# LESSONS LEARNED

1. **Environmental – Permitting**
	1. From the perspective of the owner’s representative, adherence to environmental permitting stipulations during construction was successful.
	2. The contractor was able to collect and release stranded fish in accordance with the aquatic resource permit, and in-water work occurred in accordance with the stipulations and timeframe established for the fish habititat permits.
	3. Stakeholder coordination and schedule management allowed ADF&G, the Contractor, CRWP, and DOWL to stay ahead of the amendment ultimately issued for the fish habitat permit at COP 20. The amendment briefly extended the window for in-water work.
2. **Design – Stream details**
	1. Provide additional dimensioning for typical culvert section at rock clusters.
	2. Provide detail for low flow channel entering and exiting box culvert.
3. **Design – Slope protection collar details for overflow culverts**
	1. Uncouple the plan and profile riprap slope protection detail and develop separate details for the box culvert collars and the overflow culvert collars.
4. **Design – Removal of structures and obstructions**
	1. All three sites were challenged by the presence of timber bridge components within and adjacent to the excavation.
	2. For future fish passage culverts along the Copper River Highway, recommend adding a pay item for removal of structures and obstructions. The selected contractor will likely encounter timber bridge components not reflected within the subsurface conditions report.
5. **Design – Pipe arch overflow culverts**
	1. Pipe arch overflow culverts and the coupling bands provided by Contech had connectivity issues during construction. Additional effort was required to construct non-leaking culvert joints.
	2. If sufficient roadway cover and HW/D ratio permits, recommend using round diameter pipe for overflow culverts.
6. **Design – Overflow pipes at COP 20 and COP 22**
	1. Upstream swales were constructed to accommodate high water events and periods.
	2. If a future project identifies the need for an upstream swale to facilitate overflow pipe conveyance, additional design information should be provided:
		1. Begin STA/Off and elevation for swale
		2. Gradient percentage
		3. Typical section for swale
7. **Construction – Aggregate subbase materials**
	1. Field moisture-density tests for the grading F subbase material achieved relative compaction values of 95% or greater under the following two conditions:
		1. When placed material-lifts were less than 1-ft; 8-inch to 10-inch lifts.
		2. When moisture content was approximately 1% greater than optimum moisture content.
	2. Borrow A subbase material required less rigorous conditions and acceptable densities could be met with 12-inch to 16-inch lifts and with moisture content plus or minus 1% the optimum moisture content.
8. **Construction – Diversion roadway**
	1. Diversion roadways were constructed upstream of the proposed culverts.
	2. The diversion roads assisted installation of the box culverts but presented a challenge for restoration efforts.
	3. At each of the three sites, due to several tasks occurring in parallel, the diversion road was not deconstructed in a focused, separate task. At each site, the contractor initially removed enough material to redirect flow through the box culvert, but a majority of the diversion road subbase material remained. As a result, existing conditions for the creek banks were either mostly covered or were no longer present due to diversion pipe work and/or removal of existing culvert efforts.
	4. The in-water component of restoration work includes reestablishing creek banks and minor creek bed grading. These restoration efforts overlapped with the task of removing the remainder of diversion road subbase material.
	5. In-water work associated with removal of diversion road subbase and creek bank restoration required less effort and produced less sediment discharge when water levels were not high.
	6. Schedule management – The project is constrained by local weather conditions, and the Contractor chose to slightly delay the initiation of in-water restoration work at COP 25 until storm events had passed, drier conditions prevailed, and water levels had lowered.
9. **Construction & Design – Dewatering operations**
	1. Dewatering operations, including a combination of surface water control and groundwater control, were implemented at all three sites.
	2. Dewatering presented challenges at all three sites
		1. COP 20: Challenging groundwater conditions – significant subsurface flow from the north, west, and east.
		2. COP 25: Challenging surface water conditions – sheet pile cofferdam contained the majority of water, but steady seepage did occur as a result of interconnected sheet piles not being completely water tight.
		3. COP 22: Presented the least challenge – groundwater in the excavation area was lowered to a level below the limits of excavation, which allowed the bottom layer of class I riprap to be installed after the limits of excavation has been established.
		4. At COP 20 and COP 25, the establishment of bottom-of-excavation grade and the rough placement and grading of class I riprap tasks occuured together due to groundwater challenges.
	3. In several instances, dewatering operations were strained by the contractor setting up dewatering operations slightly too close to the limits of the physical structure. Locating the dewatering sump slightly too close to the pipe can result in rework and limits overall dewatering efforts.
	4. Recommend providing additional language to section 672-3.01 of the special provisions.
		1. Dewatering casings shall be located 10-ft minimum from culvert inlet or outlet.
10. **Construction – Vegetative mat**
	1. Sourcing **–** Earlier coordination with the Contractor and the owner’s representative regarding primary or alternative locatation for veg. mat harvesting.
	2. With some additional oversight and on-site direction, and the presence of a skilled equipment operator, installation of vegetative mat can be be successful and rewarding.
	3. Veg mat installation is a big milestone.
	4. From the perspective of the owner’s representative, once the veg mat is installed, the construction project actually begins to look complete – even if other portions of the site remain to be finished:
		1. Tie-in grading beyond creek banks
		2. Foreslope grading
		3. Topsoil and seeding