# Southeast Alaska Mid-Region Access
# Air-Cushion Vehicle
# Technical Memorandum

*Prepared for*

**Federal Highway Administration**

*Prepared by*


**Robert Peccia and Associates, Inc.**
825 Custer Avenue
Helena, Montana 59604
(406)447-5000
www.rpa-hln.com

**Parametrix, Inc.**
700 NE Multnomah, Suite 1000
Portland, OR 97232-4110
T. 503.233.2400  F, 503.233.4825
www.parametrix.com

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Prepared by Robert Peccia and
Associates, Inc., Helena, Montana
Parametrix, Inc., Bellevue, Washington.
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# List of Acronyms and Abbreviations

| | |
|---|---|
| AC | alternating current |
| ACV | air-cushion vehicle |
| AEB | Aleutians East Borough |
| AADT | annual average daily traffic |
| B.C. | British Columbia |
| BHT | British Hovercraft Technology |
| bkW | brake kilowatt |
| cfs | cubic feet per second |
| DC | direct current |
| DOT&PF | Alaska Department of Transportation & Public Facilities |
| °F | degrees Fahrenheit |
| GHS | Global Hovercraft Services, Ltd. |
| GPS | Global Positioning System |
| hp | horsepower |
| lbs | pounds |
| mph | miles per hour |
| MRA | mid-region access |
| nm | nautical mile |
| OEM | original equipment manufacturer |
| psi | pounds per square inch |
| PVC | polyvinyl chloride |
| rpm | revolutions per minute |
| sq ft | square feet |
| U.S. | United States |
| USCG | United States Coast Guard |
| USPS | United States Postal Service |
| UV | ultraviolet |

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## EXECUTIVE SUMMARY

The Southeast Alaska Transportation Plan identified a mid-region access (MRA) highway corridor that would connect Southeast Alaska to the British Columbia (B.C.) continental highway system. Following completion of the Southeast Alaska MRA Study, the Alaska Department of Transportation and Public Facilities (DOT&PF) requested additional technical studies, including the Southeast Alaska Mid-Region Access Port and Ferry Terminal Technical Memorandum (Port and Ferry Memorandum), which was drafted to determine suitable port locations to support inter-modal access along previously studied corridors. This document is a supplement to the previous reports. It contains an evaluation of using air-cushion vehicles (ACVs) for passengers and vehicles along the Stikine River from the Iskut River to Wrangell and Mitkof Islands.

The three proposed MRA corridors (Bradfield Canal, Stikine River, and Aaron Creek) are proposed to be built in stages to account for funding limitations. Temporary travel means are needed to connect Southeast Alaska to the Cassiar Highway while the ultimate corridor is being completed. Stage 1 of the Stikine River and Aaron Creek Corridors proposes an ACV passenger ferry system to provide interim service between the Iskut River roadway and Southeast Alaska. Stage 1 operations would continue until a road alternative could be provided.

Three ACV terminal ports were identified along these corridors, one at the Iskut River near the confluence with the Stikine, another near Wrangell Airport, and the third at the end of the Mitkof Highway at the southeastern tip of Mitkof Island. The round-trip distance on this route is 92 nautical miles.

An ACV is a craft designed to travel over any smooth surface. The ACV is supported by a cushion of slowly moving, high-pressure air ejected downwards against the surface below and contained within a skirt. Pressurized air is captured in the skirt, causing the ACV to rise to a predetermined height. Certain skirt designs can minimize surface disturbance, creating no wake behind the craft.

A Hoverbarge is a load-lifting commercial ACV with a deck size similar to a conventional barge. Hoverbarges can be self-propelled with an air propulsion system or non-self propelled, which requires either a ground contact propulsion system or towing by boat, helicopter, or tractors.

ACVs have been used in arctic climates for military and commercial service for more than 30 years. However, environmental and ecological considerations must be addressed during the permitting process. Examples of ACV operations in the area include the Cominco Metals ACV mining operations on the Stikine and Iskut Rivers in the 1990s, the current United States Postal Service (USPS) ACV mail and freight operations at Bethel, the current Aleutians East Borough (AEB)

Cold Bay and King Cove ACV ferry service, and the recently proposed Redfern Resources ACV barge mining operations on the Taku River.

The operating environment can significantly influence ACV performance and reliability. Factors include wind speed, extreme cold temperatures, surface roughness, ice thickness, sea conditions, and spray icing. The United States Coast Guard (USCG) regulations limit ACV operations to wind speeds under 35 knots (40 miles per hour) and waves less than 10 feet. ACVs commonly cannot operate at temperatures near negative 40 degrees Fahrenheit (°F). Icing caused by the spray of freezing water can also limit operation, likely occurring in thin ice conditions or over water in temperatures less than 32°F in fresh water and 28°F in salt water. Extreme low water conditions may also suspend operations.

The Stikine route is over open ocean and a river that freezes and thaws, creating the potential for ice rubble. Operations would likely be suspended for weeks during the fall freeze and spring thaw. The Stikine River basin is also prone to high winds and extremely cold temperatures.

For ACV planning and scheduling purposes, the Port and Ferry Memorandum recommended a traveling speed of 28 knots (32 miles per hour) along the Stikine River and 38 knots (44 miles per hour) for open ocean conditions. Loading, unloading, and fueling time at terminal ports is estimated at 1 hour per stop. The total time for one round trip per ACV on the Stikine River is estimated at 6 hours. This transit time would permit two round trips per 12-hour crew shift during the summer season. During the winter season, only one round trip would be feasible. Hoverbarge operating speeds range from 4 to 8 miles per hour (mph) regardless of surface conditions. The time for one round trip per Hoverbarge on the Stikine would be almost 26 hours. The ACV Hoverbarge transit time allows only one-way travel per day regardless of season.

ACV manufacturers could design and construct ACVs to operate successfully in arctic conditions along the Stikine Corridor. The Jones Act requires United States (U.S.) maritime commerce vessels to be manned and manufactured in this country by U.S. citizens. Two ACV manufacturers that meet the project requirements and Jones Act restrictions are Global Hovercraft Services, Ltd. (GHS) and Hovertrans.

Standard GHS models could be altered to meet traffic requirements and arctic conditions for this project. The GHS-100 model can accommodate 16 vehicles and 50 passengers. The GHS-160 model can accommodate 25 vehicles and 100 passengers. Three GHS-100 ACVs or two GHS-160 ACVs would be needed to meet the projected traffic in 2030. Three terminal ports would be required on the system with one hangar or maintenance building.

Hovertrans could also modify Hoverbarge base specifications to meet the project requirements. One ACV Hoverbarge is large enough to carry the projected 2030 traffic. However, the slow operating speed would allow only a one-way trip per day on the Stikine River.

Developing accurate costs for an ACV system this early in the planning stage is difficult without a detailed analysis of the proposed route. A detailed cost analysis with the ACV manufacturers must be conducted as the project scope becomes defined in the subsequent planning stages.

GHS is a service provider that supplies and operates ACVs over 5-year periods. The service program consists of constructing a specifically tailored ACV to fit the proposed route and operations and maintenance of the ACV program. The GHS service contract may be paid for by full public financing, full GHS private financing, or a joint venture of public and private GHS financing. If 100 percent public financing were used, the system might be self-sustaining with no further capital or government subsidies required following the initial payment for service.

GHS estimated the service contract to construct, operate, and maintain three arctic class ACVs to be approximately $85 million for five years. The three ports are estimated at $1 million to $10 million each, depending on the extent of the facilities and engineering measures required.

Hovertrans estimated an 8-year lease for one Hoverbarge to be approximately $48 million. The cost of the Hoverbarge lease is for the Hoverbarge only and does not include operation or maintenance costs.

Passengers, vehicles, freight, and mail delivery would generate potential revenue. Most ferry and ACV systems in Alaska do not generate enough revenue to cover operating costs and require annual subsidies. ACV service contracts are an option to conventional purchasing and may not require annual subsidies if 100 percent public financing were used.

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# 1 INTRODUCTION

The purpose of the Southeast Alaska Mid-Region Access (MRA) Study is to evaluate alternatives to connect mid Southeast Alaska to the continental highway system via the Cassiar Highway in British Columbia (B.C.). The study area covers several thousand square miles and is bounded by the Stikine/LeConte Wilderness to the north, Wrangell and Mitkof Islands to the west, Misty Fiords National Monument Wilderness to the south, and Cassiar Highway in Canada to the east. The study area is shown on Figure 1.1.

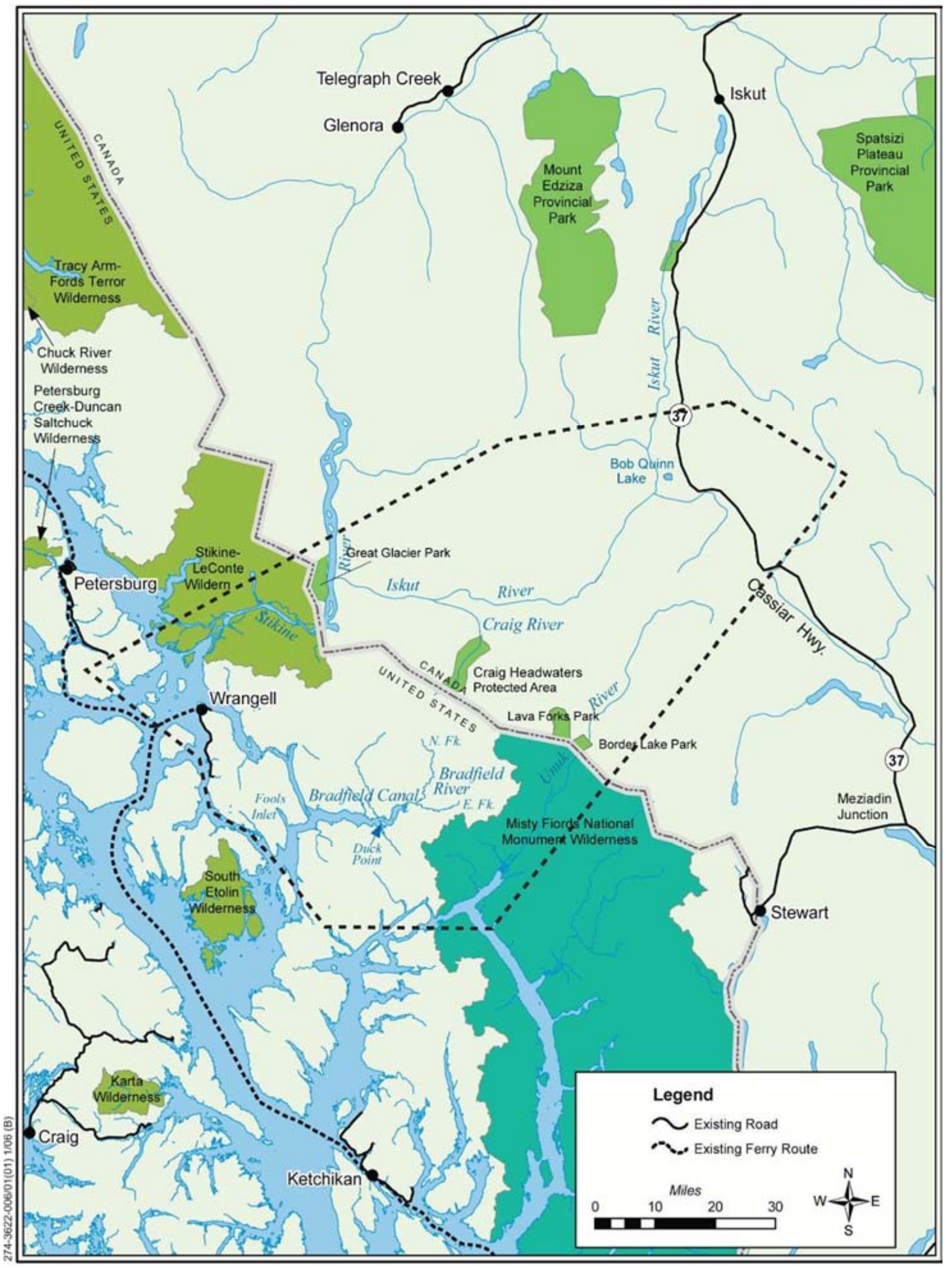


**Figure 1-1. Southeast Alaska Mid-Region Access Study Area**

## 1.1 Study Corridors

The study considers three proposed alternatives for a MRA surface transportation corridor connecting the communities of Wrangell and Petersburg in Southeast Alaska to the continental highway system in B.C. Traveling from these communities to the highway system currently requires a lengthy ferry trip to either Prince Rupert to the south or Haines or Skagway to the north. The three MRA corridors (Bradfield Canal, Stikine River, and Aaron Creek) would connect Wrangell and Petersburg to the Cassiar Highway by way of the Bradfield River, Craig River, Stikine River, Aaron Creek, Katete River, and Iskut River valleys. Some alternatives would include short ferry routes to complete the transportation network. Figure 1.2 shows the proposed corridors, as well as the existing roads and ferry routes currently in place.

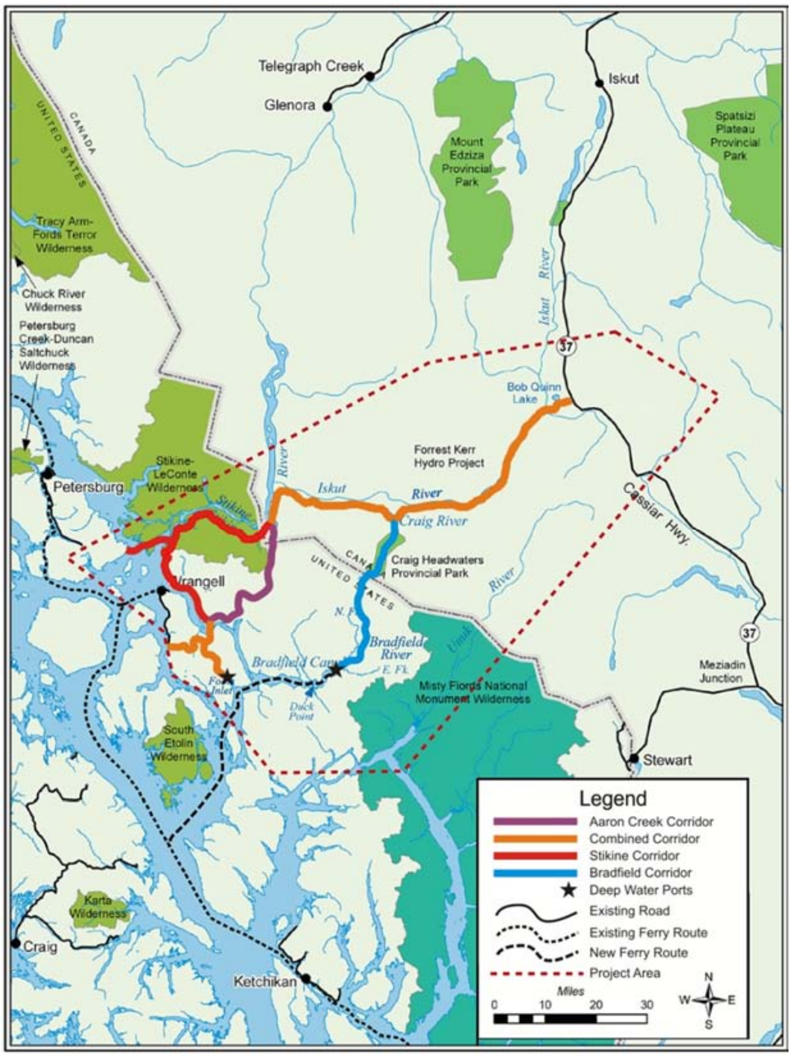


**Figure 1-2 Southeast Alaska Mid-Region Access Study Corridors**

### 1.2 Purpose

The Southeast Alaska Mid-Region Access Port and Ferry Terminal Technical Memorandum (Port and Ferry Terminal) was commissioned to indicate suitable port locations to support intermodal access along the three study corridors. Part of the assignment under that task was assessing the feasibility of potential air-cushion vehicle (ACV) terminal sites on the Stikine and/or Iskut Rivers in Canada and constructing opposing terminal sites on Wrangell and South Mitkof Islands. These terminal sites and the use of an ACV would serve as an interim connection link for both the Stikine River and Aaron Creek Corridors.

This technical memorandum is intended to further evaluate the potential use of ACVs as part of the Stikine River and Aaron Creek Corridors. The ACVs would transport passengers and vehicles along the Stikine River from an ACV terminal near the confluence of the Iskut and Stikine River to Wrangell and Mitkof Islands.

### 1.3 Proposed Route

Both the Stikine River and the Aaron Creek Corridors would connect the Cassiar Highway to Wrangell and Mitkof Islands via the Stikine River as an interim connection (Figure 1-3). Stage 1 of both the Stikine River and Aaron Creek Corridors consists of an ACV to provide interim service before final road build-out during the later stages. This option assumes extension of the road from the Cassiar Highway to a suitable terminal site on the Iskut River near the confluence with the Stikine. Stage 1 would take place until a road alternative is provided.

The Port and Ferry Memorandum identified potential ACV terminal sites for Stage 1. The three ACV terminal sites would be sited at the following locations:

- South side of the Iskut River near the confluence with the Stikine River
- Near Wrangell Airport
- Near the end of Mitkof Highway 7 at the southeastern tip of Mitkof Island

It also estimated ACV route one-way distances would approximate the following:

- Mitkof Island to Iskut Port – 41 nautical miles (nm)
- Iskut Port to Wrangell Island – 41 nm
- Wrangell Island to Mitkof Island – 10 nm

These distances assume that the Dry Strait ACV terminal location on Mitkof Island would be selected. The total round-trip distance would be 92 nm, with approximately 24 nm of open ocean and 68 nm on the Stikine River.

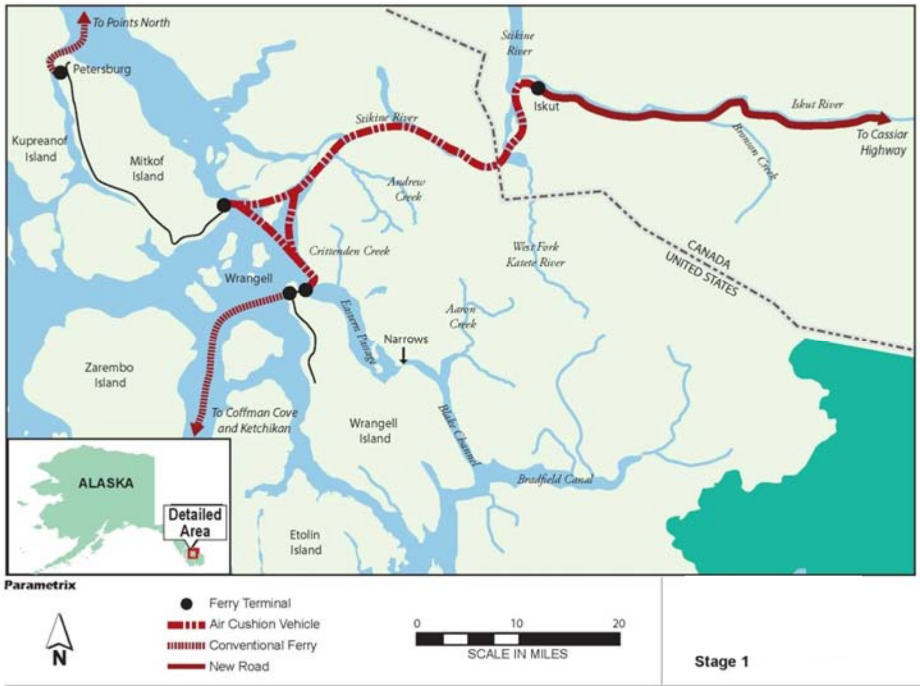


**Figure 1-3. Stikine River and Aaron Creek Corridors, Stage 1**

## 1.4 River Environment

The 379-mile-long, glacially influenced Stikine River originates in northwestern B.C. Above Telegraph Creek a 45-mile-long, 1,000-foot-deep gorge called the Grand Canyon of the Stikine separates the inland and costal portions of the river. The lower 40 miles are located in Alaska, and the river forms a delta near Mitkof Island. The river drains a 19,920-square-mile area of rugged, pristine, undeveloped wilderness of the Coast Mountains in Canada and Alaska. The lower third of the river has a relatively flat gradient and is navigable.

The average discharge 18 miles northeast of Wrangell ranges from 9,200 cubic feet per second (cfs) in March to 137,500 cfs in June. The maximum recorded peak flow on the Stikine was 351,000 cfs in September 1994.

The lower Stikine River is up to 1,000 feet wide and has broad, extensive flood plains. The fall freeze and spring thaw render the river impassable for weeks. The Stikine River basin is also prone to high winds and cold temperatures.

### 1.5 Projected Traffic

The Southeast Alaska Mid-Region Access Traffic Projections Technical Memorandum discussed the projected traffic estimates for design year 2030 along the Stikine River Corridor. The projected traffic consists of diverted and induced traffic. Diverted traffic is current traffic on existing modes that would shift to the new corridor. Induced traffic is new travel on the corridor.

The traffic memorandum indicated that the diverted and induced regional traffic would be 63 annual average daily traffic (AADT) trips for Stage 1 of the Stikine River and Aaron Creek Corridors in 2030 (22,812 vehicles per year). Diverted traffic would be 52 AADT (18,950 vehicles per year), and induced traffic would be 11 AADT (3,862 vehicles per year). The traffic projections do not include traffic that may be related to potential mineral development and shipment of metal concentrates from mines in Canada.

July is the peak travel month, accounting for 16 percent of the annual travel in 2008 in Southeast Alaska. Applying the 16 percent peak to the projected traffic would result in 3,650 vehicles during the peak month, or 118 AADT during July.

The above-mentioned traffic projections were estimated using the most recent available information (i.e., 2006 or 2007) at the time of the analysis in 2008. Since then, AMHS adopted a discount pricing strategy to attract more traffic. AMHS also added two fast ferries (catamarans) and has provided more frequent service to several communities in Southeast Alaska, which has increased ridership. These structural changes in the travel time and cost of the AMHS option have made it a more attractive option than it was when the earlier analysis estimated diverted traffic for Stage 1 (ACV). Therefore, the above-mentioned traffic projections for the ACV in Stage 1 are approximations that likely overestimate the diverted traffic that would actually occur given the changes in the AMHS pricing and service levels. Furthermore, ACV service could be adversely affected by freezing temperatures and high wind speeds. These issues with ACV service reliability could result in even lower traffic volumes than indicated above. It was decided not to update traffic estimates for Stage 1 in subsequent analyses.

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# 2 ACV BACKGROUND

ACVs have been used for more than 30 years in arctic climates for military and commercial service. Applicable ACV operations in arctic conditions include the following:

- Cominco Metals ACV – mining operations on the Stikine and Iskut Rivers, 1991 to 1996
- United States Postal Service (USPS) ACV – mail and freight operations at Bethel, 1997 to present
- Aleutians East Borough (AEB) Cold Bay and King Cove ACV – ferry service, 2007 to present
- Proposed Redfern Resources ACV – barge mining operations on the Taku River

## 2.1 Cominco Metals ACV

Cominco Metals used an AP1-88 model cargo ACV (Figure 2-1) to support mining operations between Wrangell and Bronson Creek. The ACV was operated seasonally between April and November on the Stikine and Iskut Rivers in the 1990s. The AP1-88 model ACV is approximately 70 feet long and 40 feet wide.

In 1996, an environmental review was prepared for the Friends of the Stikine society due to concerns that the ACV may have negative environmental impacts on fish habitat. The Friends of the Stikine filed a lawsuit based on the study. Mining operations were independently shut down shortly after the lawsuit was filed.

**Figure 2-1. Similar AP1-88 model ACV at Southsea Hover Terminal**

### 2.2 USPS Bethel ACV

USPS currently uses an AP1-88 model ACV to carry mail and cargo along the Kuskokwim River from Bethel, Alaska, to seven remote villages. The ACV operates year-round except for a week during spring thaw and 5 to 6 weeks during fall freeze of the river. The ACV systems were modified to make them more efficient in arctic conditions. The ACV operates to temperatures above negative 40 degrees Fahrenheit (°F). The craft can haul six tons of cargo. Alaskan Hovercraft Ventures contracts with USPS to operate the ACV. In 2003, Alaskan Hovercraft Ventures reported that the operation was profitable.

USPS conducted a 3-year ecological monitoring program to study the effects of ACV operation on fish and wildlife. The study indicated that there are no significant adverse impacts and that the ACV is an environmentally acceptable mode of transportation.

### 2.3 Aleutians East Borough ACV

The Aleutians East Borough currently uses a model BHT-130, a passenger ACV (the Suna-X; Figure 2-2), daily between King Cove and Cold Bay. At 98 feet long and 46 feet wide, the Suna-X carries 50 passengers and 22 tons of freight, including four passenger vehicles. Suna-X was designed by the British firm Hoverwork Ltd.

The 8-mile trip across the bay takes 20 minutes, with a top speed of 58 miles per hour (mph). The craft can travel in wave heights up to 10 feet and winds up to 35 mph, meeting 95 percent reliability. The United States Coast Guard (USCG) requires four pilots and two crew members on the Suna-X.

**Figure 2-2. Similar BHT-130 model ACV**

Congress approved the ACV funding as an interim measure until the controversial road through the Izembek National Wildlife Refuge can be resolved. Approximate costs were $9 million for the ACV, $7 million for the ACV terminal, $550,000 per year for crew salaries, and $300,000 per year for insurance. The ACV costs approximately $100,000 per month to operate, requiring a $500,000-per-year government subsidy. Passenger fares are approximately $80 for one-way travel.

### 2.4 Redfern Resources Proposed ACV Hoverbarge

Redfern Resources proposed operating a 750-ton-loaded, 88-foot-wide ACV Hoverbarge (Figure 2-3) on the Taku River to support mining operations at the Tulsequah Mine. The state of Alaska has halted this highly controversial project twice over concerns about environmental and fishing industry impacts.

The non-self-propelled Hoverbarge, Amphitrac, is untested and is currently under construction. In March 2009, Redfern Resources sought bankruptcy protection.

**Figure 2-3. Similar Hoverbarge at Port Glasgow**

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## 3 ACV REQUIREMENTS

An ACV is a craft designed to travel over any smooth surface. It is supported by a cushion of slowly moving, high-pressure air ejected downwards against the surface below and contained within a skirt. Pressurized air captured in the skirt causes the ACV to rise to a predetermined height. Certain skirt designs can minimize surface disturbance, creating no wake behind the craft.

ACVs are used throughout the world as a method of specialized transport wherever there is a need to travel over multiple types of surfaces. Because they are supported by a cushion of air, ACVs are unique among all forms of transportation in their ability to travel equally well over land, ice, and water.

### 3.1 Operating Conditions

The operating environment can significantly influence ACV performance and reliability. Factors include wind speed, extreme cold temperatures, surface roughness, ice thickness, sea conditions, and spray icing.

The USCG limits ACV operations to winds under 35 knots (40 mph) and waves less than 10 feet. ACVs commonly cannot operate at temperatures near negative 40°F. Icing caused by the spray of freezing water can also limit operation, likely occurring in thin-ice conditions or over water during cold temperatures less than 32°F in fresh water and less than 28°F in salt water. Extremely low water conditions may also suspend operations.

Surface roughness is one of the most important factors affecting operations. Ice rubble can prevent the skirt from sealing properly, resulting in loss of cushion. Design of ACVs operating in arctic conditions requires special attention to cushion depth. The Stikine route is over open ocean and a river that freezes and thaws, creating the potential for ice rubble. Operations would likely be suspended for weeks during the fall freeze and spring thaw.

### 3.2 Speed and Travel Time

ACV operating speeds range from 35 to 85 mph, depending on surface conditions and obstacles. For ACV planning and scheduling purposes, The Port and Ferry Memorandum recommended 28 knots (32 mph) along the Stikine River and 38 knots (44 mph) for open ocean conditions. Approximate one-way travel time for ACVs is as follows:

- Wrangell to Iskut – 1 hour, 25 minutes
- Iskut to Mitkof Island – 1 hour, 25 minutes

- Mitkof Island to Wrangell – 15 minutes

Loading, unloading, and fueling time at terminal ports is estimated at 1 hour per stop. The total time for one round trip per vehicle is approximately 6 hours. This transit time permits two round trips per 12-hour crew shift during the summer season. During the winter season, only one round trip is feasible.

Hoverbarge operating speeds range from 4 to 8 mph, regardless of surface conditions. Approximate one-way travel time for Hoverbarges is as follows:

- Wrangell to Iskut – 10 hours
- Iskut to Mitkof Island – 10 hours
- Mitkof Island to Wrangell – 2 hours, 30 minutes

The excessive transit time required for Hoverbarges would allow only a single one-way trip per day, regardless of the season.

### 3.3 Capacity

The ACV capacity is based on projected traffic, number of round trips per day, number of ACVs in operation, and cargo being transported. The projected traffic in 2030 would be 118 AADT during the July peak and 63 AADT the remainder of the year. The average weight of a passenger car is 2.5 tons and 40 tons for a semi-truck. Two round trips per ACV would probably occur during the summer season and one round trip in winter. Each vehicle would likely contain two passengers. Trucks would represent approximately 10 percent of the AADT. The required capacity is estimated as follows:

- Winter season – one ACV in operation
    - One round trip per day per ACV
    - 63 AADT total; approximately 32 vehicles each direction per trip
    - 29 passenger cars, 3 trucks, and 70 passengers, including crew members
    - Required capacity of approximately 200 tons
- Winter season – two ACVs in operation
    - One round trip per day per ACV
    - 63 AADT total; approximately 32 vehicles each direction per trip per ACV
    - 14 passenger cars, 2 trucks, and 38 passengers, including crew members
    - Required capacity of approximately 125 tons

- Winter season – three ACVs in operation
  - One round trip per day per ACV
  - 63 AADT total; approximately 32 vehicles each direction per trip per ACV
  - 10 passenger cars, 1 truck, and 28 passengers, including crew members
  - Required capacity of approximately 70 tons
- Summer season – one ACV in operation
  - Two round trips per day per ACV
  - Peak 118 AADT, 59 vehicles each way; approximately 30 vehicles per trip
  - 27 passenger cars, 3 trucks, and 66 passengers, including crew members
  - Required capacity of approximately 200 tons
- Summer season – two ACVs in operation
  - Two round trips per day per ACV
  - Peak 118 AADT, 59 vehicles each way; approximately 30 vehicles per trip per ACV
  - 15 passenger cars, 2 trucks, and 40 passengers, including crew members
  - Required capacity of approximately 125 tons
- Summer season – three ACVs in operation
  - Two round trips per day per ACV
  - Peak 118 AADT, 59 vehicles each way; approximately 30 vehicles per trip per ACV
  - 9 passenger cars, 1 truck, and 26 passengers, including crew members
  - Required capacity of approximately 70 tons

Benefits to operating multiple ACVs over a single larger craft include greater schedule flexibility, lower upfront costs, and the ability to accommodate future growth. During maintenance periods, a reduced capacity is preferred to complete shutdown of a corridor.

### 3.4 ACV Terminal Ports

ACV terminal ports require modest facilities consisting of a loading ramp, landing pad with approaches, and access roads. One terminal port in the ACV ferry system would require a hangar or maintenance facility. Ideally, access roads would be located outside floodplains.

The location of a port is critical to loading and unloading cargo. The port must be located above extreme high water in tidewater locations and above extreme flood stage for river locations. The

Port and Ferry Memorandum identified three possible and promising port locations along the Stikine River Corridor near the confluence with the Stikine and Iskut Rivers. The Iskut port may require civil engineering measures to ensure ACV access at all river stages and to limit river migration. The report also identified four promising terminal port locations at Mitkof Island and one at the north end of Wrangell Airport.

## 3.5 Environmental Considerations

ACVs have successfully navigated sensitive lands over the past 30 years. However, environmental and ecological considerations would have to be addressed during the permitting process. ACV operations may have to be altered as environmental conditions change, such as during spring thaw, fall freeze, and extreme low flow conditions.

Freezing temperatures pose a risk to ACVs due to icing from the spray generated by the craft. After a river freezes, an ACV can travel on ice; however, travel in the open ocean remains a concern. For a few weeks at breakup and at freeze-up, an ACV cannot operate on a river. When operating in freshwater, such as traveling up the Stikine River, the critical temperature is 32°F. When operating in open ocean, such as between Mitkof Island and Wrangell and between Wrangell and the Stikine River, the critical temperature is 28°F. Between 1949 and 2007, Wrangell had an average of 11.4 days in January, 5.5 days in February, 1.6 days in March, 3.4 days in November, and 7.3 days in December with the average maximum temperature below 32°F.

Data from the weather station at Wrangell Airport show that all of January and February had minimum temperatures below 28°F, as well as 6 days in March and 21 days in December (Western Regional Climate Center, 2009). Daily maximum temperatures in those months exceeded 28°F. Temperatures at inland points would be lower than those reported at Wrangell, which is influenced by the marine environment.

Per USCG regulations, operation of an ACV between King Cove and Cold Bay is limited to winds that do not exceed 35 knots and/or 10-foot seas. Whether there would be 10-foot seas in the area is uncertain, but wind speeds that would affect the maneuverability of the ACV would be likely down the Stikine River. Even if the ACV could accommodate strong winds, it would probably travel at much slower speeds during times of high wind speeds, which would result in longer travel times than expected.

Figure 3-1 shows temperature, barometric pressure, wind speed, and direction for Wrangell for the week of February 10 through 16, 2008. This week was randomly selected and is thought to represent this period over time. Figure 3-1 suggests that temperature may have precluded an ACV from operating on Saturday and Sunday of this week, although low temperatures on Friday afternoon may also have been a concern. In addition, wind speeds on Tuesday and Wednesday may have precluded ACV operations, particularly since the 90-degree wind direction would be the same winds that would be coming down the Stikine River, at even greater velocities.

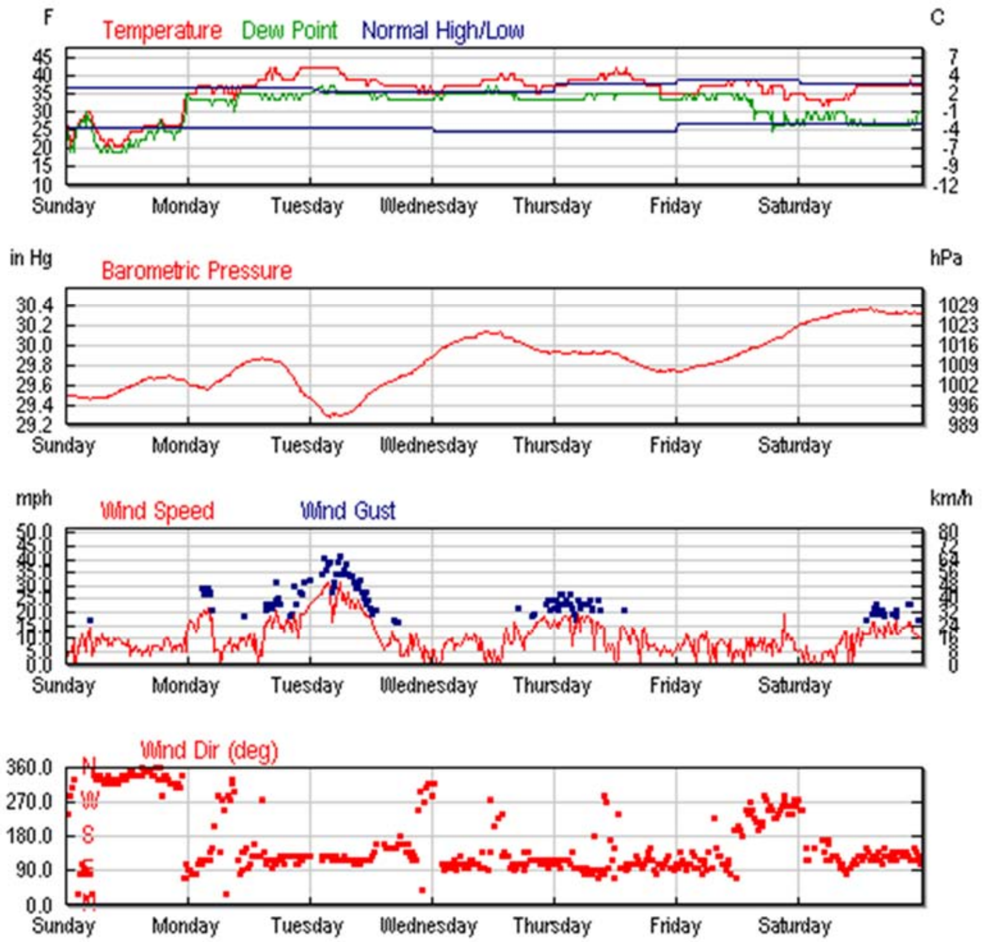


**Figure 3-1. Temperature, Barometric Pressure, Wind Speed and Direction at Wrangell February 10 to 16, 2008**

Source: Weatherunderground 2008

A review of other weeks' climatic data indicates that freezing temperatures existed for the entire week of January 27, 2008, through February 2, 2008, and again for February 6, 2008, through February 9, 2008.

The combination of low temperatures and high wind speeds, particularly during winter months, could affect the reliability of the ACV. Lack of reliability could result in fewer passengers than anticipated, as is the case for the Aleutians East Borough's ACV.

### 3.6 Noise

Most ACVs use diesel electric motors for propulsion. Noise generated for these types of propulsion systems range from 72 decibels to 85 decibels. The noise transmitted underwater is minimal as determined by a three-year demonstration study completed for USPS.

# 4 QUALIFIED ACV MANUFACTURERS

Several manufacturers in the world can produce ACVs able to operate in arctic conditions. The Merchant Marine Act of 1920, one of three federal laws known as the Jones Act, governs potential manufacturers. The Jones Act requires U.S. maritime commerce vessels to be manned and manufactured in this country by U.S. citizens. The restriction prevents American ship owners from refurbishing ships at oversea yards. Two ACV manufacturers meet the project requirements and Jones Act restrictions: Global Hovercraft Services, Ltd. (http://www.usamarineservice.com/) and Hovertrans (http://www.hovertrans.com/). Both companies produce ACVs that operate in arctic conditions.

## 4.1 Global Hovercraft Services

### 4.1.1 Company Background

Global Hovercraft Services, Ltd. (GHS) is an owner and operator of cargo and passenger ACVs. GHS provides a full-service ACV transportation system that complies with the Jones Act and USCG requirements. The GHS ACV fleet includes passenger models, cargo and drive-on/drive-off models, and rescue models. The GHS ACVs accommodate 12 to 600 passengers. GHS could produce an ACV design to meet the specific needs of traveling along the Stikine River. A 150-passenger ACV is currently under construction for another project (Figure 4-1).


**Figure 4-1. Concept of similar Atlas AH-100 ACV**

### 4.1.2 Technology

GHS developed a diesel and electric thrust vectored propulsion system that solved the problems of poor control and excessive noise. The GHS design does not use airplane parts and eliminates

90 percent of marine parts. The company uses a special skirt design that maximizes lift energy and minimizes the surface disturbance, creating a no-wake zone behind the ACV.

### 4.1.3 Performance

GHS can modify standard passenger, vehicle, and cargo models to meet the project requirements. The payload weight ranges from 16 to 600 tons. The hover height reaches a maximum of 16 feet from the bottom of the hull to the surface water. Fuel capacity is more than 30,000 gallons of diesel fuel, with the ability to use environmentally-friendly biodiesel fuel. The average cruising speed on open water conditions is 53 knots (60 mph). The ACVs can travel from 3,600 to 6,000 miles before refueling. The ease of operation for the GHS models lowers the cost of operations, maintenance, and fuel consumption.

### 4.1.4 ACV Specifications

Standard GHS models can be altered to meet the traffic requirements and arctic conditions for this project. The standard models include the GHS-100 and the GHS-160.

### 4.1.5 GHS-100 Specifications

The GHS-100 model can accommodate 8 to 12 passenger vehicles and 75 to 100 passengers on one deck. If two decks are used, the GHS-100 can accommodate 16 vehicles and 50 passengers. One semi-truck takes up the space of four passenger cars. The Stikine River and Aaron Creek Corridors would require three GHS-100 ACVs to meet the projected traffic in design year 2030.

***Off Hover***

Length of hull—100 feet

Beam of hull—50 feet

Height (landing skids to top of cabin) —15 feet

Height (landing skids to top of Pilothouse) —24 feet

***On Hover***

Length overall—125 feet

Beam overall—68 feet

Height to top of pilothouse—32 feet

***Hover Height***

Maximum (hard surface/high psi) —8 feet

Minimum (soft surface/low psi) —4 feet

***Payload and Capacity***

Payload total (minimum) —60,000 lbs/30 tons

Crew—3 (1 pilot, 1 navigator, 1 crew/deckhand)

Passengers—150 to 200 (passengers and crew members @ 260 lbs each)

Passenger and crew—total weight equals 40,000 lbs/20 tons

Additional cargo capacity—20,000 lbs/10 tons

***Displacement and Draft***

Average loaded (passengers and fuel)

Saltwater—202,242 lbs/90.28 long tons

Freshwater—197,622 lbs/88.22 long tons

Draft—12 inches

***Speed***

Over open water—35 to 85 mph

Over ice or land—85 mph

***Stopping Distance (estimated)***

Average full speed—350 feet

Average emergency stop—150 feet

Maximum wind and wave—35 to 40 knots/8 feet to 12 feet

***Propulsion System (Diesel/Electric) Engines***

Diesel/generators (3,400 hp total) —850 hp @ 1800 rpm 633 bkW

Charging/starting—24-volt

Fuel tanks (composite) —10,000 gallons

Useable fuel—9,000 gallons

Total fuel consumption per hour—150 gallons per hour

Maximum duration and distance—60 hours @ 60 mph/3,600 miles

Normal operation (round trip) —2,400 miles

(1/3 to destination—1/3 for return—1/3 for emergency reserves)

***Thrust Vectoring Duct System***

Four 5-blade propellers with 8-foot diameter

Four 180° rotation propeller ducts with 10-foot diameter

***Lift System***

Four lift fans with direct drive electric motors and speed controllers

Payload area—2,500 sq ft

Lift area—5,000 sq ft

Lift capacity—300,000 lbs/133.93 long tons

Skirt style—modified loop and segmented finger skirts

Material weight—40 ounces per yard for main loop; 40 ounces per yard for fingers

Material type—polyurethane extrusion-coated nylon reinforcement

Tensile strength—1,500 lbs

Temperature range—60°F to 180°F

Abrasion resistance/tabor H18

All seams thermal sealed for maximum strength and pressure integrity

Material resistant to saltwater, fuels, and chemicals

Material—highest UV ray resistance available

Stainless steel and nylon fastening hardware

***Electrical System***

One 50-kilowatt diesel generator—110-volt/220-volt AC

Marine breaker panel with shore power/generator/battery switch

24-volt DC system with power converter to 12-volt DC

24-volt AGM/VR sealed batteries (main engines and systems power)

Battery charger and inverter system

External shore power connection

***Control System***

Fully electronic over hydraulic direction and speed controls with backup systems

Full instrumentation and monitoring of all systems from pilothouse

***Hull and Cabin Construction***

Construction material-VE and Epoxy Resin, E and S-Glass, PVC foam core composite

Windshield/windows—scratch-resistant polycarbonate, UV, anti-fog protection

Marine windshield wiper system

Landing skids—UHMW plastic

All fasteners and hardware—stainless steel, nylon, or composite

High density rubberized coated deck with anti-skid finish

150 face-forward, USCG-approved seats

Fully insulated and padded interior and headliner

Main cabin headroom—8-foot average

Cabin access—main entrance is by a 60-foot-wide Bow Ramp. Four doors (48 inches wide) are located on each side of the main cabin for crew access and emergency escape. Two 48-inch-wide doors are located at the sides of the pilothouse for top deck access.

***Sanitation***

Two ADA accessible marine washroom facilities with fresh and wastewater holding tanks with on board pump out system

***Cabin Climate Control***

Reverse cycle heat/air-conditioning system

Passive/active ventilation system

***Safety and Navigation Package***

Navigation lights and amber strobe

Anchor, chain, and 600 feet of rope

Flux gate compass

One hundred sixty USCG-approved, Type I life jackets (plus thirty extra for children)

Eight 24-inch ring buoys

One waterproof dive light

Electric horn, whistle, and visual distress kit

ACR Globalfix GPS EPIRB category I

USCG-approved first aid kit

***Fire Control***

High-pressure water fog systems in each of the four engine rooms

Warning lights and audio signal in Pilothouse

Twelve B-1 fire extinguishers in engine rooms, main cabin, and pilothouse

***Standard Electronics Package***

GPS

VHF marine radio/hailer with antenna

Furuno radar/chart plotter (color screen)

Two remote-control spot/flood lights

***Spare Parts Kit***

One hundred twenty segmented finger skirts with nylon bolt sets

One 3M emergency patch kit for main loop skirt

One set of fuel filters

One set of oil filters

One set of hydraulic filters

One set of alternator and water pump drive belts

One set of left-hand and right-hand propeller blades

Two sets of windshield wiper blades

***Warranty***

The original equipment manufacturers' (OEM) warranty covers all engines, hydraulics, electrical components, and subsystems. The GHS warranty covers the hull and cabin structures against defects in materials and workmanship.

***Noise Levels***

***Note 1:*** The GHS ACV and items listed above are standard equipped. The craft can be factory equipped to the client's specifications and requirements.

***Note 2:*** Exact noise levels must still be determined, but the target external levels are at or below 79 dbA or industry standards. Internal levels are 50 dbA or lower.

***Note 3:*** Due to the nature of ACV technology and the constant advancements of the industry and USCG regulations, GHS reserves the right to make changes in these specifications at any time without notice. However, any changes reflected within the specifications will be reported to the buyer immediately upon determination of such change. Only certain customer-requested specifications that do not interfere with the safety or engineering of the ACV will be made with written and verbal notice to the customer.

### 4.1.6 GHS-160 Specifications

The GHS-160 model can accommodate 25 vehicles and 100 passengers. One semi-truck takes up the space of four passenger cars. The Stikine River and Aaron Creek Corridors would require two GHS-160 ACVs to meet projected traffic in design year 2030.

***Off Hover***

Length of hull—160 feet

Beam of hull—80 feet

Height (landing skids to top of cabin) —22 feet

Height (landing skids to top of pilothouse) —30 feet

***On Hover***

Length overall—190 feet

Beam overall—90 feet

Height to top of pilothouse—42 feet

***Hover Height***

Maximum (hard surface/high psi)—12 feet

Minimum (soft surface/low psi) —8 feet

***Payload and Capacity***

Payload total—800,000 lbs/400 tons

Crew—6 (1 pilot, 1 navigator, 1 chief engineer, 3 deck engineers)

***Speed***

Over open water—35 to 60 mph (30 to 52 knots)

Average wind and wave—35 to 40 knots/8 to 12 feet

***Propulsion System (Diesel/Electric) Engines***

Eight diesel/generators (8,000 hp total) —1,000 hp @ 1,800 rpm

Charging/starting—24-volt/65-amp

Fuel tanks —30,000 gallons

Total fuel consumption per hour—400 gallons per hour (max)

Maximum duration and distance—72 hours @ 60 mph

Normal operation (round trip) —2,880 miles

(1/3 to destination – 1/3 for return – 1/3 for emergency reserve)

***Thrust Vectoring Duct System***

Eight 5-blade propellers with 16-foot diameter

Eight 180° rotation propeller ducts with 20-foot diameter

***Lift System***

Sixteen lift fans with direct drive electric motors and speed controllers

Stainless steel and nylon fastening hardware for the skirt system

***Electrical System***

Two 100-kilowatt diesel generators—110-volt/220-volt AC

Marine breaker panel with shore power/generator/battery switch

24-volt DC systems with power converter to 12-volt DC

24-volt AGM/VR sealed batteries (main engines and systems power)

Battery charger and inverter system

External shore power connection

***Sanitation***

Two ADA accessible marine washroom facilities with fresh and wastewater holding tanks with on board pump

***Cabin Climate Control***

Reverse-cycle heat/air conditioning system

Passive/active ventilation system

***Safety and Navigation Package***

Navigation lights and amber strobe

Anchor and chain with winch

Flux gate compass

Sixteen 24-inch ring buoys

One waterproof dive light

Electric horn, whistle, and visual distress kit

ACR Globalfix GPS EPIRB Category I

USCG-approved first aid kit

***Fire Control***

High-pressure water fog systems in each of the eight engine rooms

Warning lights and audio signal in pilothouse

Sixty B-1 fire extinguishers in engine rooms, main cabin, and pilothouse

***Standard Electronics Package***

GPS

VHF marine radio/hailer with antenna

Furuno radar/chart plotter (color screen)

Two remote control spot/flood lights

***Spare Parts Kit***

Three hundred segmented finger skirts with nylon bolt sets

One 3M emergency patch kit for main loop skirt

One set of fuel filters

One set of oil filters

One set of alternator and water pump drive belts

One set of left-hand and right-hand propeller blades

***Warranty***

OEM  warranty covers all engines, electronics, and sub-systems.

GHS warranty covers the hull and cabin against defects of materials and workmanship.

***Noise Levels***

***Note 1:*** The GHS ACV and items listed above are standard equipped. The craft can be factory-equipped to the client's specifications and requirements.

***Note 2:*** Exact noise levels must be determined. Target external levels are at or below 86 dbA or industry standards. Internal levels are 60 dbA or lower.

***Note 3:*** Due to the nature of ACV technology and the constant advancements of the industry and USCG regulations, GHS reserves the right to make changes in these specifications without notice at any time. However, any changes reflected within the specifications will be reported to the buyer immediately upon determination of such change. Only certain customer requested specifications that do not interfere with the safety or engineering of the ACV will be made with written and verbal notice to the customer.

### 4.1.7 ACV Terminal Port

GHS can also assist with design and layout of ACV terminal ports, loading ramps, landing pads, and passenger and cargo handling areas.

#### 4.1.8 Full Service Operations

GHS can provide full service operations for clients. This includes supplying operations crew, ACV maintenance, insurance, a ticketing and reservations system, marketing for public systems, and security.

Advanced ACVs require a high-caliber crew to ensure safe and reliable operations. The GHS master captain, in charge of all crew training and ACV operations worldwide, is one of the most experienced large-scale ACV pilots and navigators in the industry. He operated the largest commercial passenger and vehicle ACVs in history, the 400-passenger, SRN-4 Mountbatten Class ACVs. The GHS operations staff comprises ACV pilots and navigators with both commercial and military experience from the Arctic to the desert.

GHS also can manage all aspects of maintenance and repairs. All costs are paid directly from operations income of the ACV service. GHS's direct relationships with suppliers can minimize maintenance expenses.

Most of the required insurance comes from GHS. The client pays for any additional insurance required by local and government law of the country of operations. These details are worked out on a contract-by-contract basis since laws vary by jurisdiction.

GHS can provide a state-of-the-art ticketing and reservations system. The system is fully computerized and essentially cashless, protecting clients against loss of income from mishandling of money at the fair box. Clients also have instant access to travel agencies and other worldwide reservations firms. The GHS program works diligently to pre-sell available spaces. They are reserved and paid for months in advance of operations. The goal is to make sure clients have a waiting list. An independent audit committee and an internationally respected accounting and finance firm monitor disperse funds on a monthly basis to the client and to GHS. The computer system allows a client 24-hour access to monitor passenger, cargo, and cash flow.

GHS also offers a full range of marketing services to help clients attract more passengers and cargo contracts by using a global network. This includes access to major logistics and shipping companies, hotel chains, cruise lines, and event planners.

Finally, GHS can provide security services, including cargo screening and passenger and luggage security. This security system may fulfill insurance company requirements for ACV operations. The result is maximum safety, minimized risk, and lower insurance premiums.

### 4.1.9 Contract Terms

The goal of GHS is to build strong, long-term relationships and contracts. The initial contract period is 72 months. It can be renewed by mutual consent for 60 months on a continual basis. The initial contract is divided into three phases. Phase one is outfitting; it consists of ACV design and construction specific to the project route and requirements. Phase one typically lasts 12 months. Phase two is pre-operations, including certification, ACV delivery, and crew training. Phase two typically lasts two months. Phase three is standard operations; it is startup of ACV operations. Phase three typically lasts from 58 to 60 months.

Down payments are determined on a contract-by-contract basis. Fixed costs include the ACV, crew, maintenance, insurance, ticketing and reservations, marketing, and security. Variable costs are diesel fuel and any fees or licenses required by law for ACV operations.

## 4.2 Hovertrans ACV Hoverbarge

A Hoverbarge is a load-lifting commercial ACV with a deck size similar to a conventional barge (Figure 4-2). Typically, Hoverbarges with lower than a 200-ton payload can be self propelled with an air propulsion system similar to ACV technology. Hoverbarges that exceed a 200-ton payload are non-self-propelled and require a ground contact propulsion system or have to be towed by boat, helicopter, or tractors. Hoverbarge payloads range from 50 to 2,500 tons.

**Figure 4-2. Siberian Hoverbarge with 200 ton payload by Hovertrans**

### 4.2.1 Company Background

Hovertrans was formed by the original managers of Mackace. The company has experience designing, constructing, and operating heavy-lift Hoverbarges throughout the world. Hovertrans also complies with the Jones Act and USCG requirements. Mackace produced the successful, 250-ton payload “Sea Pearl” Hoverbarge, which operated in Abu Dhabi, and the twin 160-ton payload "Yukon Princesses" Hoverbarges, which ferried trucks across the Yukon River for pipeline construction. In 2006, Hovertrans launched a 330-ton payload drilling barge in the swamps of Suriname.

### 4.2.2 Technology

The Hoverbarge will displace the same amount of water as a normal vessel until it reaches a certain speed. Then it will lift out and skim on top of the water. Top hover height is 6 feet, and it requires significant power. However, the Hoverbarge only exerts 1 pound per square inch while hovering, less than an average man uses to walk. The Hoverbarge is a drive-on/drive off craft, so loading ramps and pads are not required.

A natural rubber material is used for the skirt in arctic climates to provide a strong, flexible system (Figure 4-3). The Hoverbarge has 20-ton winches and an 8-ton hydraulic crane for cargo handling.

### 4.2.3 Performance

Hovertrans can modify Hoverbarge base specifications to meet project requirements. Operating speeds for a Hoverbarge range from 4 to 8 mph. The 40- to 50-mile, one-way route on the Stikine River would take a Hoverbarge 10 to 12 hours each direction. The Hoverbarge could not feasibly travel the entire roundtrip in 1 day. The slow operating speed would allow only one-way travel per day on the Stikine River.

**Figure 4-3. Siberian Hoverbarge by Hovertrans**

### 4.2.4 ACV Hoverbarge Specifications

The following are base specifications for the 200-ton Siberian Hoverbarge (Figure 4-4) by Hovertrans:

Length—148 feet

Width—82 feet

Free deck area—118 feet x 52 feet

Payload—220 tons

Hover height—6 feet

Ground pressure on hover—1 psi

Minimum operating temperature—40°C

Power—four CAT 3412 Diesel Generators

Lift—four Hovertrans centrifugal fans

Accommodation—five twin en-suite bunk rooms (insulated for cold weather)

Materials are manufactured from EH36 steel.

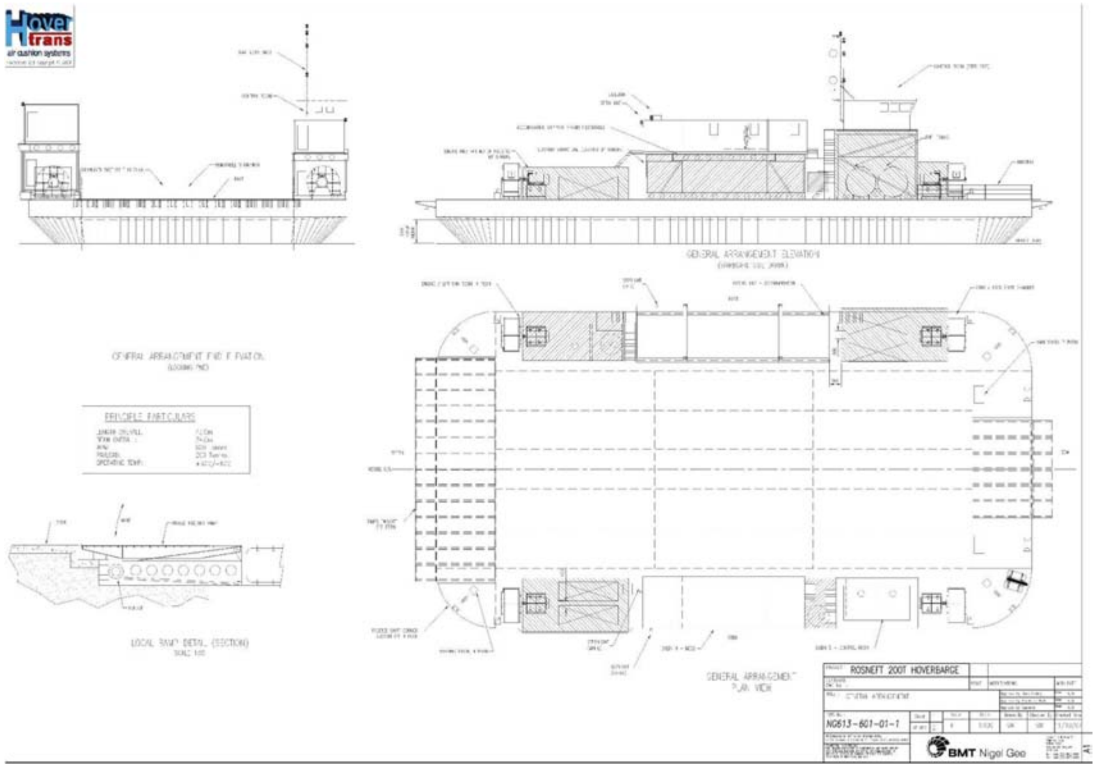


**Figure 4-4. Hovertrans Hoverbarge conceptual drawing**

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# 5 ACV COST ESTIMATES

## 5.1 ACV Costs

Developing accurate costs for an ACV system this early in the project is difficult without a detailed analysis of the proposed route. Exact ACV costs vary based on project-specific requirements, operating conditions, and environmental constraints. Contacts with ACV manufacturers were made to determine level of magnitude costs for this feasibility study. A detailed cost analysis with input from the ACV manufacturers must be conducted as the project scope becomes more defined in the subsequent planning stages.

GHS is a service provider that supplies and operates ACVs over five years. The service program consists of construction of a specifically tailored ACV to fit the proposed route, as well as operations and maintenance of the ACV program. The GHS service contract may be financed three different ways: 1) by full public financing, 2) by full GHS private financing, or 3) by a joint venture of public and private GHS financing. If 100 percent public financing is used, the system may be self-sustaining with no further capital or government subsidies required after the initial payment for service is made. Typically the cost of the service contract is one-third of the cost of buying the full system in place. Exact terms of the service contract are negotiated on a contract-by-contract basis.

GHS estimated the service contract to construct, operate, and maintain three arctic class ACVs to be approximately $85 million for five years. Hovertrans offers lease programs for Hoverbarges. The cost of the Hoverbarge lease is for the Hoverbarge only and does not include operation or maintenance costs. Hovertrans estimated an 8-year lease for one Hoverbarge to be approximately $48 million.

Three terminal ports would be needed for the Stikine River or the Aaron Creek Corridor. One of the three ports would require a maintenance facility or hangar for the ACV. The Stikine River has extensive floodplains, and the Iskut terminal location might require civil engineering measures to ensure access during all stages of the river. Terminal ports would likely cost $1 to $10 million each, depending on the extent of the facilities and the engineering measures required.

As a comparison, the AEB King Cove ACV operates on a 16-mile, round-trip route over open water twice daily. In 2007, AEB paid $9 million for the ACV and $7 million for the terminal port at King Cove. Operating expenses for the King Cove to Cold Bay route are approximately $1 million per year, including salaries for a crew of six, insurance on the ACV and terminal, fuel, and maintenance. Revenue generated from the route approximately covers half of the operating expenses. The remainder of the operating expenses is covered through annual government subsidies.

## 5.2 ACV Revenue

Passengers, vehicles, freight, and mail delivery would generate potential revenue. A detailed analysis of potential revenue must be performed as the financing or leasing options become more clearly defined.

Most ferry and ACV systems in Alaska do not generate enough revenue to cover operating costs and, thus, require annual subsidies. ACV service contracts would be an option to conventional purchasing and may not require annual subsidies if 100 percent public financing were used.

If a service contract were pursued, typically the service provider would take a percentage of the profits. This percentage would be negotiated on a contract-by-contract basis. This percentage would vary based on the portion of public and private financing dollars used and on the number of years in the service contract.

# 6 CONCLUSION

Based upon preliminary research, ACV manufacturers have the technical ability to design and construct vessels to operate successfully in arctic conditions along the Stikine River. However, cold weather, strong winds, and sensitive environmental issues may pose challenges to ACV operations. These conditions may have limiting factors on vessel's reliability and full-time operation.

Developing accurate costs of an ACV system this early in the project's development is difficult without a detailed analysis of the proposed route. A detailed cost analysis must be conducted with input from the ACV manufacturers as the project scope becomes more clearly defined in subsequent planning stages.

ACV service programs consist of construction of a specifically tailored ACV to fit the proposed route and operations and maintenance needed for the ACV program. Service contracts are financed by public, private, or a combination of public and private dollars. GHS is a service provider and estimated the service contract to construct, operate, and maintain three arctic class ACVs at approximately $85 million for a 5-year period.

Hovertrans estimated that an eight-year Hoverbarge lease would cost approximately $48 million. The lease cost would not include operations or maintenance costs. The slow operating speed of a Hoverbarge would allow only a single, one-way trip per day on the Stikine River Corridor. Even though the Hoverbarge is large enough to carry all the projected daily traffic, it could travel the proposed route in one day. Using this vessel to transport freight may be an option.

Terminal ports are estimated at $1 million to $10 million each, depending on the extent of the facilities and engineering measures required. Three terminal ports would be needed for the Stikine River Corridor route.

Most ferry and ACV systems in Alaska do not generate enough revenue to cover operating costs and require annual subsidies. ACV service contracts would be an option to conventional purchasing and may not require annual subsidies if 100 percent public financing were used.

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