Atlantic Gold

Appendix J.5

Seloam Brook Realignment Section Model Results Memorandum, Wood Environment & Infrastructure Solutions

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Dear James,

RE: Seloam Brook Realignment Section Model Results

As we further our fish habitat offset concept, Wood has completed preliminary flow design estimates of the Seloam Brook realignment habitat. The modelling that was completed uses existing hydrological data generated from previous diversion channel designs to estimate the flow parameters (water depth, velocity, and wetted perimeter) within the conceptual realignment channel. The estimates generated will provide greater certainty to the design team and regulators that the concept can convey the anticipated flows and can be sustainable beyond the life of mining operations.

Provided below are the results of the preliminary flow design estimates. This information will be further advanced during the detailed design work required for final Fisheries Act approvals.

Typical Seloam Brook Realignment Configuration

Initial configuration of the Seloam Brook realignment channel includes a stream channel as well as a surrounding integrated flood plain area (**Figure** 1). The concept being that the stream channel will be the primary fish habitat and will contain the anticipated principle flows while the flood plain will allow high-flow events such as spring freshets and extreme storm events to pass, similar to a natural wetland/flood plain ecosystem. The channel and floodplain would both be designed to provide substrates, morphology and cover in the high suitability range for the fish species known to exist in the system and to provide ecological function for other species of wildlife that depend on creek corridors.

Hydrology and Stream Flow Events

The flows used to design the stream channel and flood plain have been based on previous analytical work completed by Knight-Pieshold Consulting during the design of the previous Seloam Book Diversion channel which did not include a habitat-based flood plain. While the diversion was less habitat-focused, the flows estimated from historic hydrologic records and measures remain valid and were used in this revised integrated floodplain design. **Table** 1 provides a summary of the flows at typical key periods within the hydrologic regime predicted for the realignment channel. The estimated flows have been determined separately for each flow input to the realignment channel; Seloam Brook (reservoir flows), Southeast inflow, and Trafalgar Creek. While each will intersect the realignment channel at different locations, the combined flow from all inputs was included in the preliminary design as a precautionary measure to ensure that maximum predicted flows can be conveyed within the entire realignment habitat features.

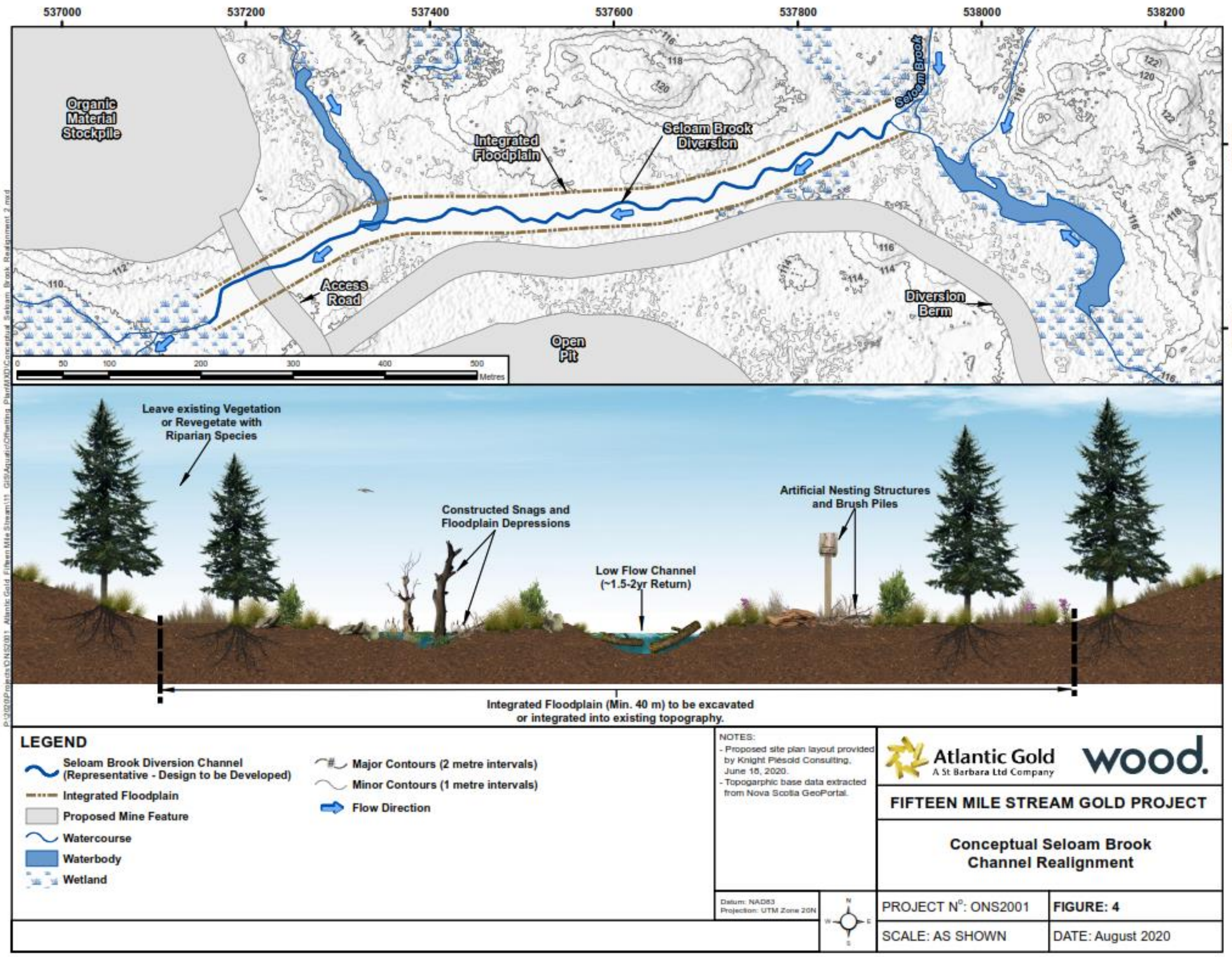

Figure 1: General stream/flood plain concept, Seloam Brook Realignment Channel.

Table 1: Realignment Flow Conditions based on information provided by Knight-Pieshold (2020)

Flow Scenario Included in Design	**Inflow Location**	**Discharge Input (m^3/s)**
1 in 20 Year Annual Dry	Seloam Reservoir (Brook)	0.22
	Southeast Inflow	0.02
	Trafalgar Brook	0.04
	Total	**0.28**
Mean Annual Flow (MAF)	Seloam Reservoir (Brook)	0.64
	Southeast Inflow	0.07
	Trafalgar Brook	0.11
	Total	**0.82**
Q10 (10-year high flow)	Seloam Reservoir (Brook)	4.8
	Southeast Inflow	2.5
	Trafalgar Brook	3.8
	Total	**11.1**
Q200 (200-year high flow)	Seloam Reservoir (Brook)	11.2
	Southeast Inflow	4.4
	Trafalgar Brook	6.6
	Total	**22.2**

Realignment Channel Considerations

The initial diversion channel design completed by Knight-Pieshold Consulting (2020) provided general conditions at the realignment location such as overall slope and measures of existing, local stream conditions. These were also incorporated into the habitat design where required.

The realignment channel configuration was based on the general outline provided in **Figure** 1; however, the following parameters/objectives were also input to the design:

1. The main stream (low flow) channel had to contain at least the flows expected during the Mean Annual Flow (MAF) at $0.82 m^3/s$;
2. The main stream channel had to contain water depths capable of maintaining fish passage during the 1:20 Annual Dry Flow at $0.28 m^3/s$;
3. The overall channel slope, based on Knight-Pieshold data, was assumed to be 0.5%;
4. The overall main channel roughness, based on Knight-Pieshold data on existing, local streams, was assumed to be 0.06;
5. The overall flood plain channel roughness, based on Knight-Pieshold data, was assumed to be 0.10.

These parameters are considered reasonable metrics for assessment of the conceptual channel. An updated detailed flow model will be further developed during detailed design to support the approvals process and to refine the habitat design.

Realignment Channel Configuration and Modelling

Based on the above considerations and general main stream / flood plain configuration, the channel and flood plain design was modelled. The Wetted Perimeter Method (WPM; Newbury and Gaboury 1993) was used in AutoCAD to model water levels, water depths, and water velocities within the designed channel.

The WPM is a fixed flow hydraulic rating method based on the hydraulic relationship between flow (i.e. discharge) and wetted river perimeter at selected transect(s) (Stalnaker et al. 1994). Using the relationship, the flow corresponding to a wetted perimeter (wetted width of the stream cross section), can be estimated using Manning's equation. The equation was applied to the key flow periods in **Table** 1 to estimate habitat conditions. Manning's equation is given by

$$\text{Velocity (m/s)} = R^{2/3} * S^{1/2} / n \qquad \text{where}$$

R = Hydraulic radius (Area (m^2) / wetted perimeter (m))
S = stream slope at transect
n = Manning's n.

The equation assumes that the transect used to represent the habitat is a suitable index of habitat for the full stream.

An AutoCAD realignment cross section was created (**Figure** 2) to model flow conditions. Using Manning's equation, the habitat conditions were simulated. Modelled values of wetted width (m), mean water velocity (m/s), and mean / maximum water depths (m) were estimated. Based on data from Knight-Pieshold Consulting (2020), mean channel slope (S) was input at 0.005 (i.e., 0.5% slope) and Manning's roughness values for the main channel (n) were input at 0.060 with the flood plain roughness at 0.100. To estimate conditions during flood periods, the Manning's value was estimated using a weighted mean of the two roughness values and the relative proportion of the wetted area within each habitat type (n = 0.096).

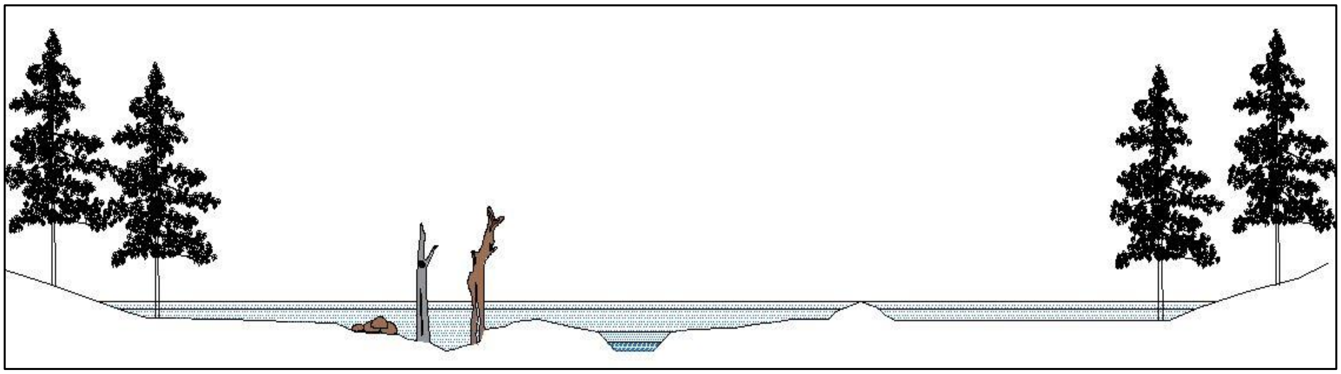

Figure 2: AutoCAD profile of Seloam Brook Realignment.

Model Results

The AutoCAD model was run at the four design flow scenarios in **Table** 1. **Table** 2 below provides the model results. The main stream channel was modified to ensure it would contain the MAF. The main stream channel was designed with a bottom width of 1.5m and side slopes of 1:2. As shown in **Table** 2, an estimated flow of around 1.0m^3/s will remain within the main channel before overtopping into the flood plain. The width of the stream at this flow is estimated at 2.90m. The model outputs also indicate that a mean water depth within the main stream channel will remain near 0.25-0.30m during the 1:20 Dry Annual flow if the channel is designed similar to existing habitat.

Flows in excess of 1.0m^3/s are shown to overtop the main stream channel into the flood plain mimicking the function of a natural channel condition. The modelled results show that flows as high as the 200-year event would easily be contained within the conceptual flood plain, and or within a combination of constructed channel and natural topography.

Table 2: Model output at identified flow conditions within the Seloam Brook Realignment preliminary design

Flow Condition (m3/s)	Estimated Model Discharge (m3/s)	Wetted Width (m)	Mean Water Velocity (m/s)	Mean Water Depth (m)	Maximum Water Depth (m)
1:20 Dry Annual (0.28)	0.28	2.16	0.47	0.28	0.33
MAF (0.82)	1.05	2.90	0.68	0.53	0.70
Q10 (11.1)	11.32	42.19	0.49	0.55	1.53
Q200 (22.2)	22.26	44.03	0.62	0.82	1.85

Summary

As shown by the model results for the preliminary channel design, an overall general flood plain width of 40-45m will easily contain the predicted 1:200 year flood event and that a main channel of 1.5m in bottom width and overall total wetted width of 3.0m would be capable of providing fish habitat similar to existing channel conditions. Greater detail regarding final channel design, 2-D extent of extreme flows, and possible use of existing topography to provide more natural flood conditions will be completed during the Fisheries Act authorization process.

Closure

The results of the modelling exercise are based on the general assumptions of the method and baseline conditions/information provided by others. The information has been generated to demonstrate that the preliminary Seloam Brook Realignment design can accommodate the design flows, and provide fish habitat and wetland/flood plain characteristics during low and high flow conditions.

Yours sincerely,

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a Division of Wood Canada Limited

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