

February 11, 2015

Kittitas Conservation Trust
205 Alaska Ave
Roslyn, WA 98941-0428

Attention: Mitch Long, Project Manager
David Gerth, Executive Director

Subject: *PRE-DRAFT* Gold Creek Conceptual Restoration Design Memo

PROJECT BACKGROUND

The Kittitas Conservation Trust (KCT) has identified the lower 3 miles (mi) of Gold Creek above Keechelus Lake near Snoqualmie Pass as a candidate location for habitat restoration (Figure 1). The primary objectives of the Gold Creek Restoration Project (Project) are to restore perennial flow and improve instream habitat for threatened Gold Creek Bull Trout (*Salvelinus confluentus*). The hydrologic, hydraulic, habitat, and geomorphic conditions within the project reach have been assessed to better understand the causal mechanisms contributing to seasonal dewatering, and the associated impacts to Gold Creek Bull Trout. These findings will be used to develop conceptual designs that meet the primary objectives of the Project by restoring natural geomorphic and hydrologic processes.

Existing information relevant to the Project has been reviewed and compiled to guide the assessments and conceptual design development. This information was used to describe the existing knowledge base related to the Project, and to identify key data gaps that needed to be resolved to define the problems effecting Lower Gold Creek (NSD 2013a). Hydrologic monitoring studies in 2013 and 2014 described hydrologic conditions related to seasonal dewatering (NSD 2013b, NSD 2014a), and geomorphic assessment (NSD 2014b) documented historic conditions, disturbances and current conditions of the valley. All of these studies identified the Gold Creek gravel pit (Pond), historic channel widening, Heli's gravel pit (Pond), and the buried drainage system on the eastern floodplain as potential contributors to dewatering. This technical memo presents the conceptual restoration designs developed to address these contributors to dewatering, which will focus on restoration of the natural geomorphic processes that once sustained a healthy population of Bull Trout in Gold Creek.

ASSESSMENTS COMPLETED

Hydrologic monitoring during the summer of 2013 and 2014 was conducted to evaluate the spatial and temporal character of dewatering in Gold Creek, and to determine the mechanisms contributing to seasonal dewatering in the creek (NSD 2013b, 2014a). This monitoring included several surface water gages in Gold Creek and in Gold Creek and Helis Ponds, and multiple groundwater wells in the adjacent eastern floodplain. Visual observations of the extent of dewatering in the creek we recorded bi-weekly to more accurately determine the spatial extent of dewatering during the monitoring season. The findings of this monitoring revealed that dewatering in Gold Creek initiates near RM 1.5, and progresses up and downstream to near RM 2 and RM 1, respectively (Figure 1). A second dewatering reach emerged during the 2013 monitoring season between RM 0.5 and 0.66, however this reach remained wetted throughout the 2014 monitoring season (NSD 2013b, 2014a). While this reach maintained flow throughout 2014, shallow water depths were observed that act as a barrier to adult fish migration upstream. Several summer rainfall events occurred during 2014 monitoring season that re-wet the creek, in contrast to the 2013 season during

which a prolonged dry period more typical during the summer occurred that increased the duration and extent of dewatering in Gold Creek. The groundwater wells revealed the orientation of Gold Creek Pond relative to the valley axis induces a lateral groundwater gradient away from the creek up-valley from the Pond. This lateral gradient drives groundwater toward the eastern side of the valley. The water surface elevation (wse) of Gold Creek Pond is held relatively constant by discharging into the outlet channel, joining Gold Creek near RM 0.55, effectively passing groundwater from up-valley of the Pond downstream to RM 0.55 considerably faster than would occur through the subsurface without the Pond (Figure 1). The large size of the Pond also moderates water levels. The 27-acre pond occupies 78% of the valley bottom. The combination of drawing groundwater away from Gold Creek and reducing the groundwater elevation up-valley of the Pond was identified as the greatest contributor to seasonal dewatering in the creek.

The geomorphic assessment (NSD 2014b) describes the historic condition of Gold Creek, historic alterations within the valley, and how disturbances have lead to the current degraded condition. Prior to human alteration, Gold Creek was a wood-forced anastomosing channel with a mature forested riparian corridor. The large trees that once lined the channel banks created a dynamically stable channel, with tree recruitment forming and maintaining instream habitat conditions. The mature riparian forest prevented over-widening of the creek as trees recruited into the channel resulting from bank erosion helped to deflect flows away from the eroding bank, limiting continued widening and providing a stable surface for the floodplain to regenerate. Logging in the valley after the 1940's cleared much of the large trees lining the channel banks that provided stability to the channel. Dramatic channel widening (90% increase in channel width) and avulsions immediately following logging has resulted in a much less stable channel and loss of instream wood limiting critical habitat (pools, cover) in the creek (NSD 2014b). The current over-widened channel increases the infiltration capacity of the channel bed, reduces channel depths over the range of flow conditions, and the channel thalweg freely migrates across the unvegetated active floodplain, preventing the establishment of riparian cover. The loss of instream wood and resultant channel destabilization was identified as the primary limiting factor to habitat conditions in Gold Creek (NSD 2014b).

CONCEPT DESIGN DEVELOPMENT

The conceptual restoration designs were developed to meet the restoration objectives to restore perennial flow and improve instream habitat for threatened Gold Creek Bull Trout (*Salvelinus confluentus*). The hydrologic (NSD 2013b, 2014a) and geomorphic (NSD 2014b) assessments informed the development of the conceptual restoration designs by identifying the contributors to the current degraded condition of Gold Creek, and providing recommendations to restore geomorphic and hydrologic processes.

Historic disturbances within Gold Creek valley have altered natural geomorphic processes and hydrologic conditions, resulting in degraded habitat conditions. The cumulative impact of these disturbances has resulted in an over-widened channel lacking instream complexity and cover, which dewateres annually for a significant reach during the summer months. The proposed conceptual restoration designs developed focus on the primary contributors to seasonal dewatering (Gold Creek Pond) and degraded instream habitat conditions (historic logging and resultant destabilized channel) (NSD 2013b, 2014a, 2014b).

GOLD CREEK PIT RESTORATION

Based on a second year of surface and groundwater monitoring (NSD 2014), it is clear that the Gold Creek gravel pit (Pond) is the major contributor to seasonal dewatering of Gold Creek. The primary influence of the pond is to lower groundwater elevations on the eastern side of the valley relative to the western side, modifying the natural gradient of flow toward the eastern floodplain and away from Gold Creek. In addition to modifying flow direction, the pond decreases groundwater elevations up to 10-ft from what

would be their natural elevation. Both of these influences of the pond are a result of the orientation and size of the pond relative to the valley.

The proposed restoration of the Gold Creek Pit (Pond) is to convert the valley back to the forested wetland complex that was present prior to excavation of the pit. Gravel extraction for construction of I-90 began in Gold Creek valley by 1970, forming a 27-acre pit, extending 1530-ft up the valley (between RM 0.75 - 1.15). This large footprint relative to the size of the valley has accentuated the hydrologic effects of the Pond relative to other gravel extraction pits of similar size but in much larger valley bottoms. Restoration of this gravel pit back to the historic forested wetland complex includes several elements (Figure 2 and 3):

- Filling of the Pond back to the historic floodplain elevation creating wetland mosaic
 - using fill material of similar size to that removed
 - compacting fill material to a similar density of the adjacent native floodplain
- Lowering berms surrounding the pond back to the historic floodplain elevation
 - use material to fill the pond
- Removing riprap, bridges, culverts, roads, or other artificial barriers to channel migration
- Filling the outlet channel
 - using fill material of similar size to that removed
 - compacting fill material to a similar density of the adjacent native floodplain
- Establishment of new tributary alignment
- Remove existing trail and establishment of new ADA compliant trail around/through restored area
- Establishment of new picnic and parking area
- Planting of native vegetation appropriate for ecotone to be established (wetlands, streamside, uplands)
- Abandon existing Bureau of Reclamation groundwater well

These proposed actions would restore the historic groundwater and hydrologic conditions present prior to gravel extraction, addressing the primary contributor to seasonal dewatering of Gold Creek. The floodplain elevation immediately north of the Pond was projected down to the floodplain elevation between the outlet channel and parking area, to estimate the historic floodplain elevation through the Pond (Figure 4). Based on this projection, an estimated 1.2 million cubic yards (CY) of fill material is needed to fill the Pond to the historic floodplain elevation. It is estimated that because the proposed restoration will include low-lying wetland complex areas (Figure 3), the amount of fill required will be less than 1.2 million CY. The berms surrounding the Pond (Figure 2) contain approximately 180,000 CY of fill that can be used to fill the Pond. All fill material imported to fill the Pond should be of similar character (range of sizes/grading, lithology, shape) and compacted to a similar bulk density once placed to that of the adjacent undisturbed floodplain immediately north of the Pond. The quantity of fill needed may require identification of multiple sources and take several construction seasons to place. Phasing of fill placement should prioritize filling the northeastern corner of Gold Creek Pond first, to better align the up-valley margin of the Pond with the axis of the valley and eliminate the cross-valley groundwater gradient drawing water from Gold Creek.

Forested Upland areas proposed would be composed of conifer species assemblages similar to that of the adjacent upland floodplain (Figure 3). The Forested Wetland Complex areas would support a mix of conifer and deciduous tree assemblages, surrounding smaller isolated and connected seasonal wetlands areas (Figure 3). Beaver dams could be incorporated into the grading of these wetland features to mimic the habitat complexity present in a similar setting on the western floodplain near RM 1.1 (Figure 1, 4). Larger

more extensive emergent wetlands (Wetland Complex, Figure 3) are proposed similar to that found on the western floodplain near RM 2.2 (Figure 1) and at Mardee Lake (Figure 4). These varied ecosystems will not only restore the hydrologic regime, but also provide habitat for a wide variety of birds, amphibians, invertebrates, insects, fish, and mammals.

Recreation developed at the Pond will be maintained by relocating facilities to the margin of the valley or at an adjacent area outside of the valley, minimizing the potential for limiting natural processes within Gold Creek valley. The proposed conceptual design (Figure 3) presents an option for relocating recreational facilities within Gold Creek valley. A new ADA compliant trail is proposed to follow the eastern valley wall, providing an overview of the restored area, then drop down into the restored area traversing the various ecosystems. The trail could be an elevated boardwalk through the restored wetland areas, with new bridges fully spanning the new tributary channel alignments (Figure 3). The parking area, restrooms, and picnic area are all relocated to the southeastern corner of the restored area (Figure 3). Interpretative signage could be included along the proposed trail to provide public education about the restoration project of the Gold Creek Bull Trout.

The proposed restoration actions at Gold Creek Pond are primarily on US Forest Service property, however they extend onto adjacent private property (Figure 2 and 3). The parcel boundaries on Figures 2 and 3 are from Kittitas County and are approximate locations. A detailed land survey of parcel boundaries should be conducted prior to developing more detailed restoration designs to ensure all potential project stakeholders are identified.

GOLD CREEK RESTORATION

The finding of the geomorphic assessment (NSD 2014b) highlights the role of channel destabilization from historic logging of the riparian corridor contributing to habitat degradation in Gold Creek. The over-widened channel has resulted from a loss of large riparian trees that once were recruited into the channel as the channel banks eroded. These large trees formed key pieces in the channel that trapped sediment and mobile wood, which over time helped to stabilize the channel by partitioning shear stress and reducing further bank erosion. This dynamic equilibrium allowed for wood and sediment recruitment into the channel while providing a much more narrow and multi-thread channel with habitat and hydraulic complexity from instream wood. Key to restoring habitat quantity and quality in Gold Creek is to narrow the active channel, increase the number to channel flow paths where possible, and increase wood loading and frequency of large logjams. Wood can be the foundation to restoring a reinforced floodplain along Gold Creek, providing bank strength until riparian trees mature. This approach uses a matrix of trees that are partially buried into existing gravel bars and exposed in the channel, restoring a narrower channel similar to the historic Gold Creek.

Given the length of channel impacted, targeted restoration of the most significantly over-widened reaches and those with the most impaired habitat conditions should be prioritized (Figure 5). The project reach was divided into 3 phases, with Phase I being the highest priority reach. The Phase I reach (between RM 1 and 1.7) (Figures 6 and 7) was selected as the highest priority reach for restoration as it includes the most over-widened channel sections (NSD 2014b), completely dewatered seasonally, and contains the initiation point of dewatering in the creek (NSD 2013b, 2014a). Phase II (between RM 0 and 1) (Figures 5 and 6) was selected as the second highest priority reach for restoration to address the downstream barrier to migration near RM 0.5 (complete to partial dewatering of the channel sufficient to limit fish passage during the summer months). A significant portion (0.5-miles) of Gold Creek is on private property through the Phase II reach (between RM 0.4 and 0.9), and will require consultation with the landowner. The Phase III reach (between RM 1.7 and 2.5) (Figure 7) was selected as the lowest priority reach because natural recovery has already begun in this uppermost reach of Gold Creek and current habitat conditions are less degraded than in Phases I and II.

Key to restoring a narrower channel is the creation of a hardened floodplain along the margins of the current channel to mimic the historic role large recruited trees and resultant logjams once provided (Figures 5-7). The hardened floodplain would be composed of a matrix of large timber of varying width and lengths, constructed on gravel bars and partially to completely backfilled and planted with native vegetation (Figure 8). Vertical and inclined posts, combined with backfilling, will provide structural stability to the roughened floodplain. Logs along the margin of the roughened floodplain structure will project into the channel at varying lengths to roughen the edge with the channel (Figure 8). The hardened floodplain will function by:

- Limiting bank erosion and further widening of the active channel
 - Hardened floodplain to be constructed along channel banks without large riparian trees along their margin to limit erosion into these areas
 - Moving banks inward from both sides of the channel to reduce channel width
 - Decrease average channel width from 119-ft to 50-ft
 - Creation of stable islands in the channel
- Roughen exposed gravel bars to promote formation of new floodplain (area protected from channel migration)
 - Extend structure from current bank across adjacent gravel bars
 - Partitioning of shear stress due to roughened floodplain will reduce sediment transport capacity, and will fill-in and further bury wood over time creating new floodplain
 - Material excavated for new channel flow paths to be used to completely to partially backfill roughened floodplain
 - Planting native vegetation on roughened gravel bars
 - Native shrub species on partially backfilled areas
 - Native tree and shrub species on completely backfilled areas

Excavation of new channel flow paths are proposed at several locations (Figures 5-7) to restore an anabranching planform, increase edge habitat availability, and to maintain flow conveyance lost from narrowing the channel during formative flow events. The proposed new channels are located in low-lying floodplain areas that Gold Creek historically occupied, limiting the quantity of excavation required. Material excavated will be used to partially backfill roughened floodplain areas adjacent to the excavation. Any trees cleared to construct new channels will be incorporated into other restoration elements of the project (roughened floodplain, engineered wood placements).

To restore instream habitat within the creek, 111 engineered logjams (ELJs) are proposed along the lower 2.5-mile reach of Gold Creek (Figures 5-7). The locations of these structures are intended to maximize habitat benefits by:

- Forcing and maintaining pools with cover (111 pools)
- Deflecting flows into constructed and side channels
- Contribute to channel stability by partitioning shear stress
- Creating hydraulic and habitat complexity (fast and slow, deep and shallow water all in close proximity)
- Localized sorting of sediment sizes due to hydraulic complexity

The dimensions of the proposed ELJs are approximately 40-ft in width and length, mimicking the size of functional and stable natural wood accumulations observed in the channel (Figure 8). The proposed ELJs are constructed with a core of structural logs partially embedded into the channel and arranged to induce a desired hydraulic and geomorphic effect. Each structure includes a large volume of smaller (racking) logs packed on the upstream end and flanks of the structure to provide complex interstitial cover for fish, and additional stability to the structure by forcing scour away from the structural core. Long-term stability is maintained as the structure recruits mobile wood moving down Gold Creek during larger floods. Structure heights are designed to be near the flow depth during the 2-year flood to maximize geomorphic function. Final elevations and locations will be optimized during the design phase through the evaluation of proposed hydraulic modeling.

HELIS POND RESTORATION

Restoration of Helis Pond, an artificial pit excavated in the summer of 1996 as a source of gravel for resurfacing roads, and construction of a flood diversion structure (berm) to protect the community from flooding (Bennett 2007). Following excavation, a trail was built around the new pond, with a footbridge over the outlet channel. The outlet channel drains Helis Pond during the spring until around mid-June (based on observations in 2013), when the pond drops below the inlet to the outlet channel as groundwater starts to decline. The surface elevation of the pond was found to be above the elevation of flowing water in Gold Creek across from the pond throughout the year (NSD 2013b, 2014a). However similar to Gold Creek Pond, Helis Pond may be drawing water from Gold Creek at the upstream end of the pond near RM 2. This location in Gold Creek is where the maximum extent of dewatering was observed during monitoring in 2013 and 2014 (NSD 2013b, 2014a). A more detailed local monitoring study should be conducted in Gold Creek and Helis Pond to better understand the exchange of groundwater and surface water between these features. This more detailed monitoring would serve to focus restoration needs and strategies at Helis Pond.

In lieu of more detailed local hydrologic information of Helis Pond and the adjacent reach of Gold Creek, restoration concepts have been developed that focus on converting the pond to an off channel wetland complex. Because this location was a relic channel of Gold Creek that was abandoned and later began revegetating, filling the pit back to its original elevation would not support wetland habitat. The range of groundwater elevations over the summer months when groundwater is at its seasonal minimum provides a means for determining wetland elevations that would support seasonal wetlands at Helis Pond. Conversion to a wetland complex would include:

- Filling the pond an elevation that would support seasonal wetlands
 - using fill material of similar size to that removed
 - compacting fill material to a similar density of the adjacent native floodplain
 - replant using native wetland assemblages
- Adding wood to outlet channel
- Preserve trail around the pond
- Adding wood to Gold Creek overflow channel draining to Helis Pond

To limit burial and disturbance to the constructed wetland, large wood obstructions should be incorporated into the channel that enters Helis Pond at the upstream end (Figure 9). This channel conveys overflow from Gold Creek during large floods, and from a small tributary from the eastern valley wall. The restored seasonal wetland would be planted with appropriate native vegetation based on the anticipated groundwater elevations across the wetland complex. The Forested Seasonal Wetland Complex areas would support a mix of conifer and deciduous tree assemblages, surrounding smaller isolated and connected seasonal wetlands

areas (Figure 9). Seasonal Wetlands that may intermittently dry during the summer months would be planted with native annual wetland plant assemblages that can tolerate seasonal dewatering. A smaller emergent wetland area toward the center of Helis Pond is proposed that would remain ponded throughout the year, with the filled elevation lower than the lowest observed water surface elevation during monitoring in 2013 and 2014. (2598.6 feet NAVD 88) (NSD 2013b, 2014a). The location of this emergent wetland area is in the deepest part of Helis Pond, limiting the amount of fill required to achieve the desired ecotone. Beaver dams could be incorporated into the grading of these wetland features to mimic the habitat complexity present in a similar setting on the western floodplain near RM 1.1 (Figure 1, 4). These varied ecosystems will not only restore the local hydrologic regime, but also provide habitat for a wide variety of birds, amphibians, invertebrates, insects, fish, and mammals.

To improve habitat and cover in the outlet channel, individual trees and small logjams are proposed along its 450 ft length. Wood pieces would be keyed into the adjacent channel banks and piles driven to anchor the logs in place. Additional racking logs and slash will be incorporated into larger constructed logjams. This channel will convey floodwaters from Gold Creek, maintaining the flood benefit for the Ski Tur community. A similar approach of wood loading is proposed for the channel entering Helis Pond from upstream. This 1,900 ft long channel has built a small delta where it enters Helis Pond, indicating that flow of sufficient magnitude to transport gravels occurs regularly. Loading the channel with wood will partition shear stresses and disperse flow in the channel, limiting its transport capacity and ability to fill the proposed wetland over time.

DRAINAGE LINE RESTORATION

An 8-in buried drainage line was identified during field surveys at manhole locations along Snowshoe Lane and Gold Creek Road. The locations of the manholes and the pipe invert at each manhole were recorded to create a map of the drainage line connecting the manholes and its elevation (Figure 10). The invert elevation of the drainage line was compared to the water surface elevation (wse) at groundwater well locations adjacent to the pipeline to evaluate if the pipe lies above or below groundwater during the summer months. WSE was compared at GW 4 and GW 8 (NSD 2014) during the summer months, and was found to be 1 to 3-ft below the elevation of the drainage pipe. Groundwater elevations are close to 3-ft below the pipeline on its northern end, but are closer to the pipeline further south along the alignment. Water was observed flowing in the drainage pipeline at Manholes 1, 9, and 8 during the summer months, indicating that the invert is below groundwater elevation at the lower end of the drainage pipe. The pipe terminates into a drainage ditch discharging directly into Gold Creek Pond from Manhole 8.

This drainage system appears to function mostly during the winter and spring months when groundwater elevations are at their highest, but continues to function at the lower (southern) end into the summer months when the creek is dewatering. No documentation pertaining to the rationale for constructing the drainage line, or when it occurred, was found. However, given its location we conclude that it is related to the planned development of the parcel of land immediately to the north and east of the drainage line, with several roads entering the parcel that have subsequently been overgrown. Offshoots from the drainage line extend into the parcel, lending further evidence that draining this plot of land for development was the purpose of installing the drainage pipe.

Because the drainage line has flowing water when dewatering of the creek occurs, we proposed filling and sealing the pipe and manholes at the lower end (approx. 1320 ft of pipe) (Figure 10). To minimize the impact to adjacent landowners and their property from seasonally high groundwater levels (winter and spring), the upper end of the drainage line will not be modified. Sealing the lower end of the drainage line will prevent artificially moving groundwater from upstream of Gold Creek Pond directly into the Pond at a much faster rate than if traveling through the floodplain. This will help to raise groundwater elevations during the summer months to lessen the extent and duration of dewatering in Gold Creek. These actions

should be conducted in conjunction with the restoration of Gold Creek Pond as the two are hydrologically linked.

LIMITATIONS

We have prepared this report for Kittitas Conservation Trust, their authorized agents and regulatory agencies responsible for the Gold Creek restoration project. Within the limitations of scope, schedule and budget, our services have been executed in accordance with generally accepted practices for river and wetland restoration in this area at the time this report was prepared. The conclusions, recommendations, and opinions presented in this report are based on our professional knowledge, judgment and experience. No warranty or other conditions, expressed or implied, should be understood.

We appreciate this opportunity to be of service to Kittitas Conservation Trust for this project and look forward to continuing to work with you. Please call if you have any questions regarding this report, or if you need additional information.

Sincerely,
Natural Systems Design, Inc.



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Attachments:

- Figure 1 – Project reach map
- Figure 2 – Gold Creek Pond Restoration Actions
- Figure 3 – Gold Creek Pond Restoration Concept Design
- Figure 4 – Gold Creek Pond Restoration Profile and Reference Photos
- Figure 5 – Gold Creek Restoration Actions (Map Index & Downstream Section)
- Figure 6 – Gold Creek Restoration Actions (Middle Section)
- Figure 7 – Gold Creek Restoration Actions (Upstream Section)
- Figure 8 – Gold Creek Restoration Reference Photos
- Figure 9 – Helis Pond Restoration Concept Design
- Figure 10 – Drainage Line Restoration Design

REFERENCES

- Bennett, J. 2007. The Spirit of Ski Tur Valley. Xlibris Corporation.
- Natural Systems Design, 2013a. Gold Creek Habitat Assessment & Conceptual Design Task 1: Data Inventory & Data Gap Analysis. Unpublished report prepared for Kittitas Conservation Trust.
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