GLENDALE CHANNEL GRAVEL ASSESSMENT

Introduction & General Overview

The scope of the assessment conducted on June 27, 2007 was confined to issues of gravel quality and the factors that could adversely affect intra gravel flow and the egg to fry survival (e/f) and subsequent efficiency and production of the channel. Operational concern such as density loading, timing of adult loading, water level flows, sampling regimes, fry enumeration methodology, etc., are deferred but merit a review in order to achieve the optimum benefits from the channel. As well, maintenance issues are also deferred except where it relates directly to the gravel bed quality itself, or are at the point of jeopardizing the facility itself.

The first impression from both the air and the ground is that the channel is overgrown with riparian vegetative growth, mostly alders which cover approximately 50 % of the gravel beds. In some cases this growth extends half way across the 15 meter wide beds. (Photos 1 & 6)

Photo 1

In general, the overall appearance reflects that very little maintenance has been done and no attention has been paid to the gravel beds since inception in 1988.

Methodology & Procedure

Staff from the Knight Inlet Lodge assisted in the gravel examination and reduced the flows by 50 – 60 % (H. Payne, pers. comm.) in order to better examine the gravel. It is acknowledged that the ideal scenario would be to totally dewater and then examine the walls at each excavation site to determine the degree of siltation and organics in the voids as well as the degree of particle separation. The number of dead eggs flushed out were noted as well as the degree of algal matter both in the gravel and on the surface. Additionally, bed depth variations were noted.

The holes and visual approach method was standard procedure at all the International Pacific Salmon Fisheries Commission (IPSFC) channel sites (now DFO). Initially, no field notes, just a good look at the condition. This served the IPSFC fairly well except that the expected results of a higher e/f survival did not always materialize after the gravel cleaning. It was observed by the author that the second year after cleaning the survival went up, not down as expected with dirtier gravel. It became apparent that spawners were partially remixing the gravel and that the air/water cleaner inadvertently caused gravel stratification. Visual checks confirmed this and the degree of stratification became a critical component in determining the health of the gravel beds. Subsequent e/f survival increases confirmed the importance of a well mixed gravel medium.

A minimum of two excavations, randomly chosen, using a garden variety shovel, were done in each leg. Each hole was dug down to the substrate.

The degree of aquatic vegetation and riparian growth overhanging the beds was also noted.

Findings

A large volume of gravel has been progressively moved downstream in the top leg to the bottom of this leg. This is a result of large numbers of spawners congregating at the top and moving the gravel over time. Almost the entire, leg is now lost to spawners due to the excessive water depth which is over 2 meters at the deepest point. At the end of the leg, where the gravel is usable, large amounts of coarse fines are visible. This originates from the substrate layer below the gravel beds. Also visible at this point is the presence of rip rap material, originally from the channel berm edges and is now scattered over the beds. This material was strewn over the entire bed width from the top to the bottom in the channel. Some individual pieces were in excess of 45 cm.

Approximately one third of this material was randomly scattered and the remainder was confined to about 3 meters on either side which severely impacts this area as usable gravel. Since the original design specifications allowed for less than 30,000 spawners and in recent years the loading has been in the order of 80,000 to 100,000 (C. Beggs, pers. comm.), it is probable that the sheer number of spawners have effectively destroyed the berm walls.

Some rip rap pieces were encountered in the gravel beds below the surface while doing the excavations. Much of the original cobble, or rip rap, originally present is visibly

absent. At the bottom of leg No. 4, large rip rap pieces are in a rough diagonal across the entire leg. There is no apparent reason or explanation why or how this occurred.

Even before attempting to penetrate the gravel, the angular nature is visibly apparent. This material grates against other particles, tends to lock into place, and does not provide ideal voids for egg and alevin development. Angular gravel makes it more difficult for spawners to move and is not as suitable as gravel that is more like round drain rock, for example. Because of this angular nature, it is even more important that other qualities, such as cleanliness and of a good mix are present.

The existing gravel consists of the same generic mix as that in all the former IPSFC sockeye channels. A percentage of particles from .2 to 1.6 cm. (.5 to 4in.) make up this mix. As a rule of thumb, salmonids prefer gravel with an average diameter of 10 % of their body length. Based on this, the gravel composition percentage appears on the big side, especially since the sizes of the pinks are smaller than sockeye.

There is a very apparent lack of smaller material visible, especially in the top 4 legs. The gravel profiles were not able to show where this small material ended up due to flows being on. This is unfortunate. It is suspected that this material is at the very bottom of the beds. Starting in leg 4, less large material was noted on the top of the gravel and smaller particles started showing up in the mix. Stratification became less pronounced, digging with the shovel was easier, indicating looser gravel. The last leg, once again, showed more, larger material in the top portion of the gravel column.

The process of stratification occurs over time due to the particle mix (shake a can of mixed nuts and the big stuff comes to the top). Left over time, a top layer of the larger material will have numerous negative results. The poor mix will allow excessive light penetration; cause eggs to clump together at the top of the small material layer; cause difficulty for spawners in moving the gravel; increase intra gravel flow beyond optimal levels and will cause the alevins to expend energy maintaining position in the faster flow rather than in growth; and could allow hydra explosions with very negative consequences.

Massive amounts of dead eggs were flushed out while digging the holes. The author has never encountered this degree of eggs in previous gravel examinations at any site. Again, in general, large numbers of eggs were noted, especially in the top 4 legs and progressively less with only a few present in each hole at the bottom end. More eggs were observed in the last leg.

Large numbers (hundreds) of partial redds were visible on the gravel surface where it was not obscured by a layer of algal and what appeared to be dead organic matter. These partially dug redds indicates the difficulty encountered with the compacted gravel.

Merely walking on the gravel created large plumes of brown organic matter. This occurred throughout the channel, completely obscuring the gravel in only a few cm. of water.

Photo 2

This material, which appears to be partially decomposed organic matter became progressively worse down each leg (except the last leg), in some cases covering 90 % of the gravel. (Photo 3)

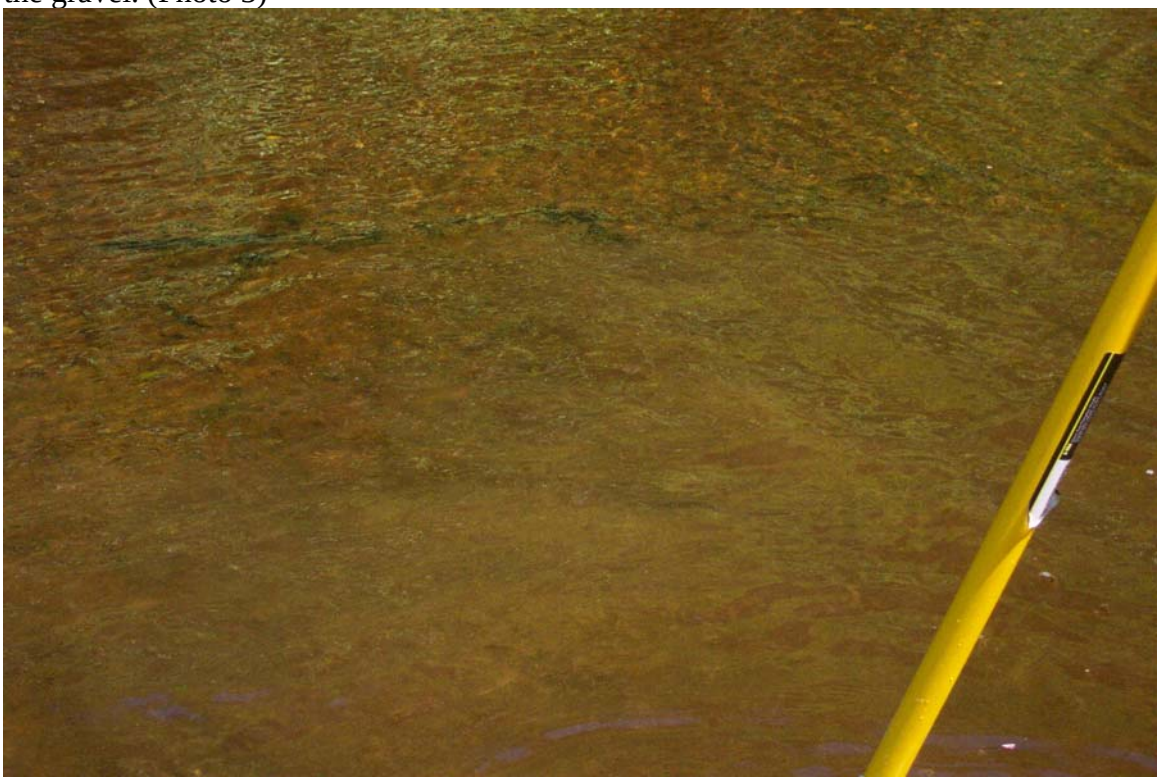


Photo 3

Some patches of live algal growth were seen as well, again more in the bottom half of the channel.

During each excavation, large amounts of brown, powdery material was flushed out and this was encountered from the gravel surface to the where actual silt was encountered. (Photo 4)

Photo 4

Once the actual silt was hit, the color changed from a dark brown to grey. (Photo 5 below)

Photo 5

More live algae was observed starting in leg 5, where green algal growth was seen throughout.

Gravel bed depth is no longer uniform. It varies from zero in some areas to 80 cm.

As mentioned in the introduction, mostly alder branches hang over the beds on both banks. This growth, while very beneficial for shade which assists in keeping the water cool during the spawning period, especially, is an impediment when maintenance of the channel beds is necessary. The value of a healthy riparian zone along natural streambeds is ideal, but excessive vegetation along the bank of an engineered channel with a very low gradient and with no ability to regenerate gravel or self-clean during freshets, is problematic on two fronts. Leaf litter, etc., drops into the channel and becomes part of the organic mass which will consume oxygen during decomposition, especially coupled with large amounts of algal material. This situation is exacerbated even if the fall leaf loss does not coincide with the spawning period. Alder leaves are heavy and sink onto the gravel where they decompose. So, coupled with a high background organics, the total amount from all sources will reduce available dissolved oxygen (DO) in the gravel column.

Secondly, excessive vegetative cover, while highly desirable during summer months to keep temperatures acceptable will have the opposite effect during the developmental period. The ability of the sun to shine on the gravel beds is highly beneficial during cold periods since the gravel beds act as a heat sink or passive solar collector and keep water

temps elevated enough to significantly reduce the formation of frazzle or anchor ice. It is not known to what degree this occurs at the Glendale channel, but if it does, this could partially explain the unusual distribution of the berm rip rap material scattered over the beds. Anchor ice in sufficient amounts can lift rocks and relocate them.

Scattered patches of aquatic plants were encountered in the last two legs.

Photo 6

An occasional fry-sized fish was seen in the channel while walking the length. Several hundred fish (smolt sized, species unknown) were seen at the extreme top of leg 1, immediately below the water entry point. This entire leg is too deep to clean and would be left as it is. These resident fish would not be disturbed by the proposed cleaning operation.

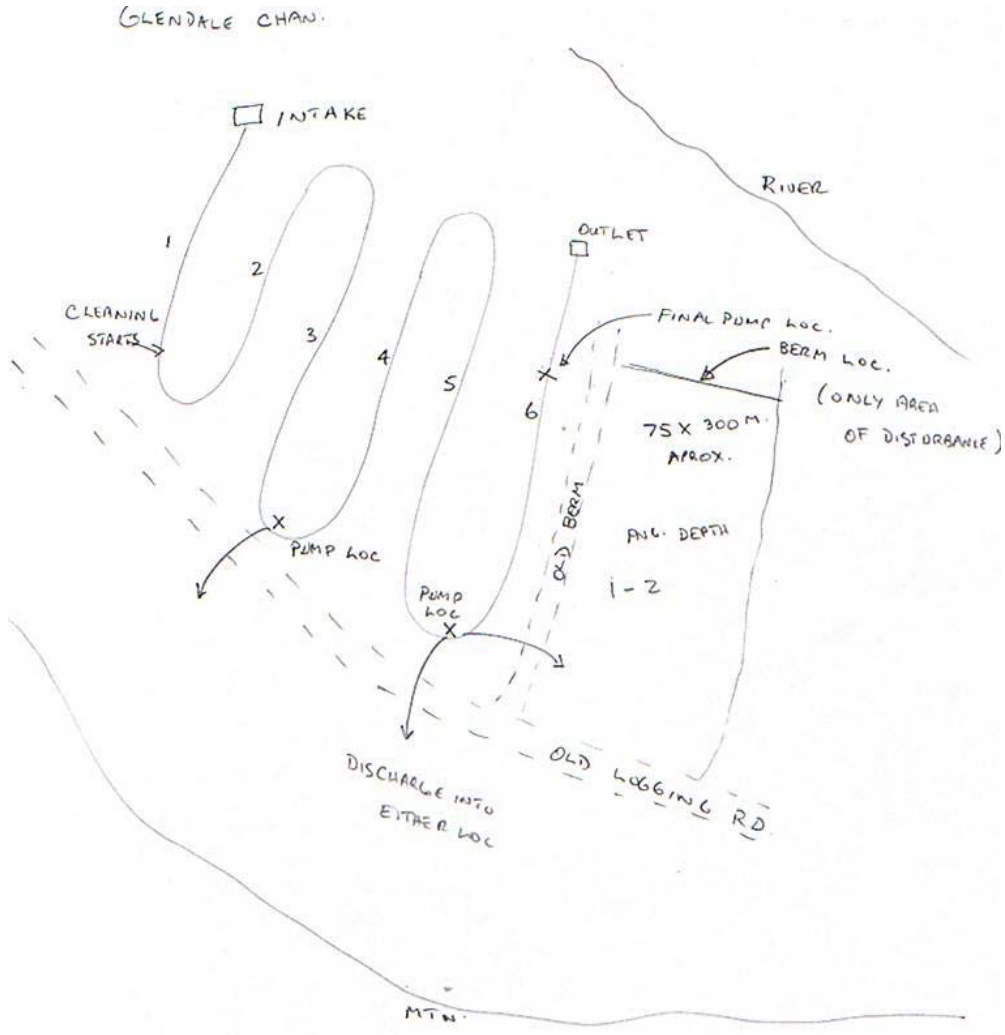
Proposed Cleaning Procedure

As outlined earlier in previous correspondence, the proposed cleaning methodology will be followed with slight changes. A reiteration is in order.

Starting at the bottom of leg 1, an excavator, using a scoop and recast method will be employed. Should cleaning permission be given, the plan is to use a clean, new, midsize excavator to pick and redistribute the gravel using flows to move any particulates downstream and wash the gravel. This cleaning method is one of several but is the best one for this site. A recent cleaning at the Hill Creek Channel, a kokanee channel,

employed this method which I recommended. The e/f survival went from 0 and 2 % to over 40 and over 50 % in the past two years. (C. Spence, pers. comm.)

Water flow would be around 40 cfs, below current background levels and pumps capable of pumping 60 cfs would be used to pump the effluent to two areas adjacent to the channel. Refer to the aerial photo and Fig. 1.



Initially, the first pump would be placed at the bottom of leg No.3 and discharge would be directed across an old logging road to a large wooded area that is completely enclosed by the old road on one side and a mountain on the other. Below leg No. 3, pumps would be relocated to the end of leg No. 6 and discharge could be pumped to two areas. Either the previously mentioned location or one that is of approximately 75m. by 300m. could

be used. This second area borders the last leg, top to bottom and averages 1 to 2 meters in depth. A wide berm parallels this last leg and the only work required to completely contain this area is to create a small berm or dam across the bottom end. No effluent will be allowed to enter Glendale River.

Two floating containment booms spanning the channel width would be present in the event of equipment failure or refueling spillage .If required, vegetable oil could be used instead of conventional hydraulic oil.

While pumps are set up, etc., a crew of four men would start and stay in front of the excavator removing cobble from the gravel beds and repacking it against the berm banks. As well, the lowest branches that obstruct the vision and prevent proper cleaning under the overhanging vegetation would be removed using small chainsaws. A minimum of branches will be removed, only the bottom 1.5 meters, or so. The crew will be made available through Chief Fred Glendale from the Knight Inlet area.

A minimum of disturbance to the wooded areas will be done by the equipment. The dam in the second land containment area will be placed approximately 75 meters upstream of the channel outlet, well above the viewing area (H. Payne, pers. comm.) for those coming to see the grizzly bears.

It is anticipated that the entire period for cleaning is expected to take 10 days or less. Since this proposal is being given at a late date there is only a small timeframe remaining. It is hoped that permission could be given at the earliest date possible. In order to meet the concerns of numerous parties, all work should be done by the 17th of July at the latest. It is hoped that equipment, etc., could be barged in on July 5th with actual cleaning starting on the 7th.]

I would be present the entire period and would ensure that substrate material was not disturbed and that expressed concerns were met.

Recommendations

Aside from the rational for cleaning, which is covered in the following section, the most obvious recommendation is that a closer look at maintenance and operational procedures is in order. These would spell out parameters that are now absent or done a best guess basis.

There is one operational recommendation that needs to be addressed as soon as conditions permit (too late for this year), and that is that the valve at the top end of the channel regulating flows needs to be changed. This valve currently does not permit full utilization. The range of movement prevents a proper degree of flow control and is limited to the actual range of the recent flow regime. This valve is at the point of imminent failure. There is a risk, for example, of the valve being frozen in a position of low flow which would be inadequate for the adult spawners, resulting in low DO’s and mortality.

Summary & Concluding Remarks

In viewing a spawning channel, it helps to adopt a perspective that recognizes the uniqueness of this enhancement tool. This is not to say that channels are more complex or more difficult to manage than hatcheries. Rather, a recognition that the facility and its' infrastructure is engineered and is more than a ditch filled with water and that it can not remain productive without a significant degree of maintenance and management.

It must be remembered that aside from the water quality, the gravel medium where all the development occurs is of critical importance. The gravel beds act as a giant incubator tray where anything that interferes with the successful deposition and development will produce stress, lessen survival and affect the fry quality. Simply put, cleaner, well mixed gravel results in better intra gravel flow, higher available oxygen thus increases a higher e/f survival.

In my opinion, the present conditions of the beds provides no greater e/f survival than found outside of the channel and may perhaps even be worse.

Based on my assessment of the current gravel bed conditions in the Glendale Channel, I highly recommend that a cleaning operation take place. It is recognized that a late date approval is not ideal, however, there currently exists an opportunity to have this done.

Victor Ewert
Redfish Services
June 28, 2007