Memo

To:	Ethan Richardson	**File No:**	EW1051
Company:	Shore Gold Inc.	**Date:**	9 October 2013
From:	Robyn Andrishak	**cc:**	Mark Humbert
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Subject:	Conceptual Design of a Raw Water Intake on the Saskatchewan River for Star Orion South Diamond Project		

1.0 PROJECT DESCRIPTION

AMEC Environment & Infrastructure, a division of AMEC Americas Limited (AMEC) was retained by Shore Gold Inc. (Shore Gold) to undertake conceptual design of a river water intake for the Star Orion South Diamond Project located in the Fort à la Corne Provincial Forest in Saskatchewan. AMEC has previously conducted a preliminary modeling study for a proposed outfall structure[1] and the conceptual design of a diffuser[2] in the same location on the Saskatchewan River.

A pier-type raw water intake is proposed immediately upstream of the planned diffuser. The project area is near the mouth of the FALC Ravine, approximately 40 km downstream of the confluence of the North Saskatchewan and South Saskatchewan Rivers. Figure 1 provides an overview of the Saskatchewan River in this area, extending 1.0 km upstream and 6.5 km downstream of the proposed location of the raw water intake.

2.0 CONCEPTUAL DESIGN

The conceptual design for the raw water intake is based on the following information:

- Constant intake flow rate of 68,000 m^3/day (0.787 m^3/s);
- Maximum intake flow rate of 80,000 m^3/day (0.926 m^3/s);
- Minimum water level at site of 349.4 m (for 7Q10 low flow discharge[1]);
- Minimum water depth of 2.5 m;
- Maximum water level at site of 356.3 m (for 1:100 year flood frequency discharge[1]);
- Burbot and other fish present in the Saskatchewan River near the site; and
- Operational life of approximately 13 years (or longer, if needed) throughout the duration of the project.

[1] AMEC. *Saskatchewan River Hydrotechnical and Dispersion Modeling Study*, 2010.
[2] AMEC. *Conceptual Design of a Diffuser on the Saskatchewan River for the Shore Gold Star Diamond Project*, 2011.

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The proposed pier-type raw water intake structure consists of an in-stream hollow concrete pier with wedge wire intake screens, buried intake pipes and an onshore raw water reservoir and pumphouse. These three components are described in detail below and illustrated on Figure 2. Some aspects of the conceptual design configuration proposed may be refined during detailed design; however, the overall layout and project footprint required are not expected to change significantly.

2.1 Raw Water Intake

Considering the design intake flow rate, river water levels and depths at low and high flow conditions, the presence of burbot, and our knowledge of the design of similar structures, the proposed raw water intake would have the following characteristics:

- Local river bed elevations 346.7 m ± 0.3 m
- Bottom of wedge wire screen elevation 347.7 m
- Top of wedge wire screen elevation 348.7 m
- Top of intake elevation (as on Drawing 2) 349.5 m to 353.0 m
- Length of raw water intake 25.0 m
- Width of raw water intake 4.0 m

The upstream portion of the intake will extend to an elevation of 353.0 m to remain above the water surface up to a 1:5-year flood frequency event to identify the structure as a navigational hazard and to facilitate maintenance access. Scour protection will be required at the base of the pier (e.g., riprap), with details to be determined at final design. Water entering the intake will flow through #60 wedge wire screens which will be installed along the entire 25 m length of each side of the intake structure from an elevation of 347.7 to 348.7 m (1.0 m in height). As burbot might possibly be present in the river, the net open screen area will be at least 24.3 m^2 to meet accepted design guidelines[3,4] and to provide a maximum flow velocity of 4 cm/s through the screens. Burbot swim in the anguilliform swimming mode and thus tire easily requiring low approach velocities for survival. Since the pier will be constructed in line with the flow, the approach velocity (water velocity component perpendicular to the face of the screen) will be minimized. The transport or sweeping velocity (water velocity component parallel to the face of the screen) will be approximately 0.8 to 1.8 m/s. The wedge wire intake screens will be enveloped by a steel trash rack to protect the screens from potential ice and debris.

2.2 Intake Pipe

Considering the design intake flow, design minimum and maximum flow velocities within the pipe, minimum depth criteria, and typical design assumptions for similar structures, the intake pipes should have the following characteristics:

- Number of pipes (in parallel) 2
- Pipe diameter (nominal) 675 mm
- Approx. length (pier intake to pumphouse) 150 m

[3] Katopodis, Chris. Department of Fisheries and Oceans. *Fish Screening Guide for Water Intakes*. Winnipeg, MB: Working Document, 1992.
[4] Department of Fisheries and Oceans. *Freshwater Intake End-of-Pipe Fish Screen Guidelines*. Ottawa, ON: Communications Directorate, 1995.

Water from the raw water intake will be carried to the raw water reservoir via two concrete pipes of 675 mm diameter placed in parallel. The pipes will be buried into the channel bed and bank for the majority of their 150 m length. This diameter is optimized for the constant intake flow of 68,000 m^3/day, and it can adequately handle the maximum intake flow of 80,000 m^3/day. If the intake flow is to be less 40,000 m^3/day, mechanisms should be provided to operate with one pipe so that adequate pipe flow velocities are sustained.

2.3 Wet Well and Pumphouse

Considering the water levels at low and high flow conditions and the head loss across the length of intake pipes, the wet well should have the following characteristics:

- Minimum water level 348.7 m (based on a 0.7 m head loss)
- Maximum water level 356.3 m
- Bottom of wet well elevation 346.0 m
- Top of wet well elevation 357.0 m

The wet well and pumphouse structure will be built on the river bank to a minimum top elevation of 357.0 m, corresponding to the 1:100-year flood level. The invert of the buried concrete pipe will connect to the structure at an elevation of 346.7 m, allowing water to enter the wet well. From here, water will be pumped to the mine site water storage facility/treatment area.

3.0 CONSTRUCTION AND ENVIRONMENTAL CONSIDERATIONS

3.1 Isolation of Instream Works

Construction of the intake structure and installation of the collector pipes will require isolation by earthen or sheet pile cofferdam walls. The cofferdam should be installed and decommissioned within the permissible limits set by the Department of Fisheries and Oceans (DFO) Canada. Generally, the allowable instream construction window for cofferdam installation and removal at the project location would be approximately July 15 through October 1.

The construction approach must consider restrictions on obstruction of flow with cofferdams during construction as well as periods of low flow in the channel. Transport Canada requires that at no time during construction should more than 2/3 of the channel be obstructed. As can be seen on Figure 1, the conceptual cofferdam alignment isolates the work area within these constraints. AMEC anticipates that the in-river construction period would take approximately 6 months and should be carried out during the fall and winter months when river levels are typically at their lowest.

3.2 Fisheries Impacts

Table 3.1 lists fish species that are known to occur in the Saskatchewan River and/or the creeks and ravines located in the project area[5]. The proposed construction approach aims to minimize disruption to the fish species present by considering the restricted activity period based on spring and fall spawning. The proposed intake design considers all the fish types listed in the table below in order to prevent potential losses of fish due to entrainment and impingement upon the intake screens.

[5] AMEC. *Star Orion South Diamond Project Environmental Impact Statement*, 2010.

TABLE 3.1
List of Fish Species Found in the Project Area

Brook stickleback (*Culaea inconstans)*	Northern pike (*Esox lucius)*
Brook trout (*Salvelinus fontinalis)*	Northern redbelly dace (*Phoxinus eos)*
Burbot (*Lota lota)*	Pearl dace (*Semotilus margarita)*
Central mudminnow (*Umbra lima)*	Quillback (*Carpiodes cyprinus)*
Cisco (*Coregonus artedi)*	River shiner (*Notropis blennius)*
Emerald shiner (*Notropis atherinoides)*	Sauger (*Sander Canadensis)*
Fathead minnow (*Pimephales promelas)*	Shorthead redhorse (*Moxostoma macrolepidotum)*
Flathead chub (*Platygobio gracilis)*	Silver redhorse (*Moxostoma anisurum)*
Goldeye (*Hiodon alosoides)*	Spoonhead sculpin (*Cottus ricei)*
Lake chub (*Couesius plumbeus)*	Spottail shiner (*Notropis hudsonius)*
Lake sturgeon (*Acipenser fulvescens)*	Trout-perch (*Percopsis omiscomaycus)*
Longnose dace (*Rhinichthys cataractae)*	Walleye (*Sander vitreus)*
Longnose sucker (*Catostomus catostomus)*	White sucker (*Catostomus commersoni)*
Mooneye (*Hiodon tergisus)*	Yellow perch (*Perca flavescens)*

4.0 SUMMARY

The works included in this conceptual design are restricted to those in the river and the directly supporting infrastructure. The details regarding the supply pumps, potential water treatment, foundations, access road and other utility connections may be prepared in a later phase of the project should Shore Gold proceed with detailed design. Also required as part of detailed design will be an updated bathymetric survey and site reconnaissance to accurately assess the bed material and confirm existing site conditions. A geotechnical site investigation will also be necessary to assess subsurface conditions within the river bed and the slope stability of the nearby bank. AMEC would be pleased to provide Shore Gold with assistance through each of these tasks.

It should be noted that AMEC believes it would be feasible to integrate effluent discharge ports into the downstream face of the intake structure which may allow Shore Gold to eliminate the need for a separate diffuser. This would reduce the project footprint, instream disturbance, and construction costs.

5.0 CLOSURE

This report has been prepared for the exclusive use of Shore Gold Inc. This report is based on, and limited by, the interpretation of data, circumstances, and conditions available at the time of completion of the work as referenced throughout the report. It has been prepared in accordance with generally accepted engineering practices. No other warranty, express or implied, is made.

We trust that the information within this report satisfies your requirements. Should you have any questions or require any additional information, please feel free to contact the undersigned at your earliest convenience.

Yours truly,

AMEC Environment & Infrastructure

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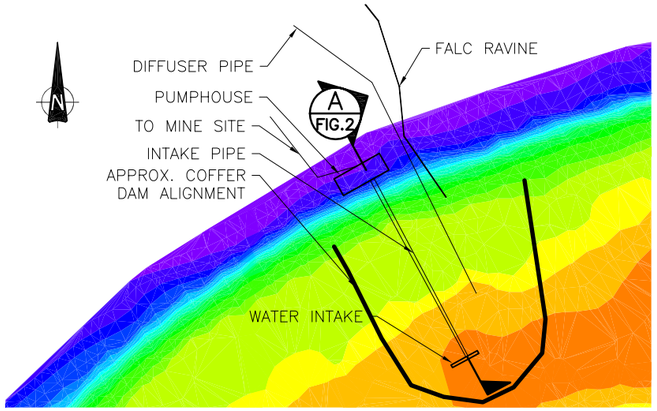

1 DETAIL
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ELEVATIONS TABLE		
MIN. ELEVATION	MAX. ELEVATION	RANGE
344.00	344.50	
344.50	345.00	
345.00	345.50	
345.50	346.00	
346.00	346.50	
346.50	347.00	
347.00	347.50	
347.50	348.00	
348.00	348.50	
348.50	349.00	
349.00	349.50	
349.50	350.00	
350.00	350.50	
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353.50	354.00	
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354.50	355.00	
355.00	355.50	
355.50	356.00	
356.00	356.50	
356.50	357.00	
357.00	357.50	
357.50	358.00	
358.00	358.50	
358.50	359.00	
359.00	359.50	

SCALE
1:30 000
0 200 400 600 m

NOT FOR CONSTRUCTION

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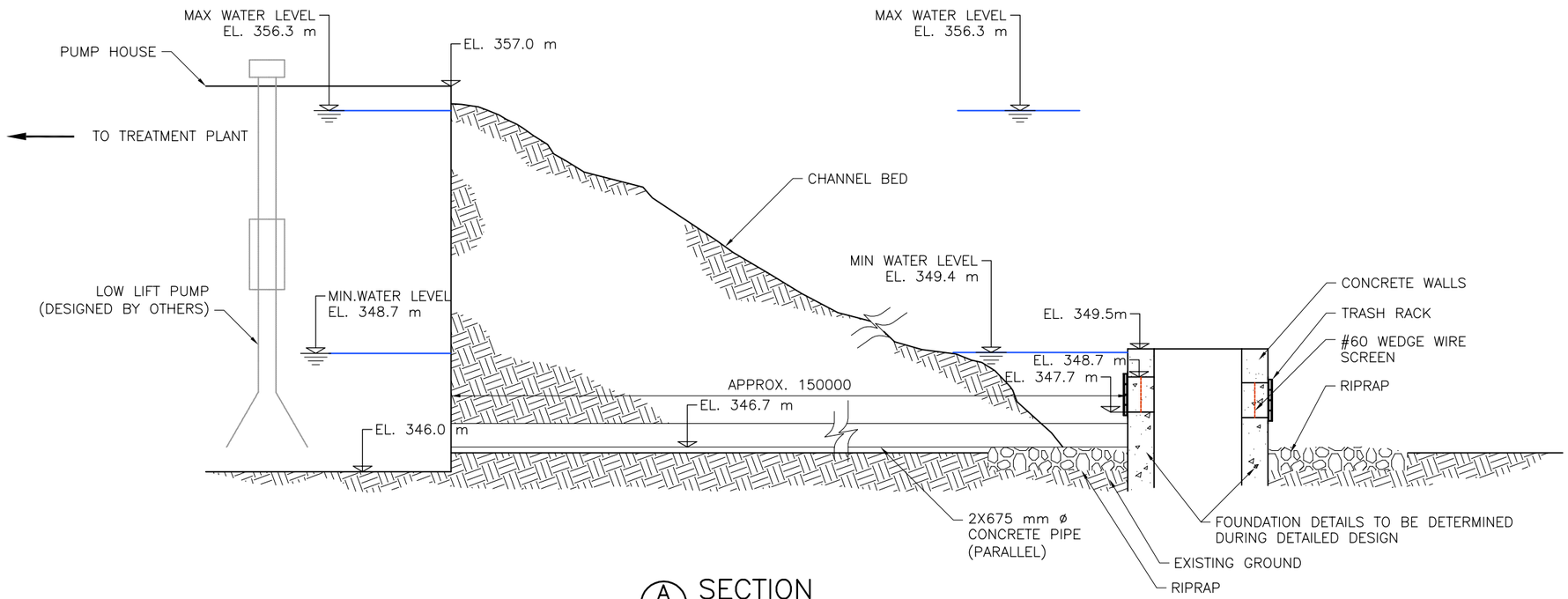
CLIENT: **SHORE GOLD INC.**

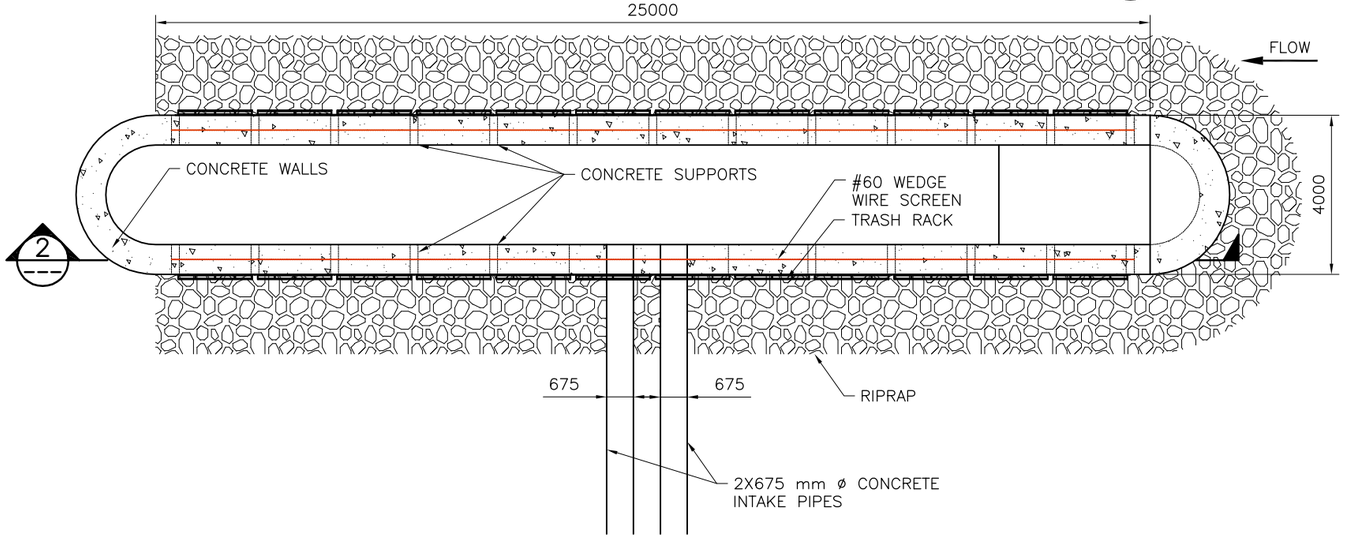
PROJECT: **STAR ORION DIAMOND PROJECT**

TITLE: **STUDY AREA MAP**

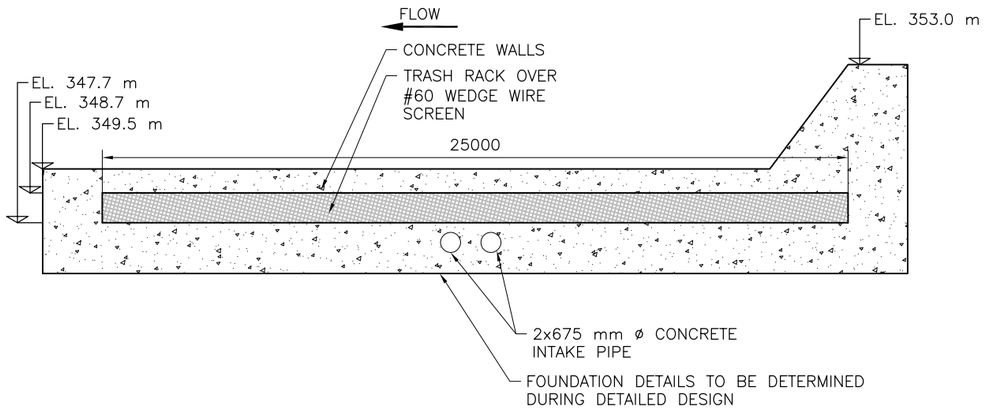
DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
OCTOBER 2013	EW1051	1051-S01.dwg	FIGURE 1	A



A FIG.1 SECTION
SCALE 1:150



PLAN – RAW WATER INTAKE
SCALE 1:150



2 DETAIL – RAW WATER INTAKE
SCALE 1:200

SCALE
1:200
0 1 2 3 4 m

SCALE
1:150
0 1 2 3 m

NOTES:

ALL DIMENSIONS ARE IN MILLIMETERS UNLESS OTHERWISE NOTED.

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CLIENT: **SHORE GOLD INC.**

PROJECT: **STAR ORION DIAMOND PROJECT**

TITLE: **RAW WATER INTAKE CONCEPT DESIGN**

DATE:	JOB No.:	CAD FILE:	FIGURE No.:	REV.
OCTOBER 2013	EW1051	1051–S01.dwg	FIGURE 2	A