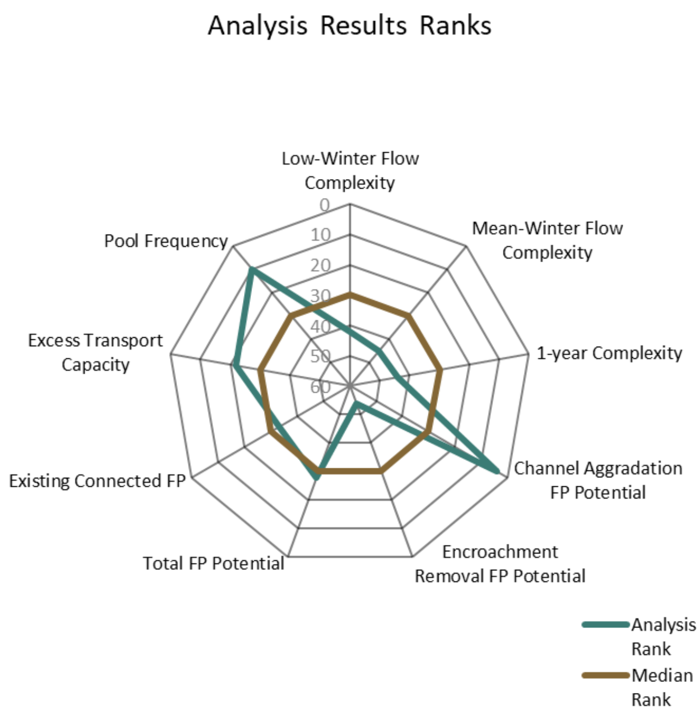
- Gravel augmentation
- Maintain side channels and LWD structures.

PA 28.3 Score Breakdown



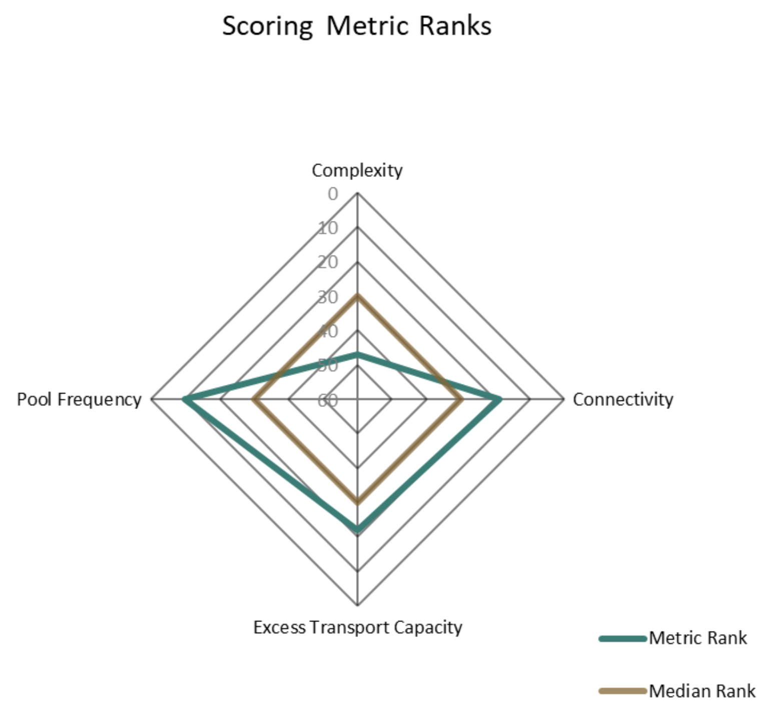
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 28.3 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.

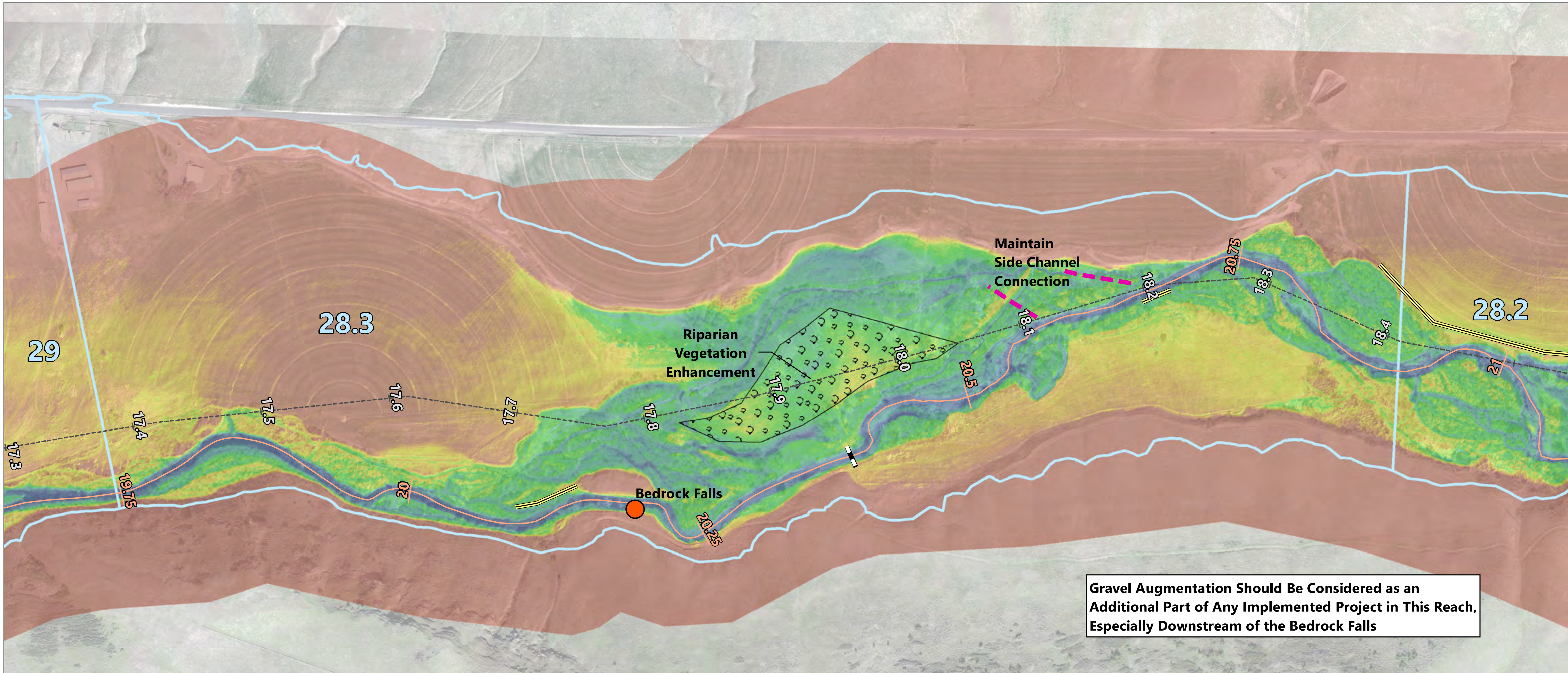
PA 28.3 Prioritization Scoring Summary

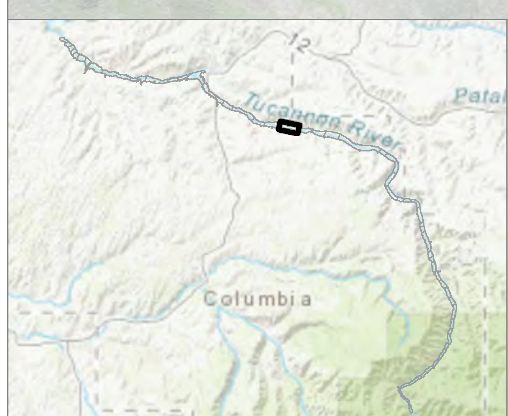


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 28.3 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	0.109	42	40%	Complexity	0.134	47	60% to 90%	4 of 5	1	40%	1.8	33	2	Treated	13	2
Mean-Winter Flow Complexity	0.137	45	40%													
1-year Complexity	0.177	44	20%													
Channel Aggradation FP Potential	0.360	4	40%	Connectivity	0.224	19	25% to 50%	2 of 4	3	40%						
Encroachment Removal FP Potential	0.013	54	40%													
Total FP Potential	0.374	28	20%													
Existing Connected FP	0.626	33	0%													
Excess Transport Capacity	0.09	22	100%	Excess Transport Capacity	1.000	22	30% to 52%	3 of 4	1	20%						
Pool Frequency	20.61	10	100%	Pool Frequency	0.529	10	10% to 40%	2 of 5	3	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Bridges Limiting Channel Migration
- Reconnect Side Channel
- 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: 19.75
RIVER MILE END: 20.91
VALLEY MILE START: 17.38
VALLEY MILE END: 18.41

0 500
Feet

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ANCHOR QEA

Project Area 28.3
Conceptual Adaptive Management and Restoration Opportunities

APPENDIX J.1
TIER 3: TREATED PROJECT AREAS

Project Area 10.1 Description

Project Area 10.1 begins at VM 38.52 and extends upstream to VM 38.92. The 2017 RM length is 0.47 mile. Field observations for PA 10.1 were conducted on September 28, 2018, when flow at the Starbuck gage was approximately 80 cfs.

PA 10.1 is characterized by extremely well-connected floodplain and high amounts of instream wood. At the upstream end of the project area, flow on the floodplain comes in from the downstream portion of PA 9. A side channel is visible in the 2018 aerial imagery that extends the entire length of the floodplain in PA 10.1. Where the site visit started on PA 10.1, flow was visible through the forest floodplain for a good distance and a large backwater area was formed near a large log jam.

The channel has a high amount of wood loading with large rootwad logs that appeared to be both placed and natural recruits. At VM 38.67, a large channel-spanning log jam has triggered a split flow around an island with established vegetation. This channel-spanning log jam appears to have captured much of the wood that would otherwise be moving further downstream, but some natural and placed log jams are still apparent.

There appeared to be an abundance of gravel material through the reach and many of the log jams had large scour pools associated with them. It is possible that much of this material

Project Area 10.1
Placed large woody material interacting with flow at the upstream end of PA 10.1, near where a large avulsion has caused much of the downstream aggregation, complexity, and floodplain connection.

Project Area 10.1 Reach Characteristics

VM Start (mi)	38.52
VM Length (mi)	0.41
Valley Slope	1.82%
RM Start (mi)	43.58
RM Length (mi)	0.47
Average Channel Slope	1.51%
Sinuosity	1.15
Connected FP (ac/VM)	21.40
Encroachment Removal (ac/VM)	1.24
Channel Aggradation (ac/VM)	4.82
Total FP Potential (ac/VM)	6.74
Encroaching Feature Length (ft)	0.00
Connected FP Rank	12

was sourced from a large avulsion that appeared to have happened at the upstream end of the project area, and is being transported downstream.

Throughout the reach are stands of mature vegetation, and in places where there are fewer large trees dense stands of young to middle-aged alders, dogwoods, and cottonwoods populate much of the immediate riparian area and new gravel bars.

Restoration Actions and Geomorphic Changes

PA 10.1 has been treated three times since 2008. Restoration work in 2008 involved dropping 15 to 20 cut trees into the river at the upstream 600 feet of the project reach to aid in recovery following the 2006 forest fires. In 2012, a larger effort to wood load the reach involved placing 8 additional LWD structures and 4 mobile LWD racking bundles 20 feet long but smaller than the key piece diameter criteria.

Analysis of the difference between the 2010 and 2017 LiDAR data shows one major change that extends for a large portion of the PA 10.1 reach. At the upstream end of the reach, a major channel avulsion has occurred into the right bank floodplain and significant erosion is evident in this area. A split flow has formed in this location with a large mid-channel bar. Downstream of here for approximately 700 feet, major deposition has occurred in the main channel, which was likely sediment released from the floodplain in the upstream avulsion. This deposition has resulted in multiple side channels and flow through the floodplain in this area (box 1).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 10.1 receives its entire prioritization score in the Complexity prioritization metric. The Complexity score is moderate, indicating that PA 10.1 ranks above average in the 60th to 90th percentile of all project areas, a range that still shows moderate complexity but does not place it in the top 10% of project areas; this project area likely only needs a little restoration work to reach that mark.

In the analysis results for the three flows of complexity, PA 10.1 ranks well above average for all three with very similar scores, indicating that complexity is relatively stable across flows. Looking at the GIS layer for islands and complexity, this complexity is achieved evenly across the whole reach with a particularly large complex pocket near the middle of the reach. Based on the relative elevation map, there are multiple side channel opportunities throughout the reach that appear to be already within the 2-year connected floodplain. Reconnecting these low-lying side channel opportunities should be the main target for enhancing the existing restoration efforts in this reach. Primary enhancement strategies should be the placement of instream wood to promote geomorphic change, in conjunction with cutting strategic pilot channels to connect perennial flow in disconnected side channels.

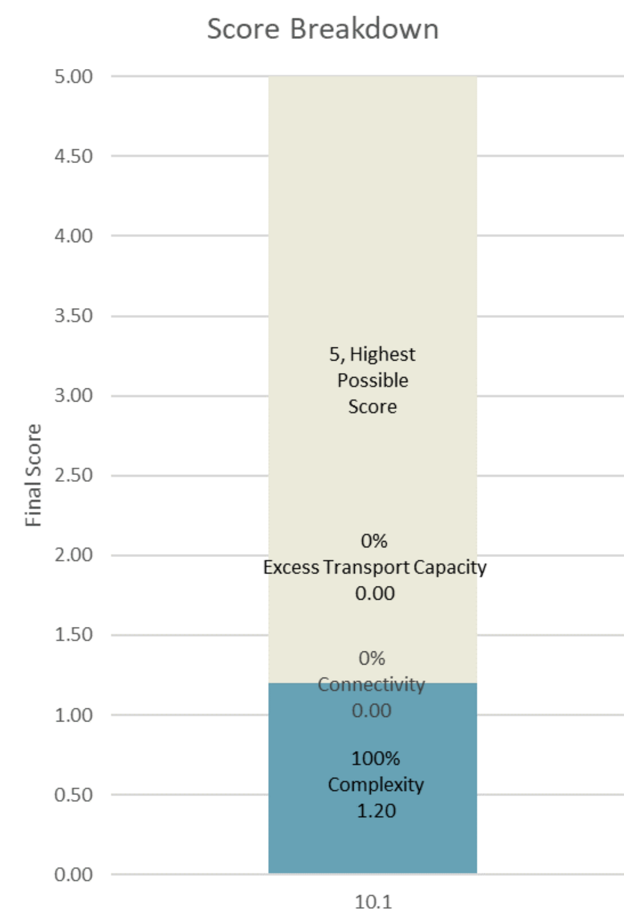
Based on the geomorphic change analysis, this reach is already depositional in nature and should respond quickly to the addition of instream wood. However, it appears the source of this sediment is an isolated avulsion at the upstream end of the reach that may not sustain the necessary sediment load for long without more geomorphic changes upstream. If this is the case, gravel augmentation should be considered as a restoration strategy, in addition to placement of instream wood and pilot channel cuts, to promote geomorphic change in the reach. PA 10.1 receives no score in the Excess Transport Capacity metric, indicating sediment added to the reach should be easily stored and maintained with the addition of instream wood.

Finally, PA 10.1 ranks around the average in the Pool Frequency metric, indicating a moderate amount of pools per valley mile. The restoration action of adding instream structure and wood, along with sediment deposition from 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

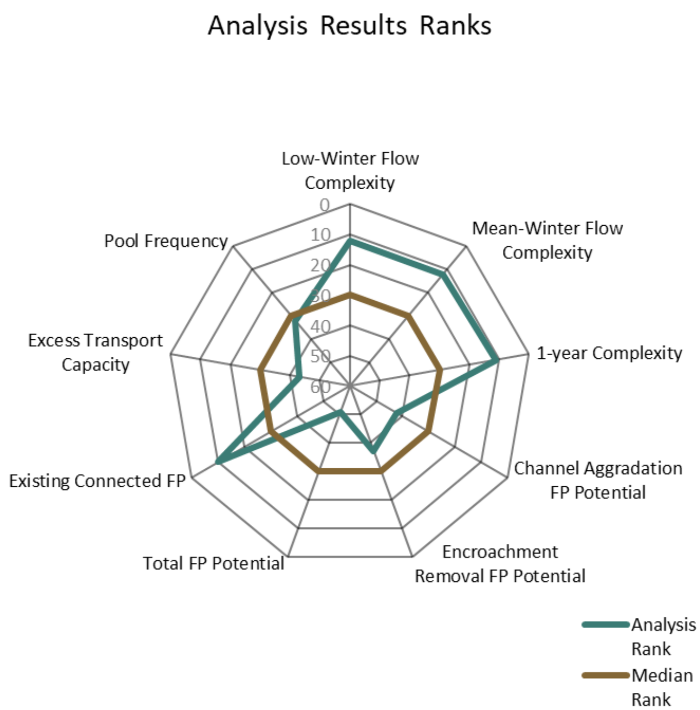
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)

PA 10.1 Score Breakdown



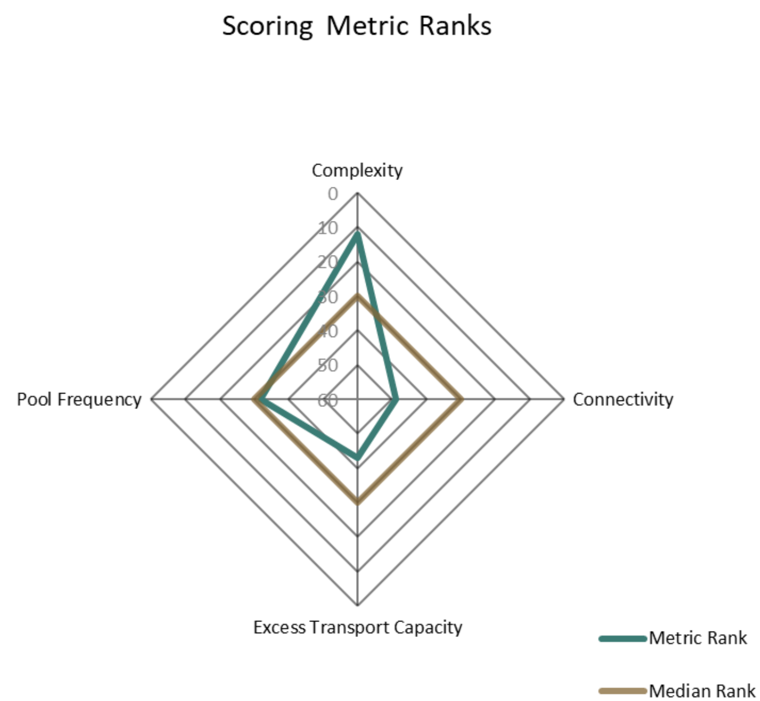
This score breakdown shows how the three prioritization metrics contribute to the final prioritization score.

PA 10.1 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.

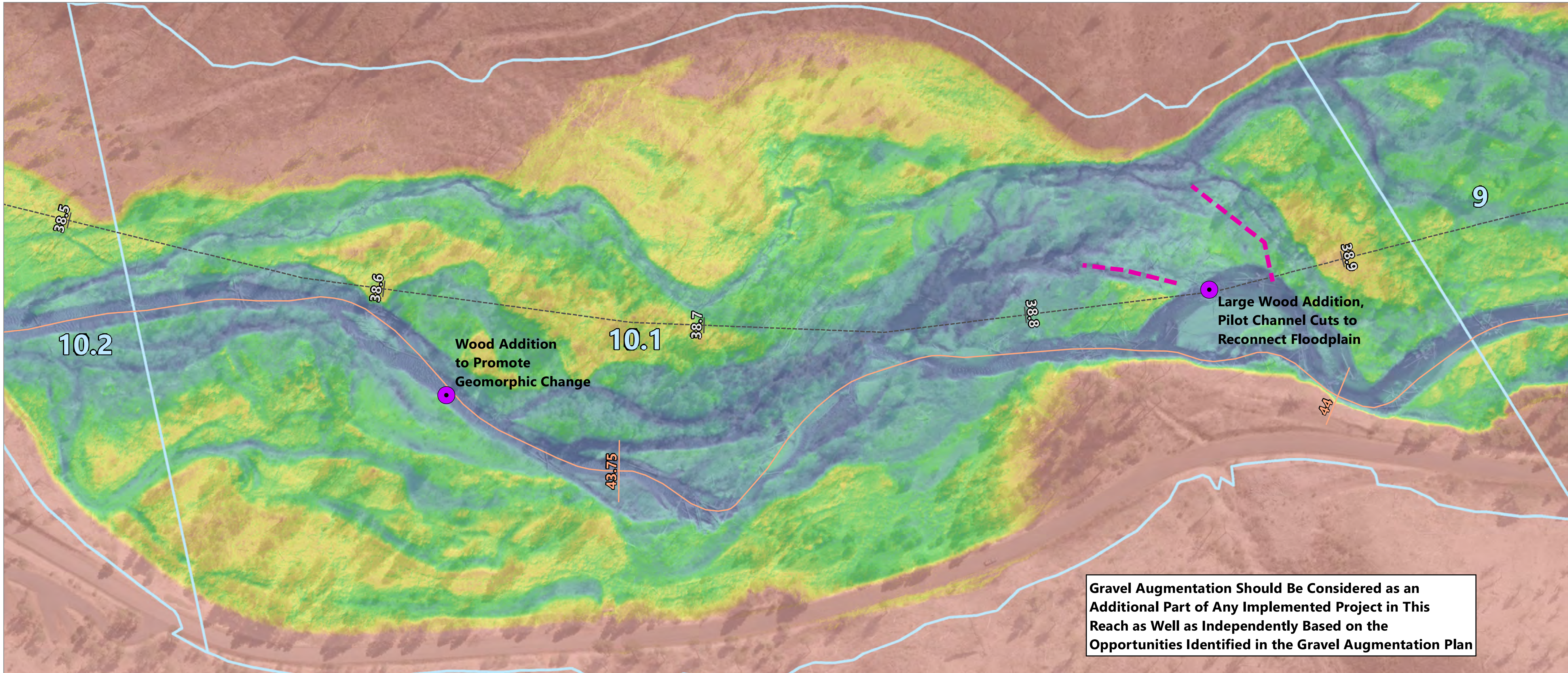
PA 10.1 Scoring Metric Ranks

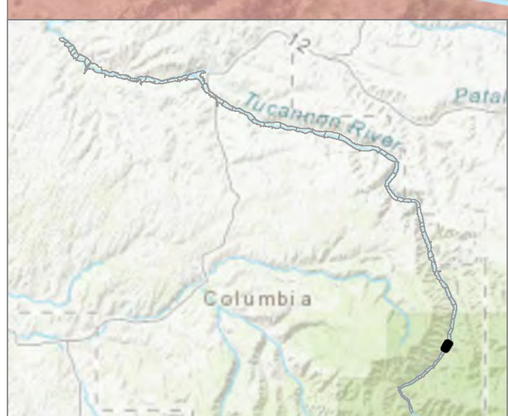


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 10.1 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	0.273	12	40%	Complexity	0.379	12	10% to 40%	2 of 5	3	40%	1.2	44	3	Treated	18	3
Mean-Winter Flow Complexity	0.410	12	40%													
1-year Complexity	0.530	11	20%													
Channel Aggradation FP Potential	0.171	42	40%	Connectivity	0.134	49	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.044	37	40%													
Total FP Potential	0.239	51	20%													
Existing Connected FP	0.761	10	0%													
Excess Transport Capacity	-0.09	43	100%	Excess Transport Capacity	0.000	43	52% to 100%	4 of 4	0	20%						
Pool Frequency	10.69	32	100%	Pool Frequency	0.274	32	40% to 60%	3 of 5	5	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Wood Addition
- 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: 43.58
RIVER MILE END: 44.05
VALLEY MILE START: 38.52
VALLEY MILE END: 38.92

0 500
Feet

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Project Area 10.1
Conceptual Adaptive Management and Restoration Opportunities

Project Area 10.2 Description

Project Area 10.2 begins at VM 37.89 and extends upstream to VM 38.52. The 2017 RM length is 0.72 mile. Field observations for PA 10.2 were conducted on September 28, 2018, when flow at the Starbuck gage was approximately 80 cfs.

PA 10.2 is more uniform and plane-bed than PA 10.1 just upstream, but a large amount of wood loading has added considerable complexity to this reach. A large camping area in the left bank floodplain limits the amount of riparian area available for a large portion of this reach, which for the most part is confined by the valley wall on the right bank. This camping area could be a good target for floodplain inundation and riparian plantings.

There are multiple LWD structures throughout this reach, but many are lacking significant scour pools; the bed material through PA 10.2 consists of cobble and boulder material, which seems to be coarser than just upstream.

At VM 38.28, a massive channel-spanning log jam has created upstream backwater and several split flows to either side and through the log jam, forming several small islands in its wake. However, a tenth of a mile upstream, field observations noted that a side channel through the left bank floodplain was not activated at this flow, and it appeared to be slightly clogged with debris and sediment.

Project Area 10.2
Engineered log jam on left bank with wood recruits forcing flow towards the right bank.

Project Area 10.2 Reach Characteristics

VM Start (mi)	37.89
VM Length (mi)	0.63
Valley Slope	1.40%
RM Start (mi)	42.86
RM Length (mi)	0.72
Average Channel Slope	1.22%
Sinuosity	1.14
Connected FP (ac/VM)	14.61
Encroachment Removal (ac/VM)	0.26
Channel Aggradation (ac/VM)	3.13
Total FP Potential (ac/VM)	3.75
Encroaching Feature Length (ft)	651.23
Connected FP Rank	24

At VM 38.24, the channel is up against the right bank valley wall and a channel-spanning log jam has been almost cut around except for a small amount of flow around the backside of the structure. However, a large pool has formed and decent complexity is maintained through this area.

At VM 38.1, a series of log jams has created split flow complexity but again failed to activate the low-flow path on the left bank, although from the 2017 aerials taken in April, the side channel appears to be flowing at that flow level. Reports indicate that it flows perennially and has a small beaver dam and pond.

Further downstream, the channel again flows right against the valley wall, which is steep with little to no vegetative cover. Several more jams were apparent for the last portion of the reach causing decent localized channel complexity, but with little floodplain interaction.

Vegetation through this reach was sparser with some large-growth conifers. Most of the immediate riparian area was dominated by young deciduous species such as alder and cottonwood; this reach appears to be in recovery from the 2005 School Fire based on several large burned trees that were visible in the floodplain. Instream wood loading was high but not as much as PA 10.1 and more wood could jumpstart some geomorphic process and floodplain connection at the lowest flows.

Restoration Actions and Geomorphic Changes

In 2012, restoration work in PA 10.2 included placing 24 LWD structures within the reach. Approximately 1,305 feet of river levee were perforated and 0.31 mile of perennial side channel was reconnected on the left bank.

Analysis of the difference between the 2010 and 2017 LiDAR data shows several major locations of geomorphic change that are likely the direct result of restoration actions. At VM 38.3, a channel avulsion and split flow has occurred on the left bank, coincident with a large engineered log jam. Bank scour is also seen immediately downstream of this area on the left bank, and the aerials show the formation for several in channel bars (box 1).

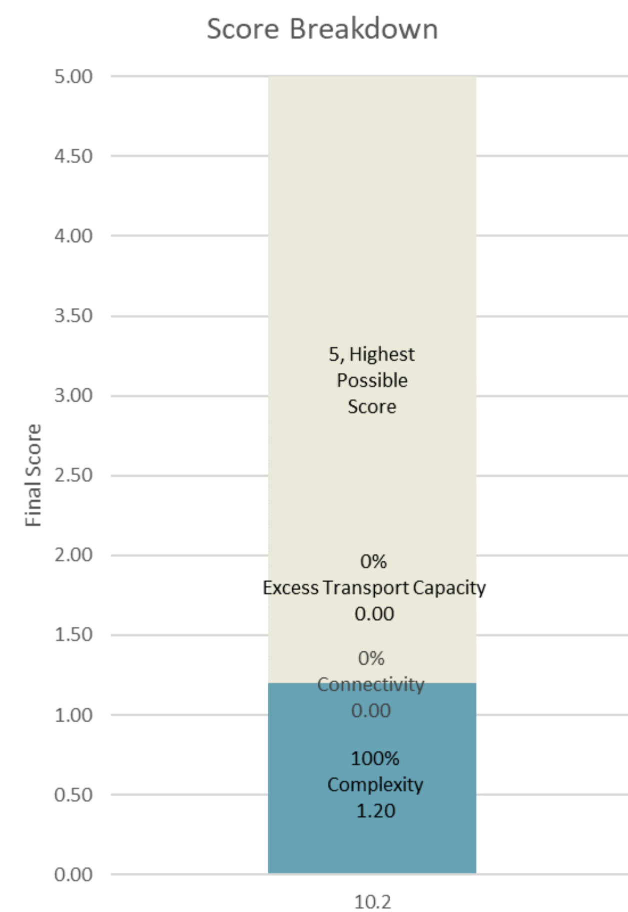
Downstream of here, a bank barb type log jam has caused bar building and channel aggradation immediately upstream of the log jam along with erosion on the outside bank (box 2). There are several more minor instances of similar processes occurring that are evident but have not been highlighted for discussion here. At VM 38.06, it appears the steep right valley wall is experiencing some bank failure and the material falling off the bank is evident as aggradation in the change analysis. It is unclear if this is occurring due to the log jam placed near the bend (box 3).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, Complexity makes up the majority of the score for PA 10.2, placing it in the 60th to 90th percentile of project areas. This range still shows moderate complexity but does not place it in the top 10% of project areas; this project area may only need some minor additional restoration work to reach that mark. This Complexity score is driven mostly by high ranks in the mean-winter and 1-year complexity analysis results, while the low-winter flow complexity ranks around average. This indicates that there are flow paths and complex areas, near the channel or on the floodplain, that are accessed at the mean-winter flow but not the low-winter flow. These opportunities are seen in the GIS layers for islands and water surface and exist mostly near the downstream half of the reach.

This reach has already been treated with wood placements and engineered log jams; however, based on field observations and the aerial imagery, it is likely that more wood and instream structure is needed in this reach. The work here was completed when unanchored wood placement was very new and at a density not tried in southeastern Washington at the time. Wood placement was conservative by current standards. Additionally, some of the placed materials are beginning to deteriorate and supplementation to the amount of wood would

PA 10.2 Score Breakdown



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

be beneficial to the reach. Adding instream structure should be a primary enhancement strategy.

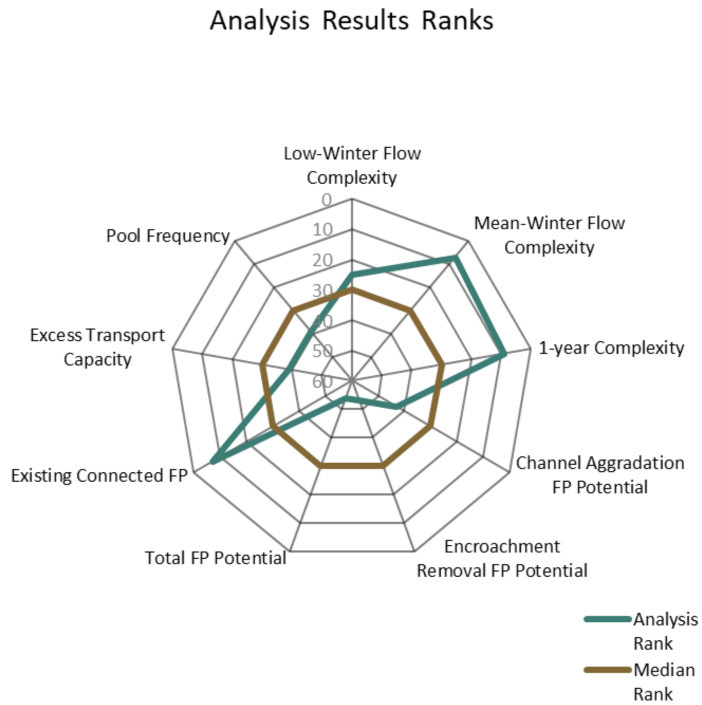
PA 10.2 also receives a small portion of its prioritization score from the Connectivity Potential metric. Although this is a low overall score, indicating that this project area ranks in the 25th to 50th percentile of all project areas, the analysis results for channel aggradation potential and encroachment removal potential both rank above average. These scores are driven mostly by several low-lying areas that could be connected by side channels on the right bank. Connecting these areas with pilot channel cuts and adding instream wood should be strongly considered as an enhancement strategy, given that these features will also contribute to complexity.

Finally, this project area ranks below average for the Pool Frequency metric. Pools in this reach can be increased through the addition of instream wood as an enhancement strategy. However, it may be possible that this reach also requires additional instream gravel material to form around the instream structure. Gravel augmentation in this reach should be considered as a second enhancement strategy that could help precipitate geomorphic changes. The project area ranks below average in Excess Transport Capacity, indicating that this reach should be able to hold and store sediment added via gravel augmentation. Local sourcing of gravel augmentation may be a challenge at this site although a stranded gravel bar at the upstream end of the project area, near box 1, has been noted as a possible source.

Summary of Restoration Opportunities Identified

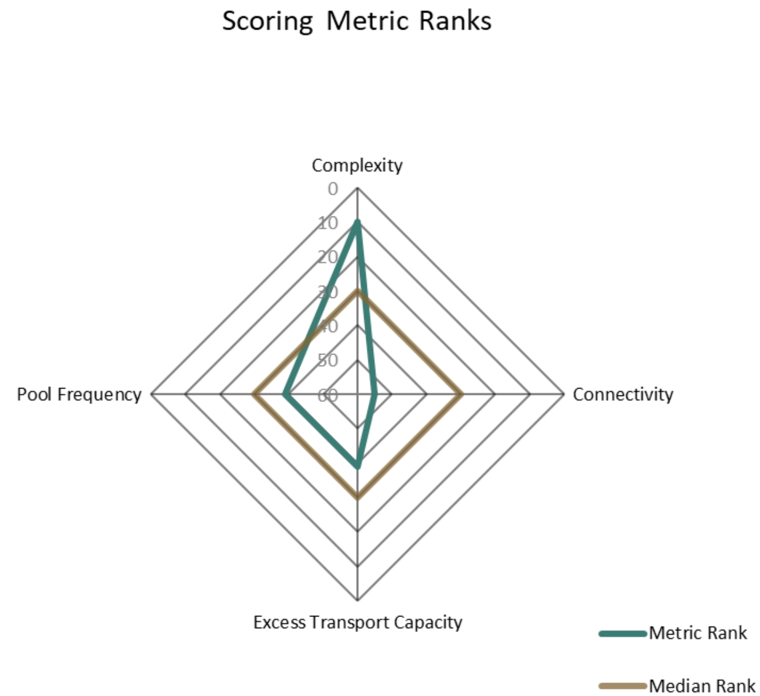
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Add instream structure (LWD)
- Riparian zone enhancement

PA 10.2 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.

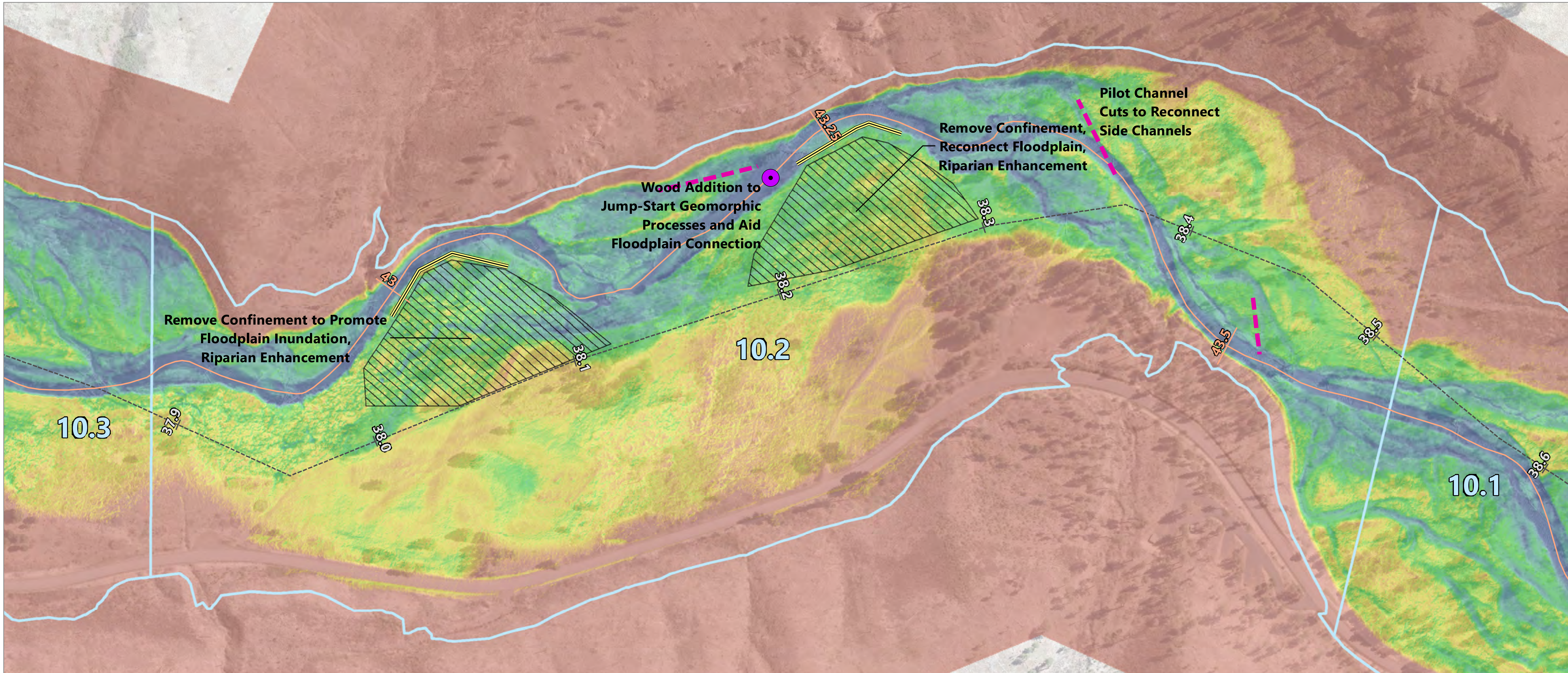
PA 10.2 Scoring Metric Ranks

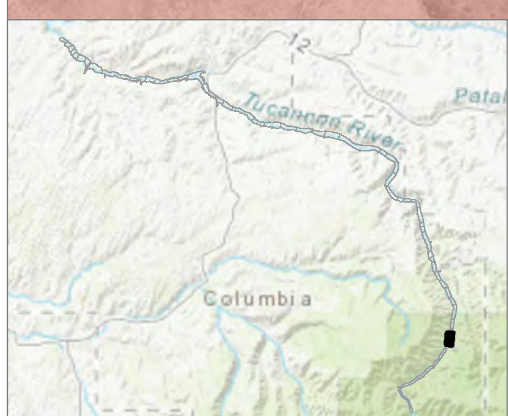


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 10.2 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	0.187	25	40%	Complexity	0.391	10	10% to 40%	2 of 5	3	40%	1.2	45	3	Treated	19	3
Mean-Winter Flow Complexity	0.483	7	40%													
1-year Complexity	0.612	9	20%													
Channel Aggradation FP Potential	0.170	43	40%	Connectivity	0.115	55	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.014	53	40%													
Total FP Potential	0.204	54	20%													
Existing Connected FP	0.796	7	0%													
Excess Transport Capacity	-0.05	39	100%	Excess Transport Capacity	0.000	39	52% to 100%	4 of 4	0	20%						
Pool Frequency	8.33	39	100%	Pool Frequency	0.214	39	60% to 90%	4 of 5	1	0%						





LEGEND:

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

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: 42.86
RIVER MILE END: 43.58
VALLEY MILE START: 37.89
VALLEY MILE END: 38.52

0 500
Feet

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

Project Area 10.2
Conceptual Adaptive Management and Restoration Opportunities

Project Area 11.1 Description

Project Area 11.1 begins at VM 36.88 and extends upstream to VM 37.51. The 2017 RM length is 0.75 mile. Field observations for PA 11.1 were conducted on October 31, 2018, when flow at the Starbuck gage was approximately 95 cfs.

The upper reach of PA 11.1 is still relatively plane-bed and uniform. At VM 37.35, a foot bridge from a parking lot to Watson Lake limits the floodplain with large riprap levees. Watson Lake itself takes up a large portion of the floodplain, loosely confining the channel in this section. At VM 37.25, just across the from the lake, the channel flows very close to Tucannon Road. Just downstream, a large mid-channel bar introduces some complexity. Further downstream, left bank erosion is evident were some instream wood has been placed.

VM 37.1 marks an increase in instream wood density, much of which was placed as part of a restoration project. Several large gravel bars were evident on the insides of meander bends near the instream wood. After several large log jams on alternating banks around VM 37, the channel becomes more uniform with low complexity again to the end of the project area.

The bed material in PA 11.1 is mostly transport-resistant boulders and large cobbles with some gravel bars beginning to form in locations of recent geomorphic change.

Project Area 11.1
Looking upstream, an engineered bank barb promotes flow towards the right bank, but was not causing split flow at the time of this photograph.

Project Area 11.1 Reach Characteristics

VM Start (mi)	36.88
VM Length (mi)	0.62
Valley Slope	1.52%
RM Start (mi)	41.70
RM Length (mi)	0.75
Average Channel Slope	1.23%
Sinuosity	1.21
Connected FP (ac/VM)	13.30
Encroachment Removal (ac/VM)	0.66
Channel Aggradation (ac/VM)	4.10
Total FP Potential (ac/VM)	4.50
Encroaching Feature Length (ft)	2,671.05
Connected FP Rank	31

Floodplain vegetation does not appear to have changed much from the 2011 assessment. Large trees were extremely limited by the 2005 School Fire and burned logs are still evident on the floodplain. However, in addition to invasive species throughout the reach, multiple stands of willow and alder were observed particularly on some of the newer gravel berms.

Restoration Actions and Geomorphic Changes

In 2015, restoration work in PA 11.1 included placing 21 LWD structures, including 5 additional floodplain structures, starting at RM 42 and continuing downstream. The geomorphic objectives for this restoration treatment included improving channel connectivity and channel complexity.

Analysis of the difference between the 2010 and 2017 LiDAR data shows that geomorphic change has begun to occur as a result of some of these restoration actions. However, much of the change is small in scale and isolated, indicating this reach is slow to respond to restoration efforts.

Just past the foot bridge is a location where gravel bars have been built and meander erosion has occurred on alternative sides of the reach as a direct result of added wood (box 1). Immediately downstream of here, major erosion has occurred on the left bank and the channel seems to be moving towards the road (box 2).

A large placed log jam has also formed a large depositional area in its wake with a minor channel avulsion and erosion towards the left bank (box 3).

Finally, at the downstream end of the reach, deposition is beginning to occur in the main channel, likely as a result of a very large channel-spanning log jam further downstream in PA 11.2 (box 4).

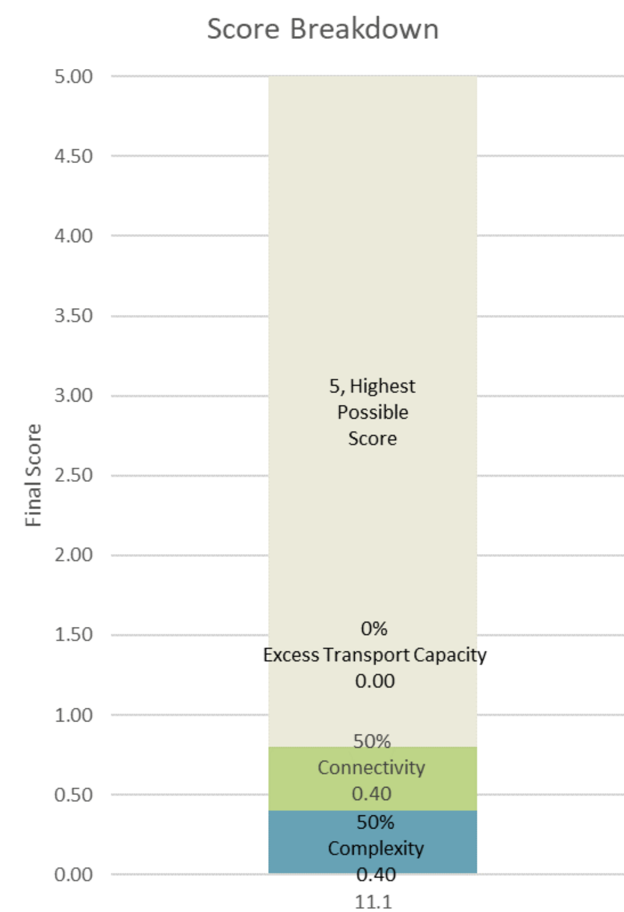
Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 11.1, receives low scores in both the Complexity and Connectivity prioritization metric, which makes up its entire prioritization score. The low score in Complexity indicates that PA 11.1 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. The low score in Connectivity indicates PA 11.1 ranks below average in the 25th to 75th percentile for potential floodplain reconnection. This rank is driven almost entirely by the Channel Aggradation analysis result, which ranks above average for project areas. The Encroachment Removal analysis result ranks as one of the lowest; however, this does not include the Beaver-Watson Lake Complex, which encroaches on the floodplain and could be a major opportunity for floodplain encroachment removals. Additionally, field reports indicated that there are spoils from reservoir excavation upstream, which could increase the floodplain area if they were removed. Finally, the Tucannon Road below the lakes is a major encroachment to the floodplain. While it would be difficult to move the road, if the opportunity ever arises to move the road out of the floodplain it should be strongly considered.

Channel aggradation potential exists almost entirely in areas surrounding the existing 2-year floodplain. This indicates that this reach is slightly incised and raising the bed elevation could have a large benefit in terms of connecting more of the available floodplain at the 2-year event. Because the lower half of the reach has already been treated with instream structure and wood, a primary enhancement strategy should be gravel augmentation. Sediment material from gravel augmentation can be trapped and stored by the existing instream wood and should help to reverse the effects of incision and connect more of the floodplain. It is likely that with gravel augmentation more structure and instream wood would be desirable to maximize the effects and ensure sediment is entrained in the reach.

Existing complexity is low across all three flows and is driven by several small pockets of split flows and in-channel bars throughout the reach. Again, since instream wood already exists, gravel augmentation would likely have a positive effect on the in-channel complexity in the reach, regularly creating complex channel forms and side channels. Additionally, raising the channel bed elevation should help to reconnect several side channel areas evident on the relative elevation map and already

PA 11.1 Score Breakdown



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

connected at the 2-year event, which would boost complexity across the reach. Pilot channel cuts should also be considered as a secondary restoration strategy, along with adding instream wood and gravel augmentation, to ensure these side channels are quickly and perennially reconnected.

PA 11.1 receives no score in the Excess Transport Capacity metric, indicating that added sediment material should be easily trapped and stored behind instream structure and wood.

Finally, PA 11.1 ranks slightly below average in the Pool Frequency metric, indicating a moderate amount of pools per valley mile. The enhancement action of adding sediment deposition from gravel augmentation, along with 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.

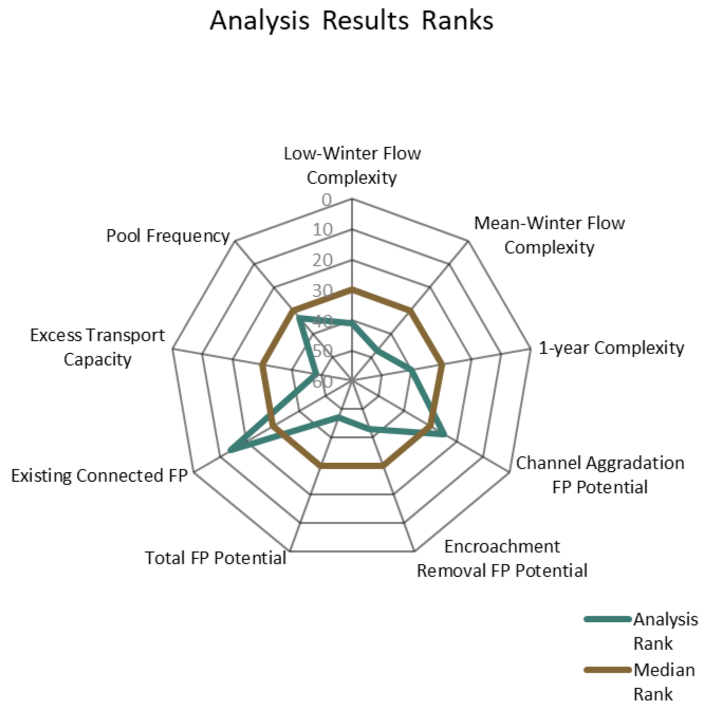
Summary of Restoration Opportunities Identified

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

Long-Term Opportunities in this Project Area

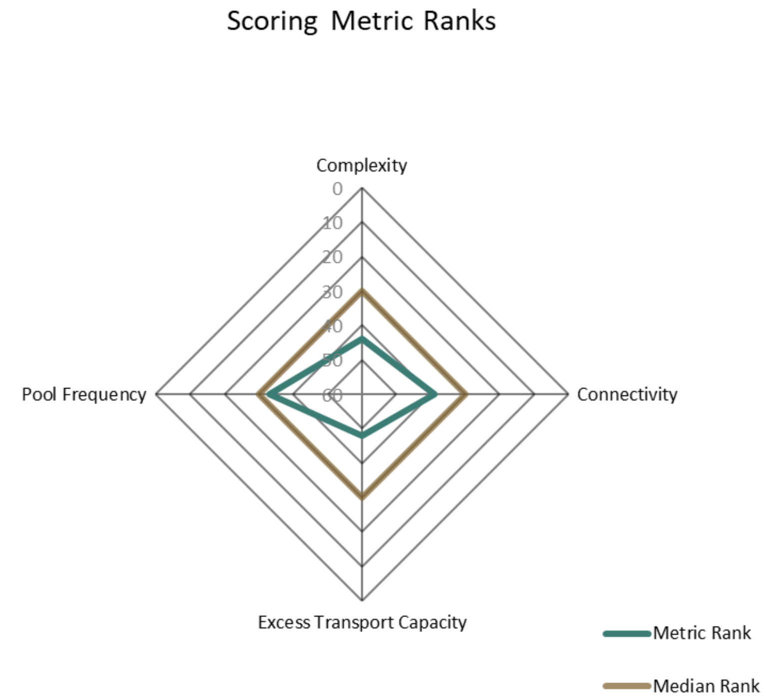
- Set back road against the left valley wall for more floodplain connection and channel migration area.
- Relocate the parking area and walking bridge for lake access.
- Reconfigure Watson Lake and Beaver Lake to reconnect floodplain and consider decommissioning and removing if ever feasible.

PA 11.1 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.

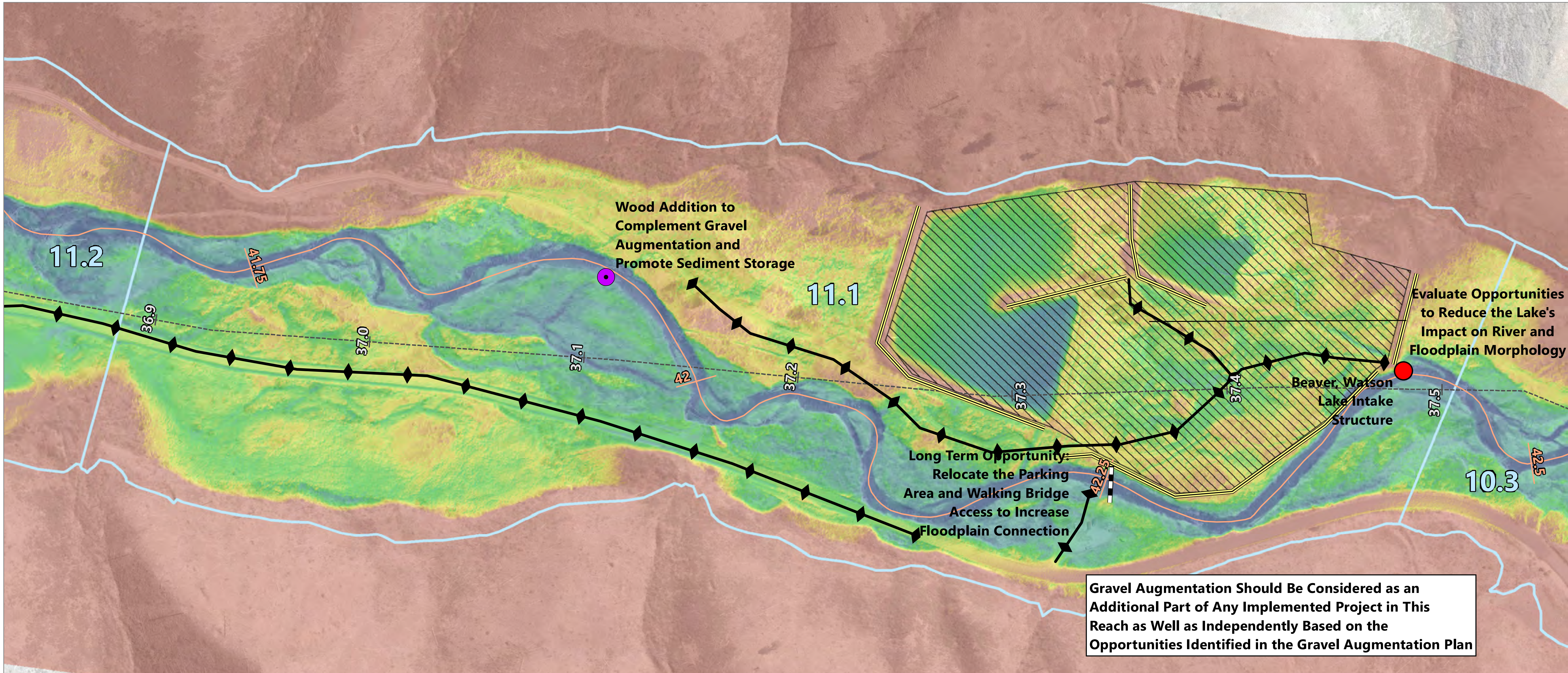
PA 11.1 Scoring Metric Ranks

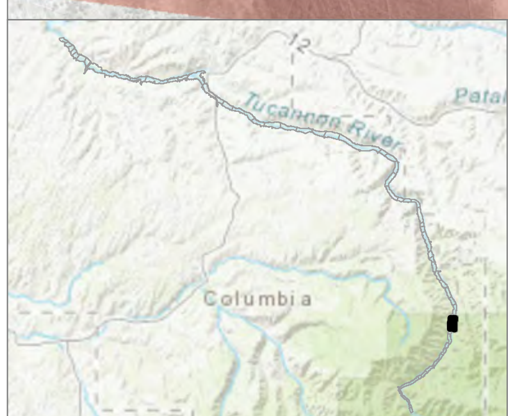


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 11.1 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	0.113	41	40%	Complexity	0.140	44	60% to 90%	4 of 5	1	40%	0.8	53	3	Treated	21	3
Mean-Winter Flow Complexity	0.129	47	40%													
1-year Complexity	0.213	40	20%													
Channel Aggradation FP Potential	0.230	25	40%	Connectivity	0.158	39	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.037	43	40%													
Total FP Potential	0.253	47	20%													
Existing Connected FP	0.747	14	0%													
Excess Transport Capacity	-0.12	48	100%	Excess Transport Capacity	0.000	48	52% to 100%	4 of 4	0	20%						
Pool Frequency	10.66	33	100%	Pool Frequency	0.274	33	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
- Reconnect Floodplain
- 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: 41.7
RIVER MILE END: 42.45
VALLEY MILE START: 36.88
VALLEY MILE END: 37.51

0 500
Feet

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ANCHOR QEA

Project Area 11.1
Conceptual Adaptive Management and Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 11.2 Description

Project Area 11.2 begins at VM 36.00 and extends upstream to VM 36.88. The 2017 RM length is 0.96 mile. Field observations for PA 11.2 were conducted on October 31, 2018, when flow at the Starbuck gage was approximately 95 cfs.

PA 11.2 is an extremely complex reach with multiple long-flow side channels and a large amount of instream wood. At the upstream end of PA 11.2, a massive channel-spanning log jam has caused visible aggradation and is associated with a large downstream pool, but has caused little geomorphic change around either bank. Over the next tenth of a mile, multiple channel-spanning log jams eventually cause a long split flow at VM 36.82. At this same location, field observations noted additional flow paths on the floodplain with multiple log jams. This side channel runs close to the main channel, and the narrow island between the two channels is mostly covered in grasses, indicating that it is inundated at high flows.

At VM 36.66 is a massive log jam in the floodplain on the right bank and several split flows and side channels just upstream of this location. A major flow path was observed to the right of this structure and a split flow to the left with several associated log jams. The side channel to the right flows for most of the remainder of the project area before joining with the main channel. A second side channel bisects the island at VM 36.45 and flows into this side channel, increasing the amount of

Project Area 11.2
Engineered log jam with accumulated woody material is causing a deep scour pool, split flow, and floodplain inundation.

Project Area 11.2 Reach Characteristics

VM Start (mi)	36.00
VM Length (mi)	0.89
Valley Slope	1.36%
RM Start (mi)	40.73
RM Length (mi)	0.96
Average Channel Slope	1.21%
Sinuosity	1.09
Connected FP (ac/VM)	20.98
Encroachment Removal (ac/VM)	2.19
Channel Aggradation (ac/VM)	5.89
Total FP Potential (ac/VM)	8.03
Encroaching Feature Length (ft)	665.70
Connected FP Rank	14

water. This side channel has multiple wood structures and deep pools, but at VM 36.4 it is confined on the right by the valley wall and an old riprap levee on the left bank.

The main channel has multiple large log jams, and another long side channel forms at VM 36.65 on the left bank. At VM 36.6, a large log jam is at the head of another long side channel on the left bank. At the time of the site visit, this channel was not flowing, although standing water was visible and likely flows at a slightly high flow event.

For the next tenth of a mile, the main channel has multiple large log jams but is relatively plane-bed before it reaches a large left bank log jam on the outside of a meander that appears to be getting close to the Tucannon Road. On the right bank in this area, there is a large split flow around a vegetated island.

At VM 36.3, there is a water supply diversion channel and infrastructure in the right bank floodplain that eventually leads to Deer Lake one-half mile downstream in PA 12.

At VM 36.15 and downstream, several log jams with large gravel bars are forcing split flow and meanders; at the end of the project area, another side channel starts on the left bank and continues into PA 12 downstream.

The vegetation through the reach is similar to PA 11.1 and does not appear to have changed much from the 2011 assessment. Large trees were extremely limited by the 2005 School Fire and burned logs are still evident on the floodplain. However, in addition to invasive species throughout the reach, multiple stands of willow and alder were observed particularly on some of the newer gravel berms. In PA 11.2, large locust stands were noted around several of the side channels and are reportedly regenerating growth following the fire. It should be noted that locusts are not native and a control action to remove them and reestablish native vegetation should be considered.

Restoration Actions and Geomorphic Changes

In 2015, restoration work in PA 11.2 included placing approximately 53 LWD structures and 18 floodplain structures. The primary objective was to increase channel roughness to increase channel complexity and maintain existing connectivity.

Analysis of the difference between the 2010 and 2017 LiDAR data shows several significant locations of geomorphic change that have occurred as a direct result of restoration efforts.

At the upstream end of the reach, a long in-channel depositional area has occurred as a result of a large channel-spanning log jam (box 1). Just downstream of here, another smaller depositional area has occurred as a result of another log jam (box 2). After this, the channel splits into a long side channel although no significant erosion is seen in the side channel. This side channel was the 2008 main channel and was cut off in 2009 when the large log jam at the upstream end formed following wood loading in fall 2008 as part of the WDFW and USFS efforts to cull hazard trees following the fire. In the main channel, a log jam has triggered a minor channel avulsion and erosion towards the left bank (box 3).

Culling fire killed trees in 2008, dropping them into the river channel in box 2.

Further downstream in the main channel, a log jam has caused a split flow with erosional areas on both banks and deposition in the wake of the log jam forming a small bar (box 4).

After the confluence of the two channels and near the downstream end of the reach, a log jam has caused a minor avulsion and erosion towards the right bank and deposited sediment on a bar in the wake (box 5). At the very downstream end of the reach, two large channel-spanning log jams have allowed deposition in the main channel and caused a small cut-off side channel into the right bank floodplain (box 6).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 11.2 receives a low score in the Connectivity prioritization metric, but this makes up the entire prioritization score for this project area. The low Connectivity score indicates that PA 11.2 ranks below average in the 25th to 50th percentile of all project areas for connectivity potential. This score is driven by an above average rank in the Channel Aggradation analysis result and an average rank in the Encroachment Removal analysis result, but well below average in the Total Floodplain Potential result, which in this case indicates the potential areas are relatively separate.

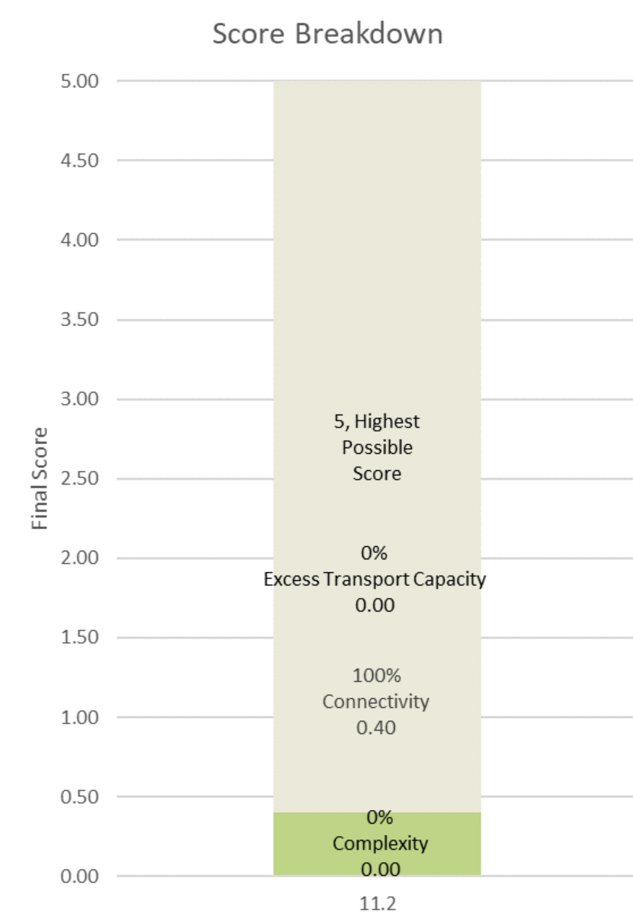
The Channel Aggradation Floodplain Potential exists mostly as the additional area around the existing 2-year floodplain that can be reconnected with channel aggradation. The Encroachment Removal Floodplain Potential exists as a small disconnected area on the left bank near the upstream end of the project area. This does not appear to be an anthropogenic disconnection and would be most effectively reconnected by established a side channel flow through this area.

PA 11.2 received no score in the Complexity metric, which in this case indicates that PA 11.2 ranks among the top project areas in the 90th to 99th percentile. This range has been identified as having enough complexity to warrant no further restoration work targeting complexity. PA 11.2 is extremely complex with a long side channel existing for almost the entire reach at all three flows, and multiple other side channels and split flows that create a very complex and well-connected reach, with ample habitat opportunity.

PA 11.2 would most benefit from a restoration management strategy, monitoring the connectivity and complexity of the reach and making changes if these levels are not maintained. Should complexity ever begin to decrease, it may be necessary to supplement the sediment supply to the reach with gravel augmentation and it may be possible that this reach is included as a larger gravel augmentation plan including multiple reaches, which would not damage the existing good complexity of the reach.

It should be noted that PA 11.2 is in a state of recovery from a fire in 2005, and much of the riparian vegetation still has not been reestablished. For this reason, an enhancement strategy of riparian vegetation plantings should be considered in this reach. The project area already ranks higher than average in the Pool Frequency metric and this is not a primary enhancement target. Should pool frequency ever decrease, enhancement strategies of wood placement and gravel augmentation should be considered.

PA 11.2 Score Breakdown



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

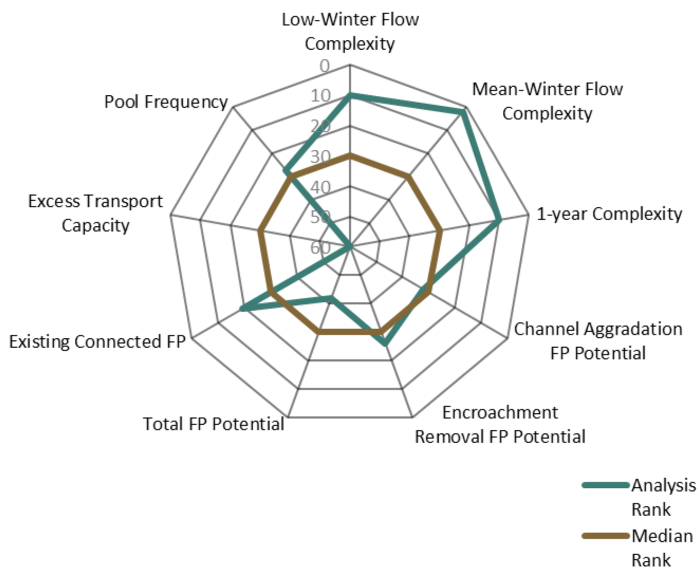
Summary of Restoration Opportunities Identified

- Gravel augmentation
- Riparian zone enhancement

Long-Term Opportunities in this Project Area

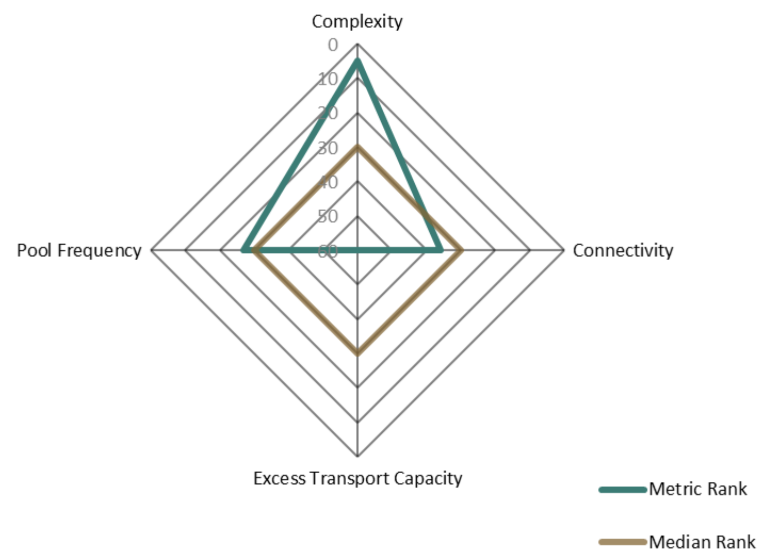
- Set back road against the left valley wall and relocate or remove parking area to expand channel migration area.

PA 11.2 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.

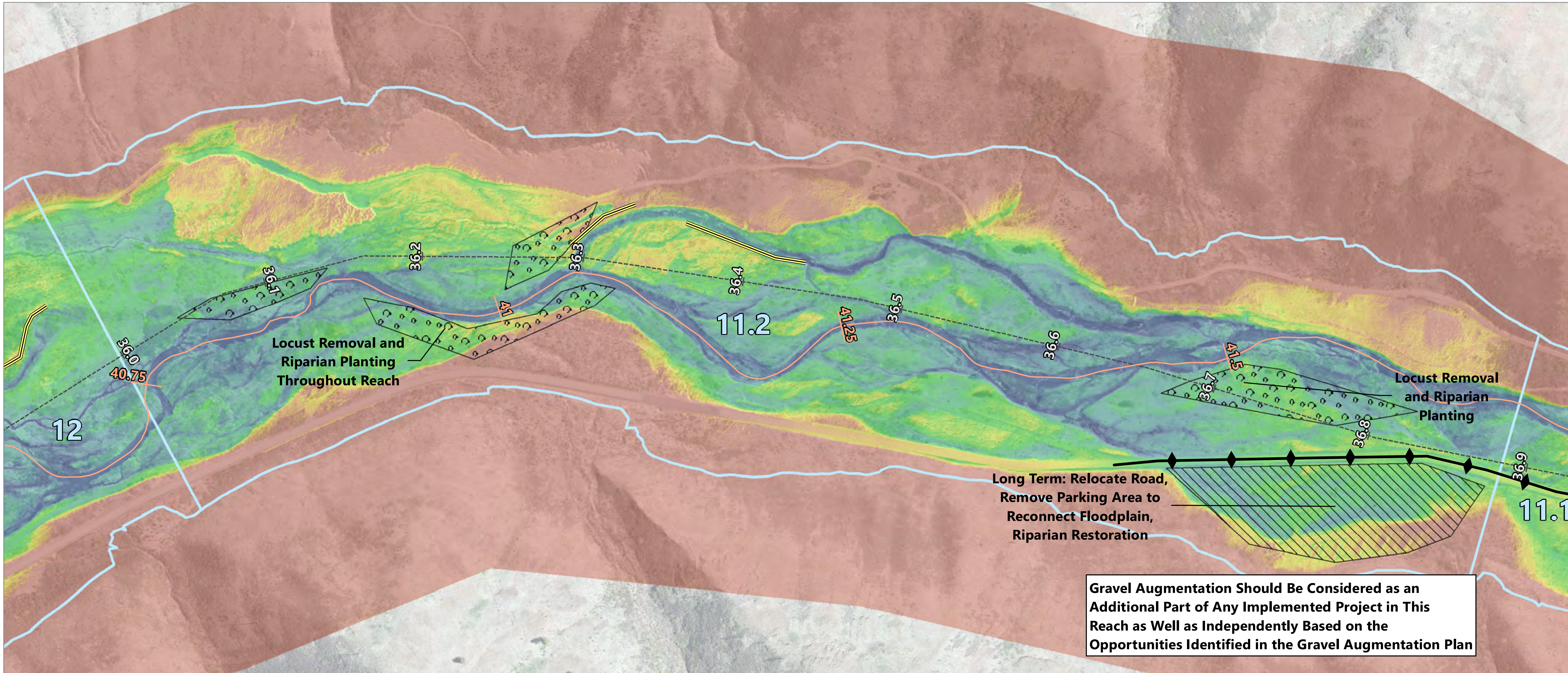
PA 11.2 Scoring Metric Ranks

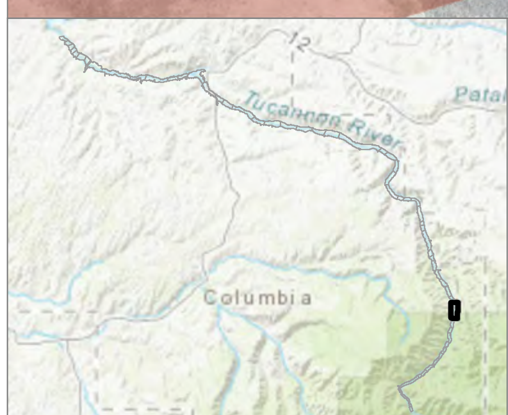


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 11.2 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	0.289	10	40%	**Complexity**	0.463	5	1% to 10%	1 of 5	0	40%	0.4	59	3	Treated	23	3
Mean-Winter Flow Complexity	0.571	2	40%													
1-year Complexity	0.596	10	20%													
Channel Aggradation FP Potential	0.203	32	40%	**Connectivity**	0.167	36	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.075	26	40%													
Total FP Potential	0.277	42	20%													
Existing Connected FP	0.723	19	0%													
Excess Transport Capacity	-0.38	60	100%	**Excess Transport Capacity**	0.000	60	52% to 100%	4 of 4	0	20%						
Pool Frequency	11.44	27	100%	**Pool Frequency**	0.294	27	40% to 60%	3 of 5	5	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Reconnect Floodplain
- 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: 40.73
RIVER MILE END: 41.7
VALLEY MILE START: 36
VALLEY MILE END: 36.88

0 500
Feet

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ANCHOR QEA

Project Area 11.2
Conceptual Adaptive Management and Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 15.1 Description

Project Area 15.1 begins at VM 32.68 and extends upstream to VM 33.00. The 2017 RM length is 0.38 mile. Field observations for PA 15.1 were conducted on September 26, 2018, when flow at the Starbuck gage was approximately 80 cfs.

For this assessment update, PA 15 as defined in the 2011 prioritization was separated into two project areas (PA 15.1 and PA 15.2) for distinct analysis. Since the 2011 assessment, PA 15.1 has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization.

PA 15.1 is largely categorized by the long side channel that forms near the top of the project area and carries nearly half the flow to the end of the reach. Upstream of the channel split, the channel is straight and uniform with almost no wood loading for about a tenth of a mile. The right bank has low floodplain through this section and at the time of the site visit even appeared to be slightly swampy with riparian vegetation.

At the channel split, a large channel-spanning log jam, in conjunction with the channel-spanning woody material, has maintained this split flow and the flow seems to be running through the wood structures on both sides. The right channel (looking downstream) had slightly more flow at the time of the site visit, and is likely the main channel. However, just upstream of this structure, some left bank erosion into the floodplain may

Project Area 15.1
Placed large woody material is interacting with flow in the side channel that has opened up as part of restoration work.

Project Area 15.1 Reach Characteristics

VM Start (mi)	32.68
VM Length (mi)	0.32
Valley Slope	1.52%
RM Start (mi)	36.78
RM Length (mi)	0.38
Average Channel Slope	1.29%
Sinuosity	1.19
Connected FP (ac/VM)	13.90
Encroachment Removal (ac/VM)	0.54
Channel Aggradation (ac/VM)	3.99
Total FP Potential (ac/VM)	5.25
Encroaching Feature Length (ft)	790.85
Connected FP Rank	27

be cutting around this structure, which could possibly make the left flow path the main channel.

Both channels have decent instream wood; the left channel structures appear to be more engaged and creating more complexity and the right channel structures appear to be a little undersized. Most of the structures in either channel do not have large scour pools associated with them, indicating that neither channel seems to be undergoing much geomorphic change.

Bed material throughout this reach consists of mostly large cobbles and boulders with very little gravel material; this transport-resistant material is likely preventing pools from forming too quickly. The channel-spanning structure could possibly be blocking sediment transport, given that this area seems to be aggrading with gravel material on a large bar that is forming on the right bank.

The right main channel runs along and is confined by a large riprap levee for most of its length. A low spot near the center of the island formed by the two channels was not receiving flow and appears to have some sediment deposit associated with it.

Riparian vegetation through this reach is relatively healthy with large deciduous trees covering much of the accessible floodplain. Near the upstream end of the channel split, the right bank levee is protecting a field or lawn that does not provide much overhanging cover other than a thin strip of coniferous trees. On the left bank at the upstream end, the channel runs along a field and the valley wall that provide little cover or mature vegetation as well.

Restoration Actions and Geomorphic Changes

In 2014, restoration work in PA 15.1 included placing 47 LWD structures in a combination of anchored and mobile key pieces using approximately 244 key LWD pieces. This treatment created a 0.31-mile perennial side channel. Project goals included increasing channel complexity and floodplain connectivity.

Analysis of the difference between the 2010 and 2017 LiDAR data shows several significant geomorphic changes that have occurred as a direct result of restoration actions.

At the upstream end of the project area, erosion is actively occurring on the left bank towards a low-lying area and a bar is building from deposition on the right bank (box 1). These changes are likely due to the large, channel-spanning log jams just downstream, which appear to be locally forcing some erosion on the right bank (box 2).

These channel-spanning log jams have triggered a long side channel to the left of the main channel. In the side channel, erosion and downcutting has occurred for a large portion of the channel, which could indicate this side channel is starting to take more flow (box 3). Just downstream in the side channel, a log jam has caused erosion on the right bank and some deposition on the left (box 4).

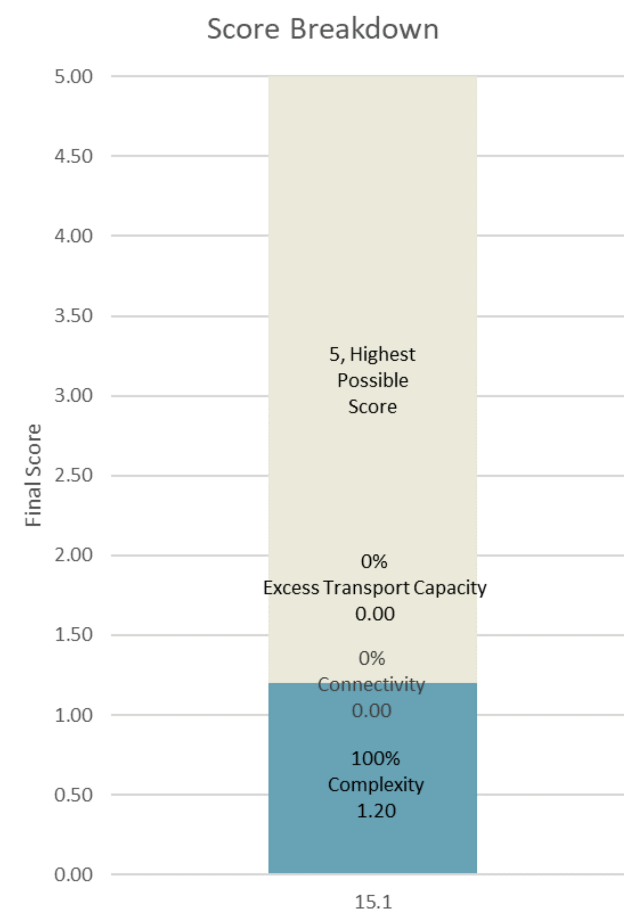
In the main channel, a mid-channel bar has caused erosion on both banks with a small amount of deposition in the wake (box 5). Finally, at the downstream end of the reach, several log jams have forced scour pools in the side channels directly behind the log jams, with some associated deposition on the island in this area (box 6).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 15.1 receives its entire prioritization score from a moderate score in the Complexity metric. This moderate score indicates that PA 15.1 ranks above average in the 60th to 90th percentile of project areas, a range that still shows moderate complexity but does not place it in the top 10% of project areas; this project area likely only needs a little restoration work to reach that mark.

The complexity in PA 15.1 is driven almost entirely by the long side channel that defines the reach and was the target of the initial restoration. The two channels create above average complexity at all three flows. However, the 1-year flow complexity is ranked slightly lower than mean-winter and low-winter flows. The actual complexity values show that complexity does not change much between the mean-winter and 1-year flow; the ranking is lower in the 1-year flow simply because

PA 15.1 Score Breakdown



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

most project areas have a higher complexity at the 1-year flow than the mean-winter flow. The complexity in this reach is basically limited to the one large side channel. A primary management strategy for this reach should be to monitor and ensure that both the main channel and side channel remain connected to some degree as geomorphic changes occur.

At the upstream end of the project area, erosion is occurring towards a low-lying forested area on the left bank, and there are several other low-lying areas on both banks at the downstream end of the reach based on the relative elevation map. Adding instream wood and strategic pilot channel cuts should be the primary enhancement strategy to connect these areas and boost complexity across all three flows. The upper area may reconnect through the natural geomorphic processes that are occurring. If this is the case, instream wood should be added to this new avulsion area to ensure in-channel complexity and stability. Additionally, if this change occurs, steps should be taken to ensure both of the existing channels remain connected and continue to provide complexity.

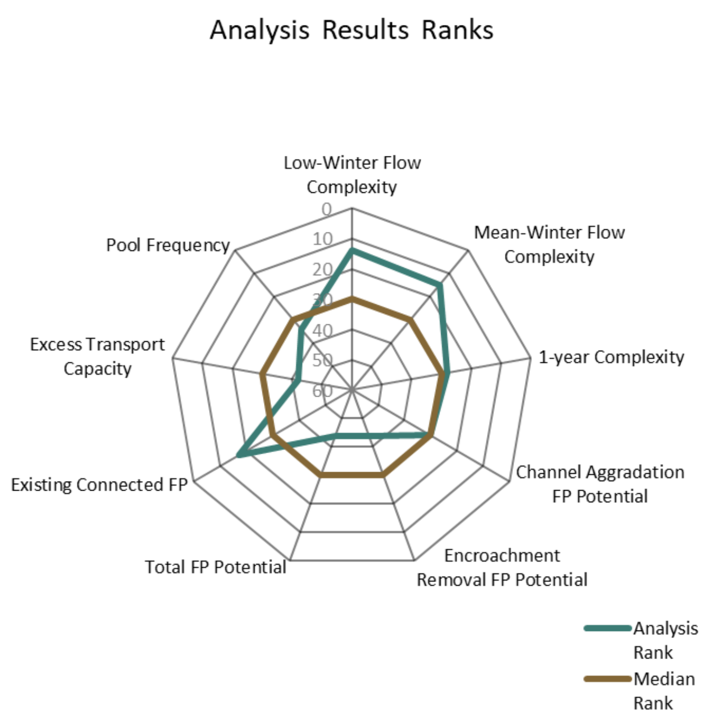
If the addition of instream wood and pilot channel cuts do not prompt the expected geomorphic response, the addition of sediment material might be necessary and gravel augmentation should be considered as a secondary enhancement strategy.

Finally, PA 11.1 ranks slightly below the average in the Pool Frequency metric, indicating a moderate amount of pools per valley mile. The enhancement action of adding instream structure and wood, and possibly 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.

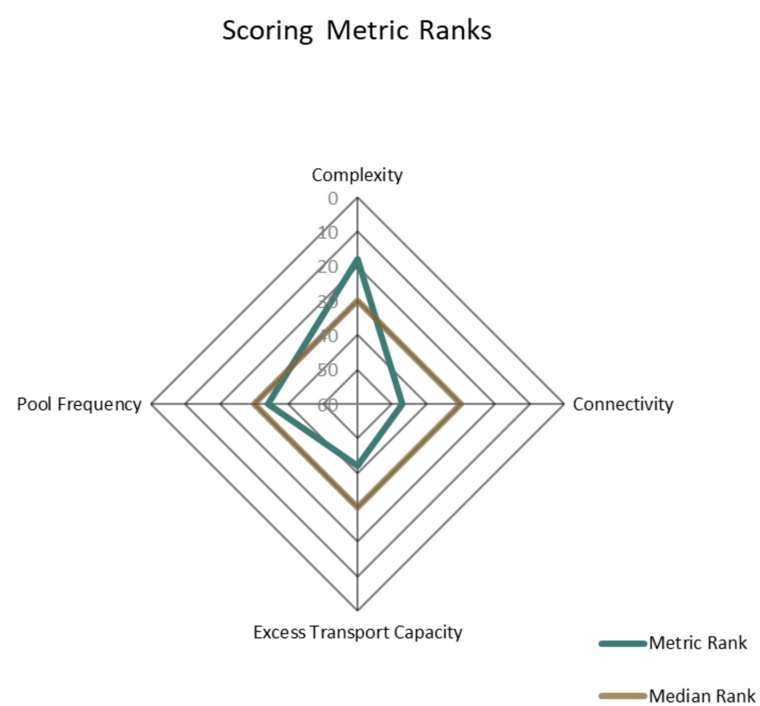
Summary of Restoration Opportunities Identified

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

PA 15.1 Analysis Results Ranks



PA 15.1 Scoring Metric Ranks

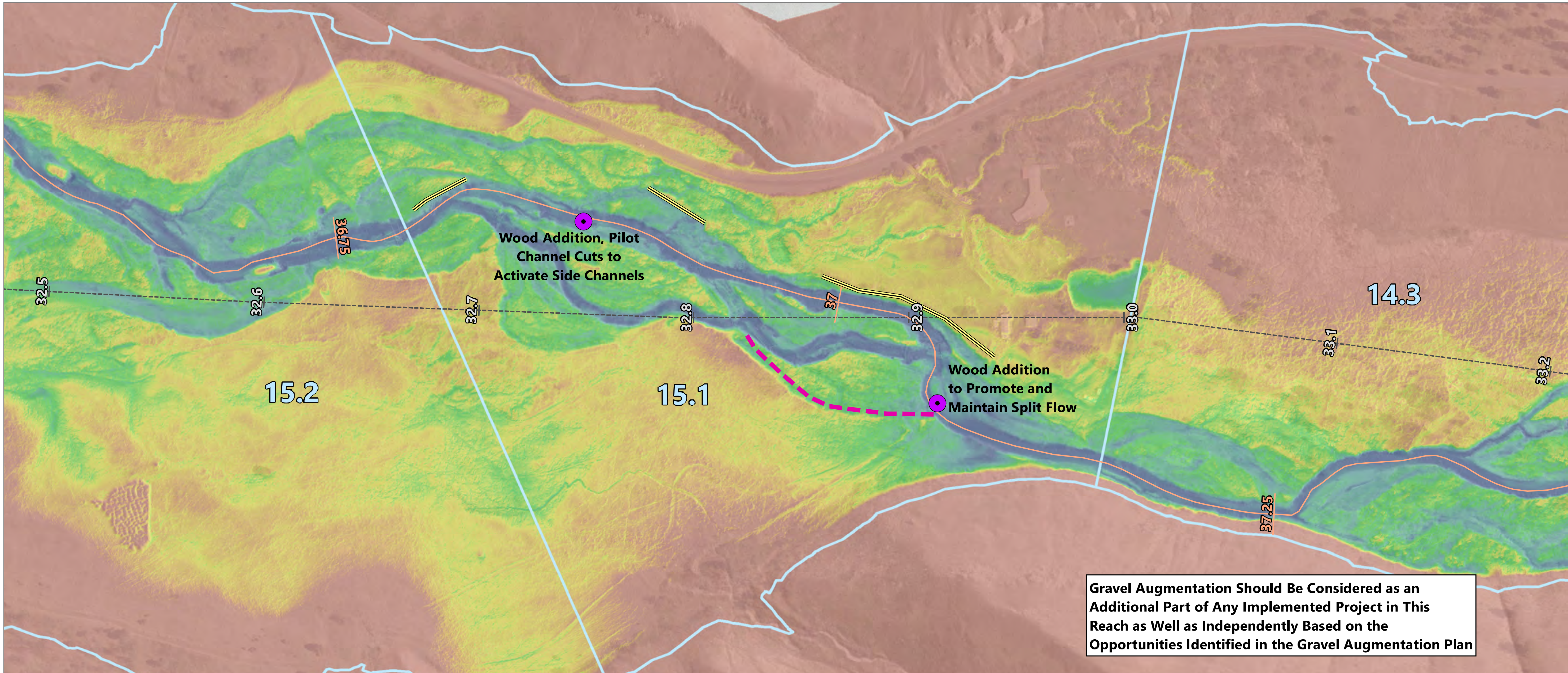


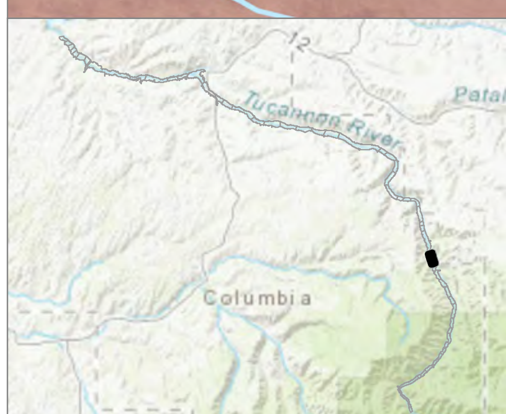
This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

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 15.1 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	0.265	14	40%	**Complexity**	0.315	18	10% to 40%	2 of 5	3	40%	1.2	46	3	Treated	20	3
Mean-Winter Flow Complexity	0.359	15	40%													
1-year Complexity	0.329	28	20%													
Channel Aggradation FP Potential	0.208	30	40%	**Connectivity**	0.149	47	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.028	44	40%													
Total FP Potential	0.274	44	20%													
Existing Connected FP	0.726	17	0%													
Excess Transport Capacity	-0.09	42	100%	**Excess Transport Capacity**	0.000	42	52% to 100%	4 of 4	0	20%						
Pool Frequency	10.50	34	100%	**Pool Frequency**	0.270	34	40% to 60%	3 of 5	5	0%						





LEGEND:

- Tucannon Project Areas
- Tucannon River Centerline
- Tucannon Valley Line
- Delineated Levees
- Wood Addition
- 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: 36.78
RIVER MILE END: 37.16
VALLEY MILE START: 32.68
VALLEY MILE END: 33

0 500
Feet

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ANCHOR QEA

Project Area 15.1
Conceptual Adaptive Management and Restoration Opportunities

Project Area 22 Description

Project Area 22 begins at VM 25.87 and extends upstream to VM 26.85. The 2017 RM length is 1.08 miles. Field observations for PA 22 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization. Since the 2011 assessment, this reach has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization.

The channel through PA 22 is characterized as a single-thread, plane-bed channel with local rapid sections and forced pools at weirs placed in the channel. The sinuosity of the channel is very low. The channel is primarily wide and shallow throughout the project area, except for a few local areas with boulder weirs and large plunge pools at rock weirs. From the bridge to the first rock weir, the channel is incised where it is confined between two large levees, as evidenced by undercutting of the bridge abutments.

Throughout the project area, the channel is confined between the valley wall and levee and riprap infrastructure along adjacent farmland. Large levees are located along the majority of the right bank. Riprap and boulders were also observed throughout the project area, along both banks, and in the channel bed. Remnant spoil piles indicate that dredging and channel straightening may have occurred historically. At least

Project Area 22
No site photograph available.

Project Area 22 Reach Characteristics

VM Start (mi)	25.87
VM Length (mi)	0.98
Valley Slope	1.06%
RM Start (mi)	29.33
RM Length (mi)	1.08
Average Channel Slope	0.96%
Sinuosity	1.11
Connected FP (ac/VM)	8.61
Encroachment Removal (ac/VM)	0.04
Channel Aggradation (ac/VM)	1.31
Total FP Potential (ac/VM)	1.63
Encroaching Feature Length (ft)	4,247.37
Connected FP Rank	56

nine rock weirs are located in the first half mile of the reach that control the channel grade throughout the area. There are multiple irrigation pumps located throughout the project area, which are typically correlated with levees or bank armoring. A few small side channels are present, but overall off-channel areas are limited.

Instream habitat is limited by lack of complexity and by hydraulic conditions that result in accelerated velocities during high flows that prevent the retention of LWD and sediment. Throughout much of the project area, the channel is wide and shallow. There are several deep pools at the rock weirs, but very little cover or other complexity. A majority of the weirs appeared to be passable by adult fish but may present difficulty for juvenile passage. The straight, confined channel likely has high instream velocities during spring runoff and floods, and very few opportunities for fish to seek refuge were identified.

Floodplain connectivity is poor within a majority of the project area. The low-lying floodplain is narrow and disconnected in many places by levees and armoring. A low area in the right floodplain that is currently used as a burn pile is disconnected from the channel by a large, armored levee.

The riparian zone is moderately healthy but is generally limited to a narrow corridor. Local areas have been degraded by development and poor floodplain connectivity. The riparian area in the last half mile of the project area generally has poor species diversity, sparse understory, and many invasive plants, including dense patches of poison hemlock.

Restoration Actions and Geomorphic Changes

In 2013, restoration work in PA 22 included placing a total of 8 LWD structures using 24 LWD key pieces, for the purpose of increasing pool frequency and cover habitat. The primary object was to create gravel deposition and minor bar development with improvement in pool frequency.

Analysis of the difference between the 2010 and 2017 LiDAR data shows there has been no significant geomorphic change in PA 22, likely because the reach is highly confined and leveed. There are several locations of very minor deposition on the floodplain and some minor erosion, but none have been highlighted for this discussion. It should also be noted that there is a long area of apparent erosion at the upstream end of the reach in the channel. This could possibly be a false indicator resulting from the 2017 LiDAR detecting bathymetry that the 2011 LiDAR could not, especially where rock weirs have forced deep pools. However, channel downcutting and incision might be expected in this type of confined reach so this apparent erosional area could be real.

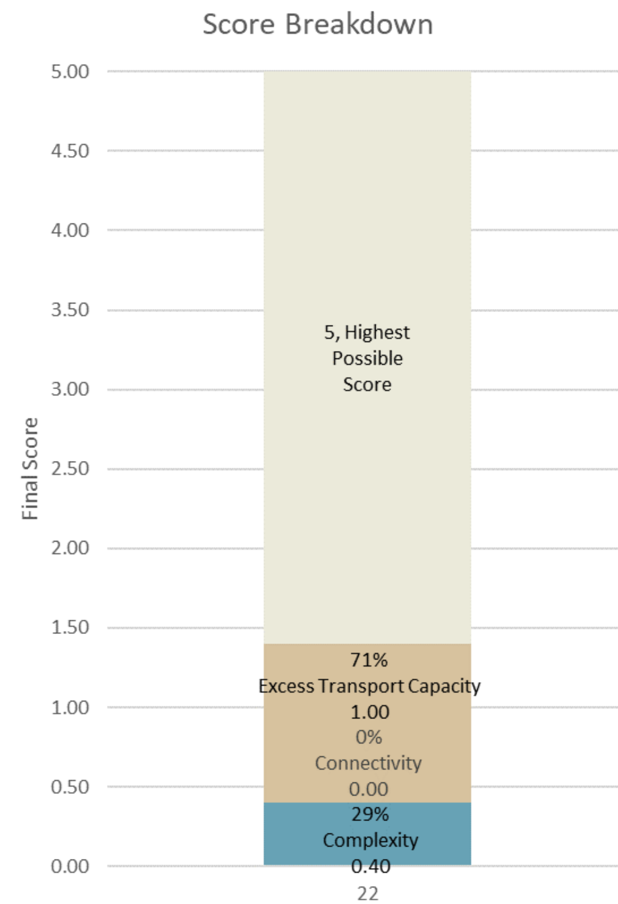
Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 22 receives the majority of its prioritization score from the highest possible score for the Excess Transport Capacity metric. This high score indicates that this project area is in the 90th to 99th percentile and the transport capacity for this reach is much higher than would be expected from the slope of the reach. This high transport capacity would make any sort of restoration project in this reach difficult without first addressing the root cause. PA 22 is highly confined by a system of levees and high banks on the right bank and valley wall on the left bank for the entire reach, and in most places the floodplain is less than a channel-width thick. This high confinement along with channel incision is likely the root cause of the high excess transport capacity in this reach. The previous restoration project in this reach was relatively minor and did not address the confinement.

The target restoration strategy for this reach should be to give the river more floodplain area and available width for side channels. This would likely require a very large restoration effort, including levee setbacks and floodplain benching to provide a wider floodplain wherever possible. The area this would require is partially occupied by agricultural fields, making this an even more difficult restoration strategy.

Gravel augmentation could also be considered as an alternate restoration action to reduce incision. However, because of the high excess transport capacity, it is possible added sediment would be easily flushed through the system. A large amount of instream wood would be a necessary addition to this strategy to trap and retain this sediment. However, without floodplain

PA 22 Score Breakdown



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

area for natural geomorphic processes to occur, gravel augmentation cannot provide as much benefit as possible.

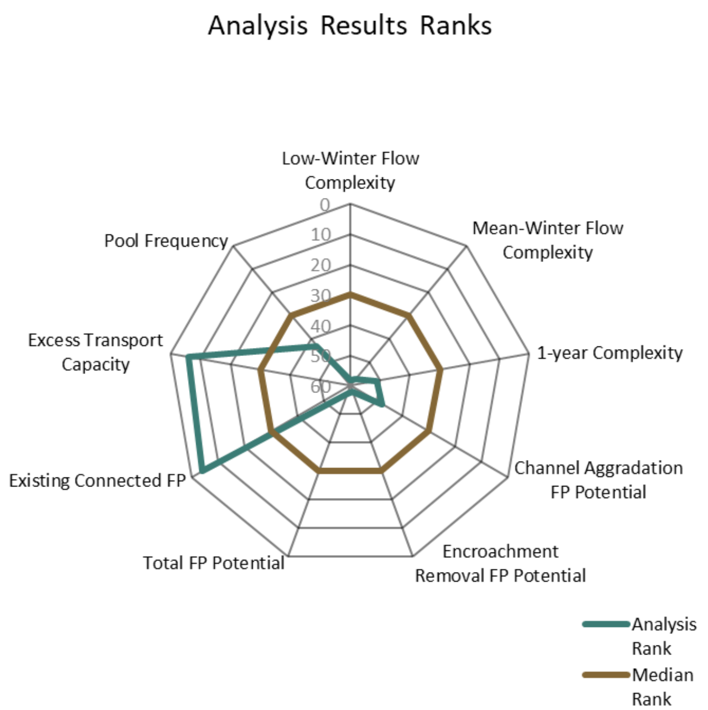
PA 22 receives a small score in the Complexity metric, indicating that it ranks below average in the 10th to 40th percentile of project areas. This complexity comes from several small pockets of floodplain with side channels. If the restoration strategies already discussed are not possible, it should be able to achieve a minor boost in complexity through the addition of instream wood to promote in-channel complexity such as mid-channel bars and small side channels.

Finally, PA 22 scores poorly in the Pool Frequency metric, indicating a low amount of pools per valley mile, although this reach has several rock weirs that force constant pools that will likely be maintained regardless of geomorphic changes. The addition of instream wood and gravel augmentation should boost pool frequency, but significant and constant gains to the number of pools is unlikely until channel incision and confinement can be addressed.

Summary of Restoration Opportunities Identified

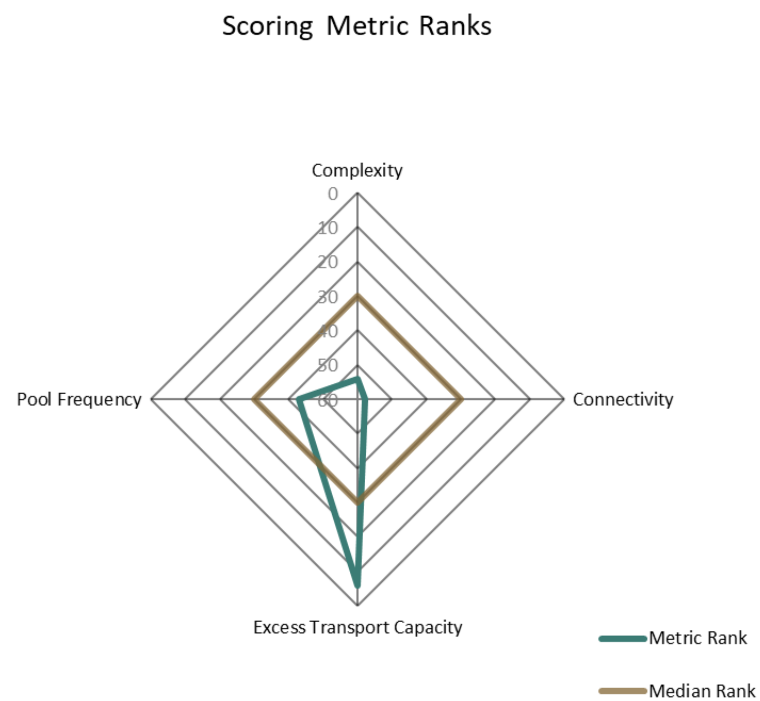
- Gravel augmentation
- Address encroaching features
- Add instream structure (LWD)

PA 22 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.

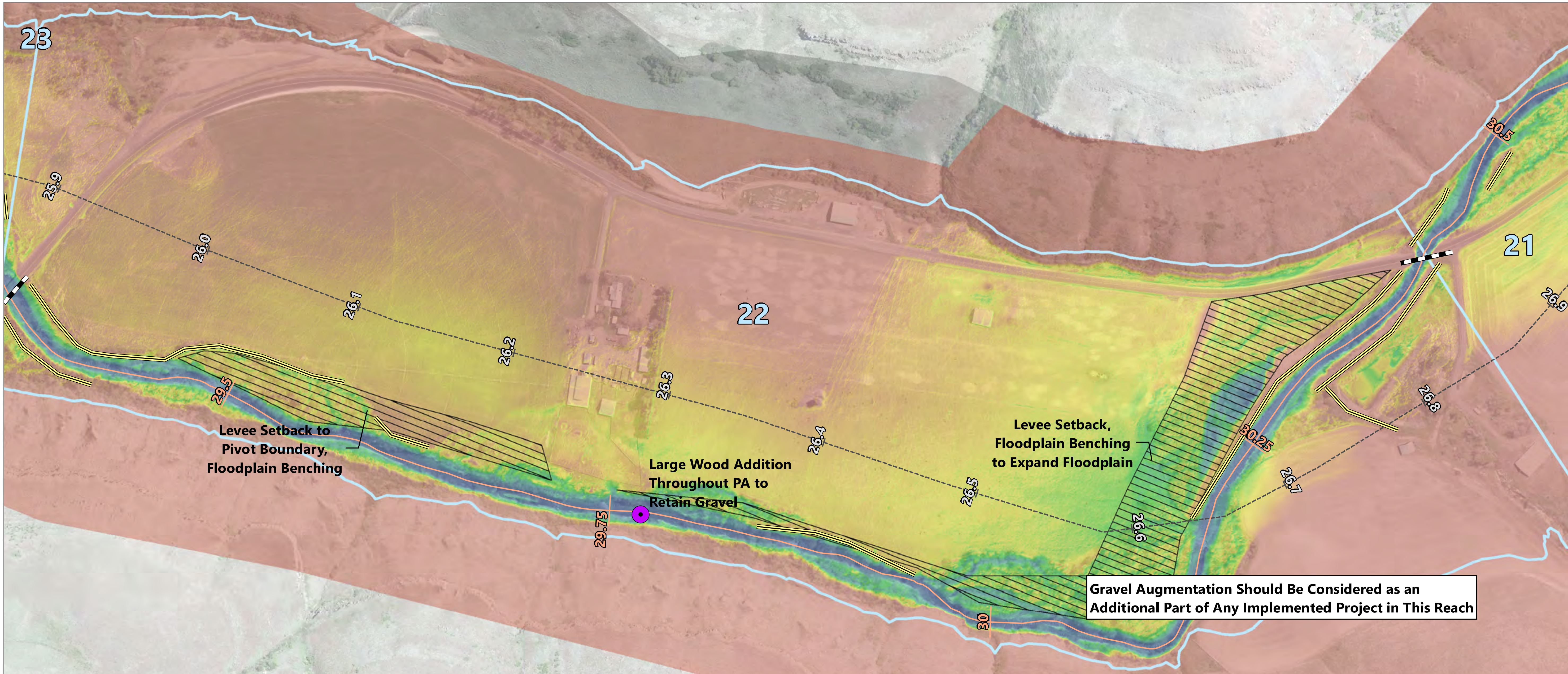
PA 22 Scoring Metric Ranks

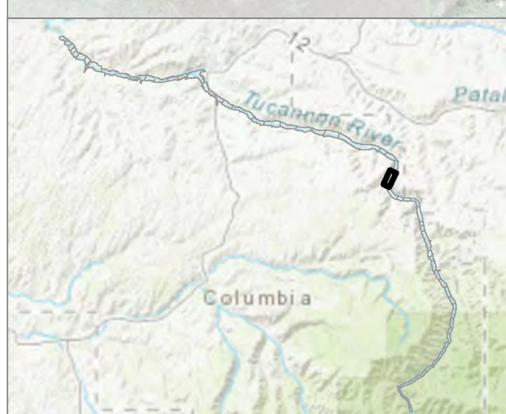


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 22 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	0.082	58	40%	**Complexity**	0.098	54	60% to 90%	4 of 5	1	40%	1.4	41	3	Treated	16	3
Mean-Winter Flow Complexity	0.094	57	40%													
1-year Complexity	0.136	51	20%													
Channel Aggradation FP Potential	0.128	48	40%	**Connectivity**	0.085	58	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.004	58	40%													
Total FP Potential	0.160	57	20%													
Existing Connected FP	0.840	4	0%													
Excess Transport Capacity	0.25	6	100%	**Excess Transport Capacity**	5.000	6	1% to 10%	1 of 4	5	20%						
Pool Frequency	7.39	43	100%	**Pool Frequency**	0.190	43	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
- Reconnect Floodplain

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: 29.33
RIVER MILE END: 30.41
VALLEY MILE START: 25.87
VALLEY MILE END: 26.85

0 500
Feet

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ANCHOR QEA

Project Area 22
Conceptual Adaptive Management and Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration

Project Area 24 Description

Project Area 24 begins at VM 24.35 and extends upstream to VM 25.06. The 2017 RM length is 0.76 mile. Field observations for PA 15.1 were conducted on September 24, 2018, when flow at the Starbuck gage was approximately 82 cfs.

PA 24 is characterized by a mostly highly confined single-thread channel with some pockets of complexity. At the upstream end of the reach, the first quarter-mile of the channel is confined to a single thread by levees on the left and right banks. However, large alternating log jams placed on either side of the channel have increased the stream length and provided some in-channel complexity. Moderate pools are associated with these structures, and the channel bed material is mostly cobbles and boulders with some more easily transportable gravel material. At VM 24.83, a large log jam has created a split flow on either side.

At VM 24.79, a large debris jam appears to have pushed high flows to the left into a low-lying area, but this area has subsequently filled with woody material and sediment; while a large backwater was present, it did not appear to be flowing at the time of the site visit. Downstream of this area, there appears to be some split flow and side channels in the left bank floodplain.

At VM 24.68, the channel again becomes mostly single-thread with log structures on alternating sides of the river. At

Project Area 24
Engineered log jam with accumulated small woody debris. The main flow is to the right of the structure and the backwater seen on the left forms a side channel at higher flows.

Project Area 24 Reach Characteristics

VM Start (mi)	24.35
VM Length (mi)	0.71
Valley Slope	1.03%
RM Start (mi)	27.52
RM Length (mi)	0.76
Average Channel Slope	0.97%
Sinuosity	1.07
Connected FP (ac/VM)	10.60
Encroachment Removal (ac/VM)	0.23
Channel Aggradation (ac/VM)	1.00
Total FP Potential (ac/VM)	1.68
Encroaching Feature Length (ft)	2,100.30
Connected FP Rank	45

VM 24.63, a log jam is forming a large gravel bar behind it and forcing water towards the next log jam on the left bank where a split flow is forming.

For the remainder of the project area, the channel is single-thread, with occasional log jam structures, and is confined by the road on the right of the floodplain and high bank on the left. At the very downstream end, the river meanders away from the road in two locations, leaving a large pocket of floodplain area in both locations that is not currently being accessed. The upstream area appears to be protected by a large levee, likely historically for the road. However, the downstream floodplain pocket, the bottom of which is actually in PA 25, shows some low areas and side channel potential.

In general, bed material in this reach is relatively large, and structures have not formed large scour pools in this reach.

The riparian vegetation in the floodplain includes large galleries of alders and some cottonwoods, but in several places the riparian corridor is relatively narrow between a field on the left bank or the road on the right bank.

Restoration Actions and Geomorphic Changes

In 2015, restoration work in PA 24 included placing 28 LWD structures and 33 single logs in the main channel and perennial side channels using 498 key pieces. Approximately 380 feet of river levee were removed to connect 5 acres of low floodplain, connect 0.32 mile of disconnected and new side channel, and enhance an additional 0.13 mile of side channel.

Project objectives were to increase LWD key pieces to greater than 2 pieces per bankfull width, increase pool frequency to more than 50% (more than 26 pools), increase low floodplain connectivity by 5 acres, and increase side channel length by 0.32 mile.

Analysis of the difference between the 2010 and 2017 LiDAR data shows several locations of significant geomorphic change, some of which are a result of restoration actions. At the upstream end of the reach, left bank deposition continues from PA 23 upstream (box 1). This could be due to a backwater effect from the large ELJ on the left bank.

Downstream, many of the restoration actions are clearly visible. Levee removal locations show up as erosional areas, and there have been several pocket areas of deposition where side channels and split flows have formed (box 2).

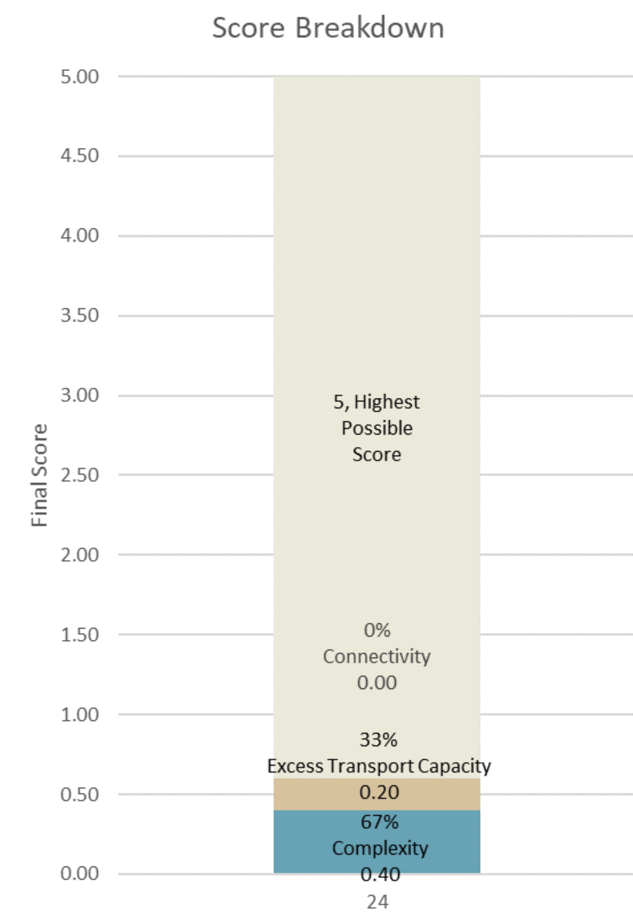
Finally, near the downstream end of the reach, the channel has avulsed and eroded significantly into the left bank as the result of a log jam on the right bank, behind which deposition has occurred (box 3).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 24 receives a low score in the Complexity metric, which makes up the majority of the prioritization score. The low score in Complexity indicates that the restoration actions in PA 24 may have already captured most or all of the complexity possible in this reach. This range has been identified as having some small additional complexity potential but would likely require a large restoration effort to achieve higher levels.

Complexity in this reach ranks well below average in all three flows but ranks the lowest in the low-winter flow analysis result and slightly higher in the analysis results for the other two flows. However, based on aerial imagery and local knowledge, several more side channels exist at the low-winter and winter mean flows that do not appear in this analysis and should be considered as part of the complexity of the reach. There may be some side channels that could be better connected for more perennial flow at the low-flow event. Based on the relative elevation map and island complexity GIS layer, most of these areas exist around the small pocket of existing complexity targeted from the restoration efforts in this reach, as well as a pocket of floodplain on the right bank at the downstream end of the reach, not currently contributing to complexity at all.

PA 24 Score Breakdown



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

The primary enhancement strategy for this reach should be to monitor the connections to existing side channels and implement remediation actions if maintenance is needed.

Finally, the Pool Frequency analysis result indicates that this project area ranks relatively high for number of pools per valley mile. The management strategies of adding instream wood and gravel augmentation should help to ensure this number of pools is maintained in the future.

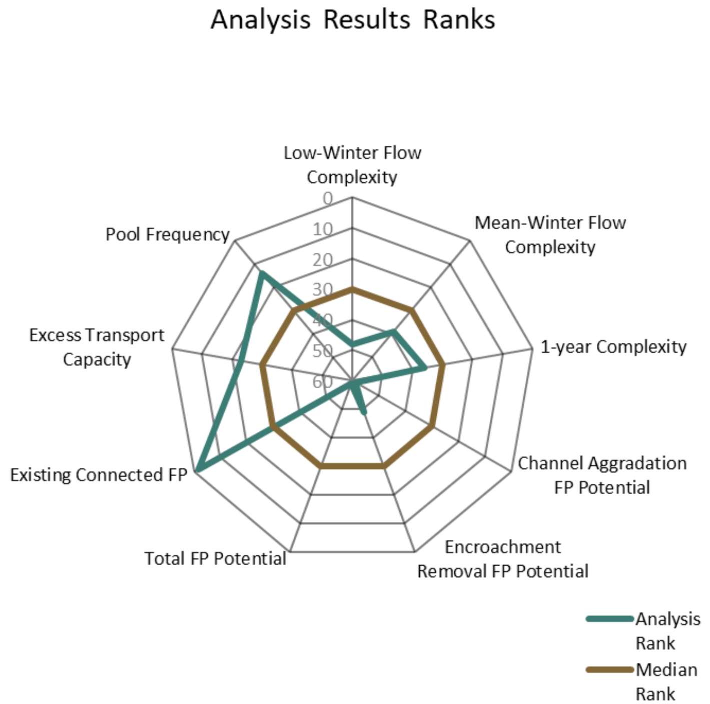
Summary of Restoration Opportunities Identified

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

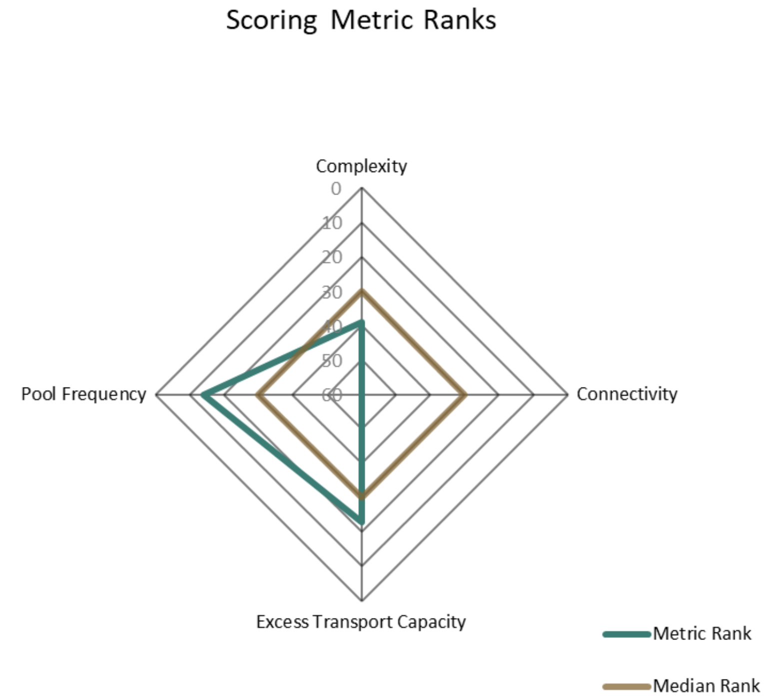
Long-Term Opportunities in this Project Area

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

PA 24 Analysis Results Ranks



PA 24 Scoring Metric Ranks

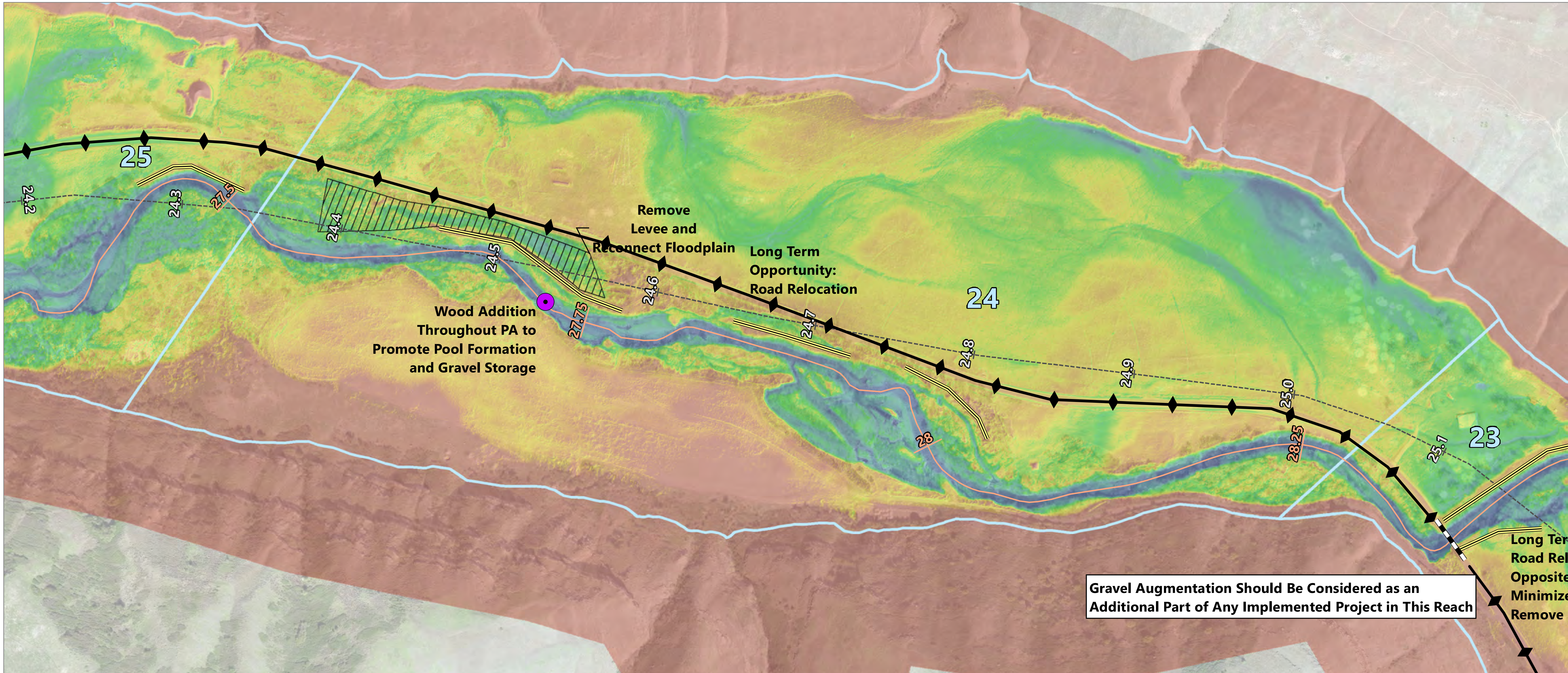


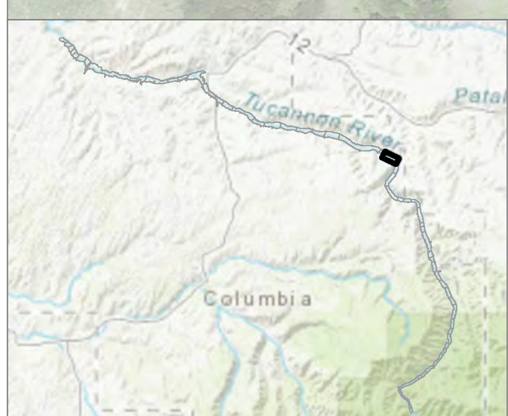
This analysis results summary shows how this project area ranks in relation to the rest of the basin for the nine metrics from the Geomorphic Assessment. The results are used as indicators for the geomorphic characteristics and restoration strategies. The median rank is highlighted in brown for comparison.

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 24 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	0.096	48	40%	Complexity	0.155	39	60% to 90%	4 of 5	1	40%	0.6	57	3	Treated	22	3
Mean-Winter Flow Complexity	0.174	39	40%													
1-year Complexity	0.235	36	20%													
Channel Aggradation FP Potential	0.081	59	40%	Connectivity	0.067	60	75% to 100%	4 of 4	0	40%						
Encroachment Removal FP Potential	0.019	49	40%													
Total FP Potential	0.137	59	20%													
Existing Connected FP	0.863	2	0%													
Excess Transport Capacity	0.09	23	100%	Excess Transport Capacity	1.000	23	30% to 52%	3 of 4	1	20%						
Pool Frequency	17.17	14	100%	Pool Frequency	0.441	14	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
- Reconnect Floodplain
- 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: 27.52
RIVER MILE END: 28.28
VALLEY MILE START: 24.35
VALLEY MILE END: 25.06

0 500
Feet

Publish Date: 2021/01/25, 3:50 PM | User: mgieschen
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ANCHOR QEA

Project Area 24
Conceptual Adaptive Management and Restoration Opportunities

Project Area 29 Description

Project Area 29 begins at the Brines Road bridge crossing at VM 16.37 and extends upstream to VM 17.38. The 2017 RM length is 1.12 miles. Field observations for PA 29 were not conducted in 2018 as part of this assessment update, and the remainder of this site description was taken from the 2011 prioritization. Since the 2011 assessment, this reach has undergone a restoration project based in part on the opportunities identified in the 2011 prioritization.

The river through PA 29 is primarily characterized by a low-sinuosity, single-thread, plane-bed channel, with local areas of split flow and LWD or bedrock-forced pools. At the upstream end of this project area, the first mile is highly influenced by bedrock outcrops along the left bank and in the channel bed. The bedrock maintains the grade of the channel and creates local rapid sections and deep pools. Boulders that have eroded from the hillside also create rapid conditions and are present in much of the channel where it flows along the toe of the valley wall. Short plane-bed sections are located between the bedrock-dominated portions of the channel and generally contain sparse LWD and armored substrate conditions.

A forested island with split flow is located half a mile from the upstream end and appears to be maintained for irrigation purposes. The channel on the right side of the island contains armor rock in the bed and banks at the head of the island and

Project Area 29
No site photograph available.

Project Area 29 Reach Characteristics

VM Start (mi)	16.37
VM Length (mi)	1.01
Valley Slope	0.80%
RM Start (mi)	18.63
RM Length (mi)	1.12
Average Channel Slope	0.71%
Sinuosity	1.11
Connected FP (ac/VM)	10.21
Encroachment Removal (ac/VM)	1.43
Channel Aggradation (ac/VM)	2.19
Total FP Potential (ac/VM)	10.47
Encroaching Feature Length (ft)	1,689.61
Connected FP Rank	49

additional armoring along the length of the right bank. Just downstream is another short split flow adjacent to an armored bank that restricts channel migration.

Downstream of the first mile of this reach, the channel is dominantly plane-bed with little complexity. There is evidence of recent migration along the right bank over the next quarter-mile; cabled LWD toe stabilization has been placed 0.35 mile upstream of the downstream end of the project area and a concrete block wall in the floodplain protects a residence and driveway. For the last quarter mile, Tucannon Road and Einrich/Brines Road bridge abutments are armored with angular riprap. Spoils are located in the left floodplain near a constructed rock/LWD barb feature. A low-lying wetland area near the Einrich/Brines Road bridge is connected at the downstream end and contains flowing water and juvenile fish.

Instream habitat conditions are generally characterized by a lack of LWD and cover, low hydraulic complexity, and poor bedload sediment distribution. Bedrock pools in the upper reach provide good holding habitat for adult fish but the bedrock-dominated and plane-bed channel has a low amount of potential spawning area. Potential spawning is better suited to the lower reach; however, the confined and plane-bed conditions likely result in high velocities during high flows and the channel lacks hydraulic refuge.

This project area is characterized by low to moderate floodplain connectivity. Although the upper project area contains a small area of low-lying floodplain, it is not disconnected by any significant infrastructure. The lower project area contains a large area of low-lying floodplain that is primarily irrigated and non-irrigated fields. No apparent infrastructure prevents flooding of these areas except for minor features such as the spoil berm at the downstream end.

The riparian zone is in generally poor to moderate health. Overall, the riparian corridor is relatively narrow and flanked by fields and pastures. Riparian trees are predominantly mature alders with few cottonwoods. The alders provide good shading in some portions of the project area, particularly along the channel margins. Understory vegetation is dominated by invasive groundcover and several areas of thick reed canary grass.

Restoration Actions and Geomorphic Changes

In 2018, restoration work in PA 29 included placing 25 LWD structures and 129 LWD key pieces. Treatment stopped just upstream from VM 17. Structures were placed at a high density, alternating in a relatively confined and incised channel reach, to increase gravel bar frequency and thereby increase pool frequency and depth. The anticipated response will be increased pool frequency and gravel bar development and sorting in this previous transport reach. Structures were placed to maintain existing forested bars and to encourage the development of additional ones.

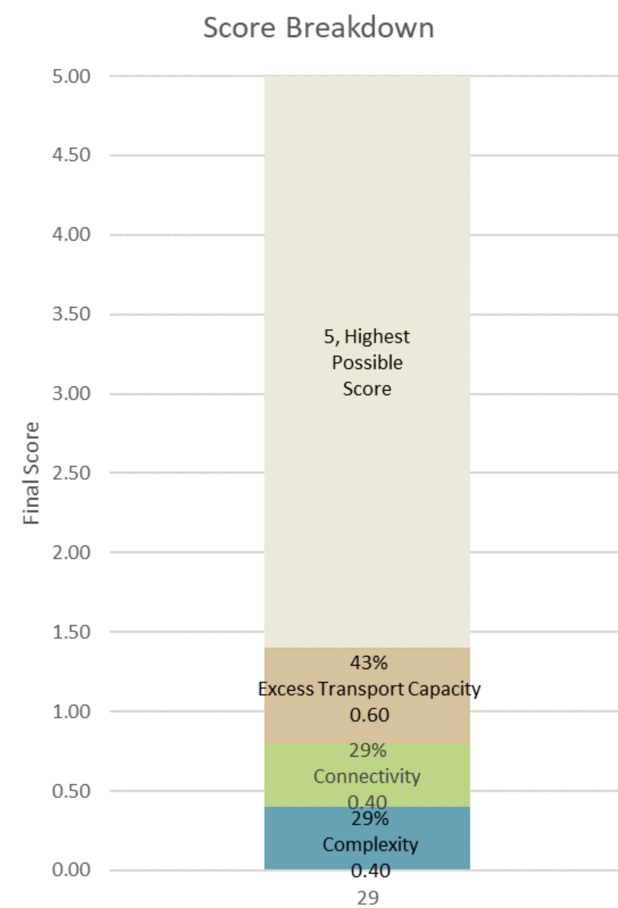
Analysis of the difference between the 2010 and 2017 LiDAR data shows several locations of significant geomorphic change, some of which can be attributed to the restoration actions taken in this reach. Near the upstream end of the project area, significant erosion has occurred on the right bank, although the cause of this erosion is not immediately clear (box 1). Immediately downstream, the channel has avulsed toward the left bank and deposition has occurred in the former main channel (box 2). From the 2018 aerial imagery, it appears the channel used to continue straight through a bar on the left bank, but deposition here has pushed the channel towards the right bank were erosion is evident. A mid-channel log jam has caused a significant avulsion and erosion in the right bank floodplain and formed a mid-channel bar with deposition (box 3).

Further downstream, two mid-channel log jams have caused alternating erosion on the left and right banks along with significant depositional bars in the wake of the log jams. A side channel through the right bank floodplain appears to have formed here as well (box 4). Finally, near the downstream end of the reach, a depositional bar has formed on the left bank and erosion is occurring on the opposite right bank (box 5).

Geomorphic Characteristics and Management and Enhancement Strategies

As shown in the following graphs and table, PA 29 receives a low score in the Complexity metric, indicating that PA 29 ranks low among project areas in the 10th to 40th percentile. This

PA 29 Score Breakdown



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

range has been identified as having some small existing complexity but would likely require a large restoration effort to achieve higher levels.

Complexity in this reach ranks well below average in all three flows but ranks the lowest in the low-winter flow analysis result and slightly higher in the analysis results for the other two flows. This indicates there are some side channels that could be better connected for more perennial flow at the low-flow event. Based on the relative elevation map and island complexity GIS layer, most of these areas exist in several small pockets of complexity in the form of small side channels in the available floodplain, some of which are only connected at the mean-winter and 1-year flows. The primary enhancement target for this reach should be to ensure these flow paths are connected to boost complexity at the low-winter flow. This can be accomplished through both pilot channel cuts and the addition of instream wood. The existing instream wood has caused in-channel complexity, but this reach could likely benefit from a higher density of wood.

This reach has shown minor geomorphic changes to the existing restoration, but gravel augmentation could be considered as a secondary restoration action for a greater response to the addition of instream wood. This would boost in-channel complexity as well as promote geomorphic changes into the side channels targeted for reconnection. This reach receives a moderate score in Excess Transport Capacity so adding more wood should be considered to ensure any added sediment is trapped and entrained in the active channel. Because this reach is moderately confined, setting back levees where possible should be considered to reduce some of the excess transport capacity for the reach.

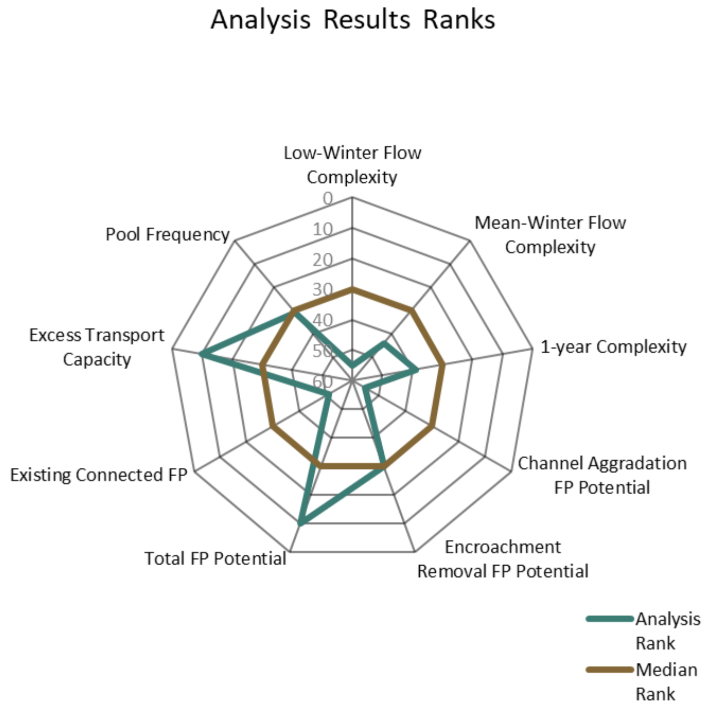
This reach scores poorly in Connectivity potential, partly due to a large, low-lying area in the left bank floodplain that is marked as unobtainable due to the presence of irrigation infrastructure. Should this area of the floodplain become available in the future, reconnecting it would provide large benefits to multiple aspects of the geomorphic processes in the reach.

Finally, PA 29 ranks slightly below the average in the Pool Frequency metric, indicating a moderate amount of pools per valley mile. The enhancement action of adding instream structure and wood, and possibly 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

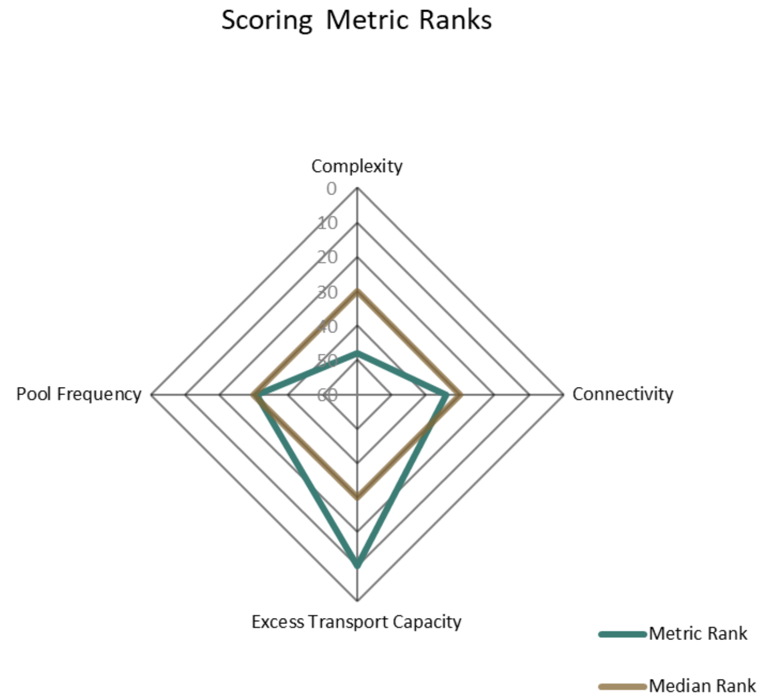
- Gravel augmentation
- Reconnect side channels and disconnected habitats
- Address encroaching features
- Add instream structure (LWD)

PA 29 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.

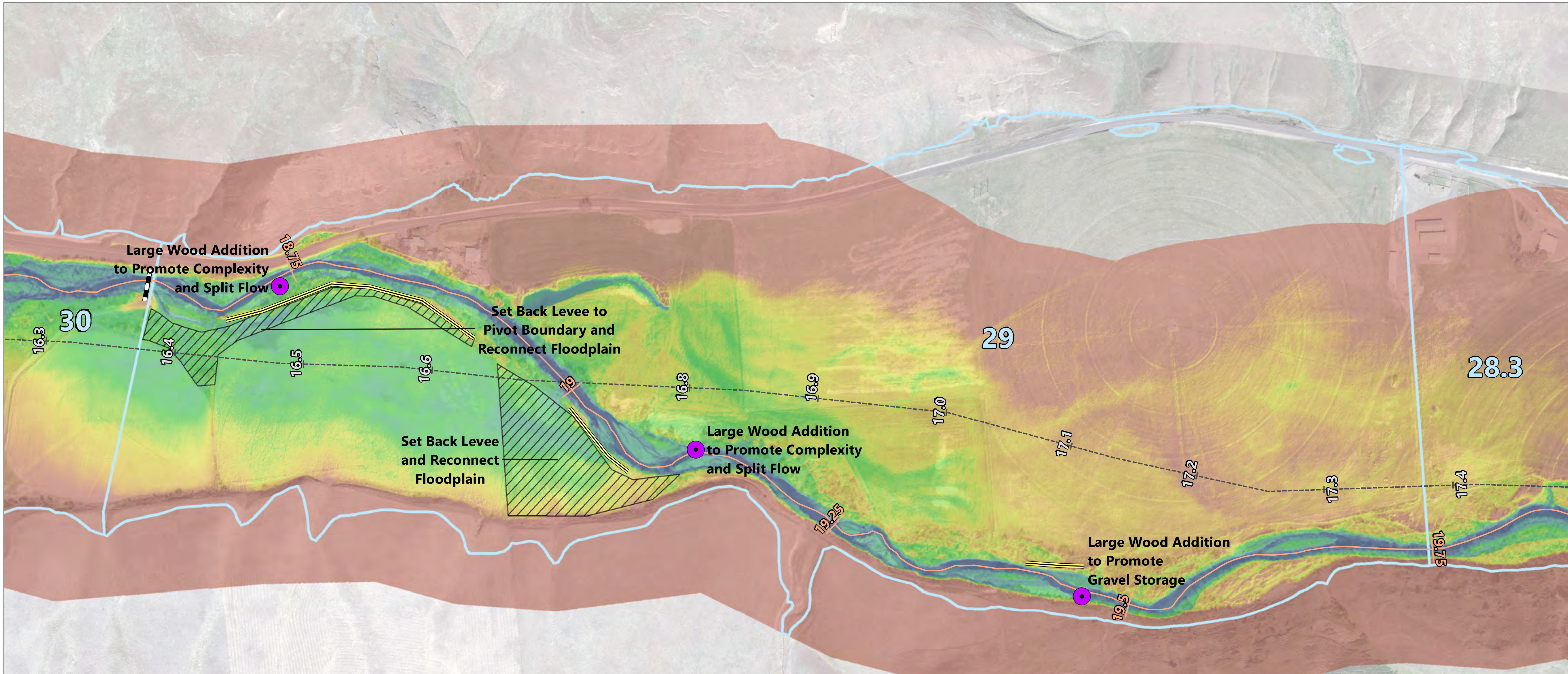
PA 29 Scoring Metric Ranks

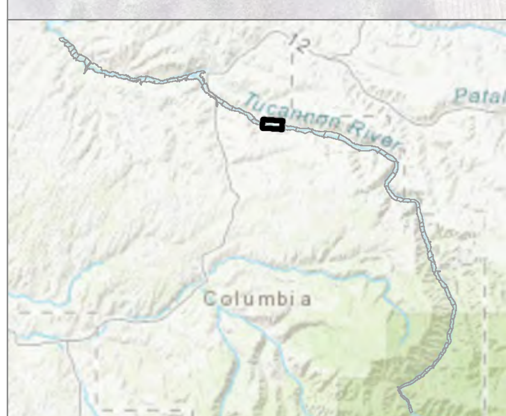


This prioritization scoring summary shows how this project area ranks in relation to the rest of the basin for the three prioritization metrics as well as pool frequency. The results are used as indicators for the geomorphic characteristics and restoration strategies, as well as to prioritize this project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

PA 29 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	55	40%	Complexity	0.133	48	60% to 90%	4 of 5	1	40%	1.4	42	3	Treated	17	3
Mean-Winter Flow Complexity	0.137	44	40%													
1-year Complexity	0.214	39	20%													
Channel Aggradation FP Potential	0.106	55	40%	Connectivity	0.171	34	50% to 75%	3 of 4	1	40%						
Encroachment Removal FP Potential	0.069	30	40%													
Total FP Potential	0.506	10	20%													
Existing Connected FP	0.494	51	0%													
Excess Transport Capacity	0.18	10	100%	Excess Transport Capacity	3.000	10	10% to 30%	2 of 4	3	20%						
Pool Frequency	10.74	31	100%	Pool Frequency	0.276	31	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
- Reconnect Floodplain

Relative Elevation in Feet

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Low : -0

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RIVER AND VALLEY MILE DATA:

RIVER MILE START: 18.63
RIVER MILE END: 19.75
VALLEY MILE START: 16.37
VALLEY MILE END: 17.38

0 500
Feet

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ANCHOR QEA

Project Area 29
Conceptual Adaptive Management and Restoration Opportunities

Geomorphic Assessment and Conceptual Restoration Plan
Tucannon Basin Habitat Restoration