Tulsequah Chief Mine

Air Cushion Barge Transportation System: Taku River Operations Plan

Prepared for
Redfern Resources Limited

Submitted by
Gartner Lee Limited

November, 2007

Gartner Lee

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Reference: **GLL 72623**

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Table of Contents

Page

1. Introduction 1

1.1 Scope and Purpose of the Operations Plan 2

2. Description of Land Use 2

2.1 Transportation Route 2

2.1.1 Taku Inlet to Taku Lodge 2

2.1.1.1 River Depth and Tidal Influence 4

2.1.2 Taku Lodge to US/Canada Border 8

2.1.2.1 Canyon Island 9

2.2 River Operations 11

2.2.1 Summer Operations - late May to mid-August 12

2.2.1.1 Canyon Island 12

2.2.2 Winter Operations – early November to early April 13

2.2.2.1 Crossing Open Leads 14

2.2.3 Transition Season Operations (Spring and Fall) 15

3. Equipment 16

3.1 Air Cushion Barge 16

3.1.1 Barge Components 16

3.1.2 Noise 19

3.1.3 Wake 20

3.2 Shallow Draft Tug – River Operations in Summer 21

3.3 Amphitrac – Winter; Spring/Fall Aquatic Operations 22

3.4 Ancillary Vessels 26

3.5 Communications 26

4. Operating Procedures and Objectives 27

4.1 Open Water Season 27

4.2 Winter Season 29

4.3 Transition Season 30

4.4 Temporary Operating Suspensions 31

4.5 General Procedures 34

5. Monitoring and Follow-up 35

5.1 River Operations; River Conditions 35

5.2 Aquatic Effects Monitoring 37

5.2.1 Stranding of Juvenile Fish 37

5.2.2 Entrainment of small fish 37

5.2.3 Disturbance of Sand Flats during Transition Season 37

5.2.4 Spawning Habitat at Canyon Island during Transition Season operations 38

5.3 Bank Erosion 38
5.4 Wildlife Effects Monitoring 38

6. Spill Contingency Planning; Emergency Preparedness 39

6.1 Spills of Hazardous Materials 39
6.1.1 Spills on water 40
6.1.1.1 Diesel Spills 41
6.1.1.2 Reagent Spills 41
6.1.1.3 Concentrate Losses 41
6.1.2 Mechanical Failure of ACB 41
6.1.3 Mechanical Failure of Amphitrac 41
6.1.4 Mechanical Failure of Shallow Draft Tug 42
6.1.5 Grounding 42
6.1.6 Capsize of ACB 42
6.1.7 River Collisions 42

List of Figures

Figure 1. Taku River in Alaska 3
Figure 2. Route through the Tidal Flats on the lower Taku River 4
Figure 3. Bathymetry of Lower Taku River at Low Flows 5
Figure 4. Taku River Hydrograph Measured at Canyon Island 6
Figure 5. Lower Taku River showing approximate routes 7
Figure 6. Canyon Island to US/Canada Border 8
Figure 7. View of Routes around Canyon Island, Looking Downstream 9
Figure 8. Canyon Island showing approximate travel routes (summer and winter) 10
Figure 9. Air Cushion Barge Components 17
Figure 10. Air Cushion Barge Operating Heights 18
Figure 11. Amphitrac Components 25

List of Tables

Table 1. Typical Amphitrac Operating Speeds 25
Table 2. Typical Barge Load to Tulsequah Chief Project 40
Table 3. Process Consumables to be Transported via ACB Transportation System 40

1. Introduction

Redfern Resources Limited (Redfern) has identified that year-round use of air cushion barges (ACBs) on the Taku River represents a technically, financially and environmentally preferable option for shipment of mine supplies and mineral concentrate to and from the Tulsequah Chief Mine in northwestern British Columbia. It is proposed that the ACBs would operate between Juneau, Alaska and an ACB landing site on the Taku River near its confluence with the Tulsequah River in British Columbia, Canada.

For the purposes of the Coastal Zone Consistency Review and State of Alaska permits, the transportation system activities consist of year-round ACB operation on the Taku River between the US/Canada border and the mouth of the Taku River, as shown approximately on Figure 1.

In 1998, the British Columbia Environmental Assessment Office approved a 160-km road as the primary means of access to the mine site. Subsequently, the government of British Columbia issued a Special Use Permit authorizing the construction of this road. In the fall of 2006, Redfern identified the ACB transportation system as an alternative means of access to the minesite. The Taku River route from the minesite to Juneau and Skagway is a shorter route for transporting concentrate and mine supplies, requires little in the way of infrastructure development (existing marine shipping facilities will be used at the ports of Juneau and Skagway), is significantly safer, and will have significantly lower unit costs of transporting concentrate as compared to trucking by road. If the State of Alaska and the Canadian authorities approve the ACB transportation system, Redfern does not plan to build the road between the Tulsequah Chief mine and Atlin, British Columbia, but will instead use the ACB transportation system to access the mine.

The proposed barging operations will operate year-round. On average, a single ACB would make one round-trip each day between the barge landing site in Canada, and Juneau, Alaska. Concentrate would be placed in sealed containers at the minesite, loaded onto the barge, and transported to Juneau. From here, the containers would be transported by conventional marine barge to the port of Skagway, where it will be loaded into bulk carriers for shipment overseas. The ACB will also transport mine supplies from Juneau to the barge landing site in Canada.

1.1 Scope and Purpose of the Operations Plan

The scope of the Operations Plan pertains to that portion of the Taku River that is subject to State agency authorizations, as described above. This area can broadly be defined as that portion of the Taku River flowing between the US/Canada border and the downstream end of the tidal flats, at the mouth of the river. Figure 1 illustrates the area encompassed within the scope of these permit applications.

The Operations Plan is provided to clearly delineate and describe the proposed transportation system operations and activities that will occur within the permitable portion of the Taku River. This Plan will support the applications for a Title 41 Fish Habitat Permit and Title 38 Land Use Permit.

The Operations Plan is designed to accommodate the highly dynamic and variable nature of river and weather conditions that will be encountered on the Taku River. The transportation system, as is typical of most transportation systems in northern regions, must be sufficiently adaptive and flexible in order to respond to changing environmental conditions throughout the year. This allows the system operators to optimize operations on a daily basis to reduce potential impacts, avoid or minimize interference with other vessels and craft that navigate the river, and ensure the safety of the vessel and crew at all times. This Plan has been developed within this context.

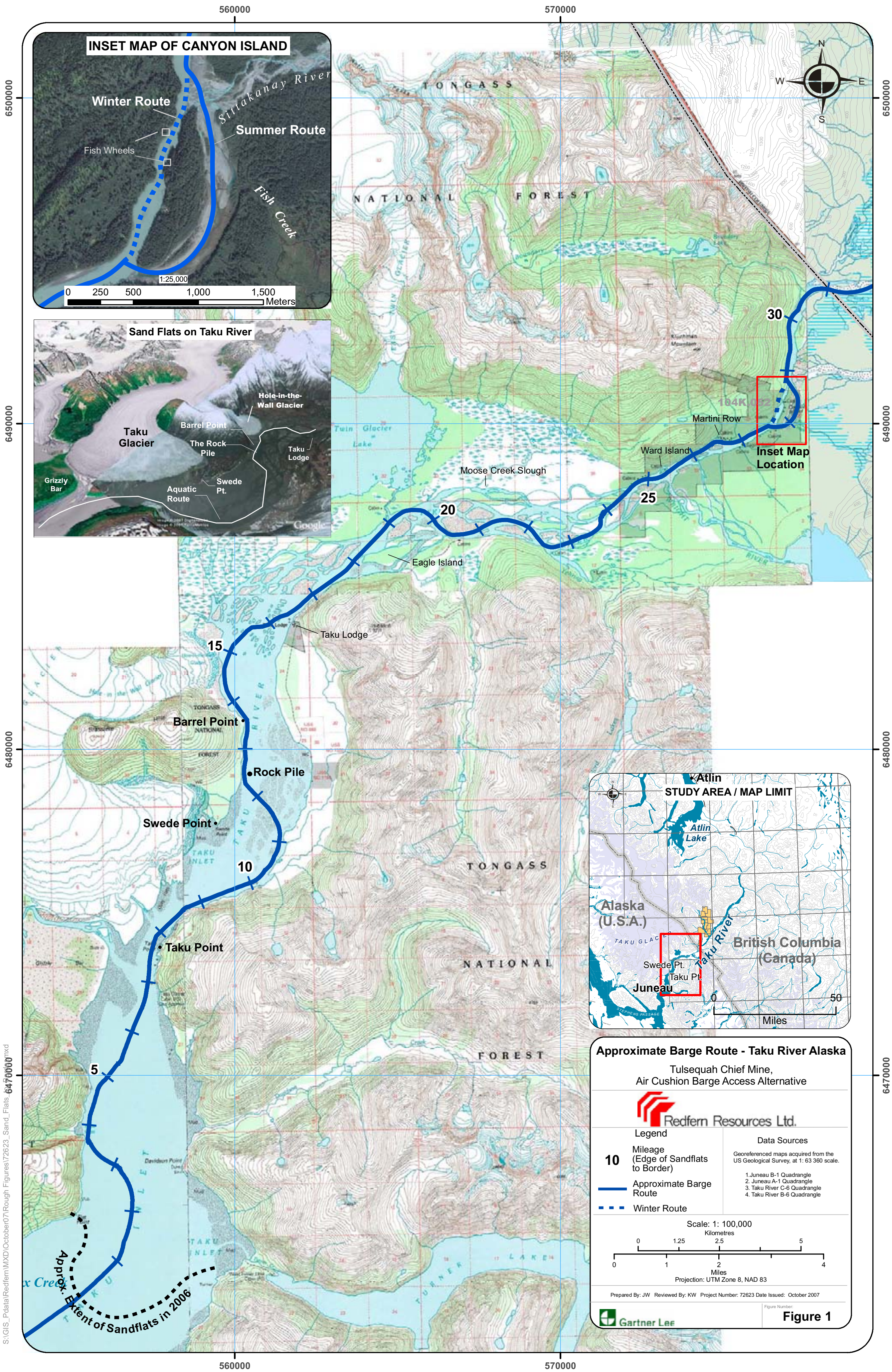
2. Description of Land Use

2.1 Transportation Route

The transportation route between the US/Canada border and the tidal flats at the mouth of the Taku River covers a distance of approximately 33 miles. Of this distance, approximately 17 miles can be characterized as the lower Taku River, encompassing that section of the river and tidal flats downstream of Taku Lodge. This entire reach of the river is influenced by tides, with the uppermost limit of tidal influence close to Taku Lodge. Upstream of Taku Lodge to the US/Canada border, a distance of 16 miles, the river follows a more defined channel and is upstream of any tidal influence.

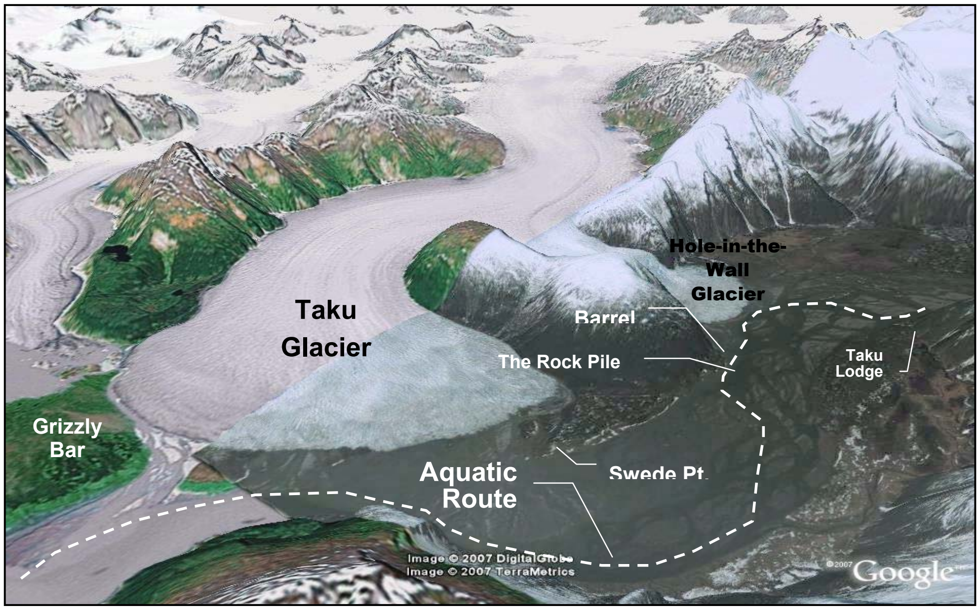
2.1.1 Taku Inlet to Taku Lodge

Sandy sediment deposited by the Taku River and Taku Glacier is deposited at the mouth of the Taku River, causing the formation of extensive sand bars across the width of the river channel. The river is a series of braided, shallow channels interspersed with sandbars extending upstream of Annex Creek to the Taku Lodge (Figure 2). This represents approximately a 17-mile reach of the river. With the high sediment load carried by the river, the mouth of the river will migrate downstream indefinitely.



INSET MAP OF CANYON ISLAND
Winter Route
Summer Route
Fish Wheels
Sittakanay River
Fish Creek
1:25,000
0 250 500 1,000 1,500 Meters
Sand Flats on Taku River
Hole-in-the-Wall Glacier
Taku Glacier
Barrel Point
The Rock Pile
Taku Lodge
Grizzly Bar
Aquatic Route
Swede Pt.
TONGASS
NATIONAL
FOREST
Twin Glacier Lake
Moose Creek Slough
Martini Row
Ward Island
Inset Map Location
104K.082
Eagle Island
Taku Lodge
Barrel Point
Rock Pile
Swede Point
Taku Point
TAKU RIVER
TAKU INLET
Approx. Extent of Sandflats in 2006
5
10
15
20
25
30
N
S
E
W
560000
570000
6500000
6490000
6480000
6470000
STUDY AREA / MAP LIMIT
Atlin
Atlin Lake
Alaska (U.S.A.)
British Columbia (Canada)
Taku River
Swede Pt.
Taku Pt
Juneau
0 50 Miles
Approximate Barge Route - Taku River Alaska
Tulsequah Chief Mine,
Air Cushion Barge Access Alternative
Redfern Resources Ltd.
Legend
10 Mileage (Edge of Sandflats to Border)
Approximate Barge Route
Winter Route
Data Sources
Georeferenced maps acquired from the US Geological Survey, at 1: 63 360 scale.
1. Juneau B-1 Quadrangle
2. Juneau A-1 Quadrangle
3. Taku River C-6 Quadrangle
4. Taku River B-6 Quadrangle
Scale: 1: 100,000
Kilometres
0 1.25 2.5 5
0 1 2 4
Miles
Projection: UTM Zone 8, NAD 83
Prepared By: JW Reviewed By: KW Project Number: 72623 Date Issued: October 2007
Gartner Lee
Figure Number:
Figure 1

Figure 2. Route through the Tidal Flats on the lower Taku River



2.1.1.1 River Depth and Tidal Influence

Through this section, the river channel depths vary between <3 ft. to 14 ft depending on the river discharge and tidal influence. Moving upstream from Taku Inlet, the influence of the tide on the depth of water in the river decreases, reaching the upstream limit of tidal influence near Taku Lodge. Here, the tide contributes only 4 inches of additional depth at river discharge of 17,700 cfs (500 m^3/sec) (low flows). At higher river discharge, the tide provides a similar contribution, but the river depth is greater as a result of the higher river discharge combined with tidal assist. Figure 3 illustrates the bathymetry of the river channel during low flows (spring and fall), and at mean low water (low tide).

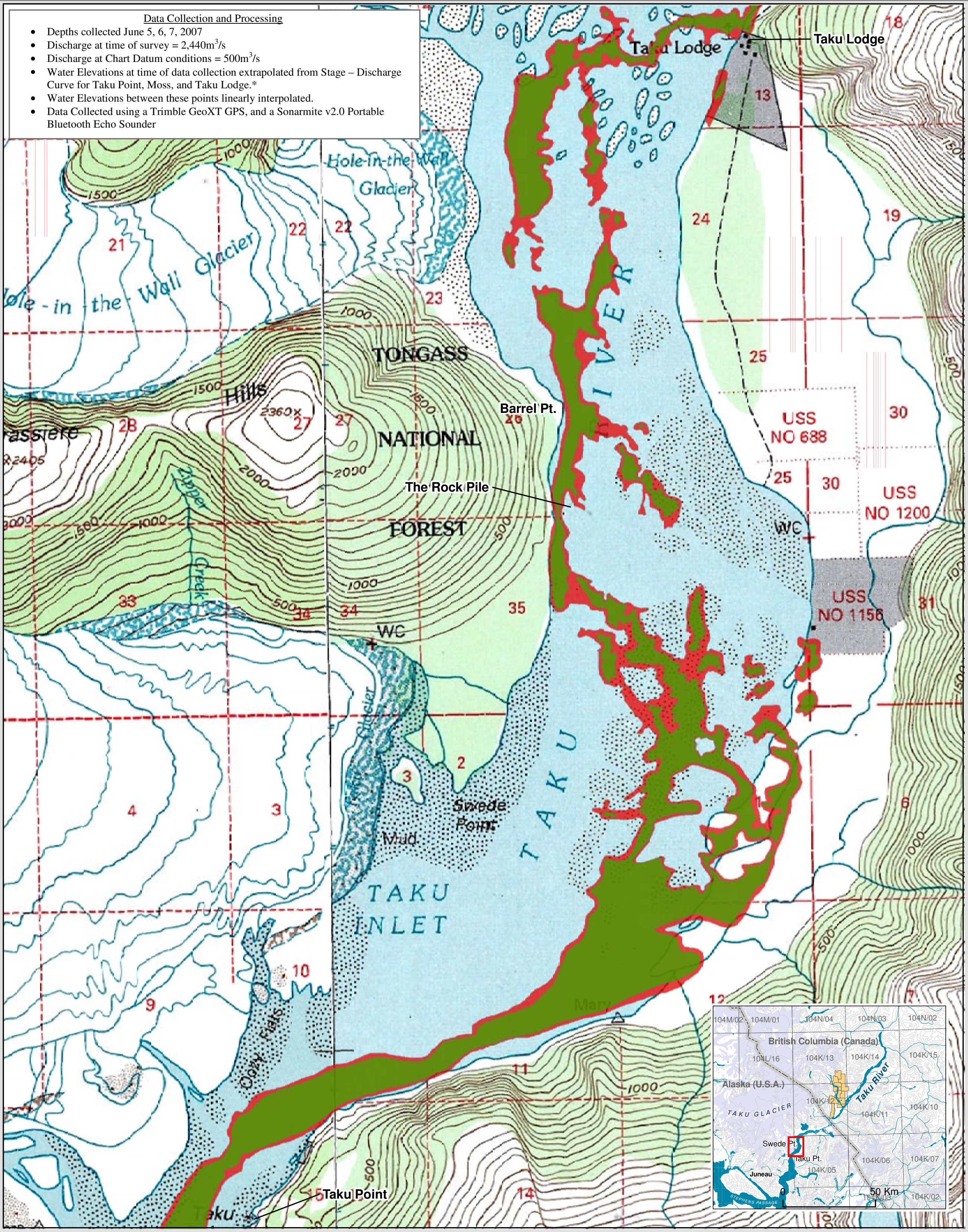
During the period from about early May until early October, the historical mean monthly river discharge varies between 17,700 cfs (500 m^3/s) in spring and fall, to over 35,300 cfs (1,000 m^3/s) during June (Figure 4).

Between late May and mid August, the river discharge typically provides sufficient depth of water for a shallow draft tug to operate successfully through this section of the river. Outside of this period, crossing this area will need tidal assist for operations to remain fully aquatic. The tug would follow the main channel through this part of the river, as approximated on Figure 5. This channel has been identified through the knowledge and experience of local river users, as well as through bathymetric analysis completed both in 1997 and again in 2007 in this section of the river. Though the channel does migrate somewhat over time, it is interesting to note that the main channel has not shifted significantly during the ten years since the 1997 bathymetric analysis was undertaken.

S:\GIS_Pdata\Redfern\bathymetry\MXD\70142_FigA3_T_O7_07.mxd

Data Collection and Processing

- Depths collected June 5, 6, 7, 2007
- Discharge at time of survey = 2,440m^3/s
- Discharge at Chart Datum conditions = 500m^3/s
- Water Elevations at time of data collection extrapolated from Stage – Discharge Curve for Taku Point, Moss, and Taku Lodge.*
- Water Elevations between these points linearly interpolated.
- Data Collected using a Trimble GeoXT GPS, and a Sonarmite v2.0 Portable Bluetooth Echo Sounder



Map Sources/Notes:
Water Depth Measurements Collected on June 5-7/2007 by Gartner Lee Ltd. field staff.
*Figure 5.1 Stage - Discharge Relationship for Lower Taku River' (Larson, M., Byres, R., 1995)
Topographic Images derived from Digital Raster Graphic (DRG) Images produced by the USGS.

Kilometres: 0, 0.25, 0.5, 1
Miles: 0, 0.25, 0.5, 1

1:30,000
UTM Zone 8N, NAD 83

Legend

- Areas with > 3 ft of water
- Areas with between 2 and 3 ft of water
- Areas with < 2 ft of water

File Name: 70142_FigA3_T_O7_07.mxd
Reviewed By: FP
Date Issued: July 2007
Prepared By: JW
Project Number: 70142

Redfern Resources Ltd

Bathymetry of Lower Taku River:

River Discharge
17,657 cfs and
Mean Low Low "0 ft" Tide
(MLLW)

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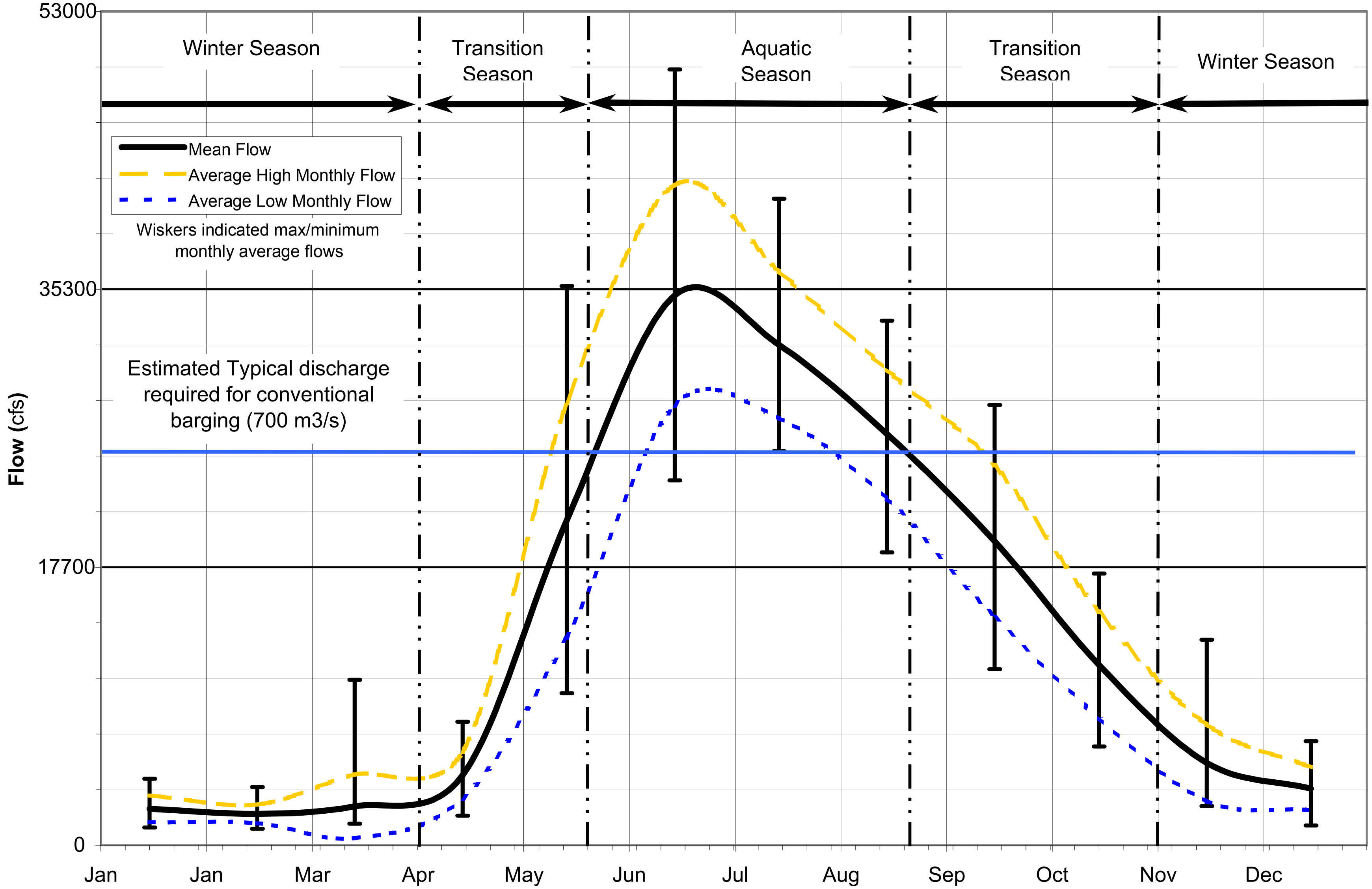
Figure 3
Version 1

Figure 4. Taku River Hydrograph at Canyon Island

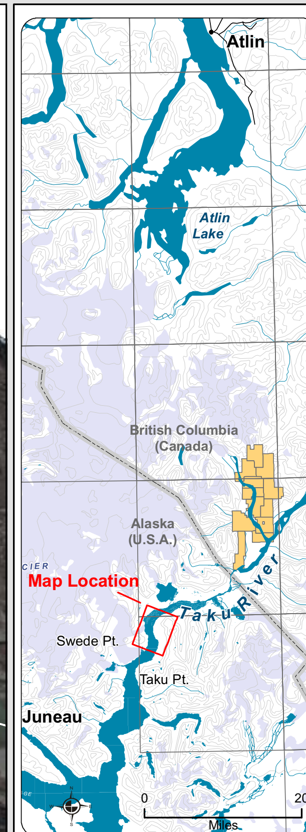
1986 - 2006



Taku_hydrograph.xls

Air Cushion Barge and Amphitrac (Shown to Scale)

Image Date: May 15 / 06



Map Sources/Notes:
Quickbird Imagery (Image Date May 15, 06),

All other data, Gartner Lee Limited

0.25 0.125 0 0.25 0.5 0.75 1 Km

1:25,000
UTM Zone 12N, NAD 83

File Name: 70142_Taku_River_Widths_Oct_2.mxd
Reviewed By: KW
Date Issued: October 2007
Prepared By: JW
Project Number: 72623

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Lower Taku River
Showing Approximate Routes,
Depending on Water Depth

18 October 2007

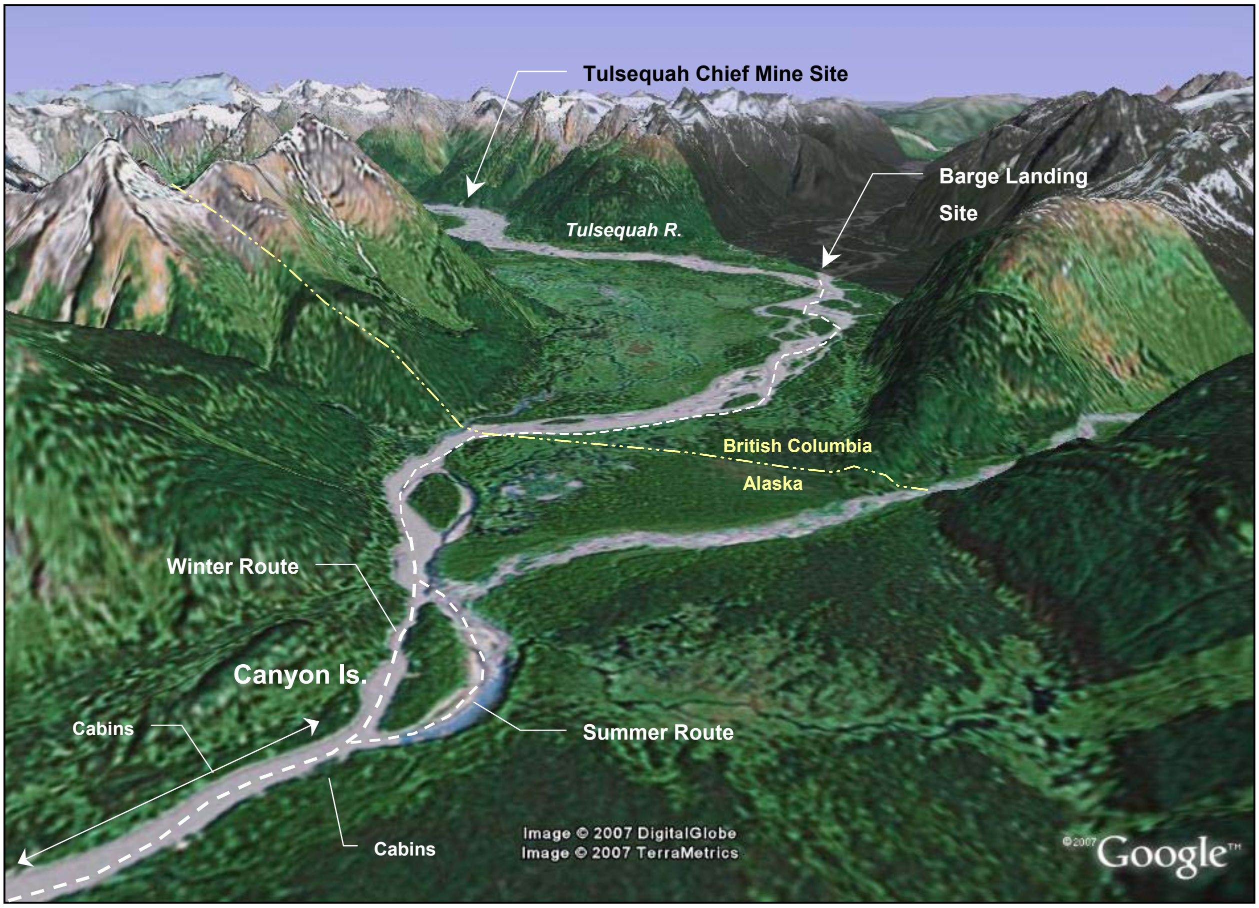
Gartner Lee

Figure 5
Version 1

File Name with or without path and/or client distribution date

During winter, once the river ice is sufficiently thick and/or land fast (on sand flats), the river operation would be on ice and snow upstream of the tidal influence, and would follow the easiest route along the floodplain.

Figure 6. Canyon Island to US/Canada Border

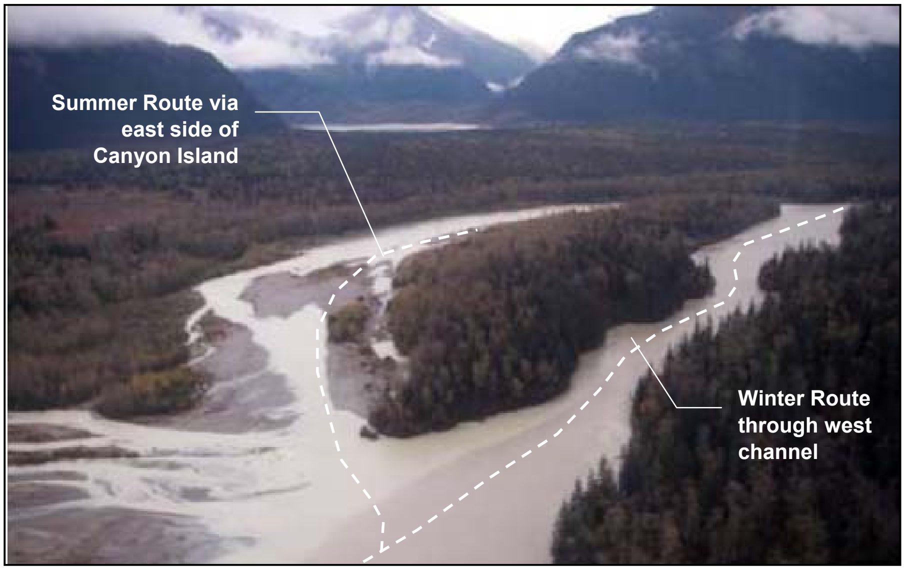


2.1.2 Taku Lodge to US/Canada Border

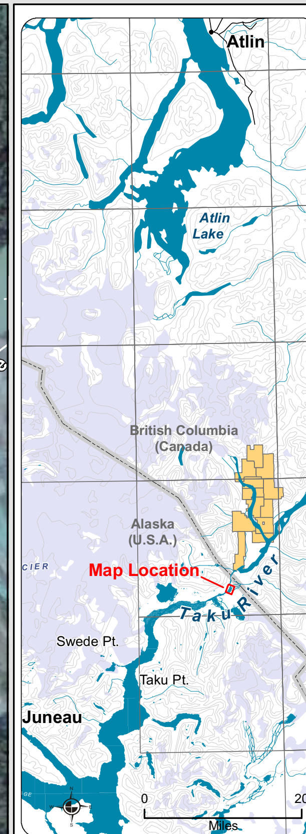
The route from Canyon Island to the US/Canada border is shown on Figure 6. The section of the river upstream of Taku Lodge is characterized by a defined channel with sufficient depth and width to accommodate the shallow draft tug throughout the open water season (break up to freeze up). Private land holdings along this section include the Taku Lodge, located across from the Hole in the Wall Glacier, and about 70 recreational cabins located further upstream along a 3 mile long reach of the Taku River immediately downstream of Canyon Island.

2.1.2.1 Canyon Island

Figure 7. View of Routes around Canyon Island, Looking Downstream



At Canyon Island, there is a single, narrow channel on the west side of the island. At the narrowest point, the channel is 90 to 130 ft. wide, through which barge navigation would be difficult. During the summer season, there is considerable boat traffic through the narrows, and two seasonal fish counters are located immediately upstream of the narrows. There is also a Personal Use fishery in July that contributes to increased river traffic at this location. For these reasons, the only practical route during the open water season is to navigate around the east side of Canyon Island (see Figure 7 and Figure 8). At times, there will be insufficient depth in the east channel for the shallow draft tug. At such times, the ACB would be towed across the gravel bars along the east side of the island by the amphitrac. The shallow draft tug would pass through the narrows, meeting the ACB at the upstream or downstream end of the island (depending on direction of travel), reconnect to the ACB and continue to its destination. Again, the entirety of the route through this area will be below the ordinary high water mark.



Map Sources/Notes:
Quickbird Imagery (Image Date 08/26/03),
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UTM Zone 12N, NAD 83

File Name: 70142_Taku_River_Widths_Oct.mxd
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Date Issued: October 2007
Prepared By: JW
Project Number: 72623

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Canyon Island Showing Approximate Summer and Winter Routes

18 October 2007

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Figure 8
Version 1

File Name with or without path and/or client distribution date

In winter, the route would follow the west channel as it is more direct, and would avoid the leads that tend to remain open throughout the winter along the east channel due to the inflow of warmer water from Fish Creek. During winter, after freeze up, the Taku River remains completely frozen upstream from the mudflats to the US/Canada border. Local residents on the river report that the west channel at Canyon Island is one the first parts of the river to freeze over and one of the last portions to break up. Therefore, the west channel would be used as the primary winter route. The route would be entirely over ice and snow during this time using the low ground pressure tires of the amphitrac. Icebreaking is neither contemplated nor desirable.

A mainstem channel that has sufficient depth to permit fully aquatic operations during the open water season characterizes the route north of Canyon Island to the US/Canada border.

Floating logs pose navigational hazards for river vessels. From time to time, it may be necessary to relocate snags that present navigational issues. The amphitrac will be fitted with a grapple mounted on the hydraulic arm. This grapple can be used to pick up the log and place it on the barge for disposal at Juneau or the barge landing site in Canada.

2.2 River Operations

The barging operation consists of two operational components- a marine component that will handle transportation between Juneau and the Taku Inlet, and a river component that will operate on the Taku River up to the barge landing site in Canada. This system will use vessels and equipment best suited to the particular conditions expected to be encountered along the route, and will be co-ordinated to provide a transportation system that is flexible, reliable, safe, and efficient.

There will be two discrete bases of operations: AML’s facility in Juneau and the barge landing site at the confluence of the Tulsequah and Taku Rivers in Canada. It is proposed that two separate crews will operate the transportation system - a Juneau-based crew that is responsible for the marine portion of the system, and a crew based at the mine that will be responsible for the river portion of the system.

The following sections describe only that portion of barging operations that will occur on the Taku River in Alaska – from the US/Canada border to the lower extent of the tidal flats at the mouth of the river.

Operations on the Taku River will require use of both conventional and specialized equipment to be able to operate year-round. The Taku River experiences considerable variation in flow during the year, as shown on Figure 4. Average monthly flows during the period from about late May until mid-August range from 24,700 cfs to over 35,300 cfs, providing sufficient depth of water in the river channel to support a fully aquatic operation using a shallow draft tug. During the winter period that typically extends from November until early to mid-April, the river is frozen. During this season, amphitracs using low pressure tires to travel over ice and snow would provide the best means of transporting the ACB along the river corridor. Operations during the shoulder seasons will require a combination of the amphitracs and the shallow draft tug to manoeuvre the ACB across the shallowest sections of the river, particularly near the Taku River Lodge where the sand flats are extensive throughout the river channel, and tidal influence is at its upstream limit. The operations proposed during each of these seasons are described in detail below.

2.2.1 Summer Operations - late May to mid-August

For approximately three months, from about mid to late May until mid August, average monthly flows in the river combined with tidal assist provide sufficient depth across the tidal flats to support fully aquatic operations using a shallow draft tug (draft $\leq$3 feet). Figure 4 illustrates the average annual hydrograph for the Taku River, as measured at Canyon Island. It should be noted that in any given year, the actual river discharge will vary, and summer operations may extend into the transition seasons (or vice versa). This will also extend or reduce the reliance on tidal assist, depending on the actual river discharge. The tidal flats extend downstream of Taku Lodge to approximately Annex Creek. The shallow draft tug is fully capable of navigating through this section of the river during medium to high tides, as the tide provides between 8 and 16 feet of additional depth in the channel, diminishing with distance upstream. The tidal influence near Taku Lodge is minimal, and river discharge controls the depth of water at this location. River discharge in excess of 24,700 cfs is required to provide sufficient depth for the shallow draft tug to navigate through the shallows at this location, without relying on tidal assist. These shoals are the "pinch point" along the river, and govern the navigability of the river when operating with the shallow draft tug. Without tidal assist, the shallow draft tug can operate at river discharge over 24,700 cfs (700 m^3/s) as there would be sufficient depth of water through the shallowest sections of the route. When the river discharge is less than 24,700 cfs and greater than 17,700 cfs (between 700 and 500 m^3/s), tidal assist is needed to ensure sufficient depth through this section of the tidal flats. At discharge less than 17,700 cfs, the shallow draft tug will not be able to operate reliably through this section of the river, and the amphitrac(s) will be used.

During the open water season, a conventional shallow draft tug will be used to shuttle the ACB up and down the river. The amphitrac will provide secondary propulsion and assist in manoeuvring the ACB where needed. The shallow draft tug will rendezvous with the marine tug to deliver the outbound ACB to the marine tug for transport to Juneau, and pick up the inbound ACB for transport to the mine. The rendezvous will take place in the open and deep waters of Taku Inlet.

A small powerboat will act as a pilot vessel to scout the river and advise other river traffic of the barge's progress will accompany the shallow draft tug. All vessels will be equipped with marine radios and satellite phones to communicate with other river traffic.

2.2.1.1 Canyon Island

Canyon Island represents a challenging section of the river to navigate due to the narrow channel, faster current and multiple users in this area during the summer. The ACB will be manoeuvred around the east side of Canyon Island, crossing over the gravel bar at low water levels. The shallow draft tug will push the ACB up to the gravel bar along the east shore of the island. From here, the ACB will be pulled or winched by the amphitrac across the sandbar to the opposite end of the island. The barge will be equipped with a Rolligon-type wheel that will be lowered to act as a keel to control side slippage when traversing sloping ground. The shallow draft tug will proceed through the deeper channel around the west side of the island (the narrows), re-connecting with the ACB at the opposite end of the island, and continuing travel up (or down) river. The pilot boat will precede the shallow draft tug and ACB to notify fishermen and other traffic of the barge's arrival at the island, as required.

The shallow draft tug carries approximately 1700 gallons of fuel on board, representing about 16 hours of continuous operations. (Refuelling will be done at the barge landing site in Canada.)

2.2.2 Winter Operations – early November to early April

The winter season typically spans the period from about early November until early or mid April, though there is considerable variation in the timing of freeze- up and break-up. During the winter when the river is frozen, up to two amphitracs will be used to tow the ACB over the ice and snow along the river. Two amphitracs can be used to provide the necessary propulsion, increase travel speed, provide greater manoeuvrability, and provide mutual aid if needed. The amphitracs will operate using soft tires travelling on the snow and ice.

The outbound ACB will be pushed and/or towed by the amphitracs along the frozen surface of the river. Similar to the summer operations, the amphitracs will rendezvous with the marine tug in Taku Inlet, transfer the outbound ACB to the marine tug, and pick up the inbound ACB for the return trip up river. In winter, the rendezvous point will be closer to shore. Here the ice makes contact with the shore, and the inbound ACB will be manoeuvred or winched onto the shelf ice by the amphitracs.

During the winter, the route will follow the west channel around Canyon Island to avoid the longer open leads in the east channel (see **Photo 1**and **Photo 2**). These leads tend to remain open throughout the winter as warmer water from Fish Creek flows into the Taku River at this location.

Photo 1. Open leads around east Channel of Canyon Island

Photo 2. Looking downstream along west channel at Canyon Island; leads are small and do not extend through length of channel

Winter operations will likely include some route grooming to expedite travel, such as levelling areas of rubble ice or pressure ridges. The hydraulic arm on the amphitrac can be fitted with a flail that will be used to break down areas of jumble ice, if needed. The ACB will be fitted with a set of rollers mounted on the front of the barge that can be lowered hydraulically to lightly compact the snow in front of the ACB. This will help pack the route to reduce the amount of snow being blown around by the ACB, thereby improving operational visibility.

The amphitracs will be equipped with sophisticated navigational equipment so that they are able to navigate in whiteout conditions along the river. Weather reports will be monitored daily however the barge masters will be ultimately responsible for making decisions concerning the safety of the vessels and crew. During periods of extremely heavy snowfall, operations may be curtailed and snow can be packed along the route using a roller bar on the amphitrac before operations recommence.

2.2.2.1 Crossing Open Leads

From an operational perspective, it will be more efficient to avoid open leads during the winter, and to travel entirely, or as much as possible, over solid, frozen river ice. Occasionally, however, the amphitracs will encounter patches of open water, such as downstream of Canyon Island where long open leads may occur. In these instances, the amphitrac would cross the channel, thereby crossing from the ice to the water, and back onto ice Shorter leads may also be encountered upstream of the island, but for the most part can be avoided. One of the amphitracs will proceed ahead of the barge, using the Archimedes screws to propel it through the open water and assist in crawling up onto the ice surface. Once up on the ice, the amphitrac can use an ice auger to anchor itself in position, then winch the barge across the lead and up onto the ice. The second amphitrac would follow the barge, assisting in manoeuvring the barge if needed. Crossing of leads will be kept to a minimum, and avoided where possible. This procedure (avoidance) will allow ice to form naturally, and be largely unaffected by operation. Crossing of open leads, when these cannot be avoided, will be largely confined to those sections of the river where leads tend to persist naturally throughout the winter.

2.2.3 Transition Season Operations (Spring and Fall)

Between the Taku Lodge and Annex Creek, a distance of about 17 miles, sand flats are exposed at periods of low water. The logistics of the transition season operations will depend greatly on the depth of water available in the river channel near the Taku Lodge, and the timing of freeze-up and break-up on the river. The latter will dictate the timing of the transition from tires on ice and snow to using the Archimedes screws for aquatic propulsion, to using the shallow draft tug once there is sufficient depth in the river channel.

Above Taku Lodge, the shallow draft tug will commence operations in the spring after the river has broken up, usually in the month of April, and water is freely flowing through the mainstem of the river. The river peaks in June in response to snowmelt, beginning in April and increasing into June. The river, which rises from baseflow conditions to peak flows in two months (April to June) takes approximately four or five months to return to baseflow conditions (July to November). The *long falling limb* is fairly typical of glacially driven rivers. Ninety percent of the river's total annual discharge occurs between May and November. According to streamflow records at Canyon Island, ice forms on the river in November and under-ice conditions begin in early December and are constant by the end of December. Break-up occurs in early April. Once or twice each year, glacial dam outbursts occur when the dam formed by the Tulsequah Glacier fails, and the outburst floods the Tulsequah River and on into the Taku River. The magnitude of these outburst floods is high enough to affect the streamflow records of the Taku River for periods of about two to three days. Increase in flow from either the freshet or outburst floods on the Tulsequah River cause water levels to rise gradually over a few days, and are not catastrophic events. As there is attenuation of these floods by the time they reach the Taku River confluence, the rising floodwaters would not affect the operation of the barging system in any significant way. The increased river velocity during these floods is not anticipated to present navigational challenges for the ACB.

The tug will operate on the river upstream of the Taku Lodge for a period of about six or seven weeks until the river discharge increases sufficiently to provide enough depth to navigate through the shoals near Taku Lodge. From this time onwards, the shallow draft tug would be able to complete the entire river trip until about mid to late August when river levels drop off and there are likely to be times when the tug would be unable to navigate through the shoals near Taku Lodge. From this point on, the shallow draft tug would remain upstream of the Taku Lodge, and the amphitracs would provide amphibious operations through the sand flats until freeze-up, which generally occurs sometime in November.

A typical round trip on the river during the transition seasons would involve the following:

- ACB is towed downstream by the shallow draft tug, accompanied by up to two amphitracs for additional manoeuvrability and extra propulsion.
- Just upstream of Taku Lodge, the shallow draft tug would hand off the ACB to the amphitrac(s), which would shuttle the ACB across the sand flats (to the rendezvous with the ocean tug in the Taku Inlet).
- The upstream-bound ACB would be similarly shuttled across the sand flats by the amphitrac(s), and meet the shallow draft tug just upstream of Taku Lodge.
- The supply-laden ACB would then be towed upstream by the tug, assisted by the amphitrac(s) (continuing on to the barge landing site in Canada.)
- The shallow draft tug would anchor just upstream of the sand flats during the time that it would take the amphitrac(s) to cross the shallows and rendezvous with the marine tug.
- As a contingency, the amphitrac(s) will be able to winch the barge across difficult sections of the sand flats. This will be accomplished by one amphitrac proceeding ahead of the barge, anchoring itself on the sand bar, and winching the barge across the sandbar, assisted by the second amphitrac pushing the barge, if necessary.

3. Equipment

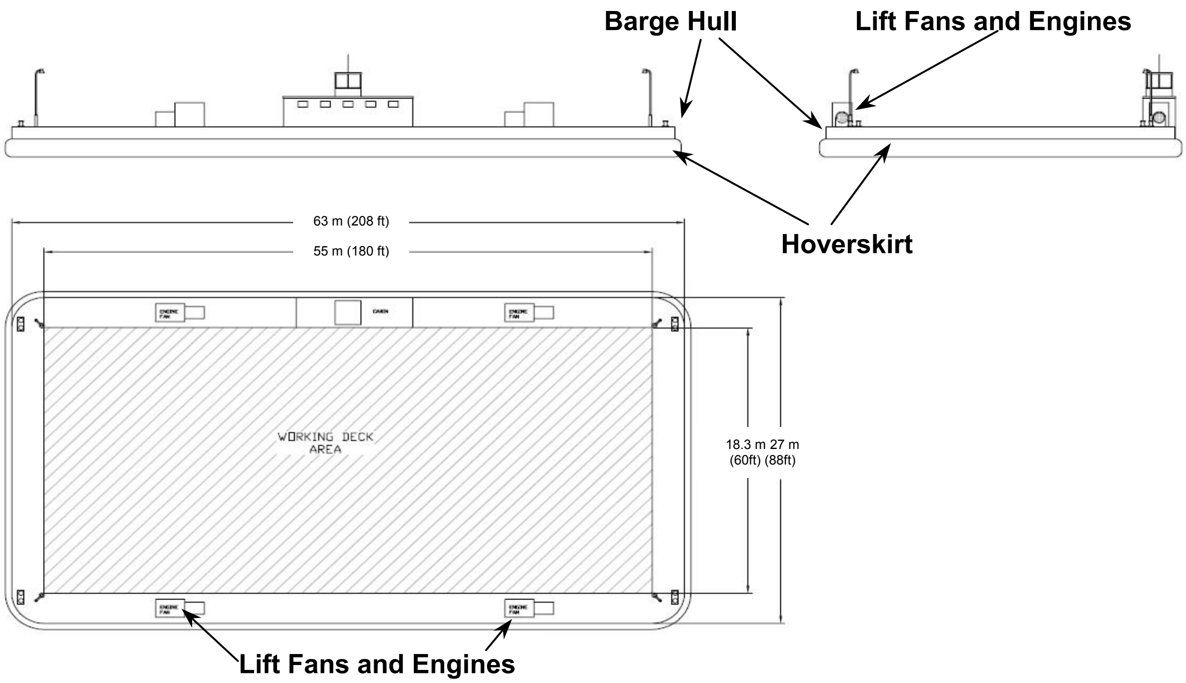
3.1 Air Cushion Barge

Air cushion barges are slow moving (5 to 10 knots), shallow-draft barges that can be towed by aquatic vessels such as tugs, or moved over land with land-based vehicles, or winched along a fixed cable. They are built to meet marine specifications to accommodate the specific sea conditions on or off hover. The air cushion makes the barge amphibious, able to operate in open water or on land, and through extreme weather conditions. The barge travels at low speed with the bottom of the flexible skirt in the water.

3.1.1 Barge Components

The main components of the barge are shown on Figure 9, and include the marine steel hull, the skirts, and the fans and engines that provide the lift when on hover. The overall dimension of the barge will be approximately 208 ft x 88 ft. Unloaded, its weight will be 300 tonnes. Fully loaded, the gross weight will be 750 tonnes.

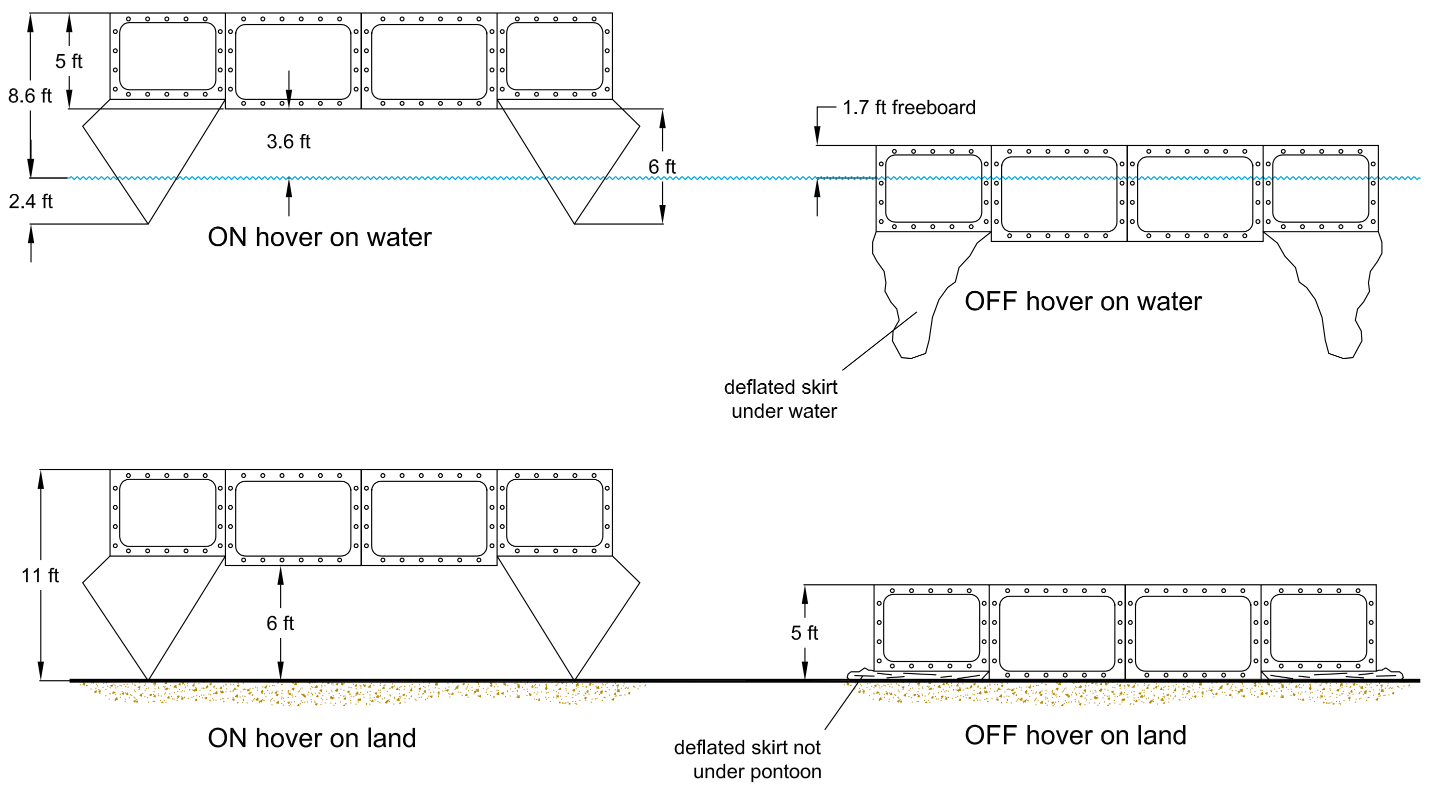
Figure 9. Air Cushion Barge Components



The dimension of the pontoon is 60 x 180 ft, representing the usable deck area. The pontoon is 5 feet thick. Over water, the barge will hover at a height of approximately 6 ft over the water's surface. When fully loaded, the draught will be approximately 2.4 ft on hover, and the deck of the barge will be approximately 3.6 feet above the surface of the water. When not hovering, the barge will float with the pontoon in the water and the deck about 1.7 ft above water. Figure 10 illustrates the hoverbarge on and off hover over water.

Air Cushion Barge Operating Heights

showing critical dimensions; barge width NTS



Vertical Scale: 1" = 10'

File:70142_By2_Fig3-2_BargeSchematic.dwg
Reviewed by: FP
Date Issued: July, 2007
Prepared by: MP
Project Number: 70-142

Redfern Resources Ltd.

Project: Tulsequah Chief Mine, Air Cushion Barge Access Alternative Project Description
Location: Northwest British Columbia

Air Cushion Barge Operating Heights

Gartner Lee

Figure 10
Version 1

On land, the barge will be able to move across obstacles less than the hover height. When not on hover, the barge will gently settle on the ground surface. The skirts fold under themselves when the barge comes off hover and do not become trapped beneath the pontoon.

The skirt, comprised of many individual segments, surrounds the perimeter of the ACB. When inflated with air, the skirt creates a flexible seal with the water/ground surface. On uneven ground, the skirt segments will conform to the uneven surface, and at sea, this dampens the wave action as the barge travels through the water. When fully loaded and operating on water, about 2.4 ft of the skirt will drag through the surface of the water. As the skirt system is comprised of many individual segments, damage to one or several adjacent segments does not affect its performance. Adjacent skirt segments simply over inflate and fill the gap created by the damaged segments, thereby reducing loss of air and maintaining hover pressure. The barge can tolerate considerable damage to adjacent segments before there is any noticeable loss of air pressure.

Pressurized air escapes from beneath the skirt, or between the skirt segments. A spray skirt lining the perimeter of the barge will contain spray and minimize ice formation on the skirts in winter.

Four 500 HP diesel engines will drive the fans pressurizing the skirts and provide power for lighting, heat, and cable winching. There is adequate resilience in the lift system for complete failure of one engine with no affect on performance. The fans are positioned on each corner of the barge deck. The pressurized air will be forced through the skirt segments into the space underneath the pontoon, and it is this air pressure that lifts the barge. The average pressure exerted on the surface (ground or water) is 1 psi (pounds per square inch). By comparison, a human foot exerts 5 to 10 psi of ground pressure.

3.1.2 Noise

The ACB engines will be muffled and enclosed to minimize noise. The noise generated by the ACB and the Amphitrac will be approximately 70 dB at 100 ft, roughly equivalent to a tug passing by.

The ACB generates very little underwater noise. Noise, which is a vibration, will not be transmitted directly from the steel pontoon to the water as there is no contact between the pontoon and the water when on hover. The only contact between the ACB and the water would be the skirts that do not transmit sound well. All other sound will be muffled by the 3.6 ft air gap between the pontoon and the water's surface. Noise transmitted to the water will also be muffled by the 5 ft internal air gap between the upper and lower surfaces of the pontoon.

3.1.3 Wake

During the aquatic season, the ACB will be pushed or pulled by the shallow draft tug, assisted by the amphitrac if needed. It is difficult to precisely describe the wake that will be generated by the combined vessels as they shuttle back and forth on the Taku River; however, each vessel can be independently analyzed and some preliminary conclusions drawn. The size of the wake is a function of the draft of the vessel (deeper draft generates more wake), and the speed of the vessel (faster speed generates more wake).

A Rolligon (similar to the proposed amphitrac) makes essentially no wake when traveling in water. It is uncertain as to what the Archimedes screws will contribute to wave generation, but any wake produced by the amphitrac would be dampened by the much larger ACB following close behind it.

The ACB itself will make a minimal wake, as demonstrated in Photo 3, showing the Yukon Princess being ferried across the Yukon River at 5 mph. This photo was taken when the Yukon River was flowing at ten knots. The wake generated by a craft is affected primarily by its speed, draft and length. The ample length of the ACB generates little or no wake.

The main contributor to wake, therefore, will be the shallow draft tug pushing the ACB. The tug will produce less wake than a marine tug due to the shallower draft.

Wake is of concern primarily in areas of development along the riverbanks, where increased bank erosion and potential damage to docks and/or moored craft is a concern. In areas such as Martini Row where cabins are concentrated over a very short stretch of the river, speed can be reduced through this area to minimize wake. The operation of the barge system will contribute minimally to ongoing bank erosion that results from the annual freshet that modifies the river morphology annually, such as occurred in June 2007. No wake issues were identified during conventional barging operations during the summer of 2007.

Photo 3 ACB *Yukon Princess* operating on Yukon River at 5mph showing minimal wake

3.2 Shallow Draft Tug – River Operations in Summer

A shallow draft tug will be used as the primary means of propelling the ACB during the open water season on the Taku River. Shallow draft tugs are commonly used on large, shallow rivers such as the Yukon and Tanana in Alaska, the McKenzie River in Northwest Territories, and the Mississippi and Ohio Rivers in the United States. Numerous designs have been developed over the years that are appropriate for this purpose. The closest parallel to Redfern's requirements is found on the McKenzie River, where powerful boats with shallow drafts are used. As a result, numerous vessel designs have been developed over the years that are appropriate to the application of towing an ACB on the Taku River. Some of the best designs for shallow draft tugs are produced in British Columbia by Robert Allen Ltd. and A.G. McIlwain Ltd. An example of an A.G. McIlwain design, the *Streeper*, is shown in Photo 4.

Photo 4. W R Streeper Shallow Draft Tug

The specifications of the shallow draft tug proposed for this operation would be similar to those of the W.R. Streeper, as follows:

■ Length	67 ft.
■ Beam	26 ft.
■ Full Load Draft	2.4 ft.
■ 4 Main Engines	6 Rudders
■ MHP	1,500
■ Fuel Oil Capacity	1700 gal.
■ Crew Accommodation for 5	
■ Steel Hull, Aluminium House Work	

The tugboat will have a draft of approximately 2.4 ft. This is accomplished by embedding the propellers in tunnels inside the hull. This allows the use of large propellers to increase the bollard pull of the vessel, while protecting them from the damage that would be caused by touching the bottom or submerged logs.

The shallow draft tug will carry sufficient fuel onboard for at least one round trip on the river, and will be refuelled at the barge landing site in Canada.

3.3 Amphitrac – Winter; Spring/Fall Aquatic Operations

The amphitracs will be used as the primary source of propulsion during the winter months when the river is frozen. The amphitrac is essentially a Rolligon that has been converted to an amphibious vessel, so that it can operate on land, using soft tires, or in water, using Archimedes screws. Rolligon type vehicles are low ground-pressure tractors with large soft tires that have been used routinely on the Alaskan North Slope for the past 35 years. Vehicles of this type are the only vehicles permitted to operate on the tundra due to the low ground pressure exerted by the soft tires (see Photo 5).

Photo 5. Rolligon on Alaska's North Slope

The Rolligon will be converted to an Amphitrac by the addition of the following:

- marine pontoons that will make it amphibious;
- retractable rear wheels will be metal to add greater traction for snow and ice;
- two retractable Archimedes screws will be added to each side to provide propulsion in water, and to assist the vehicle as it transitions from water to ice. The screws will also increase the stability of the amphitrac;
- rubber tires will be retractable during aquatic operations;
- winches fore and aft to provide additional pull when required;
- standard marine safety equipment will be on board as well as a zodiac-style life raft; and
- there will be small but comfortable crew quarters on the amphitrac.

Photo 6. Illustration of Amphitrac

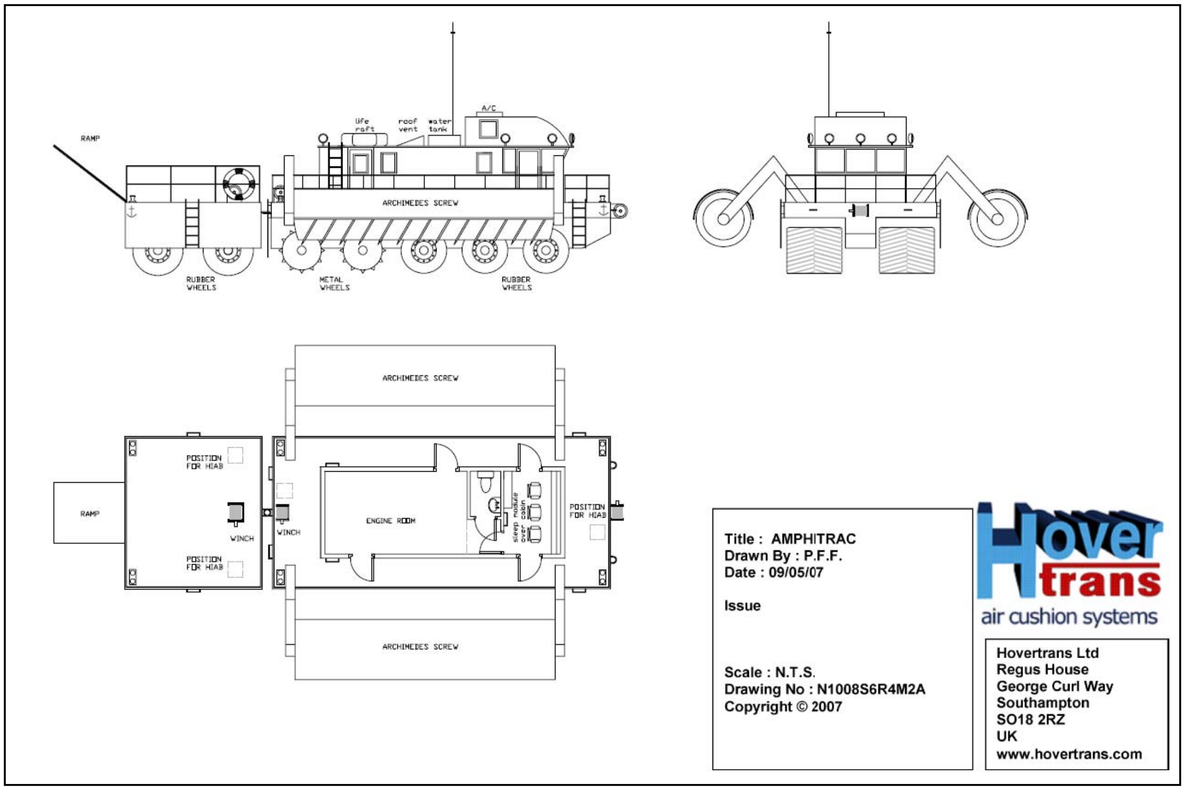
The low-pressure tires on the amphitrac are operated between 2 and 5 psi, but are typically set at 3 psi. Tire pressure can be adjusted within this range to suit the ground conditions, with lower pressure used for softer ground surfaces. A schematic diagram of the amphitrac is shown on Figure 11, and illustrated in Photo 6.

Amphitrac Specifications:

- overall dimensions are 59 ft x 28 ft
- two 660 Hp diesel engines will provide all the necessary drive power (hydraulic)
- Fuel consumption approximately 35gal/hour

The engines will be sized for maximum power needed (1,200 hp), such as transitioning from water to ice, and moving upstream against the river currents.

Figure 11. Amphitrac Components



During summer, the amphitrac can assist the shallow draft tug to provide additional upstream propulsion and downstream control over the barge. The Archimedes screws allow the amphitrac to move through water as well as the ability to climb out of water onto land or ice. The Archimedes screws are on retractable hydraulic arms that allow the operator to adjust both the depth and pitch of the screws to suit conditions. The screws also provide additional lateral stability by acting as outriggers. The anticipated speeds that the amphitrac is estimated to travel under various conditions are summarized in Table 1.

Table 1. Typical Amphitrac Operating Speeds

Operating Mode – Towing Loaded ACB	Speed (mph)
Maximum speed over wet sand and gravel (tires)	20
Compact Snow and Ice (tires)	20
Average ground speed towing fully loaded ACB	9
Calm water (minimal current using screws)	8

The amphitrac carries approximately 2000 gallons of diesel fuel onboard that is sufficient for approximately 26 hours of continuous operation, and will be more than sufficient for one roundtrip between the barge landing site in Canada and Taku Inlet. Refuelling will be done at the barge landing site where fuel will be stored for this purpose.

When operating independently of the shallow draft tug, such as during the winter season over frozen ground, or during the shoulder season when there is insufficient depth for the shallow draft tug in the channels through the sand flats, up to two amphitracs will be used to manoeuvre the ACB along the route. The amphitracs can either pull or push the ACB, providing the barge master flexibility in handling and manoeuvring the ACB depending on route conditions. When pushing, the amphitrac will be connected to a yoke located on the back of each ACB. In difficult sections of the route, for example when making the transition from water up onto the ice, the amphitrac can precede the barge, then winch the barge across the difficult terrain before resuming normal travel.

The skills required for the operation and maintenance of the amphitrac should be readily available in Juneau. These include diesel mechanics, barge masters, and operators. It is anticipated that some barge masters and crew may be Taku River residents and/or users as local river knowledge will be an asset to optimizing operations.

3.4 Ancillary Vessels

Several smaller vehicles and vessels will be used in conjunction with the primary vessels.

- A small powerboat will accompany the barge during the open water season to act as a pilot vessel ahead of the barge, as required. This vessel will assist the barge master in determining the best route to follow-up and down river, and provide advance warning to other river users of the barge’s progress.
- A snow machine(s) will accompany the barge during winter, in the event of emergency evacuation of personnel, or to scout obstacles along the route.
- All tugboats and the amphitracs will be equipped with zodiacs for emergency evacuation.

Secondary vehicles and vessels can also be used to place temporary ice anchors where winching may be required in order to overcome difficult sections of the route.

3.5 Communications

Telecommunications are an essential component of marine transportation, and are particularly important in remote locations that do not have other available communication systems. A satellite phone between the barge landing site, the vessels, and Juneau will be used to provide reliable, constant communication for crews operating the system.

4. Operating Procedures and Objectives

Operating procedures have been identified that will avoid or minimize potential adverse effects associated with the ACB operations on the river. The effectiveness of these procedures will be tested during the first couple of years of operations, and operations will be adapted, to the extent practical, to meet the stated operational objective. Annual follow-up with property owners, commercial tourism operators, commercial fishers and other users of the river will be carried out to ensure that concerns regarding barging operations can be addressed in a timely manner.

4.1 Open Water Season

Several operating procedures have been identified for operations during the open water season on the Taku River. These procedures include an appropriate route that would be followed; use of appropriate and suitable equipment for river operations; timing and scheduling considerations; as well as specific procedures or measures to minimize potential adverse effects of operations during this season.

Procedure: *Travel in the Thalweg (deepest part of river channel) during the Open Water Season.*

The ACB and associated river equipment will travel in the thalweg (deepest portion) of the Taku River for the majority of the route. The route along the mainstem of the river channel avoids many sensitive aquatic habitat areas, as well as nearshore or shallow water areas that are frequented by wildlife and birds. The use of the main, deepest channel as the preferred route along the Taku River during the open water season will achieve multiple objectives:

- avoid potential channelization effects;
- avoid potential disturbance to exposed sand flats;
- avoid potential disturbance of substrates upstream of Taku Lodge;
- avoid potential re-suspension of sediments (as fine sediments will not generally accumulate in the thalweg to be re-suspended by the propeller wash from the tug);
- avoids eulachon spawning areas as identified on Juneau State Land Plan: Areas 14a44 and 14a55 by staying in mainstem channel;
- avoid salmon spawning is side channels and creek mouths;
- Minimize the wave energy produced by the passing tug/barge so that by the time it reaches the beach areas, the potential for stranding juveniles is minimal;
- avoid the high value moose foraging habitats identified in preliminary assessments (e.g., sloughs, side channels). Further observation and monitoring will refine knowledge of these key habitats, and where appropriate, the route will be adjusted to provide additional distance buffers, if required, to minimize disturbance;
- ACB route avoids most of the high value grizzly and black bear habitats identified in preliminary assessments;
- avoids ADF&G research activities such as fish trapping that occur close to shore; and

- avoids direct interference with hunting activity along the Taku River. The areas typically used for moose hunting do not include the mainstem of the Taku River, and hunting of mountain goats occurs at higher elevations above the valley floor, and would be unaffected by the ACB operations. Bear hunting is very limited, occurs mostly at lower elevations accessible from the river, and disturbance would be limited to the temporary noise generated by the ACB as it passes by on the river.

Procedure: *Use of Shallow Draft Tug and ACB during open water season.*

These vessels draw less than 2.5 feet of water, making them appropriate for use on shallow rivers such as the Taku. Use of shallow draft vessels will achieve the following objectives:

- avoid potential channelization effects;
- avoid disturbance of sand flats associated with deeper draft vessels (marine tugs and barges);
- avoid potential disturbance of substrates upstream of Taku Lodge (associated with deeper draft vessels (marine tugs and barges);
- use of the ACB and shallow draft tug will minimize wake and potential bank erosion. ACBs produce very little wake as compared to conventional barges; and
- minimize re-suspension of sediment and potential bank erosion that can result from excessive wake associated with conventional barges.

Procedure: *Large Woody Debris will be removed from the river channel only if it poses a significant navigational risk. Any woody debris removed from the river channel will be places on board the ACB and disposed of at a suitable location at the loading facilities in either Juneau or at the barge landing site in Canada.*

This procedure will reduce the potential for accidental damage to the vessels, and will be restricted to debris located in the actual travel route that present a hazard to the safe operation of the transportation system.

Procedure: *All equipment associated with the ACB transportation system will be equipped with industry standard mufflers to reduce noise levels to 70 dB at 100 feet. Engines on all equipment to be enclosed to reduce sound transmission.*

This procedure will accomplish the following:

- use of the ACB reduces underwater noise associated with barging activity by reducing mechanical transmission of noise to the water column;
- minimizes noise effects on marine mammals and fish; and
- ambient noise levels above the surface of the water will be reduced, thereby limiting the effects of noise on property owners and other river users as the barge travels along the river.

Procedure: *When water depth in east channel at Canyon Island exceeds 3 feet, the shallow draft tug will be used to tow the ACB through the east channel. When water levels in the east channel are less than 3 feet, the amphitrac (on soft tires) will be used to tow or winch the ACB across the dry gravel bar on the east side of Canyon Island.*

The objectives of these operational procedures at Canyon Island are to:

- avoid potential disturbance of spawning in the east channel at Canyon Island;
- avoid interference with the personal use fishery that is concentrated at the west channel;
- avoids interference with the fishery research activities and fish wheels located in the west channel; and
- avoid compaction or rutting of gravels at Canyon Island by using the low ground pressure vehicle and ACB when crossing the gravel bar at this location.

Procedure: *Avoid areas where marine mammals are observed to congregate.*

This will reduce disturbance of seals that tend to congregate in the spring at the edge of the ice.

Procedure: *Approaching ACB to co-ordinate transit through the take-off and landing area at Taku Lodge by maintaining constant radio communication with approaching aircraft when approaching or within the immediate vicinity of the aircraft landing zone.*

This procedure will minimize any disruption to the aircraft traffic at Taku Lodge. The ACB/amphitrac and shallow draft tug will all be equipped with radios and will monitor the aircraft frequency in this area, allowing direct communications between the barge and aircraft to co-ordinate activities.

4.2 Winter Season

The winter operations will involve the use of the amphitrac and ACB, traveling along the frozen river. The route followed during the winter will generally remain in the middle of the frozen mainstem of the river, but may vary within the floodplain depending on ice conditions, the presence of jumble ice and open leads, snow accumulations, and other weather related factors. The specific winter procedures that have been identified will include the following:

Procedure: *Use the West Channel around Canyon Island during the winter season.*

This procedure will avoid potential impacts to the high value fish spawning and over-wintering habitat associated with open water areas in the east channel and at the mouth of Fish Creek.

Procedure: *Maintain 650 foot buffer on critical winter moose habitats and river crossing sites where possible*. No key crossing locations have been observed so far; open water does not represent a major barrier to moose.

***Procedure:** Use ice-covered sand flats and ice shelves during winter.*

- Use of ACB and amphitrac during winter to travel across ice covered sand flats and ice shelves, avoiding the shallow reaches lower Taku River sand flats, thereby avoiding potential disturbance to sand flat.

***Procedure:** To the extent practical, avoid ice-breaking during winter freeze-up and spring thaw.*

This procedure will accomplish the following objectives:

- Avoids ice breaking and allows the river to freeze up and thaw naturally. A frozen river surface is the preferred operational condition for the Taku River ACB transportation system in winter.

Travel on a solid, frozen surface of ice and snow is preferred during the winter season, as this will allow the amphitrac to operate continuously on rubber tires, and avoid making transitions into and out of the water. Due to the variable conditions that are likely to be encountered during winter and transition season operations, it is reasonable to assume that some breaking of ice cover will occur from time to time, at spot locations. Nonetheless, the objective will be to minimize these occurrences. This will be accomplished by the following procedures:

  - through the avoidance of permanently open leads, and areas where leads are found to commonly occur from time to time during the winter, to the extent practical;
  - monitor and record locations where ice cover is most variable, and where it is most stable, and to adjust the route to follow areas of more consistent, stable ice;
  - Use of land fast ice (over gravel/sand bars) and over ice-covered shallows will be used when moving from open water channels onto ice;
  - Record the period of time that is required each year for solid stable ice cover to develop
  - to the extent practical, operations will be adjusted to allow a stable ice surface to establish in sections of the river that cannot be easily avoided, and that are prone to variable ice conditions.
  - Adjustments in operations would accommodate mid-winter thaws, if these should occur to the extent that the stability of ice is compromised in certain locations. Given the heavy snow accumulation in this area that acts as an insulating layer over the ice, extensive mid-winter thaws are rare occurrences.

4.3 Transition Season

The barging operations during the spring and fall, when water levels are insufficient for the shallow draft tug to operate in some sections of the river, and when ice is forming or breaking up on the river, will require specific procedures and equipment in order to continue operations throughout these periods. The results of the channel depth analysis in the lower Taku River (Tulsequah Chief Mine Air Cushion Barge Transportation System, Volume 1, Appendix A) show that the shallow draft tug can successfully navigate the river once the discharge reaches 24,700 cfs (700m^3/s) or greater, regardless of tidal conditions. Shallow draft tugs can also navigate at flows of 17,500 cfs (500 m^3/s) combined with tides in excess of 8 ft. Based on the mean flow of the Taku River hydrograph, the shallow draft tug could generally operate from the middle of May to about the third week of August without relying on tidal assist (see Figure 4) The shallow draft tug could operate an additional 6 weeks during higher tides when the Taku River discharge falls below 24,700 cfs (700 m3/s). At other times during the transition periods when there is insufficient depth for the shallow draft tug, the amphitrac, operating mostly aquatically, on wheels and/or ice, is required. These periods of transition will typically fall between early April and the late May, and from mid- to late August until early November.

Procedure: *Use tidal assist (a rising tide, mean tide or higher) whenever possible during the transition season to traverse the shallow portions of the sand flats fully aquatically.*

This procedure will minimize the potential disturbance to the sand flats during the transition season, when river discharge is low and tidal influence will play a larger role in the depth of water in the channel(s) crossing the sand flats.

4.4 Temporary Operating Suspensions

Given the unpredictable nature of weather, coupled with variable river, ice/snow conditions, particularly during the winter months, Redfern has identified certain circumstances that would likely result in the temporary suspension or delay of operations. During the first couple of years of operations, detailed log books will be maintained to record weather and river conditions and operating procedures performed on a daily (or weekly) basis. This information will be used to refine operational procedures, scheduling, etc. where changes to these procedures are indicated through experience gained on the river. The proposed operating plan incorporates 20% downtime to accommodate weather delays, suspension during freeze-up and break-up, and routine maintenance. The table below presents some of the potential conditions that would likely cause operations to be temporarily suspended; it should be recognized, however, that the operating ranges indicated and the associated operating guidelines will vary as further experience is gained during the initial years of operations, and due to unusual weather events that cannot be predicted.

Operating Constraints for ACB Operations on the Taku River

Condition	Range	Operating Guideline
Snow accumulation over 48 hours	> 16 inches	• The route will be groomed ahead of the ACB using the amphitrac (multiple passes will be required, depending on depth of fresh snow)
	8 to 16 inches	• May require two amphitracs to push and pull the ACB along the lightly compacted route.
	< 8 inches	• No specific procedures needed.
Temperature	< - 22° F (-30° C)	• Delay operations until temperatures predicted to remain above -22° F for at least 24 hours. * ** Concern relates to crew safety; equipment is designed to operate at temperatures at or below -22°F;*
Sustained Wind Speed *High wind speeds that could cause temporary delay in operations are more of a concern in Taku Inlet, Gastineau Channel area and are less of a concern on the river itself.*	>46 mph *(>Beaufort Scale 8; fresh gale or stronger)*	• Delay operations until wind speed remains below 46 mph for 24 hours;
	25 to 46 mph *(Beaufort Scale 6-8; strong breeze to fresh gale)*	• If wind speed is building, or strong winds continue to be forecast, delay departure until suitable conditions are forecast for 24-hour period. • If wind speed were subsiding, and forecast to continue to drop, operations would proceed on schedule.
	<25 mph *(Beaufort Scale 6; calm to fresh breeze)*	• If wind speeds were less than 25 mph, operations would proceed as scheduled.

Condition	Range	Operating Guideline
Thickness of Floating Ice and Extent of Ice Cover[1]	≤ 3 inches thick shelf ice ≥3 inches thick shelf ice ≥ 80% continuous ice cover on river	• Maintain aquatic operations in open mainstem channel (avoid thin ice shelves forming along sides of river channel, or near gravel bars) • Select route that traverses solid shelf ice, avoiding open leads in mainstem as much as possible to minimize ice breaking and maintain efficient operations • No operational constraints if shelf ice cover is continuous, as ACB route would remain on top of ice avoiding need to transition from open water onto floating ice.
Jumble Ice Accumulation	Not expected to pose operational constraint on most of river (areas of accumulation can largely be avoided)	• Use flail/roller bar on amphitrac to groom route and flatten jumble ice, if needed
Visibility *Vessels will be equipped with navigational aids similar to marine vessels, including floodlights, strobe lights, search lights etc.*	<50 feet 50 to 100 feet >100 feet	• Delay departure until visibility improves to ensure operator visibility between tow vessel and ACB (approx. 50ft). • Follow GPS route; reduce speed as determined by barge master • No constraints identified
Current Velocity *Fastest current is in the narrows at Canyon Island, during freshet, where maximum velocity can reach 9 to 10 knots.*	9 to 10 knots <9 knots	• Narrows at Canyon Island will not be traversed by ACB during aquatic season. Route will use east channel at Canyon Island where current is slower. • Barge master to assess whether additional power is required (e.g. second tug or amphitrac) to maintain control at all times. • SDT has 2000 HP engine and is more than adequate to manoeuvre ACB upstream and downstream at this velocity.

[1] For purposes of this document, shelf ice means all floating ice extending from the shoreline, and including land fast ice extending up to the mainstem (thalweg) river channel. Due to the braided nature of the river and lower water levels during the late fall and winter, formation of ice is quite extensive and tends to form first over gravel bars and shallow channels, whereas the thalweg remains ice free for a longer period, and tends to freeze last (where river current is highest). Travel on ice-covered land or gravel/sand bars is preferred, avoiding potential for ice breaking that can occur if transitioning from open water onto floating ice.

4.5 General Procedures

Procedure: *Implement the Wildlife Management Plan.*

This Plan will provide direction to minimize impacts to wildlife habitat and populations through best management practices and establishment of wildlife monitoring programs. The monitoring will include a Bear/Human Management Plan and outline general operating expectations and procedures for reporting wildlife sightings and incidents, etc. The Plan provides framework for modifying operations if warranted.

Procedure: *Implement a No Firearms Policy for all Redfern employees, including the ACB crews and personnel.*

Procedure*: Implement a Wildlife right-of-Way Policy for transportation system operations*.

This procedure will minimize potential for collision or disturbance of moose using the transportation route in winter. The slow travel speed of the ACB will allow animals to move away from the approaching ACB, also minimizing the potential for wildlife collisions.

Procedure*: A minimum distance of 650 feet from active bald eagle nest sites will be maintained during ACB operations, where possible*.

Identify high value *bald eagle* sites and avoid during operations through distance or timing, to extent possible. This measure will minimize disturbance of active bald eagle nest sites during operations.

Procedure*: Avoid, to the extent possible, high value nearshore and freshwater foraging birds and waterfowl habitats during operations through distance and timing.*

The ACB route mostly follows the deeper channels thereby avoiding nearshore areas favoured by marine foraging birds and waterfowl.

Procedure*: Avoid high value Shorebird habitats* during operations through distance and timing, where practical. The ACB route mostly follows the deeper channel of the river, thereby avoiding shorebird habitat and disturbance of foraging birds.

Procedure: *Develop a Transportation Communication Plan that will, at minimum, include the following*:

- a schedule of ACB transits throughout the open water season to be communicated to commercial fishermen and organizations, the Taku River Recreation Association and the general public in advance of the open water season, and any commercial fishing openings;
- advance notification of any changes to the schedule, to the extent practical;

- direct communication with commercial fishing organizations prior to the start of the commercial fishing season, and again at the close of the season to identify particular issues that may arise;
- radio communication on the tug operating on a common marine frequency;
- equipping the barge and tug with standard marine lighting to ensure visibility;
- direct communication with the Alaska Dept. of Fish and Game prior to the start of the Personal Use fishery, and again at the close of the season to identify particular issues that may arise and identify means to avoid or minimize conflicts with this fishery and navigation;
- seasonal discussions with the Taku River Recreation Association to review the Communications Plan and identify opportunities for improvement; reporting of incidents;
- communication with ADF&G to identify any interference to research activities; and
- discussions with the Taku Lodge operators to co-ordinate schedules to minimize disruption to the incoming and outgoing aircraft activity. This may include routine or seasonal meetings to review the success of the co-ordination and communication.

Procedure: *The ACB and towing vessels will be maintained in good condition and repair, ensuring a tidy, clean and generally acceptable appearance of the vessels at all times.*
This will reduce visual impacts.

Procedure: *The ACB and towing vessels will be navigated by experienced crew who are familiar with the river and obstacles along the route.* If warranted, travel speeds will be reduced along the section of the route near recreational properties (Martini Row, for example) to ensure that potential collisions with structures adjacent to the shore (docks; wharves) and small craft are avoided in congested areas.

Procedure: *In the event of a mishap that results in damage to structures such as docks, wharves or other property moored along the shoreline, the property owner would be compensated for any damages attributable to the ACB operations.*

Procedure: *During times of heavy boat traffic, a pilot vessel will notify any small craft of the pending approach of the ACB.*

5. Monitoring and Follow-up

5.1 River Operations; River Conditions

During the first two years of year-round operations, information concerning actual operating conditions will be recorded throughout the year. The range of seasonal conditions (river discharge, ice formation and stability; currents; weather conditions) have been assumed based on a combination of historic records, local knowledge and local experience related to weather and river conditions that are likely to occur on the Taku River. Operations will be adjusted to accommodate variability in the conditions as change occurs, on a daily, weekly, and seasonal basis, and to accommodate unusual conditions that may be encountered throughout the seasons, to the extent necessary and practical.

A daily trip log will be maintained by the barge master, and will include the following records:

- Cargo manifest and load
- Crew list
- Equipment used (SDT; one or two amphitracs; ancillary vessels)
- Trip statistics (departure times, lapsed time; etc)
- Daily log of operational procedures (use of Archimedes screws (location; conditions); transit time; travel speed; use of ice auger/winch;
- Record of any significant alteration of route and rationale for alteration
- Wildlife sightings
- Delays; reasons for delays; duration
- Daily weather conditions, including temperature; wind speed and direction; precipitation; snowfall accumulation (weather data will be collected at the Tulsequah Chief mine,
- A GPS track of each trip will be recorded digitally and logged
- A depth sounder will be operated continuously and monitored by the barge master
- A log of the depth sounder will be maintained, and reviewed weekly to review the preferred route/channel depth over the seasons.
- Ice thickness (specific locations to be determined; measured weekly)
- Weekly recorded observations on freeze-up and break-up

River discharge (daily) recorded at Canyon Island will be monitored and recorded.

This information will be summarized in a report at the end of each season (twice annually).

5.2 Aquatic Effects Monitoring

Monitoring is proposed to confirm predicted aquatic effects, and if warranted, to identify and implement additional adaptive management measures to further minimize effects. The monitoring objectives, monitoring plans, adaptive management measures, and reporting requirements will be developed in consultation with the appropriate management agencies.

5.2.1 Stranding of Juvenile Fish

A monitoring program will be implemented during the initial months of open water operations to confirm that there are not significant numbers of juvenile fish being stranded due to ACB operations. This monitoring will be carried out at low gradient beach areas along the route during the first year of operation. If it is found that significant numbers of fish are being stranded by ACB operations, adaptive management measures will be identified and implemented to reduce stranding. Such measures could include reducing speed when ACB approaches identified stranding sites.

5.2.2 Entrainment of small fish

A monitoring program will be implemented during initial months of open water operations to confirm there are no significant adverse effects associated with entrainment of small fish under the air cushion as the ACB crosses from water to gravel bars. If observations indicate that significant numbers of small fish are being entrained, then adaptive management measures will be taken to ensure that these effects are minimized to the extent possible.

5.2.3 Disturbance of Sand Flats during Transition Season

Prior to routine usage of the ACB/amphitrac in the transition season, trials at the tidal flat area would be conducted with environmental monitors to select the preferred operating method that minimizes disturbance to the sand flats during the low water transition season. The choice of the most appropriate route (sand bars or aquatic route) over the sand flats during eulachon migration and spawning periods will minimize any effect on the eulachon population. Initial tests will be made to select the most appropriate route and tide level combinations and the effects will be monitored during the barging operation. Adaptive management measures such as modifying the route followed through this area in order to minimize these potential effects will be implemented.

5.2.4 Spawning Habitat at Canyon Island during Transition Season operations

Engage an environmental monitor to observe the Canyon Island area in late summer and fall when water levels are lower, and implement adaptive management measures if spawning impacts are observed.

5.3 Bank Erosion

An erosion monitoring program will be implemented in areas that have been identified as susceptible to bank erosion during the first two years of operations. If monitoring observations indicate that ACB operations are contributing significantly to bank erosion and associated re-suspension of sediments, then adaptive management measures such as speed reduction in specific areas may be warranted to further reduce such effects.

- Monitor wake waves in vicinity of Martini Row using wave height-monitoring equipments. Adjust barge operation (e.g., travel speed) if unacceptable wakes are reported.
- Monitor wake waves in areas identified as susceptible to wake-related erosion.

5.4 Wildlife Effects Monitoring

Wildlife monitoring programs have been identified for a number of species, in particular grizzly bears, moose, grey wolves, and several species groups of birds that inhabit or migrate through the area. These wildlife monitoring programs are presented in a conceptual form below, with the intention of developing more detailed programs in consultation with agency personnel and professional assistance prior to operations. The primary purpose of monitoring habitat use of these species would be to determine whether there is significant disturbance of foraging or nesting activities attributable to the ACB operations, and to adapt operations to further reduce significant effects. This would be achieved through providing additional buffers between the prime habitat areas along the route, and/or timing adjustments, if warranted. Wildlife monitoring would be carried out during the first couple of years of operations, to determine the effectiveness of any adaptive management measures that may be identified in the first full year of operations. The specific wildlife monitoring programs that will be implemented during this initial period of operations include:

- Monitor *grizzly bear* habitat use on Taku tidal flats through mapping bear locations and modify route/timing based on observed use patterns.
- Implement monitoring of *moose winter movements* and locations of *moose and grey wolves* before and during the ACB operations. This would be done using periodic aerial and ground snow track surveys and plotting locations of moose/wolves along the Taku River in relation to the ACB route.
- Monitor *bald eagle* habitat/nest use to determine if the ACB operations are affecting nest use. This monitoring would involve obtaining accurate nest location information during the late winter when nests are readily visible using aerial surveys. The nests would be checked for

occupancy during the late spring-early summer using ground surveys and occupied nests would be monitored from the ground to determine if ACB movements are causing disturbance.

- *Nearshore and Freshwater Foraging Birds and Waterfowl* Habitat use and populations will be monitored, and operations modified where practical and warranted.
- Monitoring of *shorebird* habitat use and populations and modify operations where practical. Mapping of high use areas would allow the identification of preferred route(s), and may provide opportunities to modify routes or timing to reduce disturbance effects.

6. Spill Contingency Planning; Emergency Preparedness

The conceptualization of the air cushion barging (ACB) system has evolved in an iterative manner with engineering design, transportation logistics and environmental management all given due consideration. As a result, preventative and mitigative measures have been incorporated into the proposed air cushion barging system, and the potential for accidents and malfunctions has been discussed and considered at some length during this process. Protocols will be implemented that are designed to minimize environmental disturbances and hazards to people, aquatic systems and wildlife. Most importantly, all reagents or dangerous goods shipped upstream and all concentrate and dangerous goods shipped downstream will be transported in standard containers designed for marine and riverine use and approved by all the relevant regulatory agencies in both Canada and the United States. In addition, the proposed transportation system will be connected to the larger shipping route from Alaska to the contiguous United States and therefore all shipping containers will be required to meet all standard shipping regulations on that route. Redfern will develop a comprehensive spill prevention and contingency plan, prior to commencement of operation of the transportation system, which will be used by Redfern and any transportation system contractors.

The following sections outline examples of potential mishaps, including spills, and where appropriate, measures incorporated to prevent or minimize the associated risk.

6.1 Spills of Hazardous Materials

Potentially hazardous materials, such as diesel fuel, reagents, and ore concentrate, will be transported in significant quantities on the ACB system. On average, there will be one round trip daily between the ACB landing site and Juneau. On a typical outbound ACB load, nine or ten containers of ore concentrate will be shipped, and on a typical inbound barge load, up to 14,000 gallons of diesel fuel and 34 tonnes of cement will be transported. Table 2 lists a typical ACB load traveling upstream and Table 3 lists the process consumables that will be transported by the ACB system and in what containers they will be shipped. Materials will be assembled into standard ISO containers before shipping to site.

Table 2. Typical Barge Load to Tulsequah Chief Project

Material	Approximate Weight (tons)
Diesel	51
Cement	37
Process Consumables	23
Misc. Equipment and Supplies	6.6
Food and Camp Supplies	5.5
Propane	2.2
Explosives	2.2
Process Plant Maintenance Supplies	1.6
Rock Bolts	0.6
Misc. Underground Supplies	0.3

Table 3. Process Consumables to be Transported via ACB Transportation System

Material	Delivery Container[2]
Flocculant	55 lb bags
Copper Sulphate ($CuSO_4$)	1.1 ton supersacs
Zinc Sulphate ($ZnSO_4$)	1.1 ton supersacs
Sodium Sulphite ($Na2SO_3$)	1.1 ton supersacs
Methyl Isobutyl Carbinol	Tanker truck or 200 L drums
DF250 (frother)	Tanker truck
Potassium Amyl Xanthate	Pellet form in 1.1 ton drum or 1.1 ton tote bags
Sodium Cyanide (NaCN)	Briquette form in 220 lb. drums or 1.1 ton tote bags
Sodium Metabisulphite ($Na_2S_2O_5$)	Powder form in 1.1 ton fabric bags
Sodium Ethyl Xanthate	Pellet form in 1.1 ton drums
3418A	Liquid in drums
Sulphuric Acid (H_2SO_4)	Tanker truck
Dextrin	220 lb. fabric bags or 55 lb bags
Ferric Sulphate (Fe2(SO4)3)	Tanker truck
Lime	Unslaked powder form in 44 ton trucks

6.1.1 Spills on water

All cargo will also be transported in marine-certified containers to prevent leakage or spills into water. Hazardous materials will be handled and transported in accordance with current regulations pertaining to transportation of hazardous goods. The containers will be secured to the deck of the barge to prevent shifting during transit. There will be no transfer of bulk materials from one barge to

[2] All materials packaged in bags will be transported in containers on the ACB

another during the transfer from river to marine operations; rather the river and marine tugs will exchange barges.

6.1.1.1 Diesel Spills

Fuel will be transported to site in either ISO tanks or standard fuel tanker truck approved for public transportation systems. These will be secured on the ACB by industry-standard methods. Redfern has committed to joining SEAPRO (Southeastern Alaska Petroleum Resource Organization). SEAPRO has pre-positioned oil spill response teams and equipment maintained in a state of readiness in the event that any member organization has an incident. There is a SEAPRO team located in Juneau, AK. SEAPRO is also classified as an oil spill removal organization for rivers and canals.

6.1.1.2 Reagent Spills

Redfern will establish and implement a Spill Contingency Plan that specifically addresses potential spills of hazardous materials and fuel that will be transported on the barge. The Spill Contingency Plan will comply with all applicable regulations and requirements in Alaska. In the event that a portion of the transportation system is contracted to an independent operator, Redfern will require that the operator meet all legislated requirements regarding the shipping of dangerous goods.

6.1.1.3 Concentrate Losses

The ore concentrate will be shipped in sealed containers. Given the weight of these containers and the stability of the barge, loss of a container overboard is considered to be very unlikely. The sealed containers would prevent or minimize spillage of concentrate into the environment, even in the unlikely event that a container became submerged. If the container were to become submerged negative impacts to the environment would be limited as oxidation of the concentrate would be prevented by submergence.

6.1.2 Mechanical Failure of ACB

It is possible that one or more of the four engines on the ACB could fail during operations. The ACB can maintain hover on only two engines, and the likelihood of all four engines failing simultaneously is very remote. The loss of hover on the ACB would mean that the barge would settle onto the surface and float or rest on the pontoon, depending if it is on water or land at the time. As more than one towing vessel (the shallow draft tug and amphitrac, or two amphitracs) will frequently operate together, crews would be able to provide mutual support to manoeuvre the barge into a secure position until the engine(s) could be repaired. No adverse environmental impacts are anticipated.

6.1.3 Mechanical Failure of Amphitrac

It is possible that one or more of the engines could fail during operations. Two engines will be dedicated to powering the screws and metal wheels; one engine will be dedicated to powering the soft tire wheels. It is very unlikely that more than a single engine would fail at one time. If one of the engines powering the screws were to fail, it can still progress on a single engine. If the engine powering the soft tire wheels should fail, a second amphitrac would tow the amphitrac to the minesite where the engine would be repaired. No adverse environmental impacts would occur as a result of mechanical failure.

6.1.4 Mechanical Failure of Shallow Draft Tug

While it is possible that the shallow draft tug could experience a mechanical failure during operations, contingency plans will be prepared to deal with this situation. Typically, another tug or suitable vessel will provide assistance to the crippled vessel, and tow it to Juneau where it can be repaired. In the case of the shallow draft tug operating on the river, the amphitracs would provide the needed assistance to tow it out to the Taku Inlet where it would then be towed or escorted to Juneau by a marine tug or other suitable vessel. The barge would be taken off hover, anchored, tied to shore, or set down on shore, until such time that another vessel could rendezvous with the barge and complete the trip. No environmental impacts are anticipated.

6.1.5 Grounding

In the event that the shallow-draft tug run aground, the standard procedures will be followed to re-float the tug. This may involve waiting for tidal assist, commercial towing, or winching off.. While grounding is an inconvenience, it does not usually pose a serious threat to safety. Given that the tugs are most likely to run aground on sand or gravel bars the risk associated with this kind of accident is minimal. In any event, running aground is a standard operational risk and there are minimal environmental impacts associated with this type of mishap. The ACBs cannot “ground out” as they are fully amphibious.

6.1.6 Capsize of ACB

Capsize of the ACB is highly unlikely given its size, dimensions and low profile. The ACB hover height is remotely controlled, and can be lowered off hover to provide additional stability on water or land if needed. The design is such that it will float on the pontoon, and continue to remain afloat even if there is damage to a portion of the pontoon. As such, it is very improbable that the ACB would capsize or sink. The ACB skirts remain flexible in temperatures as low as – 50° C, and extreme cold temperatures are very rare in this environment.

6.1.7 River Collisions

The Taku River is used for pleasure boating as well as recreational, sport, and personal use fishing. In order to avoid any collisions with other craft, the ACB, amphitracs and tug boats will be equipped with lights and a fog-horn or noisemaker and will follow all navigational rules and regulations. Only qualified operators will be retained to run the ACB, tug boats and amphitracs. In the event that a portion of the transportation system is contracted out, Redfern will require the operator to follow all relevant regulations and legislation regarding emergency preparedness.