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**Subject: Summary of technical information and identification of data needs  
(Final Deliverable for Task 2.1)**

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## Introduction

The project site is located near RM 20.35 on the Green River in the City of Kent at the former Rosso and Teufel nursery site. The site was acquired by King County in 2011 as part of a long-term habitat enhancement and flood mitigation strategy for the Green River. The site is located on the west bank and is currently vacant... The Green River at this location is entrenched with steep banks covered in shrubs and grasses, primarily blackberry, alder, and willow (Figure 1). Several large cottonwood trees are located -near the top of the bank on the upstream edge of the project area with the southern tree supporting an active bald eagle nest this year (2016). In compliance with the US Fish and Wildlife guidelines, activities will be restricted within 330 feet of the nest during nesting season (February through August 31).

[www.cardno.com](http://www.cardno.com)



**Figure 1.** Photo of the project site from the east bank during the site visit on January 26, 2016. Note eagle's nest in far left cottonwood tree on the far bank.

Several background studies are available for this and nearby properties. A phase II environmental site assessment was conducted in 2011, and additional follow-up work was done at the project site in 2015. The 2011 report indicated dieldrin contamination at some locations on the property (Hart Crowser 2011), and the 2015 report indicated contaminant concentrations below MTCA Method A cleanup levels from samples collected at the project site (Hart Crowser 2015). No contamination issues were identified in the vicinity of the project site along the eastern



edge of the property. Groundwater monitoring from wells located on the property downstream of the project area indicated connectivity with the Green River and water depths ranging between 15 and 17.7 feet below the ground surface in January and February 2015. Dieldrin and total suspended solid concentrations in groundwater samples were at or below the laboratory reporting limits (Hart Crowser 2015).

A cultural resources study was completed for the project in 2015. The report recommends that once 30% plans have been developed for the mitigation project, they should be reviewed by the King County Historic Preservation Program to assess the extent of ground disturbance that will occur, and evaluate whether archaeological monitoring may be warranted. At a minimum, it was recommended that an Archaeological Resources Inadvertent Discovery Plan be developed for use during construction.

### **Project Objectives and Constraints**

Tree cutting by King County along the Green River in compliance with US Army Corps of Engineers levee vegetation policies in 2009 required an HPA permit from WDFW, which included mitigation for the loss of streamside vegetation. This project meets the HPA mitigation requirements by planting 1,046 trees within 150 feet of OHW to mitigate for trees cut on the Briscoe levee in the City of Kent, and the Desimone levee in the City of Tukwila, and by placing 85 logs in the low flow channel to mitigate for trees cut on the landward side of the Horseshoe Bend, Signature Point, Russell Upper, Holiday Kennel, and Briscoe levees in the City of Kent. Access to the site will be from the Teufel site on the west bank with construction access, staging areas, and storage areas adjacent to the project site.

Additional objectives and constraints include:

- Place 85 logs with rootwads in the project area to comply with mitigation requirements. Logs should have a minimum 24-inch basal diameter, be at least 20 feet long (preferably 25 feet), and have rootwads.
- Design the project to ensure stability and retention of all components during the design flood flow (100-year flood). Chains and bolts can be used.
- Design the large wood component of the project to maximize rearing and refuge habitat for juvenile salmonids. Design the riparian planting to maximize shade to the river along the northern boundary of the project site, which is identified as having critical and high shade need in the Muckleshoot Indian Tribe sun aspect maps.
- Ensure that the project is in compliance with the City of Kent floodplain regulations by not increasing the 100-year flood elevation.
- Follow the King County Procedures for considering public safety when placing large wood in King County Rivers (2010).
- Design structures with boater and floater safety as a top priority.
- Complete the plans in time to present them at the public safety meeting in June 2016.
- Complete conceptual designs in time to allow one-year for permitting for a 2017 construction target.
- In-water excavation should be minimized.

### **Site Visits and Meetings**

The site was visited on January 26, 2016 with Jack Bjork and Eric Harlow from Cardno, and Jennifer Rice, Kerry Bauman, and Fatin Kara from King County. The site was first viewed from the east bank bike trail on the Russell Road levee, and then the team drove to the other side of the river and entered through the locked gate and walked over to the two geotechnical investigation bore holes. Project issues and constraints were described, along with past and potential land-use issues. The Green River was flowing at approximately 2950 cfs (as measured at the USGS Auburn gage 12113000) and was higher than the typical spring flow, obscuring the bank below the vegetation line. The eagle's nest was noted, along with the vegetated bank conditions, i.e., almost complete coverage of the bank with Himalayan blackberry. Cultural resources and potential contamination issues were not expected to be issues at the project site portion of the property.



The kickoff meeting was held on March 9, 2016 at the King County offices, and was attended by Jennifer Rice, Kerry Bauman, Fatin Kara, and Andy Levesque of King County; Jack Bjork, Eric Harlow, Matt Faulkner, and Dan Elefant of Cardno; Matt Miller of AESI; and Alex Anderson of NHC.

A Cardno survey team visited the site on March 16 and 17 to survey the bank toe, vegetation line, water surface elevations, and collect bathymetry data at the previous modeling cross sections. Eric Harlow met the team at the site and gave the crew a Cardno lock so that Cardno employees could access the site. The eagle's nest was observed in the southernmost tree at the project site. The survey team established the location of the nest (from a distance) and marked a 330-foot buffer on the King County property on the west side of the river, per Category F. (non-motorized recreation and human activity) of the National Bald Eagle Management Guidelines (US Fish and Wildlife Service 2007).

Matt Miller from AESI visited the site on March 23, but did not enter the property. Observations were made from the east bank.

### **Geotechnical**

In 2015, Hart Crowser conducted a geotechnical investigation of the project site that included two borings on the bank adjacent to the Green River project site. The borings were 61.5 feet deep and included samples at 2.5- to 5-foot depth intervals. Boring logs revealed mostly sandy substrate with some gravel, scattered wood, and silt down to about 52 and 53 feet below ground surface and silt below that to the bottom of the boring at 61.5 feet. The memo described the soil conditions as follows:

- *Loose Silty Sand.* This layer consists of 19 to 25 feet of very loose to loose, silty to very silty fine sand. On the opposite bank a layer of "Silt and Organics" was encountered in boring GE1-B-5 at a depth of about 12 to 25 feet (elevation 31 to 18 feet, NAVD88). This layer was generally not observed in borings HC-1 and HC-2.
- *Medium Dense Sand with Occasional Gravel.* This layer was encountered below the Loose Silty Sand layer down to a depth of 52 to 53 feet (elevation -8 to -10 feet, NAVD88) and consists of generally medium dense poorly-graded sand with occasional gravelly zones and scattered wood fragments. This layer also included a thin, silty Sand zone near a depth of 35 feet (elevation 9 to 12 feet, NAVD88). Previous explorations ended in this layer at a depth of about 51 feet, which corresponds to an elevation of approximately -8 feet (NAVD88).
- *Lower Silt.* This layer was encountered at a depth of 52 to 53 feet (elevation -8 to -10 feet, NAVD88) and consists of medium stiff to stiff silt. The current explorations were both ended in this silt layer at a depth of 61.5 feet, which corresponds to an elevation of approximately -18 feet (NAVD88). (Hart Crowser Letter dated January 7, 2016).

The natural angle of repose of the bank at the project site is approximately 39 degrees (1.2H:1V) based on the cross section. An initial review of the data indicates that the bank would support slopes of 2H:1V above the water line and 3:1 below the water line during construction, although construction below the water surface is not anticipated. No additional geotechnical investigations are planned for this project, and recommendations will be summarized in a separate geotechnical memo.

### **Survey Results**

The Cardno survey crew visited the site on March 16 and 17 to verify control points, locate the eagle's nest, stake the eagle's nest buffer at 330 feet on the King County property, take survey confidence points, resurvey three previous cross sections located outside of the buffer, collect an additional cross section on the downstream side of the buffer, and survey the edge of the woody vegetation. Additional surveys will be completed within the eagle buffer after July 15<sup>th</sup>. Results of the survey indicated that most of the confidence points on the level upland surface



were within acceptable tolerances, but several points along the sloping bank did not pass (Figure 2). This result is expected given the steep and variable surface along the stream bank.

The resurveyed cross sections of the bottom of the channel did not change dramatically since the last survey in 2006. Figure 3 shows a preliminary cross-section comparison for cross section 20.277, which is located at the downstream end of the project area. The cross sectional area did not change much over the 10-year period, although the left bank and the maximum depth decreased by about 1.5 feet at the thalweg. For purposes of hydraulic modeling and construction for this project, the changes in bathymetry since 2006 are minor and unlikely to have much of an effect.

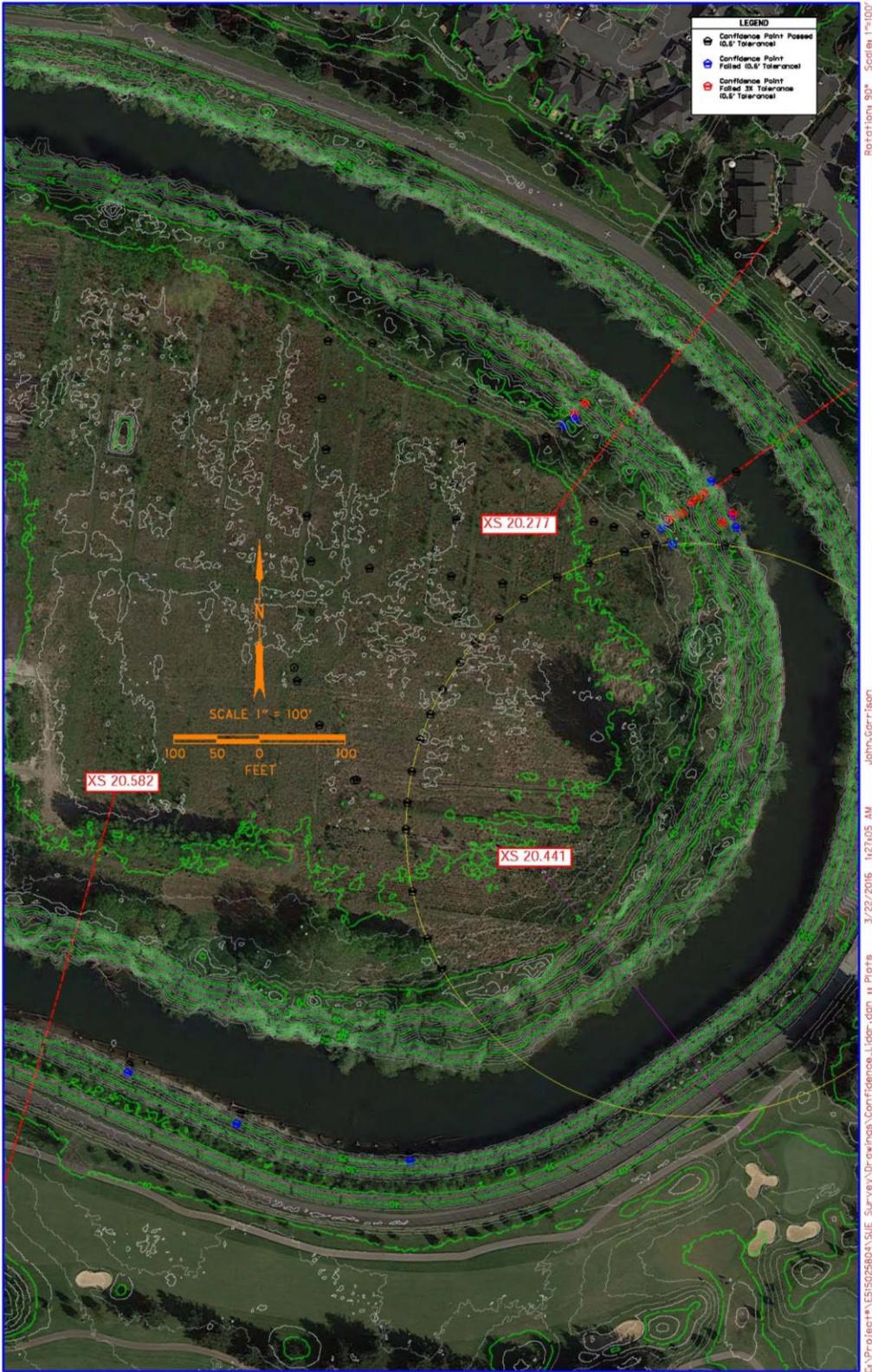
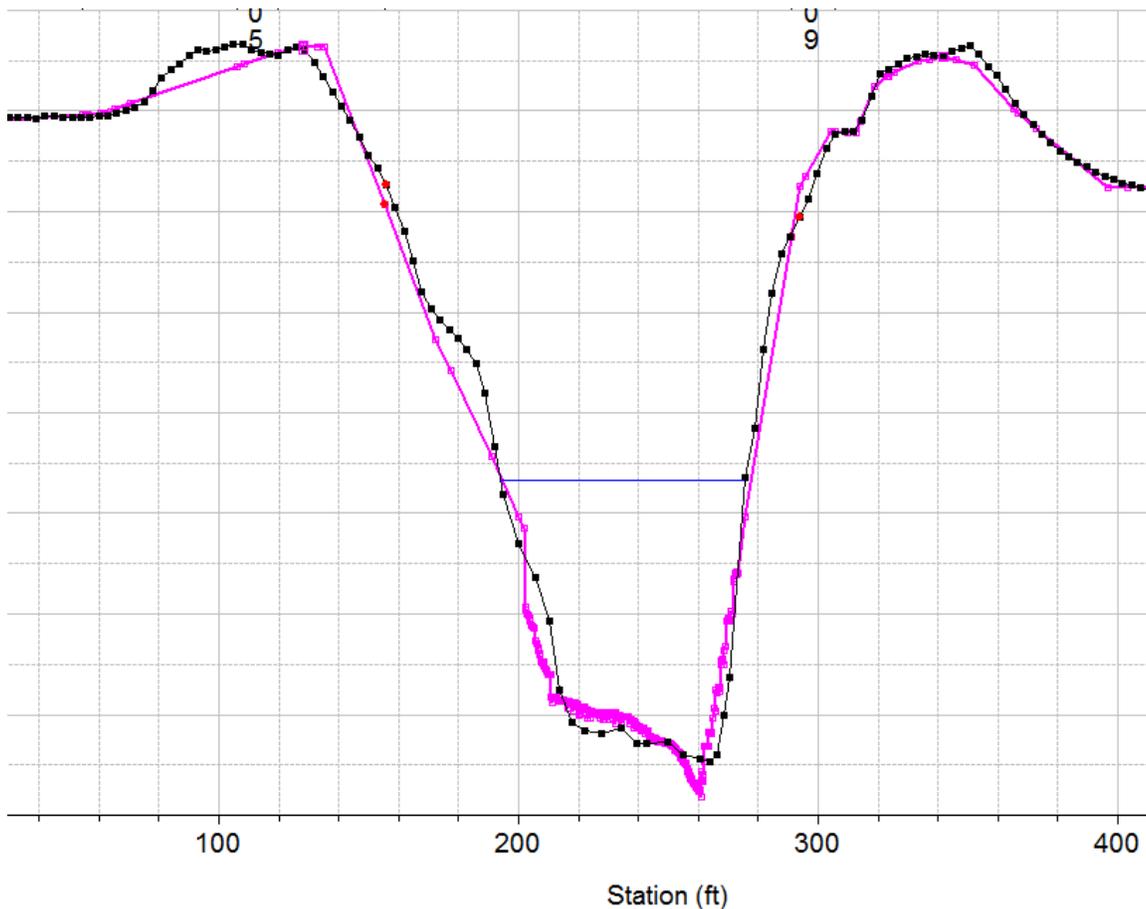


Figure 2. Survey confidence point map.



**Figure 3.** Preliminary cross section 20.277 at the downstream end of the project area. Vertical scale is 2 feet, and horizontal scale is 20 feet (10:1 vertical exaggeration). The pink line represents the 2006-2007 cross section and the black line represents cross section data collected in March 2016.

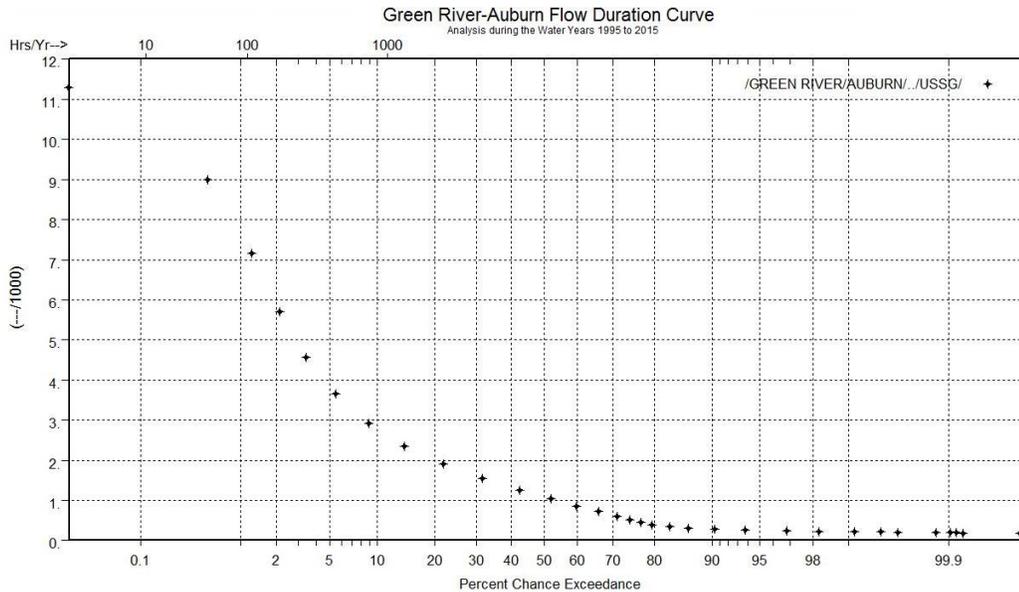
### Hydrology and Hydraulics

The nearest active USGS gage is located at 200<sup>th</sup> street in Kent (USGS 12113344), which is approximately three river miles downstream from the project site. The gage at Kent, however, only has discharge records dating back to the end of 2011. The USGS gage located approximately 12 river miles upstream at Auburn (USGS 12113000) is the nearest upstream active gage to the project site and has a record of discharges dating back to 1936. Figure 4 is a preliminary flow-duration curve based on flows at the Auburn gage.

Estimated discharges and water surface elevations are also available from the preliminary flood insurance study HEC-RAS model for cross sections within and near the project area (Figure 5). The 10-year to 500-year discharges in Figure 5 represent the FEMA-accepted values for the project area, and show the strong impact of dam regulation on peak flows as the values are very similar. More recent work by the US Army Corps of Engineers (2012), however, indicates that the 500-year discharge at the upstream Auburn gage would be 18,800 cfs. Modeled discharges between 250 cfs and 2000 cfs are also included in the table.

The modeled water surface elevations for the 1500 cfs and 2000 cfs are 21.35 feet and 22.95 feet, respectively. The surveyed water surface elevation for the same cross section from March 16, 2016 was 19.3 feet for a discharge of 1680 cfs as recorded at the Kent gage three miles downstream from the project site. This is about two feet lower

than the modeled water surface elevation for an estimated 1500 cfs flow at the cross section, indicating that the HEC-RAS model will need to be recalibrated to achieve better lower-flow results at the site.



**Figure 4.** Flow duration curve for USGS gage 12113000 at Auburn. Horizontal axis is in 1000s of CFS.

HEC-RAS Plan: FEMA Final Locations: User Defined					
River	Reach	River Sta	Profile	Q Total (cfs)	W.S. Elev (ft)
Green River	Mainstem	20.277	10-year	11700.00	39.24
Green River	Mainstem	20.277	50-year	12650.00	40.20
Green River	Mainstem	20.277	100-year	12690.00	40.24
Green River	Mainstem	20.277	500-year	12800.00	40.36
Green River	Mainstem	20.277	2000	2000.00	22.95
Green River	Mainstem	20.277	1500	1500.00	21.35
Green River	Mainstem	20.277	1000	1000.00	19.49
Green River	Mainstem	20.277	500	500.00	17.13
Green River	Mainstem	20.277	250	250.00	15.52

**Figure 5.** HEC-RAS model results for discharge (Q) and water surface elevation for cross section 20.277 within the project site. Note that the USACE study (2012) indicated that the 500-year discharge at the upstream Auburn gage would be 18,800 cfs.

**Utilities**

There are no utilities located in, or adjacent to, the project area that would impact design or construction of the mitigation project.

**Natural Resources**

King County staff identified and described natural resources at the project site. The following studies and reports were reviewed prior to a site visit on April 15, 2016 by Jen Rice, Project Manager, and Kerry Bauman, Project Ecologist:

- Anchor QEA. 2004. Final Lower Green River Baseline Habitat Survey Report. <http://www.govlink.org/watersheds/9/reports/LowerGreenBaseline.aspx>
- R2 Resource Consultants. 2014. Lower Green/Duwamish River Habitat Assessment.
- Muckleshoot Indian Tribe. 2014. Bathymetric Survey Data, Lower Green River: RM 15.7 to RM 27.7.
- Muckleshoot Indian Tribe. 2013. Riparian Aspect Priority Maps: Lower Green River.
- King County ArcMap Critical Areas layers.

The project site is located on the inside of a meander bend of the Green River so flow velocities are slow and sediment (mostly sand) tends to be deposited. A large lateral scour pool formed by scour against riprap along the right bank was identified by Anchor QEA in 2003 (pool dimensions 175 m long, 18-20 m wide, and 1.0 m residual pool depth; Anchor QEA 2004), but R2 (2014) characterized the entire area as glide in 2013 (Figure 6, Figure 7). The Muckleshoot Indian Tribe bathymetric survey also identified a pool along the outside bend of the right bank, as well as a sand bench along the inside bend of the left bank (Figure 8; MIT 2014). An accumulation of small wood is currently present within a portion of the project area (Figure 9). **The Green River is a Shoreline of the State and is mapped XX in the Kent....**

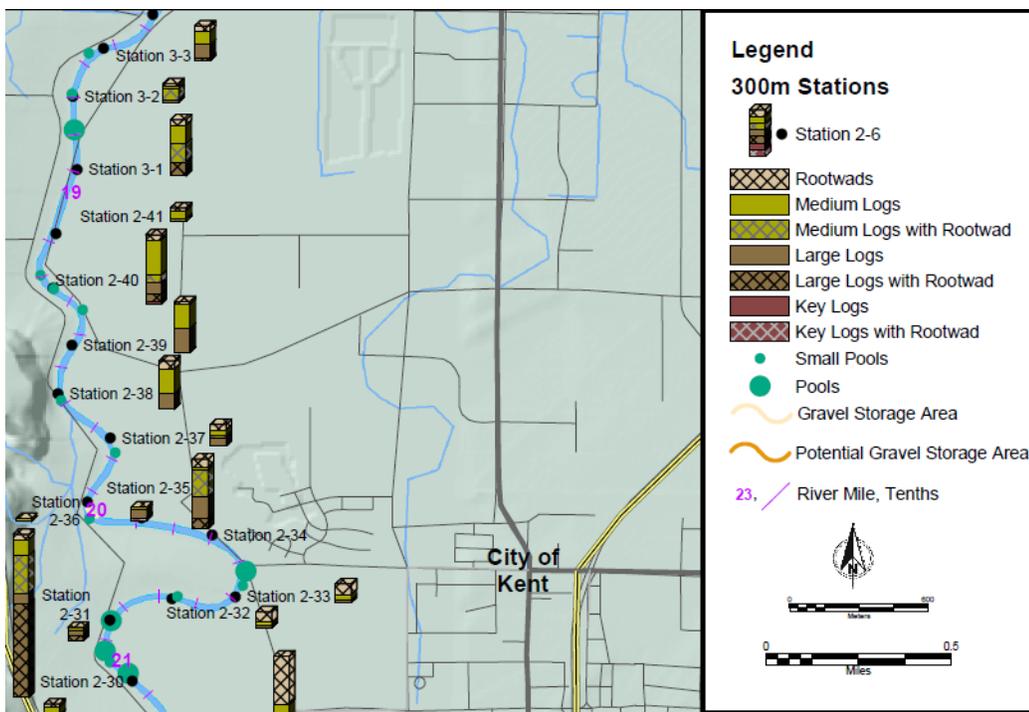


Figure 6. Aquatic Habitat as identified in the Final Lower Green River Baseline Habitat Survey Report, Anchor QEA 2004.

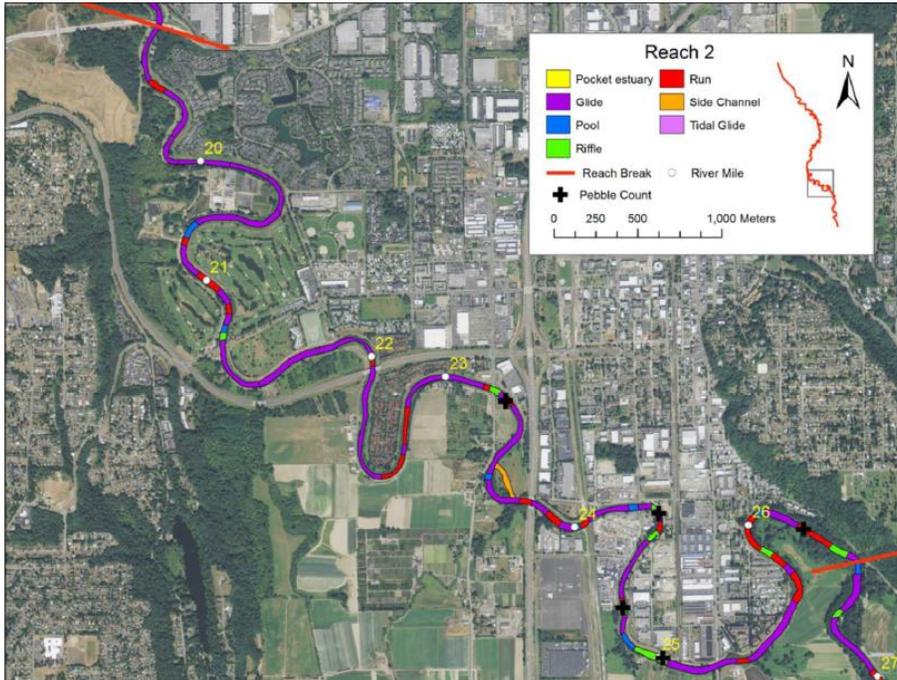


Figure 7. Aquatic Habitat as identified in the Lower Green/Duwamish River Habitat Assessment, R2 Resource Consultants 2014.

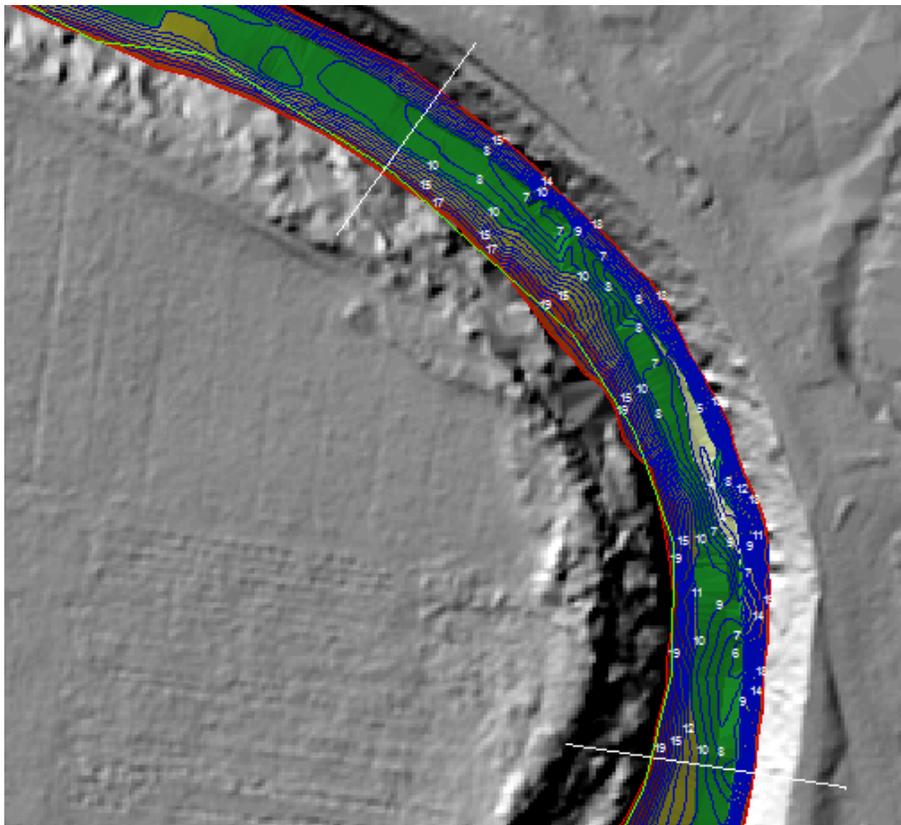


Figure 8. Aquatic Habitat as identified in Muckleshoot Indian Tribe Bathymetric Survey, MIT 2014. The bare earth digital elevation model is from Green River LiDAR data collected 12/07/13; King County GIS.



Figure 9. Teufel wood addition project site looking upstream, April 15, 2016.

Vegetation throughout the project site is disturbed by previous land-use as a nursery. Few large trees are present although many cottonwood saplings (*Populus balsamifera*) have colonized the site; grass and weedy forbs dominate the herbaceous layer (Figure 10). The riverbank within the wood addition project site is dominated by dense Himalayan blackberry (*Rubus armeniacus*, Figure 11 ). A small stand of two or three mature cottonwoods is located at the upstream end of the wood addition project site; these trees provide some shade to the river and an active bald eagle (*Haliaeetus leucocephalus*) nest is located in one of them (Figure 12). A lone Oregon Ash (*Fraxinus latifolia*) also shades the river in the wood addition project area.

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Figure 10. Typical vegetation at the Teufel property, April 15, 2016.



Figure 11. Path through the blackberries to the Teufel wood addition site, April 15, 2016.

Figure 12.



Figure 12. Stand of cottonwood trees; active bald eagle nest is located in the rightmost tree.

The project vicinity and access routes were evaluated for wetlands on April 15, 2016; none were found. Two wetland plots (TP-1, TP-2; Figures 13-15) were established in areas that appeared most likely to have wetland characteristics based on the presence of soft rush (*Juncus effuses*). Although vegetation met hydrophytic vegetation criteria in both plots, neither hydric soils nor wetland hydrology were present (Appendix A). The test plots were therefore identified as non-wetland because all three wetland indicators (hydrophytic vegetation, hydric soils, and wetland hydrology) must be present for a test plot to be wetland.

The King County “all wetlands in King County” GIS layer identifies a large wetland across Frager Road from the Teufel property, and a portion of this wetland extends onto the northeast corner of the property (Figure 13). This wetland was not field verified on April 15, 2016 because it is not within the large wood addition portion of the project area. However, the area may be within the revegetation portion of the project area, in which case it will be evaluated for the presence of wetlands and the planting plan will be developed accordingly.



Figure 13. Wetland plots, mapped wetlands, and Muckleshoot Indian shade priorities on the Teufel property.



Figure 14. Wetland Test Plot-1; no wetland. April 15, 2016.



Figure 15. Wetland Test Plot-2; non-wetland. April 15, 2016.

The wood addition site and entire northern border of the Teufel property have been identified as having high and critical solar aspect for providing shade to the river (Figure 13) No seismic, earthquake, or landslide hazard areas are located within the project site (King County GIS), the site is not in a channel migration hazard (King County GIS), and there are no single source aquifers located on the project site (King County GIS). **Check Kent critical areas maps.**

### Recreation and Safety

The King County River Recreation Study (2014) collected data on river users for a section of the Green River from RM 15.9 to RM 19.4, which is located about a mile downstream from the project site. The study used remote cameras for 313 days in 2013 to record river users and found the following:

- 81 groups were recorded, for an average of 0.3 groups per day and 0.5 individuals per day
- 94 percent were adult and 70 percent of all floaters were wearing life vests
- Vessels included Kayaks (64%), canoes (11%), other (10%), rafts (9%), and inner tubes (6%)
- No groups had alcohol visible, but 30% had coolers

Compared to the other two sections of the Green River studied (upstream at Whitney Bridge RM 41.3, and Auburn-Black Diamond to Isaac Evans Park RM 29.1-33.4), the lower Green River near the project site had much lower numbers of people per day, the highest life vest usage, and the highest use of boats rather than rafts and inner tubes (Table 1).

	Whitney Bridge RM 41.3 and 41.1 LB	Auburn-Black Diamond RM 33.4 LB to Isaac Evans Park RM 29.1 RB	Russell Woods Park RM 19.4 LB to Briscoe Park RM 15.9 RB	Totals for Green River System
Number of Remote Cameras	2	5	4	11
Number of Days of Camera Operation	106	376	313	795
Total Groups Recorded	701	860	81	1,642
Average Groups Recorded per Day	6.6	2.3	0.3	2.1
Total People Recorded	2,312	2,626	167	5,105
Adults (18+)	2,128 (92.0%)	2,220 (84.5%)	157 (94.0%)	4,505 (88.2%)
Youth (12 to 17)	106 (4.6%)	260 (9.9%)	7 (4.2%)	373 (7.3%)
Children (1 to 11)	78 (3.4%)	146 (5.6%)	3 (1.8%)	227 (4.4%)
Male	1,441 (62.3%)	1,726 (65.7%)	129 (77.2%)	3,296 (64.6%)
Female	871 (37.7%)	900 (34.3%)	38 (22.8%)	1,809 (35.4%)
Average People Recorded per Day	21.8	7.0	0.5	6.4
People Wearing Life Vests	254 (11.0%)	322 (12.3%)	118 (70.7%)	694 (13.6%)
Total Vessels Counted	2,016	2,103	131	4,250
Rafts	281 (13.9%)	526 (25.0%)	12 (9.2%)	819 (19.3%)
Canoes	29 (1.4%)	49 (2.3%)	14 (10.7%)	92 (2.2%)
Kayaks	58 (2.9%)	103 (4.9%)	84 (64.1%)	245 (5.8%)
Inner tubes	1,556 (77.2%)	1,204 (57.3%)	8 (6.1%)	2,768 (65.1%)
Other	92 (4.6%)	221 (10.5%)	13 (9.9%)	326 (7.7%)
Vessels with Paddles	283 (14.0%)	566 (26.9%)	112 (85.5%)	961 (22.6%)

**Table 1.** Remote camera results for the Green River. From: Synthesis of 2013 Recreation Studies, King County River Recreation Study (2014).

### **Data Needs and Next Steps**

The reports and data provided by King County have been reviewed and summarized to the extent relevant to the project in this memo. There are no additional data needs at this stage other than a completed survey and bathymetry data within the eagle's nest buffer, which will be collected once restrictions on working within the buffer have ended for the season in July.

On April 13, Jack Bjork and Eric Harlow from Cardno spoke with Jennifer Rice regarding the project and requested direction regarding the project- habitat goals relating to water surface elevations, constructing below the water surface, using more than 85 logs to fill out the length and depth of the proposed area, and using bolts. Jennifer provided the following e-mail response on April 14:

- (1) Regarding the question about the optimum depth of the log structure—Kerry says that the chinook salmon juvenile rearing time period is January-June, so we'd want to target the depth of the structure to flows during that time period, for which the mean flows are about 1440 cfs in the project vicinity. We were thinking it would be good to go slightly below this with the structure, to maybe 800 cfs, to provide rearing habitat when the discharge is below the mean. We definitely do not want to excavate below the bed, and don't think it will be necessary given the flows we want to target. As for the optimum height for the structure, we agree that OHW (2,000 cfs) is probably a good target as you suggest.
- (2) As for the density of the structure—we'd envisioned a matrix of logs with 3-4 log layers. We're thinking that with a structure that is 5-7 feet vertically-constructed with plus or minus 25 foot logs—we're still looking at at least 280 feet in length. Jack had asked if 85 logs was a maximum number and I got clarification from Kerry today. We should keep the total number of large logs with rootwads around 85 so that we stay within our budget—at the same time, she envisions smaller "Christmas tree" size members being included per the attached concept description.
- (3) Last-but-not least—you'd asked about using bolts rather than chains. I talked with one of our engineers who's helping us with design review since Andy's retirement, and he has had experience with this method. His only concern was about the structural integrity and possible twisting of the logs in high flow events if not designed or constructed properly. We'd be interested in discussing this option more if you think it deserves additional consideration. It would be helpful to have a conversation of cost-benefit and/or risk-benefit associated with this option if it's one you think is appropriate for this site.

With this information, preliminary concept designs will be prepared and submitted to King County on April 22<sup>nd</sup>. Input from the County will be incorporated and the concept plans revised as needed.