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North Cascades National Park Service Complex
Lake Chelan Recreational Area
Washington

North Cascades Stehekin Valley Vehicle Decision Document

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Report Notes and Acknowledgments

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Introduction

This document serves as technical substantiation in support of a procurement for a fleet of vehicles to be used to operate a scheduled shuttle operation with multiple stops at North Cascades National Park Service Complex (NOCA), in the Stehekin Valley, located at the northern terminus of Lake Chelan in central Washington State, and an interpretive tour and ad-hoc group tours.

The community of Stehekin within Lake Chelan National Recreation Area is one of the very few communities in the lower 48 states not reachable by road. The 100 year-round residents (300+ in summer) who have vehicles in the Stehekin Valley got them there by barge, an option not feasible for the recreation area's 30,000-45,000+ annual visitors.

Located at the north end of 55-mile long Lake Chelan, the Stehekin road system is owned and maintained by the National Park Service (NPS). All visitors and residents use ferryboat, floatplane, horseback or hike to reach Stehekin. This is not too dissimilar to the way tourists in the 1880's and 1890's would reach Stehekin. They too took a "civilized" route, which included a train to Wenatchee, a steamboat up the Columbia River to Chelan Falls, a stage up to the town of Chelan, and finally a daylong excursion aboard a comfortable steamer up the fifty-five mile Lake Chelan[1].

While walking and bicycling allow visitors to see some aspects of this National Park Service area, for most people motorized transportation is a necessity for experiencing the park and getting to lodging facilities. The need for some form of motorized transportation for visitors was formally recognized in the latest General Management Plan (1995) by incorporating as an element a Transportation Plan. In 2004, the Transported Plan and vision for Stehekin was further articulated in a consultant-produced transportation study[2].

Currently, there is a very poor level of transportation service within the Stehekin Valley. The existing shuttle bus and concession tour operator uses old school buses that are prone to breakdowns. Multiple fuel types are used. The existing vehicles –already beyond their normal service life - are difficult to maintain and repair. Visitors pay for this service ($7 Adult round-trip fare for Rainbow Falls Tour; $5 Adult one-way fare for the Shuttle), but the quality of the experience, and the adverse noise and air emission impacts are contrary to and substantially below the standards at which the NPS wishes to manage this resource and accommodate visitor access.

Consistent with the transportation plan and vision for this area, and award of an ATPPL grant, the NPS has decided to procure a replacement fleet of vehicles. This report serves as a vehicle decision document, providing technical substantiation of requirements for the new replacement fleet of vehicles.

This document is organized in sections:

- "Vehicle Requirements" articulates the core vehicle requirements. These requirements have been developed in consultation and collaboration with NOCA staff and Otak Inc. Transportation Plan and statement of work developed by NPS, and also have been based on a field site reconnaissance of the route, including observations derived from a simulation of the intended duty cycle for the vehicle when operating to provide the interpretive service and the shuttle operation. Observations and measurements of the existing vehicles have also been made as a comparative baseline.

- "Questions and Answers" presents a sequence of decision recommendations, organized in the following format: Q*uestion, Answer (Q&A),* and *Discussion.*

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[1] See North Cascade National Park: Contested Terrain: An Administrative History, chapter 1.

[2] See Otak Inc., *Stehekin Transportation Study & Landing and Dock Conceptual Design*, March 2007.

- "Findings and Next Steps" summarizes key findings, including a recommendation for the replacement vehicles, and sets forth 'next steps' with respect to procurement strategy and action items.

Vehicle Requirements

Vehicle requirements for the transit and tour operations at NOCA have been determined based on consultation with NOCA staff and with the bus concessionaire, completion of a *vehicle requirements survey instrument* by NOCA staff (see Appendix), use of data collected by the FHWA Federal Lands Highway Road Inventory Program on the vertical profile of Stehekin Valley Road, award of an ATPPL grant, and a field site reconnaissance visit by both the project team planner and engineer. During the field site reconnaissance visit, the project team planner and engineer inspected the route, and rode the existing vehicle along the route. Observations were made of the negotiability and stability of the existing vehicle on the route. On the Rainbow Falls tour, the precise duty cycle was followed, which is a point-to-point shuttle service with interpretation on-board the vehicle with a single stop at Rainbow Falls. The park ranger with whom we drove the route did not simulate the transit shuttle service but did approximate operating speeds of the shuttle service on the route. But the shuttle stops were pointed out along the way, and the number of stops and inter-stop distances were provided on the *vehicle requirements survey instrument*. The discussion below is organized in sections corresponding to the General Service Administration (GSA) "How 2 Select Buses" brochure. All other issues, factors and preferences not corresponding to GSA's heading sections are articulated in the "Special Needs and Considerations" section, below.

What is the maximum number of adult or child seats, wheelchair positions, and standees to be accommodated?

NOCA staff has indicated a desired passenger capacity exceeding 20 seats (i.e., > 20). For safety and liability reasons and due to the nature of the type of operation (i.e., the necessity of unobstructed views to the landscape and resource, and the rough road surface), there are no standees allowed. NOCA staff has provided usage data for a sufficient duration of time on the existing services illustrating the time-dependent demand profile for both the shuttle operations to High Bridge and the interpretative tour to Rainbow Falls. Thus more precise estimates of the average passenger load and the expected maximum passenger load for each type of service have been computed. These are presented in Tables 1 and 2 for the Stehekin Shuttle service and the Rainbow Falls tour respectively. Subsequent to these computations, there is information that suggests that the passenger data may be low for the Stehekin shuttle (underreporting from the operator, particularly 1994-1999). Consequently, our recommendation for vehicle size must account for this possibility.

Table 1 Stehekin Shuttle Service

	Average Passenger Load[1] (Avg. 1998-2006)	*Expected Maximum Passenger load[2] (based on 1998-2006 range variation for each peak season month*
June	2.39	5.73
July	5.71	12.02
August	6.80	14.18
September	4.92	10.97

Source: Computed from NOCA data, Visit Stats.xls 5/9/2007

Notes: 1. 30 days, 2 vehicle runs per day to June 15, 4 vehicle runs per day to June 30
31 days, 4 vehicle runs per day for July and August
30 days, 4 vehicle runs per day for September
2. {[Range in passenger load (1998-2006)= Max − Min]/2 + Average Monthly Passenger Load}/ # of vehicle runs for the month

Table 2 Rainbow Falls Tour

	Average Passenger Load[1] (Avg. 1994-2006)	*Expected Maximum Passenger load[2] (based on 1994-2006 range variation for each peak season month*
June	18.43	22.99
July	20.90	27.14
August	20.53	30.15
September	18.40	27.43

Source: Computed from NOCA data, Visit Stats.xls 5/9/2007

Notes: 1. 30 days, 2 vehicle runs per day in June and September; 31 days, 2 vehicle runs per day in July and August
2. {[Range in passenger load (1994-2006)= Max – Min]/2 + Average Monthly Passenger Load}/ # of vehicle runs for the month

The results presented in Table 1 and 2 indicate that a smaller vehicle with ***minimum*** seating configuration of 19 seats[3] and one securement position[4] is suitable for the Stehekin Shuttle service - and winter operations, including ad hoc group tours for snow shoeing on backcountry trails but that a 35 ft. vehicle with ***minimum*** seating configuration of 30 seats, and two securement positions is necessary to service the Rainbow Falls interpretative tour Because of the rarity of use of the securement positions, the proposed vehicles will have 'removable' or 'adjustable' seats (e.g., flip-up seats) at these positions. Specifying a seating configuration with several additional seats for each size vehicle beyond the minimum seating configuration numbers noted here would not be unreasonable given that these results have been based on averaging over many vehicle runs and may not be indicative of any single vehicle run.

Visitation to Lake Chelan National Recreation Area varies from 30,000 to 45,000 or more per year, influenced by regional tourism patterns, media coverage of wildland fires east of the Cascades, and other factors. The main visitation season is May-September. Visitation has reached as high as 50,000+ (1999 and 2000), but has generally been stable within this range. The visitation quantity is directly related to the frequency and capacity of the ferry system that services Stehekin. The current system handles the demand (30,000-45,000), though the demand is reduced by the fairly high price of the passenger ferry service and the unattractive quality (and high price) of the existing school bus equipment upon transfer at Stehekin Landing. At this time, the current ferry system provider has not indicated an intention to develop a larger fleet nor to increase capacity by shifting to larger passenger capacity vessels. In fact, it appears that one vessel run per day employing a fast 'Lady Cat' catamaran will be dropped during the 2007 season.

What is the budget?

NOCA indicated a vehicle acquisition budget of $907,000 to replace existing buses used within the Lake Chelan National Recreation Area at Stehekin. NOCA proposes to purchase four (4) replacement buses consisting of three (3) buses identical in size and configuration – heavy-duty 36 adult passenger shuttle buses; one (1) bus would be smaller in size to handle surge capacity needs and operate during winter/shoulder season – light/medium duty 18 adult passenger shuttle bus. Cost estimates prepared by NOCA and based on GSA Autochoice website data accessed in April 2006 are presented below:

Heavy Duty Buses
Base price - $213,541
Options[5] - $9,459
Hybrid/electric diesel or other alternative fuel power train
- $50,000
Total cost per bus - $273,000

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[3] Adding an additional 5 seats to account possibly flawed or underreported passenger load data.

[4] Provided the overall length of the vehicle with this number of seats does not exceed 22 ft. in length

[5] Options include: center door, automatic tire chains, interior overhead parcel racks, parts and service manuals, rear and front axle spare tire assemblies, two-tone paint, cloth stain/fluid resistant fabrics, video camera backup, dash mounted color monitor

Light/medium Duty Bus
Base price - $54,100
Options[6] - $3,520
Hybrid/electric diesel or other alternative fuel power train - $30,380
Total cost per bus - $88,000

GSA in its "How 2 select buses" brochure appropriately cautions that "cheaper is not always better." The longer life of a premium bus might be the better value when life cycle costing (LCC) is considered. LCC analysis of vehicle options includes the acquisition cost of the vehicle and the maintenance and repair cost (including major engine re-builds) over the design life of the vehicle with the longest design life. Operational labor cost is independent of vehicle choice; therefore it is not a factor in considering a decision between two or more vehicle options. Fuel cost, however, is a function of the efficiency of the drive train (i.e., engine and transmission), choice of fuel, and weight of the vehicle. The difference in the quality of visitor experience is also a key determinant in the decision-making framework. There are a number of vehicle attributes that affect visitor experience. These include: ride quality, seating comfort, interior and exterior noise levels, heating, ventilation, and air conditioning (HVAC) system output, quality of public address (PA) system, height levels for vehicle access, aisle width, auxiliary storage facilities, and views from the vehicle. From the NPS staff perspective at NOCA, the visual look of the vehicle design and the degree to which it connects with the historical precedent of motorized touring vehicles on the Stehekin Valley Road – that is, proper fit of the vehicle to the landscape and to place – are critical needs. In making our vehicle recommendation, we have attempted to weigh all these factors. It should be stated that a formalized Value Engineering and Lifecycle Cost (LCC) analysis is beyond the scope of this document; but all these factors have been assessed and weighed in a qualitative sense based on the authors' professional judgment, including our recommendation to purchase the most durable vehicle satisfying the park's core requirements within the park's budget, noting that any increase in acquisition cost would be offset by savings in maintenance costs (and recapitalization costs for shorter-life vehicles) over the life of the vehicle.

What is the type of bus operation?

Application

Transportation operations at Stehekin consist of two basic types of services. The first is the Stehekin Valley transit shuttle service. One-way trip length to High Bridge is 11 miles, with ~ 8 miles on unimproved gravel road. Round Trip time is 2 hours. Until 2003, an NPS-operated van service would run in the Upper Valley portion of the Stehekin Valley Road, with passengers transferring from the Stehekin shuttle at High Bridge. But the floods of 2003 closed the upper 9 miles of the road, and the Stehekin Valley shuttle now turns around at High Bridge. Other than the two termini at Stehekin Landing and High Bridge, there are six (6) additional stops but other than the Stehekin Pastry Company, the other five stops are 'on-demand' so it is highly unlikely during any vehicle run (a one-way trip between the two termini) that all stops are made. Additionally, during both summer and winter operations, ad-hoc tours are run to other attractions within the valley, such as the Buchner Orchard, or group tours to trailheads for snow shoeing during the winter.

The other type of service is the Rainbow Fall interpretative tour, a point-to-point shuttle service between Stehekin Landing where the ferry vessels dock (and where visitor orientation is provided in the Visitor's Center) and Rainbow Falls, a spectacular 312 ft. waterfall. At Rainbow Falls, there is a turnaround and the bus returns to Stehekin Landing. The interpretive tour operates over the 3.2 mile paved portion of the Stehekin Valley road and 0.3 miles on the unpaved gravel portion, and roundtrip time is 60 minutes. During summer months, two (2) vehicles will meet the passengers off-loading from the ferry vessel. Two tours per day during peak visitor season are operated corresponding to the two ferry vessel arrivals. In the off-season (October-May), one (1) vehicle will meet the ferry vessel. The buses during peak season will either operate in 'convoy mode' to Rainbow Falls, or sometimes the dispatch of the second bus will be delayed to relieve crowding at the arrival at Rainbow Falls if both buses are particularly full.

[6] Options include: interior rear baggage compartment, parts and service manuals, two-tone paint, fixed touring passenger windows, video camera backup dash mounted, color monitor

Data for average weekday and average weekend load per vehicle are not available at NOCA, but as Table 1 and 2 indicate peak season average passenger load for the Stehekin Valley transit shuttle service averages 3-7 passengers, and for the Rainbow Falls interpretative tour range between 18-21 passengers.

Duty Cycle

Both the Rainbow Fall interpretive tour and the ad-hoc tours are always point-to-point, and generally of short length. There are few acceleration/deceleration events, and passenger loading/off-loading takes place only at the two termini of the tour.

For the Stehekin Valley transit shuttle service, the duty cycle consists of up to six (6) stops between the two termini of the route. The stops and their respective milepost and inter-stop distances are listed below:

Stop	*Milepost (miles)*	*Distance to Next Stop (miles)*
Stehekin Landing	0	2
Stehekin Pastry Company	2	1
Stehekin School	3	0.5
Rainbow Falls	3.5	0.5
Harlequin Bridge	4	1
Rainbow Falls Loop Trail	5	4
Stehekin Valley Ranch	9	2
High Bridge	11	n/a

At High Bridge stop, the bus makes a turnaround and proceeds in the reverse direction to Stehekin Landing. The bus also will make 'flag' stops anywhere along the route.

Average dwell time at each stop is 3 minutes. Average operating speed is 20 mph with a maximum of 25 mph. These slow operating speeds are due to the condition of the roadbed, the road surface profile, the narrow cross section with often steep side discontinuities, and the desire to provide ample time for interpretation along the route. The vehicles however must be able to drive highway speeds because the vehicles are barged across Lake Chelan for major rebuilds and maintenance activities beyond the material infrastructure and human capabilities on-site at Stehekin. This use necessitates a maximum cruise speed for the vehicle consistent with highway driving, i.e., 55 mph.

The total vehicle miles traveled (VMT) per day, averaged across all vehicles deployed on both types of service, is roughly 100 miles during peak visitor season. Annual miles for the fleet are less than 18,000 per annum.

The operation is a *scenic* interpretive tour, even for the more traditional transit shuttle service, since the intent is to provide an intimate experience and introduction to the resource. Comfortable seating and large windows (side, and front) are critical vehicle attributes.

Seating Type

Seats should be high back, contoured and upholstered. Hip-to-knee room, measured from the front of one seat back cushion horizontally across the highest part of the seat cushion to the seat or panel immediately in front, shall be no less than 26.5 inches. At all seating positions in paired transverse seats immediately behind other seating positions hip-to-knee room shall be no less than 28 inches[7].

Interior Seating Configuration

NOCA staff has expressed a desire to have a forward seating configuration. This facilitates views by the visitor of the resources of the park from either side of the vehicle. Perimeter seating would preclude this possibility.

[7] APTA Standard Bus Procurement Technical Specification, Section 5.4.5.1

Type of Windows

Windows should be as large as possible while still preserving the structural integrity and crashworthiness of the side panels. Body frame construction and rollover protection capability should be designed to minimize the use of obstructive side pillars. The windows should not be tinted (to maximize views from the bus, and to not distort the colors of the actual landscape). To improve air circulation, and lessen the dependency on A/C, two roof air vents that can be opened are desirable. At least one window on each side should also have a quick-release emergency exit capability (with appropriate markings) in accordance with federal motor vehicle safety standards (FMVSS).

Type, Number, and Location of Doors

Because of the nature of the service operated at NOCA (i.e., interpretative tour and limited shuttle operations with few stops), fast loading and unloading of the vehicle is not a requirement. On an ordinal scale from 1 to 5 (1 being 'least desirable,' 5 being 'most desirable'), NOCA staff indicated a preference for multiple doors with an ordinal ranking of 3. Therefore, one front door would be adequate. The door width should not be less than 34" to allow unrestricted use by ADA-compliant mobility devices. To reduce potential injury to visitors waiting to board, the front door should not be of the swing type, but similar to a transit accordion-style door type. This door type requires no additional clearance outside the vehicle envelope. It would be desirable if the vehicle has a back door to facilitate loading/unloading of gear in a baggage compartment at the rear of the vehicle.

Amount and Location of Baggage and Equipment Storage

Although overhead baggage racks would be desirable to achieve a better linear distribution of visitors loading and unloading personal belongings (e.g., hiking gear; strollers), front or rear racks are preferable to maximize the window size and preclude any obstruction to views from the vehicle. This is the case despite the potential for front or rear baggage racks to become a bottleneck and obstruct the internal passenger flow within the vehicle, and to/from the doorway. Bicycle racks on the front of the vehicle are required since many bikers may bicycle to High Bridge and vicinity (a distance of ~11 miles over high rolling-resistant road surfaces), but due to exhaustion desire to board the shuttle bus on the return trip to Stehekin Landing.

What are the environmental and operating conditions?

What are the average and maximum road speeds required?

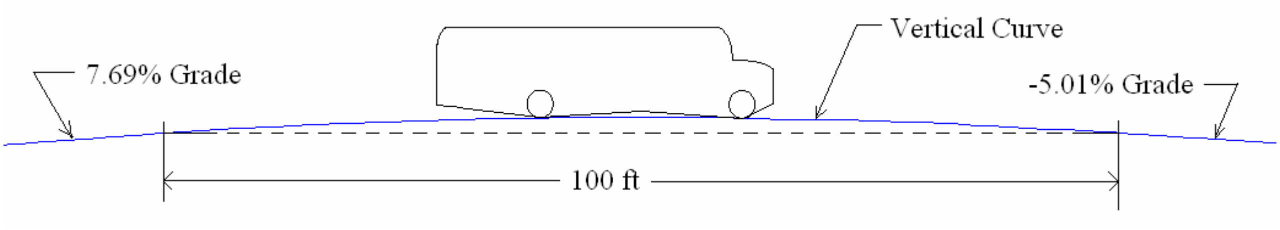
Average speed for both the Rainbow Fall tour and the Stehekin Valley transit shuttle is 20 mph, with maximum speed no greater than 25 mph. Because of the low average speed, low-range axle gearing (capable of being switched to high-range for highway use) is a necessary requirement to prevent premature failure of the vehicle transmission. Minimum highway speed for the vehicle is 55 mph. Because of intermittent highway use, the proposed vehicle should perform well on safety and structural integrity Altoona tests, and must pass all pertinent federal motor vehicle safety standards (FMVSS) to allow its use on public roads.

Are the roads flat, hilly or mountainous? What are the maximum grades?

The most critical vertical profile segment is at milepost 7.5, where a vertical crest curve must transition between a 7.69% upgrade and a 5.01% down grade over a 100 foot length (less than design standards at the desired operating speed). Stopping sight distance at this point is extremely limited.

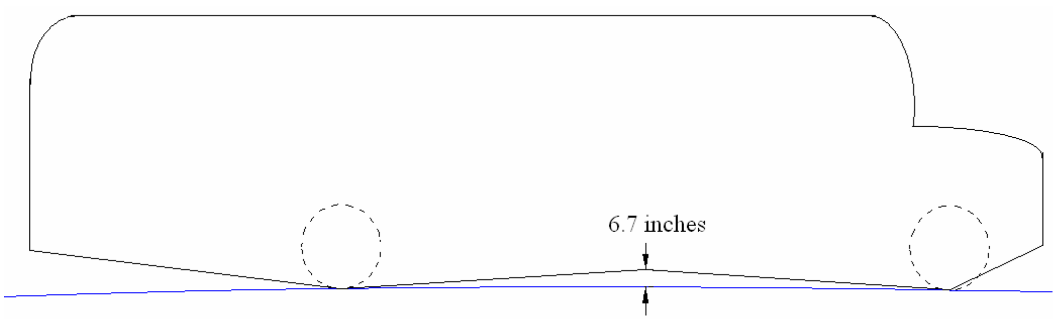
According to the Federal Land Highway (FLH) *Stehekin Road Alignment Report*, the algebraic difference in grade transitions at this location is 12.7%, located at the 7-mile re-route. River flooding caused road attrition at this location. To ensure a stable roadway during future flooding, and mitigate erosion problems at this location, the re-route shifted the road away from the riverbed before re-connecting to the original road. This relocation shifted the roadway further away from the riverbed but increased the vertical height of the roadway due to the existing elevation of the landscape at the re-route location.

Figure 1 Milepost 7.5, Stehekin Valley Road – Severest Vertical Curve



A close up identifies the resulting ground clearance of 6.7 inches for the "Spirit of Mobility" New Yellow Bus – **one of several alternatives under consideration** - transitioning over the 7-mile re-route. On flat and level ground, the ground clearance of the Spirit of Mobility is 7.6 inches.[8]

Figure 2 Spirit of Mobility Ground Clearance Silhouette on Severest Curve



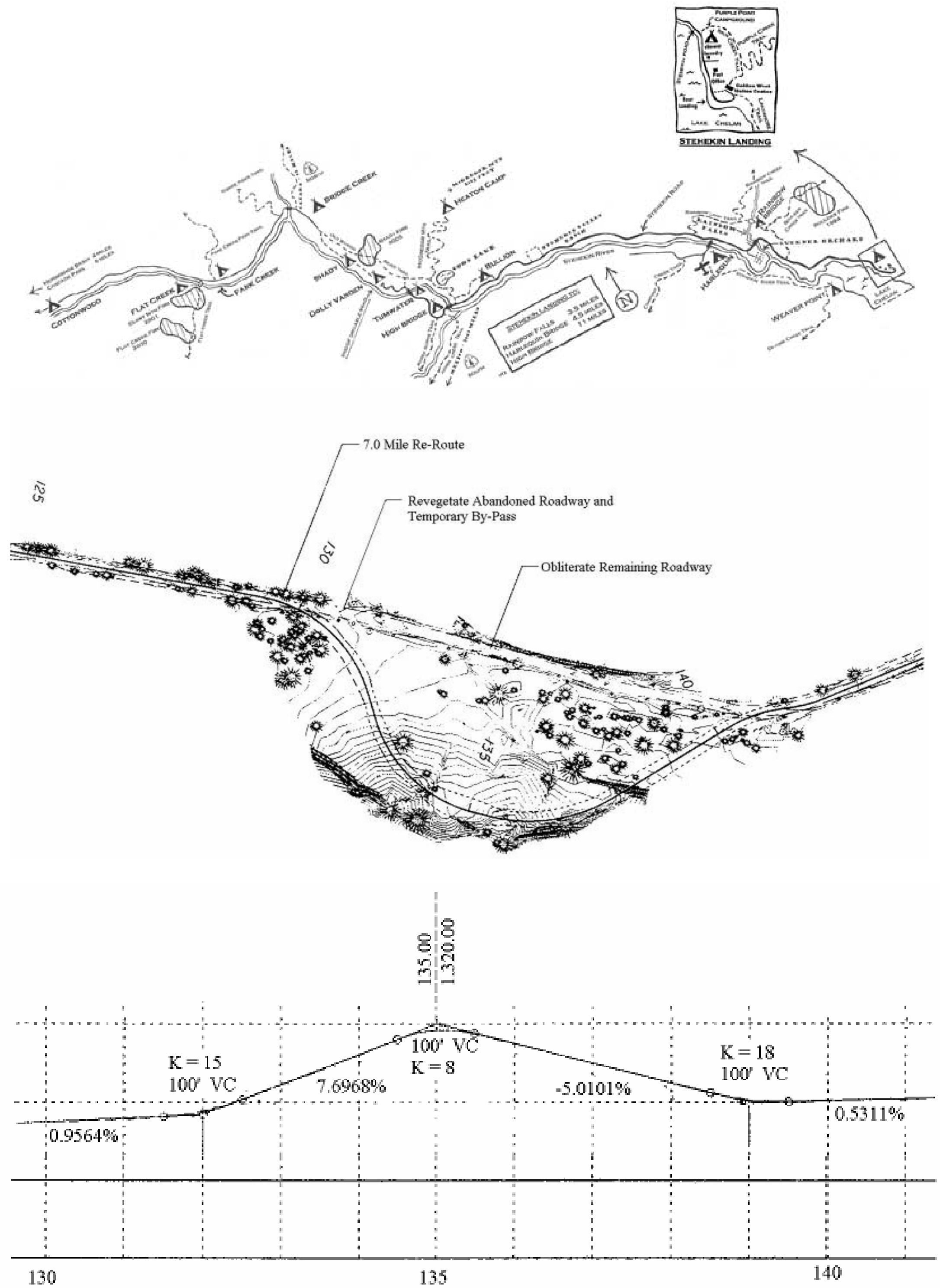
The Spirit of Mobility uses the International 3200LF chassis. This is a common low-floor chassis used by bus manufacturers.

There are no horizontal curve sections of Stehekin Valley Road that are problematic, nor any combined horizontal and vertical curve that poses a problem.

Figure 3, below, illustrates the route and identifies the location of the steepest portion of the route.

[8] The Pennsylvania Transportation Institute, *STURAA Test: 10 Year 350,000 Mile Bus from TMC Group Inc, Model Ameritrans*, July 2006, p.8; width of the "Spirit of Mobility" New Yellow Bus is 102".

Figure 3 NOCA Stehekin Valley Road and Bus Route



This 'worst case' vertical profile and grade difference, in conjunction with a crushed stone surface, suggest a number of core attributes for a suitable vehicle. These core attributes include axle ratios suitable for mountainous terrain, a limited slip differential on a heavy-duty transmission, and a high horsepower/torque engine to overcome the high rolling resistance of the gravel surface. NOCA staff has expressed a desire for automatic transmission. There is no banking of the curves or super-elevation to speak of, and while the road is graded to maintain a proper crown, sections of the road are rutted due to inadequate drainage and sheet flow of runoff, and the road is flat or slopes inward to the side drainage ditch. Handholds that visitors could grab, attached to the vehicle in appropriate places (e.g., interior side panels, and/or to the seat backs), which may offer a more comfortable ride, are recommended. Anti-sway bars added to the chassis/suspension system may allow for a less stiff suspension system to compensate for this particular movement.

Are the road surfaces smooth, gravel, dirt, mud or snow, or are there severe off-road conditions?

The proposed vehicles will be operating in a primitive road application. The road used by the Stehekin Valley transit shuttle over ~8 miles of the route consists of a compacted, graded crush gravel surface ('semi-improved'). Road surface, surface profile and crown are however uneven. At the most severe vertical transition, ground clearance measured at the center of the wheelbase for the existing vehicle is 11 inches. The route is non-exclusive, single-lane with two way directional flow of traffic. If necessary, other vehicles pull off to the side and let the shuttle vehicle pass. Width of the road is 10 ft. There are no shoulders on the road. Traffic is quite light. The Stehekin Valley transit shuttle vehicle, a limited number of private vehicles and NOCA staff vehicles, pedestrians and bicyclists share or will be sharing the road. NOCA staff is not sure whether the existing vehicle gross vehicle weight rating (GVWR) (~31,000lbs.) has had a detrimental affect on the roadbed. The maximum gross vehicle weight limit given the existing condition of the roadbed is not known. The condition of the road and roadbed appears to be primarily affected by weather. Poor drainage patterns damage the road and roadbed and lead to ruts, excessive run-off, and loose gravel. Mud is also a concern. NOCA staff is increasing the number of culverts, and constructing river slope stabilization and channel diversion (using 'river barbs') in several locations to improve drainage.

Core requirements dictated by road conditions include: isolation of engine/transmission noise and vibration; high-quality suspension system; extremely rugged chassis and body frame; body noise insulation within side panels; high traction tires and perhaps a specialized tread pattern that is particularly effective in shedding water under the tire-roadbed contact surface.

Figures 4 and 5, below, provide photographic illustrations of the route.

Figure 4 Stehekin Valley Road

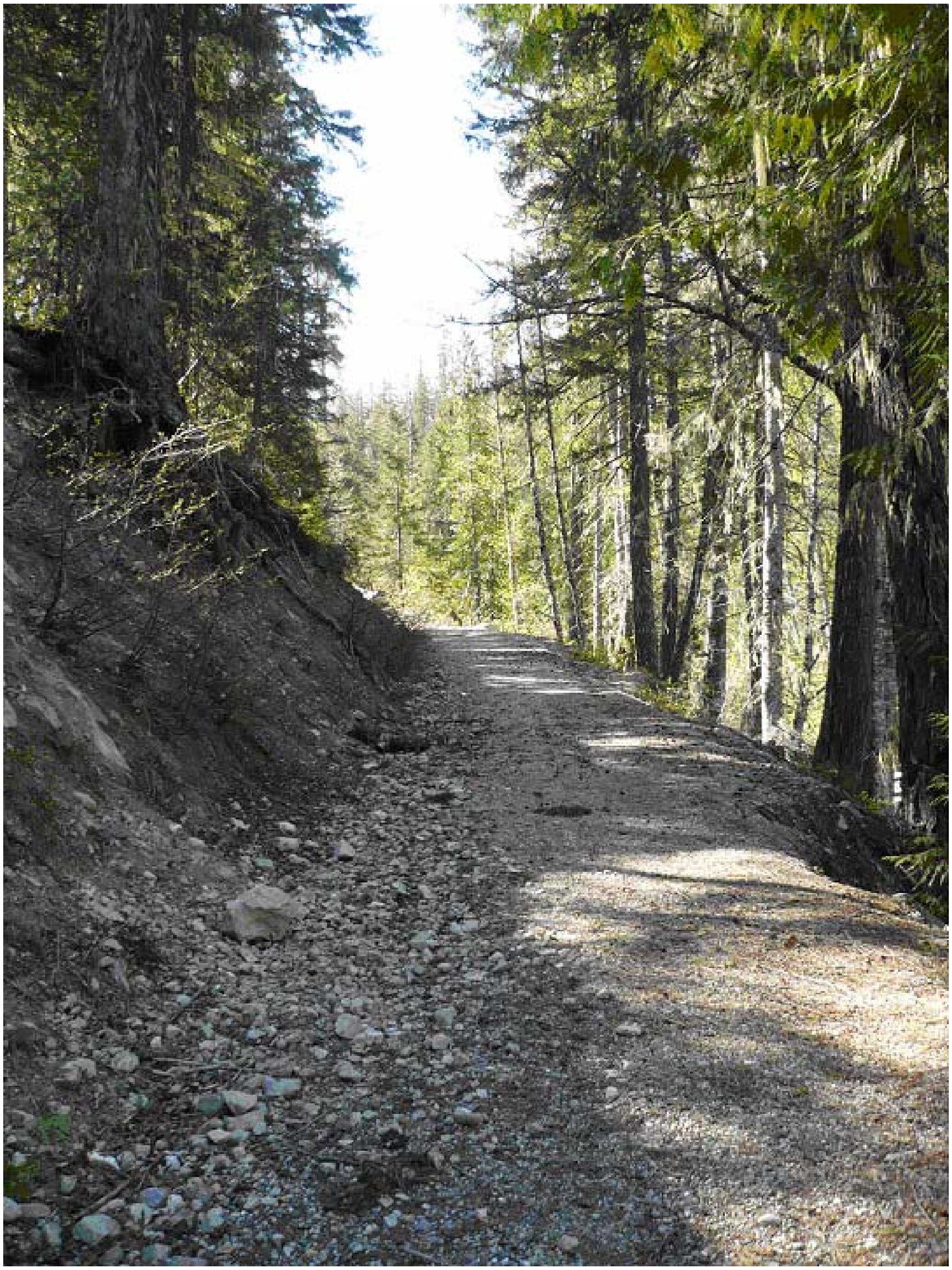


Figure 5 Stehekin Valley Road – Orchard Entrance

Are there physical size limitations?

As noted, the width of the road beyond the paved segment is 10 ft. At the most severe vertical transition, ground clearance measured at the center of the wheelbase for the existing vehicle is 11 inches. Ground clearance –front, midsection, and aft - is a function of the wheelbase, and approach, break-over, and departure angles respectively of the vehicle. There are no overly restrictive horizontal curves. A 22-ft. length transit bus has a turning radius of 25-27' depending on wheelbase. Three (3) feet should be added to the turning radius to account for a front bike rack. The geometry of the terminus of the shuttle route is such that a 3-point turn is necessary in any case.

What are the lowest/highest operational temperatures?

Summer temperatures during the peak visitor season average 80-85° but can run over 100 degrees Fahrenheit. During winter season, temperatures average 32 degrees Fahrenheit. Weather events during winter include snow, rain and ice. Other roadside conditions include wildlife encounters, and mixed use of the road by pedestrian and bicyclists. Air conditioning (A/C) and a well-designed system of natural ventilation combined with high-powered fan for low-speed/stationary conditions is a critical core requirement. Natural ventilation works based on the differential air pressure created by the forward motion of the vehicle combined with air buoyancy due to the differential temperature and humidity of the air in flow and the air within the vehicle. The vehicle should have at least two (2) roof vents[9] designed to scoop the air

[9] The volume of airflow induced by wind is: $Q_{wind} = K * A * V$, where Q_{wind} is the volume of airflow (m^3/h), A is the cross-sectional area of the inlet (m^2), V is the outdoor wind speed (m/h), and K is the coefficient of effectiveness which depends on the angle of the opening. The only parameters subject to control are the angle of opening, and the total cross-sectional area of the inlets. Hence, two roof vents and 'transom' windows along both sides of the vehicle are specified. See A. Walker, *Natural Ventilation*, National Renewable Energy Laboratory, DOE at http://www.wbdg.org/design/naturalventilation.php

inflow into the vehicle and to exhaust the stale air from the vehicle. It is also imperative that the windows be designed to have a large non-operable section for maximizing views to the roadside, and an upper 'transom' window that is operable by the passenger in an easy slide motion with intermediate locks at 2 positions minimum. The 'transom' type windows will maximize the use of natural ventilation for the vehicle. Because of the upper position of the operable segment of the window, the intrusion of dust should not be a problem, and noise induced by the outside airflow should also be minimized. A white roof would reduce the thermal heat absorption and also lessen the load on the A/C system. The A/C should have two control zones—fore and aft in the passenger 'cabin.' A/C should be specified to the maximum BTU limit available. Also, due to low engine speeds, and outdoor garaging of the vehicle, the coolant should be specified with these ambient temperature conditions in mind.

Are there special needs and considerations?

Alternative fuel types; additional fuel capacity

NOCA staff has expressed a strong desire for an alternative fueled vehicle, in keeping with National Park Service (NPS) policy to use alternative fuels as a component of a sustainable alternative transportation system. See **Questions and Answers (Q&A)** for a discussion and recommendation of a viable alternative fuel choice, given the site location, sources of supply, site-specific infrastructure needs (e.g., fuel storage tank and dispensing system), and capability of NOCA and the concessionaire staff to operate and maintain a vehicle running on an alternative fuel. Sufficient fuel capacity for a 200-mile range (daily VMT for the Stehekin transit shuttle vehicle is 88 miles/day), given energy density of the alternative fuel and effective fuel efficiency, is desirable. Fast fill on-site dispensing system with compatible vehicle hook-up is also desirable.

The existing vehicle uses diesel.

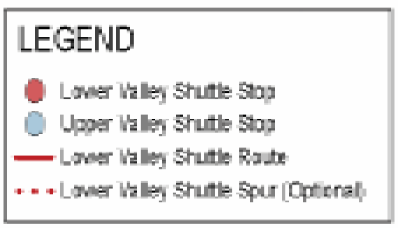
Visual design and connection to historical precedent

According to the North Cascades Administrative History[10], the National Park Service considered the Stehekin Valley Road as a motor nature trail, an essential means for visitors to see the valley and retreat into the Stehekin country's wild landscape. The General Management Plan (1988) stated that the road would be "maintained at its current length, width, and character." That is, it would be kept open from the landing to its terminus at Cottonwood. The road would gradually progress from a two-lane, paved road from the landing to Harlequin Bridge, to a gravel road from there until above Bridge Creek where it narrowed and became a primitive road, still safe for vehicles at slow speeds. The idea was to "increase the visitor's perception of penetrating more deeply into wilderness, leaving modern America behind. Because of the narrowness and roughness of the road surface, speeds will be kept very low (between 5 and 25 mph) to allow travelers to relax and study their surroundings. The low speeds will also allow wildlife and horses to safely use the road." Above High Bridge, only park shuttle buses would be allowed to penetrate the 'primitive' portion of the road (see Figure 6). The General Management Plan revision (1995) reaffirmed this philosophy for managing the road. In 1990, 1995 and again in 2003, nature reclaimed the upper portion of the road beyond High Bridge, forcing the agency to curtail the upper valley shuttle service, and terminating the lower valley shuttle service at High Bridge.

[10] See *Contested Terrain: An Administrative History of the North Cascades National Park Service Complex*, at http://www.nps.gov/archive/noca/adhi-13c.htm

Figure 6 Map of Lower and Upper Shuttle Routes in the Stehekin Valley

Source: Otak Inc., *Stehekin Transportation Study & Landing and Dock Conceptual Design*



Early proposals (1892) for a national park in the North Cascades focused primarily on the Lake Chelan country. The impressive fjord-like lake and backdrop of high, glacier-chiseled mountains inspired local residents and tourists with its scenic grandeur. This alone, they suggested, warranted turning the northern section of the lake and surrounding high country into a national park similar to Yellowstone (1872). From the beginning, and throughout the early part of the 20th century, promoters of a national park at North Cascades always considered North Cascades in the tradition of the other great western national parks, i.e., Yellowstone, Glacier, Mt. Rainier, Grand Teton and Yosemite.

Figure 7 illustrates how the Stehekin Valley Road was used as a "motoring nature trail" in the 1920's.

Figure 7 Stehekin Valley Road Touring Vehicle

Source: North Cascades Historic Resource Study

The tradition of motorized touring in the great western parks is illustrated in Figure 8.

Figure 8 NPS Touring Vehicles in the 1930's: Yellowstone and Glacier

The necessity of the new vehicles to be procured for Stehekin to be compatible with historic precedent (see visualization of that precedent above in Figures 7 and 8), the visual character of previous vehicles that made use of the road (e.g., Figure 7), and the agency's intent to manage the road and provide for a "motor nature trail" at deliberate "slow speed" is considered a core, i.e., critical, requirement.

Does the bus manufacturer being considered have dealer, warranty or maintenance facilities close to your facility?

This is a critical consideration since the park has limited staff capability and infrastructure to maintain the vehicle. The vehicles would have to be barged across Lake Chelan for major rebuilds and repairs. A partnership agreement with Chelan County Transit system (~ 55 miles from the park) is one possibility worth exploring, particularly after all warranties run out[ii].

[ii] Typical warranty conditions are 3 years, 150,000 miles and cover body, chassis and drive-train.

During both summer and winter operating seasons, both the interpretive tours and the shuttle are operated seven (7) days per week. It is therefore imperative that most preventative maintenance replacements and checks are done during the off-season when the number of vehicles needed to operate the service drops to two. Because of a lack of 'downtime,' the park places a high premium on the reliability and robustness of the vehicles.

Unreliability of the *existing* vehicle has been a major issue. For this reason, the proposed vehicles should not have complex systems that require specialized diagnostic and repair tooling that are unlikely to be available at the local maintenance facilities used to maintain and repair the vehicles. The precise arrangement for maintenance of the proposed vehicles has yet to be worked out.

The vehicles should have marked tow points front and aft.

Special Options

The location of the exhaust tailpipe and the catalytic converter temperature of the proposed vehicle are critical concerns. Fire ignition is always of concern, and the wilderness boundary is up close to the road at various points. Relocation of the exhaust pipe outlet to either the middle of the undercarriage (avoiding the roadside edge) or to the roofline is a core requirement.

An automatic hands-free on-off switch for the public address (PA) system is needed since the interpreter is also the driver. The audio system for the public address system must be high quality and easily discernable by the visitor. The PA system must be able to project sound both inside and outside the vehicle.

The proposed vehicles should have attached to the front of the vehicles the Sportworks DL2 Narrow Profile (NP) bicycle rack[12].

The vehicles should have power and antenna wire for VHF communications.

An automatic transmission is needed. This is based on strong NOCA staff preferences and the fact that the driver is also the interpretive guide, and a manual transmission with clutch would increase the driving task workload.

Delivery Times

The park needs delivery of the vehicle in time for the 2008 season, i.e., May 2008.

Questions and Answers (Q&A)

This section addresses a sequence of significant decisions that North Cascades National Park Service Complex, Lake Chelan Recreation Area, must address in support of its vehicle procurement. This section is organized in a free form, question and answer (Q&A) format. When appropriate, a *Discussion* sub section is added to provide analytical support and serve as a foundation for the decision.

Q. What are NOCA's core (critical) vehicle requirements for its shuttle operation and interpretive tour?

A. Unreliability of the *existing* vehicles as expressed and documented by NOCA staff in the *vehicle requirements survey instrument* and the site reconnaissance visit including inspection of the road surface confirm the need for a medium/heavy-duty chassis that is durable and rugged. Any vehicle purchased

[12] The Toronto Transit Commission (TTC) staff and representatives from the Toronto Cycling Committee evaluated four alternative bicycle rack designs and overwhelmingly concluded that this model was preferred for attachment to the new low-floor hybrid-electric Orion VII buses (360), and for retrofit to TTC's existing bus fleet. See http://www.ttc.ca/postings/gso-comrpt/documents/report/f3020/_conv.htm

should be at least 10-year/350,000 mile “Altoona tested”[13]. A high quality suspension system, limited-slip differential, high traction treads on tires, and low gearing for high engine load and low speed operation are also critical core requirements. The proposed vehicles must be well insulated from noise and vibration (e.g., additional insulation in the side panels and between the engine block and the driver and passenger compartments) since the sole purpose of the operation is to provide a high quality visitor experience on both the transit shuttle service and the interpretive tour. The vehicle must be ADA-compliant using a ramp system only. As documented below, there is a need for two distinct vehicle sizes, one having a minimum passenger seating capacity not less than 30 seats, the other having a minimum passenger seating capacity not less than 16 seats, preferably 19 seats. The vehicles also must be capable of operating at highway speeds, and the driver’s workstation ergonomics must be optimized for both comfort and safety. Alternative fuel, if not strictly a core requirement, is a strongly expressed desire by the NOCA staff to the extent that the recommended alternative fuel option is feasible and economically sustainable. The exhaust pipe outlet must be routed to either the midpoint of the rear bumper or preferably the roofline. If the exhaust pipe is routed to the roofline, special consideration needs to be paid to isolate noise and vibration from the exhaust pipe to reduce the potential for amplification by the bus body.

To enhance the quality of the visitor’s experience, in addition to a high quality suspension system, the vehicle must have:

- Low interior and exterior sound level (< 65 dBA)
- Comfortable seating
- Large windows
- Air conditioning and natural ventilation via transom windows that are operable by the passenger, and two (2) roof vents
- Automatic on/off public address system with high quality (i.e., high signal-to-noise ratio) audio
- Bicycle rack attached to front of vehicle
- Floor space within interior of vehicle for storage of baggage/gear of visitors, preferably in the rear
- Visual design and connection to historic precedent of vehicles used for ‘motor nature’ touring on the Stehekin Valley Road
- Common visual design across fleet of vehicles of different size

Q. What are NOCA’s other needs/requirements (“nice to have” attributes)?

A. Other needs/requirements (“nice to have” attributes) expressed by NOCA staff include: multiple doors for access/egress, large roof window

Q. What are NOCA’s order preferences for “nice to have” requirements?

A. NOCA staff ranked both attributes as equal.

Discussion: Based on the ordinal ranking in the NOCA staff response to the *vehicle requirements survey instrument*.

Q. Should NOCA proceed with its original plan to procure three (3) buses of identical size and configuration, and one (1) bus of smaller size and configuration?

Our analysis of the service operation at Stehekin, including the time-dependent visitor demand profile for both types of service (i.e., the transit shuttle service and the interpretative tour) indicates that two size configurations are appropriate. The minimum passenger-seating requirement for the Rainbow Falls interpretative tour is 30. The Stehekin Shuttle requires a smaller sized vehicle with minimum passenger seating configuration of 16 seats, preferably 19 seats. Our original recommendation was that each size configuration should have a spare or backup of equal size. Thus we had recommended that two (2) large

[13] All transit vehicles purchased with Federal Transit Administration (FTA) funds are required to be tested at the Altoona, PA test site.

(>=30 seats) vehicles, and two (2) small (>=16 seats) be procured. Our rationale was that when passenger transfer rates are particularly high during the summer peak season, both of the large vehicles or one large vehicle and one small vehicle can be deployed to meet the ferry arrival. This provides good flexibility and a better match between seat capacity and demand for the interpretative tour. At most, three (3) of the four vehicles to be procured would be in service concurrently. This always provides at least one (1) vehicle for backup. New information, however, indicates that the data used as a basis for this recommendation may be flawed, and it is unknown to what degree underreporting of the data underestimates the actual average load and the calculated expected maximum load on the Stehekin shuttle service. **Thus, it is prudent to now revert back to the original park's intention to procure three (3) large size configuration vehicles (>= 30 seats). During winter operations, it is known that the smaller size vehicle is adequate for its intended service, including ad hoc tours to trailheads for snow shoeing.**

Q. What are the available options for vehicles that can satisfy the 'core' vehicle requirements for the shuttle operation and the interpretive tour?

A. There are many suppliers that can offer all the described options listed in this document for conventional as well as alternate fueled buses. Some options may be costly while others are considered standard equipment, which may be included in the vehicle base price.

The following vehicle features are recommended for NOCA:

Chassis, Powertrain & Mechanical Components

- Low-floor chassis
- Five-speed electronic transmission
- Hydraulic brakes
- Engine mounted air compressor
- Electronic throttle
- Air dryer
- Heavy duty axle package
- Air ride suspension
- Tilt and telescopic steering column
- Steel belted radial tires
- Front mounted engine and radiator
- Front and rear mud flaps
- Front and rear tow hooks
- Documentation of FTA-Altoona testing for 10-Years/350,000 miles
- Consumables parts list with manufacturer's parts numbers

Electrical Features

- 200-amp alternator
- Manual reset circuit breakers
- Fast idle control
- Color and number coded electrical wiring
- Reverse alarm
- Engine hour meter
- Side mount turn signals
- Additional microphone jack
- PA system with headset microphone (including spare microphone) and properly positioned loudspeakers to evenly distribute quality sound amplification.
- Complete electrical schematic provided inside the electrical power source panel for on-site troubleshooting.
- Taillights are mounted in rubber gaskets, permanently sealed and completely impervious to dirt/moisture with a minimum 5-year life.

Body Features

- rubber floor with ribbed isle
- ¾–inch exterior grade plywood floor, sealed and undercoated
- Driver stanchion

- Two stainless steel overhead hand rails
- Roof ventilation
- Right hand entry handrail
- Non-tinted large touring style windows with operable (transom) component
- Intermittent windshield wipers
- Driver side and passenger side mirrors
- Automatic air actuated entry door with mechanical override
- Keyed exterior door switch

HVAC
- Driver area, dash a/c, heat and defrost
- Two rear heaters (35,000 BTU minimum)
- Two speed minimum driver's fan
- Passenger area a/c system rated for 34,000 BTU/hr, minimum
- Ozone-friendly refrigerant
- Tropical-climate package (or equivalent)

Safety Features
- First aid kit
- Fire extinguisher
- Roadside flares
- Reflector kit

Paratransit Features
- Fully automatic wheelchair ramp with manual override
- ADA securement system in area of flip up seating
- Exterior entry door light
- Overhead handrail
- ADA signage

Recommended Additional Features
- Spare tire and wheel assembly
- Hubodometer
- LED exterior lights
- 2-way radio antenna conduit pre-wire
- 2-way radio pre-wire
- High-back bucket seating with grab handles

Q. Which vehicle is recommended (and why?)

A A modified approach was taken at NOCA in searching for an appropriate vehicle. Previous study[14] had indicated that the New Yellow Bus – a vehicle specifically designed for park applications – could potentially be a good fit at NOCA. Additionally, the park was quite interested and excited about the potential use of the New Yellow Bus at NOCA. For these reasons, and also because of a compressed schedule, it was agreed among all parties[15] that our approach at NOCA in preparing the Vehicle Decision Document would be to provide an independent and objective assessment on whether the New Yellow Bus is appropriate to the application and conditions at NOCA, or whether we discover a 'fatal flaw' that would, in our judgment, render this bus as not suitable and therefore NOT recommended for the park. At that point, we would then expand the search for other vehicles that could meet the park's core requirements, and fit the application and context. A useful analogy that describes this approach is that the US Coast Guard has prior intelligence (e.g., last reported position) that a 'target' is lost off the coast of the state of Washington. The Coast Guard could implement one of two strategies: (1) start the search (and deploy resources) off the coast of Washington, then expand the search area outward if necessary; or (2) start the search at Baja California, and work one's way methodically up the Pacific coast. Clearly, the 'intelligent' strategy is the first!

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[14] See Otak Inc., *Stehekin Transportation Study & Landing and Dock Conceptual Design,* March 2007, chapter 5.

[15] Personal communications to Dianne Croal/NPS/PWR, and Steve James/NPS/NOCA, 4/18/07.

As part of this approach, we posed three (3) critical tests for the New Yellow Bus to assess fit for the application and conditions at NOCA: (1) there is a 'family' of available sizes and seating configurations – but with the same visual design and profile -that can satisfy the service demand profile for the two types of operations at Stehekin (see p. 7-8); (2) the New Yellow Bus can traverse the most restricted vertical curve and geometry of the route with adequate clearance (see p. 13-14); (3) the New yellow Bus uses tested, commercial grade chassis and power-train, and test results (and limited operating experience) indicate adequate durability, reliability and maintainability.

Also, the vehicle recommended for NOCA should be durable, but not as massive as a heavy-duty (12-year 'design-life') vehicle. This is important because a heavier vehicle, which is not recommended for NOCA, will only be less efficient to operate and on average more costly to repair and maintain.

It is our judgment that the *Spirit of Mobility* New Yellow Bus **passed** all three critical tests. With regard to the third test (i.e., durability, reliability and maintainability), the experience at Yellowstone confirms good operational and maintenance experience[16].

The *Spirit of Mobility* New Yellow Bus, manufactured by Arboc Ltd., is an Altoona-tested 10-year 'design-life' vehicle, with a tested 350,000-mile life cycle.

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[16] Personal communications, Andrew Nickerson/Yellowstone, 8/2/07:

- The first new yellow buses were built on a Chevy chassis with a gas engine that could run on gas or propane.
- The initial buses were not powerful enough and the gas engine was replaced with a diesel engine that provided adequate power
- The manufacturer switched to International Trucks, powered by an International diesel engine, this combination worked very well
- Over the road (wheels) proved to be extremely reliable
- Only notable problems arose with over the snow (tracks) use, which put undue stress on the drive train
- "Drop Box" is the only non-OEM component with the New Yellow Bus configuration, this would overheat when using tracks over snow
- Had "usual" check engine lights and a few stalling issues which were resolved by International under warranty
  - Warranty is (as recollected) 3 years
- Yellowstone utilizes multiple configurations including the "utility" 24 passenger carrier
- 6 Vehicles, 8-15,000 miles / year service and run on a B20 bio-diesel blend
- Can utilize the wheel chair space with a clamp-in luggage rack
- Can replace the front seats with a luggage rack
- Otherwise utilize the rear seats for excess baggage
- Utilize the "Vista" glass roof, and after some minor initial leaks repairs were made in-house and have been leak-free since
- Side windows (lower) allow for ventilation
- Air conditioning system is located at the back and supplies air to the front / mid / and aft of the truck
- Idle noise is noted as "minor," however if prolonged idling in hot conditions is to occur, the driver may want to advance the RPM at idle to supply adequate power for the air conditioning to function fully
- Fuel is reduced from B20 to straight diesel at the start of the fall, as B20 has unstable "gelling" points at cold temperatures

Figure 9 Spirit of Mobility "New Yellow Bus" Manufactured by ARBOC LTD

Figure 10 254-Inch Wheelbase - 35 Passenger, 3 Wheelchair position Floor Plan – New Yellow Bus

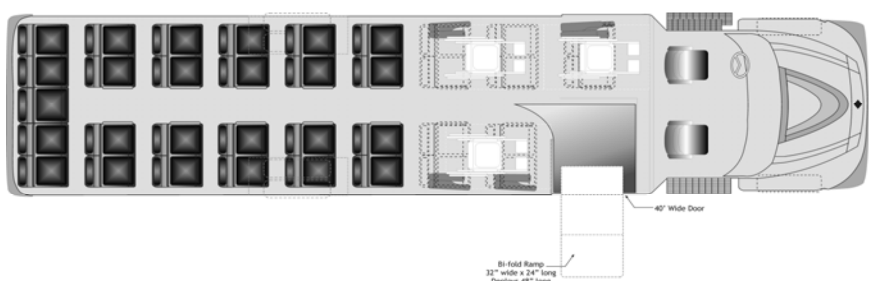
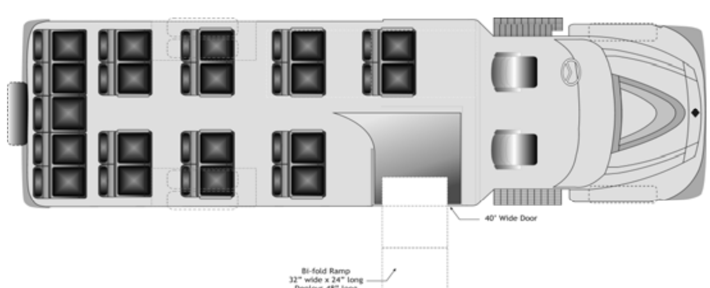


Figure 11 200-Inch Wheelbase - 19 Passenger, 2 Wheelchair position Floor Plan – New Yellow Bus



The above schematics are illustrative of two prototypical interior configurations corresponding to the bus size recommendations for the two types of transportation services at Stehekin (i.e., interpretive tour and transit shuttle service).

Q. What other vehicles were briefly assessed but rejected for use at NOCA?

The project team also briefly assessed the International Corporation HC Series bus. This uses the same chassis and drive train as the new yellow bus (which is important because it means that from a transportation operations and engineering perspective, this bus could work at NOCA) but the bus critically lacks in visual design and connection to historical precedent at Stehekin.

Figure 12 IC Corporation HC Series Shuttle Bus

Two additional Coach-on-chassis vehicles were also briefly reviewed. These are the ElDorado Aero Elite and the Goshen Coach GCII Tour (see Figures 13 and 14 below). While both have flexible size and seating configurations (including rear luggage rack and rear access, which the New yellow Bus does NOT have), these vehicles use a rear lift to be ADA compliant and could only operate on the Rainbow Falls Interpretative Tour where the two termini (i.e., Stehekin Landing and Rainbow Falls) have sufficient clear space to deploy the lift. This is NOT the case for the Stehekin shuttle route. They too lack in visual design and connection to historical precedent.

Figure 13 Eldorado Aero Elite and Interior Seating Schematics

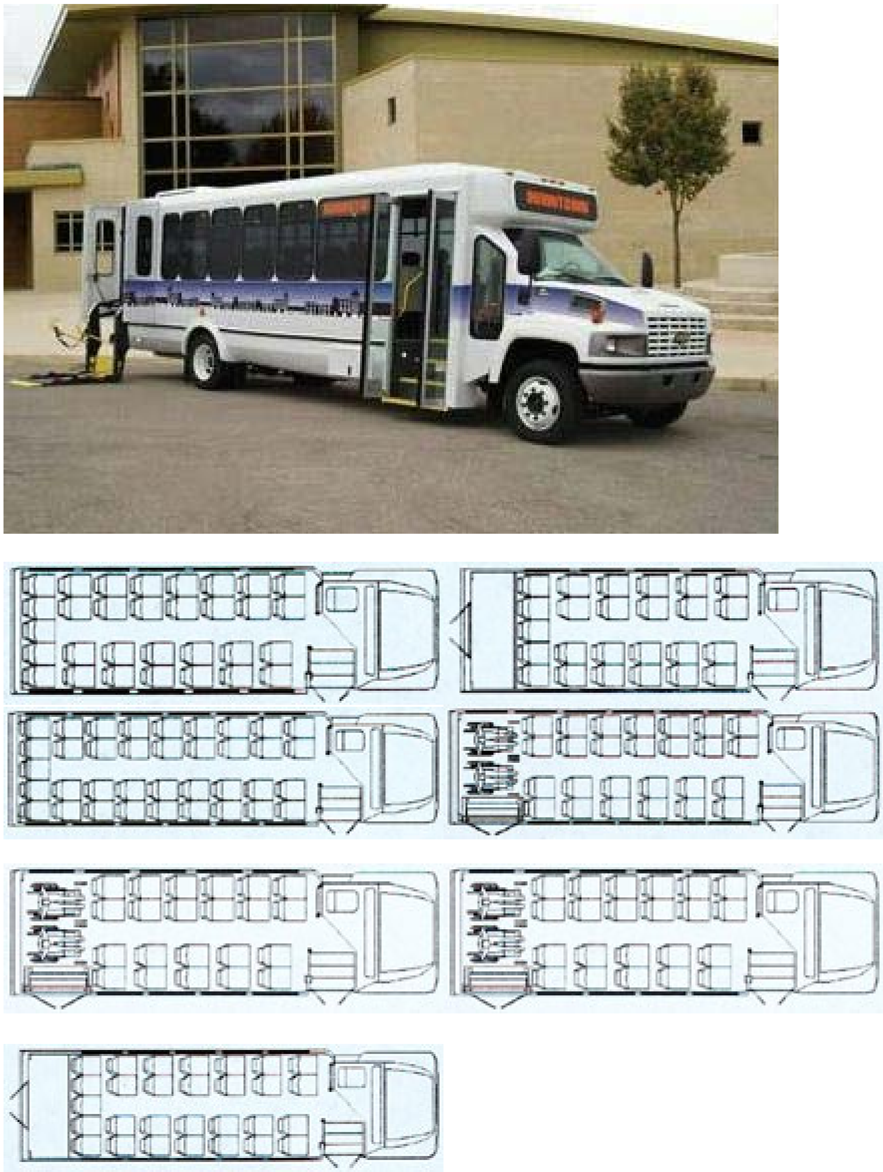
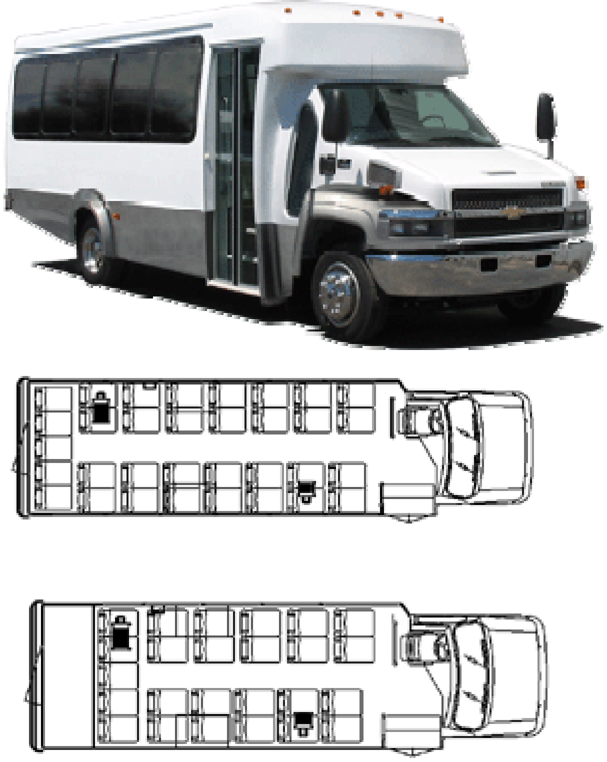


Figure 14 Goshen Coach GCII Tour and Interior Seating Schematics



Additionally, another class of potential vehicles for use at NOCA – small transit buses (30-35 feet) – has also been briefly reviewed. Two possibilities are the Optima Opus low-floor bus and the Blue Bird Xcel 102 ultra-low floor bus (see Figures 15 and 16). The Optima Opus low-floor bus is rejected for the following reasons:

- The unit price (~$280,000) precludes acquiring the programmatic number of buses for the operation at NOCA (4 buses) within the existing budget
- The Optima Opus had clearance problems when tested on the Tallgrass Prairie "semi-improved" gravel road, and may have similar issues on the Stehekin Valley road.
- The visual design does not fit the landscape and place at Stehekin (i.e., journey into the primitive wilds), and provides no connection to historical precedent for motor touring on the Stehekin Valley road.

The Blue Bird Xcel 102 ultra-low floor bus also has similar limitations to the Optima Opus bus.

Figure 15 Optima Opus Low-Floor Bus and Interior Seating Schematics

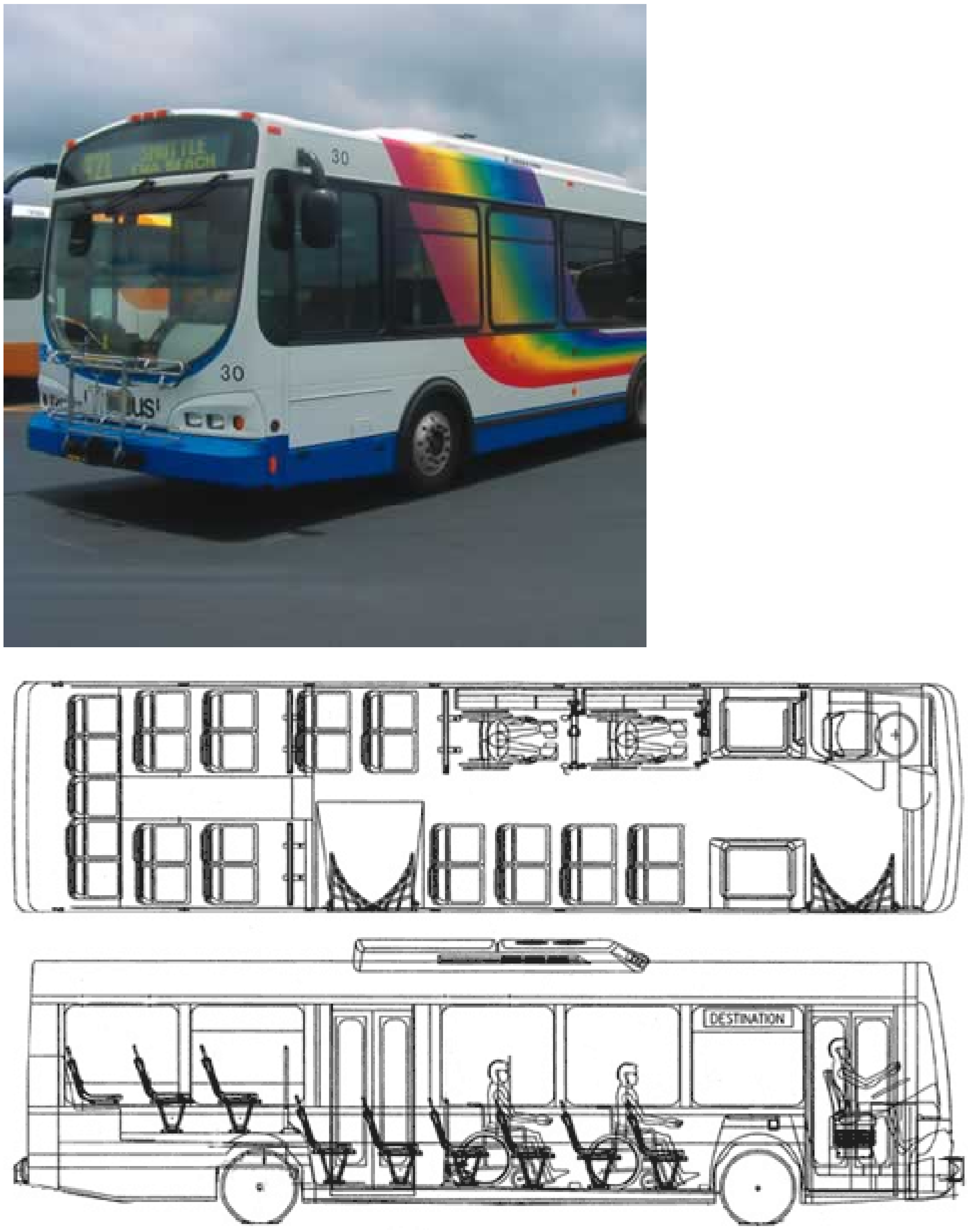


Figure 16 Blue Bird Xcel 102 Bus

Q. What alternative fuel option is recommended at NOCA?

A. Biodiesel (B20 blend[17]), blended with ultra-low sulfur diesel[18] is recommended as the "least-cost, least-risk" strategy at NOCA. Fuel lubricity should also improve with the use of bio-diesel. Of the choices for alternative fuels, only propane (LPG) and bio-diesel are in relative proximity (<75 miles) to Stehekin (see Figure 18). While there is an on-site storage and dispensing system at NOCA for propane, it is **NOT** our recommendation to use propane to fuel the vehicles (**see next question**). There is a 5000 gallon capacity diesel storage tank and dispensing system (with electronic debit card capability) that is both well situated to the route, and has a well planned site circulation perimeter road that would allow buses to access the site, load the fuel, and easily turn around. (see Figure 17). NOCA staff has indicated that this site could be used for fueling the buses at Stehekin.

It is recommended that the buses procured for Stehekin include in the technical specification a passive catalyzed diesel particulate filter (DPF), or if the fuel vendor can provide a fuel-based catalyst (FBC), a passive FBC/DPF combination[19]. Based on both experimental and on-road studies, a thorough review of the literature on ultra-fine particles (UFP) and the use of retrofit technologies for particulate matter control concluded that (a) the use of ultra-low sulfur diesel fuel (15 ppmw); (b) use of low sulfur (~0.15% sulfur by weight) lubricating oil; and (c) installation of catalyzed continuously regenerating traps (CCRT) that contain sulfur trapping sites in the catalyst coating of the filter can reduce all $PM_{2.5}$, including total UFP number, to levels virtually indistinguishable from background.[20] This has been confirmed with additional real-time measurement of concentrations. This measurement was made within operating diesel buses – passenger

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[17] B20 blend received by the park should conform with the State of Washington contract for B#1, which uses a National Bio-diesel Board BQ9000 Accredited facility and complies with ASTM D6751 specifications – see http://www.metrokc.gov/procure/green/ulsd.htm

[18] With the cooperation of Philips Petroleum, the Puget Sound Clean Air Agency (PSCAA) has helped introduce ultra-low sulfur diesel (meeting EPA 2007 standards for sulfur content of 15 parts per million weight (PPPW)) into Washington State. The fuel is now available at the Philip's refinery located in Ferndale, Washington. See Washington State University Extension Energy Program, at http://www.energy.wsu.edu/documents/renewables/Fuels.pdf

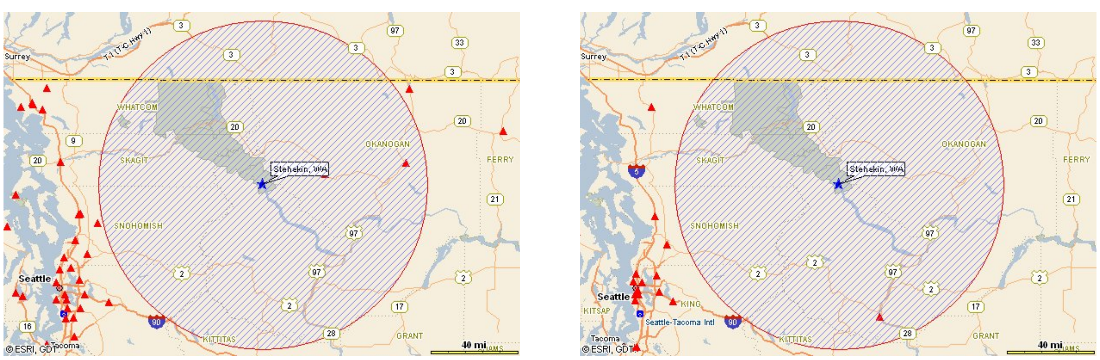
[19] See Health Effects Institute (HEI) Special Committee on Emerging Technologies, Chart 1: Emerging Technologies for Diesel and Diesel-Like Engines – Exhaust After-treatment, June 9, 2003.

[20] See Phil Johnson and Paul Miller, NESCAUM, *Ultra-fine Particles: Issues Surrounding Diesel Retrofit Technologies for Particulate Matter Control*, February 2007.

compartment. It was also made in following vehicles in the proximity to diesel buses in Boston (see Discussion, and figures below).

Figure 17 Fuel Storage and Dispensing Site at NOCA

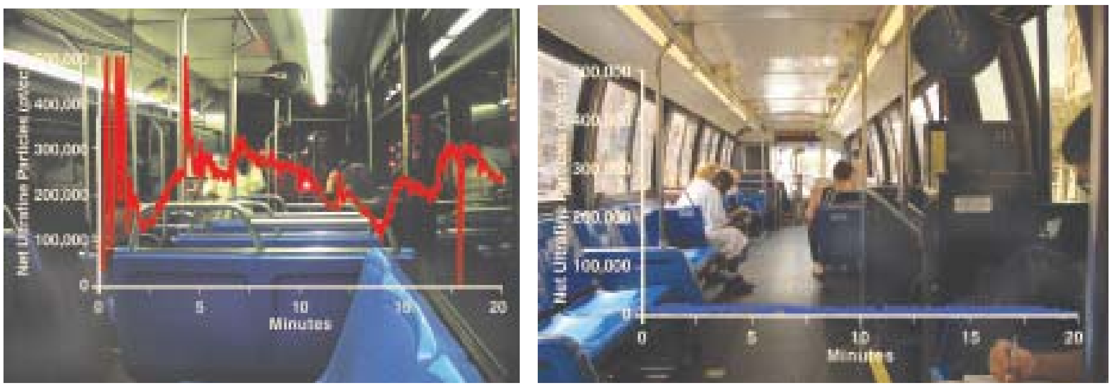
Figure 18 Alternative Fuel Facilities: Propane and Bio-diesel



Source: US DOE, Alternative Fuel Station Locator at http://afdcmap2.nrel.gov/locator

Discussion: 'Core' requirements at NOCA dictate the need for a medium/heavy duty 30+ foot bus for the Rainbow Falls interpretative tour, and a smaller sized bus for the Stehekin shuttle. The standard propulsion system for these types and sizes of vehicles is conventional diesel (Compression ignition engine). However, there are a number of reasons why the Park Service, in general, and NOCA in particular, should seriously consider other propulsion systems using alternative fuels. Conventional diesel (~350 ppmw sulfur content) poses serious public health concerns, including increased risk of lung cancer and other respiratory illnesses from fine particulates and oxides of nitrogen[21]. Incomplete combustion of petroleum diesel produces exhaust laden with particulates and chemical compounds that contribute to regional haze, acid rain and global warming[22]. Real-time measurement of particulate concentration **within** the interior of the bus – the passenger compartment - and in the vicinity following the bus – affecting following vehicles (or pedestrians and bicyclists) in the traffic stream – show the effectiveness of using ultra-low sulfur fuel combined with DPTs.

Figure 19 Real-time Particulate Concentration Measurements Within Bus

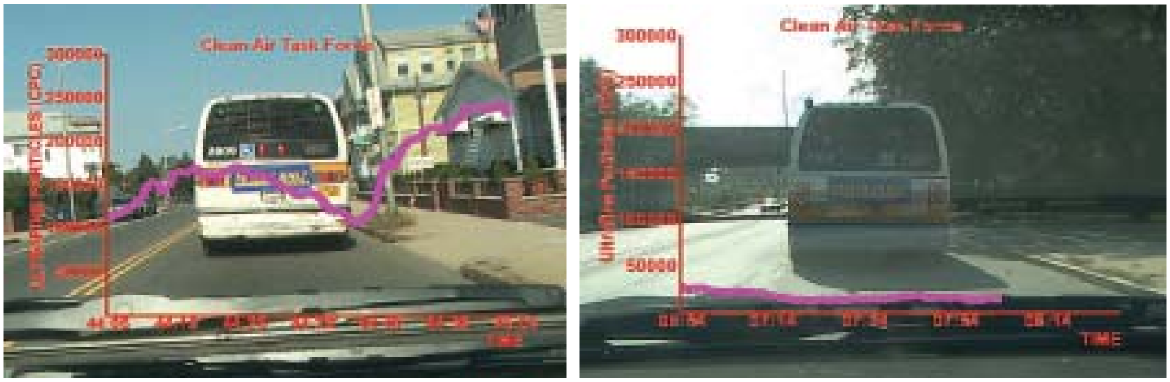


Clean Air Task Force (CATF) researchers measured high ultra-fine particle levels on a conventional transit bus in Boston (left), while levels on a bus retrofitted with a particle filter were barely detectable (right).

[21] See Environmental and Energy Study Institute, Fact Sheet on Clean Buses; also, South Coast Air Quality Management District (SCAQMD), Multiple Air Toxics Exposure Study II, draft report, 1999; and State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Officials (STAAPA/ALAPCO), Cancer Risk from Diesel Particulate: National and Metropolitan Area Estimates for the United States, March 2000 at http://www.4cleanair.com; Cal/EPA Office of Environmental Health Hazard Assessment and the American Lung Association of California, Health Effects of Diesel Exhaust.

[22] NPS monitors haze, ground-level ozone and acid precipitation in the National Park System via the Interagency Monitoring of Protected Visual Environments (IMPROVE-visibility data), the NPS Gaseous Air Pollutant Monitoring Network (ozone data), and the National Atmospheric Deposition Program (NADP-acid precipitation data) respectively; See Appalachian Voices, National Parks Conservation Association and Our Children's Earth, Code Red: America's Five Most Polluted National Parks, September 2002; also, Clean Air Task Force, Out of Sight: Haze in our National Parks, August 2000.

Figure 20 Real-time Particulate Concentration Measurements In Proximity to Bus



Conventional and retrofit MBTA buses in Boston show the benefits of diesel particle filters to people in cars following behind
Source: Schneider and Hill, *No Escape from Diesel Exhaust*, February 2007
At **http://www.catf.us/publications/reports/No_Escape_from_Diesel_Exhaust.pdf**

In Washington State existing legacy diesel engines emit 8,403 tons per year of particulate matter of which 7,873 tons per year fall into the fine particulate size range (less than 2.5 microns in diameter, known as $PM_{2.5}$). On a statewide basis heavy duty on-road vehicles, marine vessels and construction equipment dominate the contribution to diesel $PM_{2.5}$, accounting for 67 percent of the total[23]. An additional reason for opting for alternative propulsion systems that are non-petroleum based is to reduce supply and price instabilities and geopolitical vulnerability. Imported petroleum accounted for 54% of net petroleum consumption for the US transportation sector in 2001, while the Energy Information Administration (EIA) in its 2003 Energy Outlook projects net petroleum imports to account for 68 percent of US demand (across all economic sectors) in 2025[24].

Key factors influencing this recommendation include remote site location and fuel availability, duty cycle of intended application, operating on an off-road 'semi-improved' road surface, and no economy-of-scale due to a small vehicle fleet. Additional considerations were cost, safety and complexity of on-site fuel storage and dispensing systems, and cost and complexity of vehicle operation and maintenance. An additional factor unique to NOCA, having to do with fire risk, is that a modern, turbo-charged diesel engine will have a significantly lower exhaust gas temperature than a spark-ignited (i.e., gasoline or propane) engine[25]. Bio-diesel should not have any significant effect on exhaust temperature[26], requires no major diesel engine redesign or modification for B20 or B50 mixes and only minor hose, fuel filter and gasket changes for compatibility with B100, but will result in a significant reduction in regulated and unregulated emissions[27]. Bio-diesel is in our judgement the "least-cost, least-risk" strategy for NOCA. Visitors will detect a better 'smell' as well.

The US Environmental Protection Agency has lowered federal exhaust emission standards for heavy-duty diesel bus engines and is requiring the use (by 2006) of ultra-low sulfur diesel (ULSD) fuel (< 15 ppm). New

[23] See Washington State Department of Ecology, *Diesel Particulate Emission Reduction Strategy for Washington State*, December 2006, at http://www.ecy.wa.gov/pubs/0602022.pdf

[24] Cited in Environmental and Energy Study Institute, Op. Cit., p. 2.

[25] Personal communications, Robert McCormick, PhD., Center for Transportation Technologies and Systems, National Renewable Energy Lab.

[26] Ibid.

[27] See, e.g., BioBus: Biodiesel Demonstration and Assessment with the Societe de Transport de Montreal (STM), Final Report, May 2003 which found total mass of particulate matter (PM) reduced by 25–30% depending on mechanical versus electronic fuel injection with vegetable-based B20, carbon monoxide (CO) emissions reduced by 20–30%, total hydrocarbons (THC) emissions reduced by 20%, and nitogen oxides (NO_x) reduced by 3–5% for a higher cetane-rated blend. For non-regulated emissions, sulphates (SO_4) were reduced by 15%, polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs) and carbonyl compunds were either unchanged or slightly reduced (PAHs) by 10-20%. Fine particulate matter below 2.5µm ($PM_{2.5}$) were reduced due to lower mass of elemental carbon particles due to a lower sulpher content in the fuel blend. See also National Biodiesel Board, Regulated Fleet Use of Biodiesel: Frequently Asked Questions.

emission standards will go into effect in 2004 and 2007 as illustrated in Table 3, below[28]. ULSD fuel will facilitate in the next five years effective use of active catalysts (e.g., selective catalytic reduction (SCR), exhaust gas re-circulation (EGR)) and sophisticated after-treatment devices (e.g., NO_x adsorbers, and diesel particulate traps (DPT)), technologies that perform poorly with use of high-sulfur content diesel. Our recommendation is for passive catalyzed DPTs because that is where the state-of-practice is at this point in time.

Table 3 Federal Exhaust Emission Standards for Diesel Bus Engines (g/bhp-hr)

Years	HC (NMHC)	CO	NOx	NOx + NMHC	PM
Current–2003	1.3 (1.2*)	15.5	4.0	N/A	0.05
2004–2006	(0.5)	15.5	[2.0]	2.4 [2.5]	0.05
2007–2010	(0.14)	15.5	0.20	N/A	0.01

( ) Non-methane hydrocarbon emission standard
[ ] Optional requirement
NO_x standard was obtained by substracting maximum NMHC emissions allowed from the composite NO_x+NMHC emission standard.
* Only for heavy-duty engines using natural gas.

For completeness, summarized below are the limiting factors that preclude viability of other alternative fuel/propulsion systems at NOCA.

Battery-electric, hydrogen-fuel cell vehicle: Fundamentally, both electric propulsion technologies are not yet “commercial-grade” (i.e., mature in terms of proven experience in transit operations), although a number of transit systems have demo projects operating[29]. Battery-electric could be a promising technology at NOCA since electric motors can be designed for high torque, low-speed operation (consistent with operating requirements for the shuttle service and interpretive tour). A large stack of battery packs (which are quite heavy) would be necessary to supply enough specific power (i.e., the ratio of power delivered by a battery to its weight, expressed in watts per kilogram (W/kg)) for the application. Battery life – based on the number of recharge cycles– is still low (~600 cycles for Lead-acid; ~1500-2000 cycles for NiCD batteries). Vehicle acquisition cost for fuel cell propulsion is prohibitive for NOCA. Reliability of the vehicle is an issue; some electric vehicle fleets have experienced intermittent electrical problems that can’t be traced to a defect in the design or components[30].

Hybrid-electric: A hybrid-electric vehicle (HEV) combines an electric propulsion system (electric motor or motors driving the wheels) with another power plant such as a conventional internal combustion engine (diesel, gasoline, propane or natural gas), turbine, or fuel cell stack in order to take advantage of each. The HEV vehicle is at a more advanced state than the battery electric and hydrogen-fuel cell vehicle. A significant issue with HEVs is the relatively complicated control process needed to operate all of the electrical systems and optimize use of the energy storage device and power plant[31]. HEV design and integration are still in an early development stage. The integration process can be costly and can only be finalized with demonstration/prototype vehicles in the field for actual service experience[32]. In a recent paper on the case for hybrids in transit buses based on a meta-analysis and literature review, most bus builders still regard the technology as ‘exotic’ or advanced, and that the engineering of these systems within their vehicles

[28] Source: Battelle, Technical Assessment of Advanced Transit Bus Propulsion Systems, August 2002, prepared for Dallas Area Rapid Transit (DART).
[29] See Leslie Eudy, Challenges and Experiences with Electric Propulsion Transit Buses in the United States, DOE/GO-102003-1791, November 2003.
[30] L. Eudy, op. cit., p. 10.
[31] Control system design would include regenerative braking management—the propulsion system applies a load on the drive axle (like a mechanical brake retarder) during braking to convert kinetic energy into electrical energy that is fed back into the battery storage device, and, depending on design, a charge-sustaining subsystem; see Battelle, Technical Assessment of Advanced Transit Bus Propulsion Systems, prepared for Dallas Area Rapid Transit System, August 2002.
[32] Battelle, Technical Assessment of Advanced Transit Bus Propulsion Systems, op.cit., p. 23-25; also, Electric Hybrid Bus (BEE) Project in Santa Clara, Implementation of an Electric Hybrid Transit Bus Operation by a Municipal Electric Utility, 2003.

is still not fully known. This has major implications for the engineering and integration of the systems, quality assurance, field support and warranty issues, and risk-taking on behalf of the buyer as well as vendor[33].

Instructive in this regard is the experience of Santa Clara, California[34]. While deemed 'successful' in meeting project objectives, there were nonetheless delays in delivery of the vehicles, problematic construction of the front cowls and windshields, system-design problems, and problems with energy integration between the Capstone micro turbines, batteries, and the PEI battery management integration software. Both the vehicle manufacturer and the system integrator contractor (which was absolutely critical to 'success' of the project) filed for Chapter 11 bankruptcy. So too did the operator (i.e., 'concessionaire'). High complexity, site infrastructure requirements, acquisition cost (incremental premium costs are 60-80% higher than comparable standard diesel transit buses; a 40 ft. hybrid can exceed $500,000) and unreliability concerns all argue against use of HEV vehicles at NOCA. A further unknown factor is that to date, the 1,000+ HEV vehicles in use by urban transit systems operate solely on paved roads. Although the electronics are sealed, nevertheless it is unknown how well HEV vehicles may operate on unimproved gravel roads in a high dust and vibration environment[35] (i.e., there is no accumulated performance history).

In discussions on-site at NOCA, the Chelan Public Utility District (PUD) made a case for selecting hybrid-electric, arguing that the on-vehicle storage of electrical power could be fed back into the power grid at Stehekin to reduce peak loads and achieve a social and economic benefit for the residents at Stehekin. Analysis, however, shows that this is NOT possible due to two reasons: (1) because of the 'slow charge' technology, the recharge time of the battery pack exceeds the time headway (the time between consecutive vehicle runs) of the Stehekin Shuttle service, and (2) the peak power load for the transit system is coincident with the peak electric load at Stehekin (and the vehicles would be operating on the route, unable to be plugged into the electric system). This is illustrated in Figure 21, in which the time-dependent electrical load at Stehekin is overlaid with the Stehekin transit shuttle schedule.

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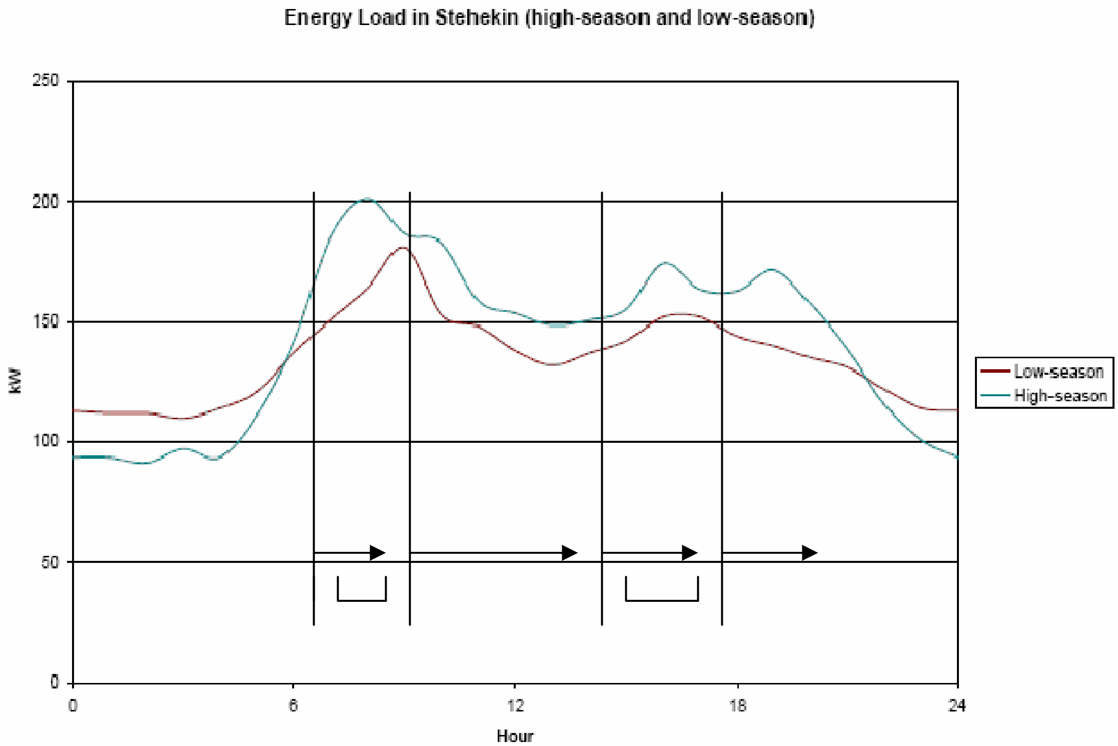
[33] See Cliff Henke, WestStart-CALSTART, *The Case for Hybrids in Transit Buses: A Meta-Analysis and Literature Review*, December 2005.

[34] Electric Hybrid Bus (BEE) Project in Santa Clara, Implementation of an Electric Hybrid Transit Bus Operation by a Municipal Electric Utility, 2003, pp. 1-7.

[35] Personal communications, Kevin Walkowicz and Dan Pedersen, US DOE/NREL, 5/23/07.

Figure 21 Overlay of Stehekin transit shuttle schedule (2007) with the time-dependent electrical load at Stehekin



Source: Jessica G. Kirchhoffer and Philip C. Malte, *Balancing Energy Options in Stehekin, WA* June 2003.

Q. Why is propane as an alternative fuel NOT recommended for use at NOCA?

A. There are a number of reasons why propane as an alternative fuel is NOT recommended at NOCA:

- Choice of an alternative fuel is a secondary decision, and the preferred vehicle selection – the New Yellow Bus – does not yet operate with propane.
- Propane tanks are under high pressure (~100-170 psi) and a leak would pose an undue fire hazard risk at NOCA since propane is heavier than air and collects in low-lying areas at ground level, and roadside vegetation and forest lands virtually abut the Stehekin Valley Road.
- Additional operational and safety training would be necessary for fleet staff.
- Quality assurance program (and sampling)are needed to test purity of the propane fuel source.
- Propane operates with a modified spark-ignition engine (rather than a compression –ignition or diesel engine). Previous experience at Yellowstone and Cape Cod indicate that large (i.e., 30 ft.) propane-fueled vehicles, particularly when operating at full load and on upgrades and/or "semi-improved" gravel surfaces with high rolling resistance, tend to be under powered for the application.
- The propane modification kits are manufactured by vendors other than the OEM vehicle manufacturer, and can introduce problematic issues of compatibility and integration.
- The storage volume relative to diesel of propane is 54% greater[36], so it would require substantially more barge movements over Lake Chelan to provide an equivalent amount of fuel (providing an

[36] See TCRP 38, Guidebook for Evaluating, Selecting, and Implementing Fuel Choices for Transit Bus Operations, Chapter 7, p.44, 1998.

equivalent range in mileage) as with diesel for the fleet of vehicles. These barge movements also consume energy, and generate emissions.

Q. Federal Property Management procedures[37] require—except under unique waiver conditions—that federal civil agencies purchase motor vehicles through the General Services Administration (GSA). What is the sequence of acquisition steps, what is the corresponding required documentation at each step, and what is the timeline for each step?

A. Federal agencies are required to use GSA for vehicle procurement. Standard, commercial vehicles can be procured using GSA AutoChoice. If the vehicle desired is not available through AutoChoice, the park can do a special procurement through GSA, use GSA's Express Desk, or request a waiver (leaving the park to purchase the vehicle on its own if the waiver is approved).

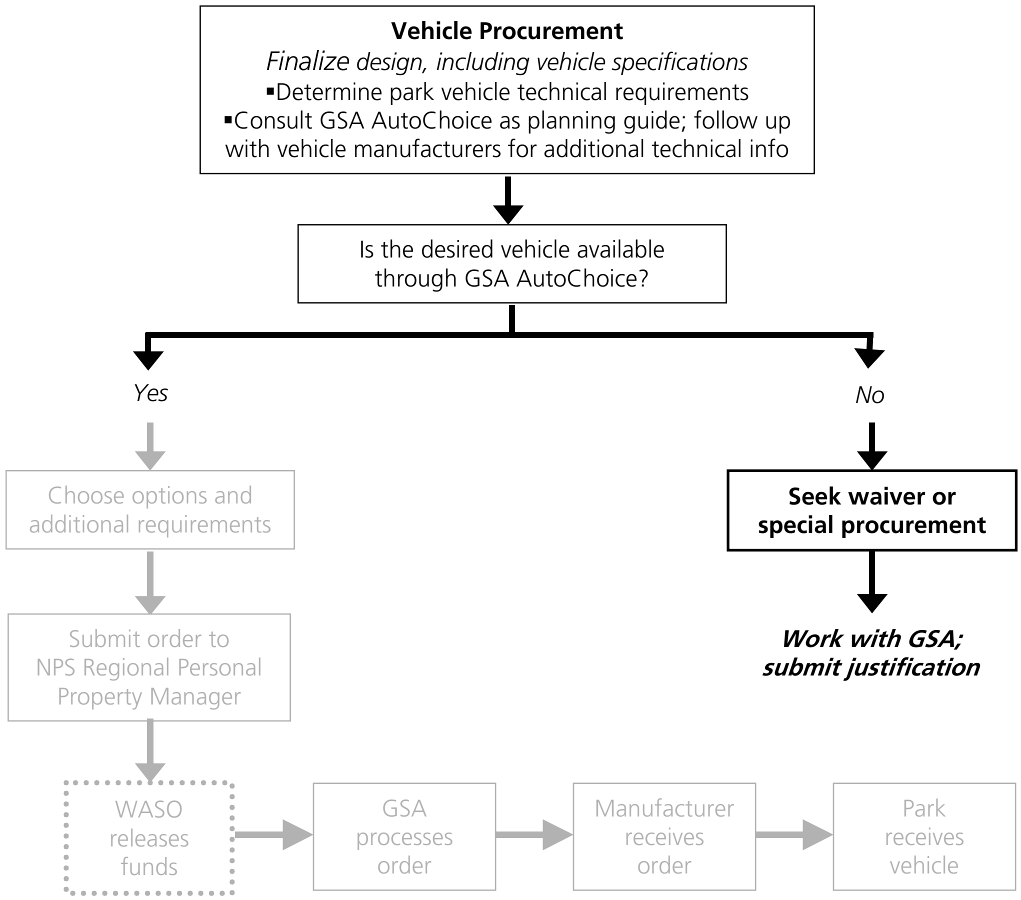
North Cascades and the US DOT/Volpe Center staff have, as documented in this report, worked to determine the most appropriate vehicles for the park. However, GSA does not currently have a contract for the New Yellow Bus, the recommended vehicle for Stehekin.

Previous discussion with Russ Miller, Director of Automotive Engineering at GSA, has confirmed that GSA will work with the park on a special procurement to procure the New Yellow Bus. GSA has worked with Yellowstone, Glacier and Yosemite in a similar fashion to procure suitable buses for their operations and operating conditions. This vehicle decision document serves as justification for pursuing the special procurement process. (see Figure 22 below). An additional 5% to the cost of the vehicle is added under a special procurement to cover GSA costs, but this procurement process means that the park does not have to directly handle the procurement, compared to a waiver that would leave the responsibility of the procurement to the park.

See the flowchart below for a graphical representation of this process.

[37] See Title 41, chapter 101, part 101-26, section 101-26.501-1.

Figure 22 Vehicle Procurement Flowchart



Findings and Next Steps

Key findings of this investigation include the following:

- Despite relatively low bus utilization at Stehekin (~100 mile per day across the fleet of vehicles deployed to service the Stehekin transit shuttle and the Rainbow Falls interpretative tour), the unpaved gravel road surface requires a rugged, durable chassis and suspension system. Thus, the class of vehicles appropriate to the application and operating conditions at Stehekin are Altoona-tested vehicles meeting the 10 -year/350,000 mile thresholds.

- Analysis of average passenger load and expected maximum passenger load for the Stehekin transit shuttle service and the Rainbow Falls interpretative tour indicate that a small size configuration bus (minimum seating capacity of 16 seats, preferably 19 seats) and a large size configuration bus (minimum seating capacity of 30 seats) are needed for the two types of services respectively.

- Recommendation that the most prudent course of action – given the uncertainty in the data used to calculate the time-dependent demand profile for the Stehekin transit shuttle – is to endorse the park's original procurement plan to acquire three (3) large buses and one (1) small bus.

- Recommendation by the project team for procurement of the **New Yellow Bus** fitted with a clean diesel engine (operating on ultra-low sulfur diesel fuel), and including a continuously regenerated diesel particulate trap (DPT).

  There are other potential buses that could serve the application and operating conditions at Stehekin. The New Yellow Bus in our judgment best serves the "core requirements" of the park, including the need to fit within the place and landscape and connect to historical precedent. Its visual design mimics the motorized touring vehicles that operated on the Stehekin Valley road during the 1920's-1930. The New Yellow Bus also passed three critical tests: (1) there is a 'family' of available sizes and seating configurations – but with the same visual design and profile -that can satisfy the service demand profile for the two types of operations at Stehekin; (2) the New Yellow Bus can traverse the most restricted vertical curve and geometry of the route with adequate clearance; (3) the New yellow Bus uses tested, commercial grade chassis and power-train, and test results (and limited operating experience) indicate adequate durability, reliability and maintainability.

  The project team's vehicle recommendation is based on engineering judgment informed by the park's responses to the *vehicle requirements survey instrument*, the site reconnaissance field visit, and simulated operation of the intended duty cycle for the shuttle operation and interpretive tour. Although a formalized, quantitative Value Engineering/Life Cycle Cost (LCC) analysis is beyond the scope of this document, the recommendation is informed by **qualitative** value engineering and life cycle cost (LCC) assessment that balances 'core requirements' and costs.

- Recommendation by the project team of bio-diesel (B20, blended with ultra-low sulfur diesel) as an alternative fuel option for the recommended vehicle.

Next steps include:

- Share Vehicle Decision Document with GSA (Russ Miller), prior to setting up three-way conference call with GSA (NPS, US DOT/Volpe Center, and GSA) to articulate process and steps to initiate a special procurement with GSA as a 'partner'.

Appendix I: North Cascades (NOCA) Stehekin Valley Vehicle Requirements Survey Instrument

4/10/07
D. Spiller/RTV-3C

NORTH CASCADES (NOCA) Stehekin Valley– Vehicle Requirements Survey Instrument (notes by NOCA staff)

Vehicle-Related Questions

1. With respect to the current vehicle (s) used at NOCA, what characteristics of the vehicle – systems and performance - would you like **retained** in any future vehicle purchase?
Functionality, durability, seating capacity

2. What characteristics of the vehicle –systems and performance – would you **like to change** in any future purchase of a vehicle?
Scenic viewing skylights, low floor boards/ADA accessibility, propane/ electric hybrid or bio diesel, appearance - Aesthetically appropriate for Stehekin – fits in with the character of the Stehekin area
3. What is the horsepower rating of the existing vehicle's engine, and do you consider it: (a) under-powered; (b) adequately powered; or (c) over-powered? N/A
4. What is the current type of fuel used? At what fueling station (location) is the current vehicle fueled? What is the fuel range in mileage of the existing vehicle? Is this considered adequate? How many times per week is the vehicle fueled? Is fueling done at the beginning or end of the operating day? What is the time to refuel? Is the refueling time considered: (a) satisfactory; (b) too slow?

5. On a scale from 1-5 (1 being least desirable, 5 being most desirable) please rank the following (re: future/new vehicle): these are subjective answers and should be discussed further

(a) ride quality/suspension system	1	2	**3**	4	5
(b) ease of maintainability	1	2	**3**	4	5
(c) cost of operation and maintenance	1	2	**3**	4	5
(d) reliability	1	2	3	4	**5**
(e) large side windows	1	2	3	4	**5**
(f) large roof windows	1	2	**3**	4	5
(g) alternative fuel	1	2	3	4	**5**
(h) seating capacity> 20 passengers	1	2	3	4	**5**
(i) seats forward facing	1	2	3	**4**	5
(j) low interior/exterior noise level	1	2	**3**	4	5
(k) visual look and appeal of vehicle	1	2	3	4	**5**
(l) low-floor for disabled access	1	2	3	4	5
(m) bike racks on vehicle	1	2	3	4	**5**
(n) heating/AC	1	**2**	3	4	5
(o) multiple doors for access/egress	1	2	**3**	4	5

(p) public address system	1	2	3	4	**5**
(q) storage for baggage/gear	1	**2**	3	4	5

7. What is the turning radius of the current vehicle? Is it appropriate?

8. What is the height and width of the current vehicle: (a) physical envelope of 'outside vehicle' dimensions; (b) physical envelope usable by patrons for the interior of the vehicle?

9. What is the seating capacity of the current vehicle?
Roughly 40 passengers

10. How many wheelchair securement locations on the vehicle are needed based on demographics of the visitors using the Stehekin Valley transit shuttle service? Probably 1 maximum, but we need to comply with ADA

10. What is the Gross Vehicle Weight Rating (GVWR) of the current vehicle? Has the weight of the current vehicle resulted in any damage or additional maintenance operations to the existing pavement and/or roadbed of the Stehekin Valley road?

11. What is the *break-over angle* (see definition on last page) of the current vehicle (**ground clearance** **height** and **wheel base** dimensions are acceptable, if *break-over angle* is not available)?

12. Do drivers have a CDL license? If so, what class? Up to what size of vehicle? drivers have a CDL-B

13. Have you had any safety-related issues with operation of the existing vehicle? Please discuss details.
Minor vehicular incidents (accidents with minor damage, no injury) due to size of vehicle??

14. Have you had any maintenance-related issues with operation of the existing vehicle? Please discuss details.

15. Do the brakes work sufficiently on the current vehicle?

16. Does the current vehicle provide for air-conditioning and heating for passengers? If so, is it utilized?
None

Route-Related Questions

15. If engineering drawings and/or a photo log of the Stehekin Valley road exists, please forward a copy.

16. If a base USGS topographical survey map for the Stehekin Valley shuttle route is available (hardcopy or electronic file), please mark on it the **location** and **length** of the following, using these annotated symbols. Otherwise, please provide approximate milepost locations along the route for these features.

poor drainage / wet locations.......	D
poor friction (including side slippage)	F
poor vehicle clearance (i.e., bottom of vehicle scrapes surface)	C
sharp vertical transitions (i.e., front or rear overhang of vehicle scrapes surface)	SV
tight vehicle turns (along route, and at stops).......	T
sight or stopping distance problems	S
up grades exceeding 5%	UG
down grades exceeding 5%	DG
vehicle turnouts	V
load-limiting structures (e.g., culverts, bridges), with load limit	L(10 tons)
locations requiring frequent maintenance.......	M

17. What is the policy with regard to standees? All passengers currently sit in seats – standing not recommended. An NPS Ranger COULD be standing (if space and PA system allow) to conduct interpretive programs while utilizing the bus. Appropriate safety devices should be in place (hand holds, etc.)

18. Is the route single lane, with one-way directional flow of traffic? Single lane, with two-directional flow of traffic but with turnouts for vehicle passing (Generally the route is single lane with two directional flow and turnouts)? Single lane, with two-directional flow of traffic but with turnouts for vehicle meets? Two-lane, two-directional flow of traffic?

19. What is the minimum cross-sectional width of the road, and at what location (milepost from initial terminus of route)? Are there shoulders along the Stehekin Valley road? There are generally no shoulders, but there is some space to pull out in non-designated pull-out spots.

20. What material is the wearing course of the road? (e.g., untreated soil, stabilized soil, course aggregate, macadam, bituminous asphalt, portland cement concrete) Some areas of asphalt (the first 4 miles) the remaining road is gravel

21. What is the average daily traffic (ADT), and peak-hour traffic on the Stehekin Valley road?
Daily vehicle traffic is roughly 100 one-way vehicle passes in the summer time (going up valley and down-valley). Heaviest traffic use is during (boat time) - in the summer this is 10:45 – 11:45 and 12:30 – 2:00. Heavy between 10:30 and 2:00

22. Do other vehicles share the road with the scheduled Stehekin Valley transit shuttle vehicle? If this is the case, what is the vehicle mix (i.e., percent autos, vans, RVs, buses, bicycles, pedestrian/hikers, equestrians)?
Pedestrian and bike traffic is all day long (from 7:00 am to 8:00 pm) – heaviest mid day with roughly 100 bikes and pedestrians per day in the summer.

Service Operations-Related Questions

23. Approximately how many minutes is a round trip (up and back) of the Stehekin Valley transit shuttle service? Please describe the following elements of the service:

(a) The number of round trips (or two-way runs) per day (provide current or proposed, if changes are anticipated, time schedule); 60 minutes (Rainbow falls Tour Bus) and 2 hours (Stehekin Shuttle).

(b) Which of the daily trips are coordinated with the lake vessel arrivals at the Stehekin docks?

The Rainbow Falls Tour Bus Trips

(c) How many transit vehicles arrive to meet the lake vessel arrival?

During the summer months, there are two. In the winter, there is one.

(d) If multiple transit vehicles arrive to meet the lake vessel arrival, are the transit vehicles operated in 'convoy mode' along the route, or are the transit vehicles dispatched (a)at uniform times after the lake vessel arrival; or (b) as soon as each transit shuttle vehicle is filled to capacity? A little of each.

(e) How many boarding spaces are available for the Stehekin Valley transit shuttle at the docks? The park intends on improving the landing area and designating a bus staging area. Two may be parked and loading at the same time, but it creates congestion for other private vehicles waiting to meet boat passengers and pick up freight.

(f) Approximately what percent of passengers on a 'typical' lake vessel arrival during the peak visitor season transfer to the Stehekin Valley transit shuttle service? During peak season, at least half of the passengers arriving by lake vessel board the buses

(g) Length of shuttle route (in miles); One-way for the Rainbow Falls Tour is 3.5 miles. One way for the Stehekin Shuttle service is 11 miles.

(h) Which of the route stops (and associated mile post) has the maximum number of passengers who alight? A larger majority of people board the Rainbow Falls Tour Bus at Stehekin Landing. The Stehekin Shuttle services picks up and drops off the majority of it's passengers at Stehekin Landing and High Bridge.

(i) Which of the route stops (and associated mile post) has the maximum number of passengers who board the transit vehicle? See above

(j) The number of stops along the route (and their respective milepost), excluding the initial staging area or terminus; Rainbow Falls Tour Bus: Passengers board at Stehekin Landing, disembark and re-board at Rainbow Falls (mile 3.5) and disembark at Stehekin Landing.

Stehekin Shuttle: Passengers board and disembark at Stehekin Landing, Stehekin Pastry Company (Mile 2), Stehekin School and Rainbow Falls (mile 3 and 3.5), Harlequin Bridge (mile 4), rainbow Falls Loop Trail (upper end) at roughly mile 5, Stehekin Valley Ranch (mile 9) and High Bridge (mile 11). This bus also makes "flag" stops anywhere along the route.

(k) Which of the stops is 'on-demand' only? Stehekin Shuttle - Stehekin School, Rainbow Falls, Harlequin Bridge, Rainbow Loop Trail, Stehekin Valley Ranch.

(l) Average dwell time for interpretation at each of the stops along the route; Roughly 3 minute

(m) Average and maximum operating speeds over the route Average 20-25 MPH

Other Questions

24. Approximately how frequent, and during what days and seasons, are there passenger overload events in which passengers must wait for the next vehicle run? What is a reasonable estimate of visitor demand that is NOT met (i.e., 'turned away')? Seldom

25. Based on anecdotal and informal information from the driver's daily driving activity, on a scale of 1 to 5 (1 being least satisfied and 5 being most satisfied), are visitors satisfied with existing Stehekin Valley transit shuttle service?

    1 2 **3** 4 5

26. Based on same anecdotal and informal information, discuss major issues or problems that visitors have with the Stehekin Valley transit shuttle service and the existing vehicle(s). The buses are converted school buses and do not fit in with the character of the National Park and Stehekin – they are ugly. They use a lot of fuel and are somewhat "noisy". Current bus drivers are friendly and courteous.

27. What is the average passenger load (number of passengers) per vehicle run in each direction during weekday peak season? During weekend peak season?

Average number of passengers on the Rainbow Falls Tour during Peak Season is: 50 per day. Average Number of passengers on the Stehekin Shuttle per day during peak season is: 40- 50 per day.

28. What are the hours per day and number of days of operation per annum? What is the vehicle-miles-traveled (VMT) per vehicle per day?

Rainbow Falls Tours – runs daily, year-round. Average hours during the winter months is 1 per day, average hours during the summer season is 2 per day. Rainbow Falls Tour mileage is roughly 12-15 mile per day. Stehekin Shuttle runs roughly 11 hours per day and mileage is roughly 88 per day.

29. What are the typical operating temperatures (ambient temperature) during the peak visitor season? 80 to 85 degrees What is the operating temperature during the winter season? ? 32 degrees Other weather-related events that could effect vehicle operations? Snow, rain and ice during the winter months. Other roadside or habitat or environmental conditions that could effect vehicle operations? Wildlife (Deer) on the road, pedestrians with dogs, kids and bikes.

30. Is there a reservation system for the vehicle(s) and service?

Rainbow Falls Tour Bus – yes (tickets sold on the passenger boats and numbers called in prior to boats arriving in Stehekin). Stehekin Shuttle – no.

31. What is the fare/fee charged for a round trip on the Stehekin Valley transit shuttle? Stehekin Shuttle is $5 one-way for adult, $2.50 for child under 12, and $5 for bikes and dogs.

32. Who does the maintenance of the vehicle(s)? Can you provide the monthly maintenance cost per vehicle? Can you provide data for the average time between engine rebuild for the existing vehicle?

33. Is the vehicle(s) garaged indoors or outdoors? Outdoors.

Appendix II: Additional Park Service Questions Re: New Yellow Bus

Q. What about snow conditions at Stehekin?

A. Depending upon how well the road is plowed, it may be necessary to use tire chains on the small configuration New Yellow Bus for winter operations. Siped tires are not recommended since they only weaken the tire structure.

Q. The park and concessionaire indicated they prefer rear loading door for luggage/pack storage/access. Is it possible to create a back door or is that out of the question? What about some sort of enclosed storage compartment on the outside rear (not an open rack)? Can seats accommodate storage of day packs underneath? Is there overhead luggage storage?

A. We confirmed with the manufacturer that it is NOT possible to have a rear door for access with the "retro" shaped back. One issue with rear loading is that the bus is higher in the rear than at the front of the bus. However, a front luggage rack near the door entry, as is the case with airport shuttle vehicles, works quite well. Upon entry, passengers would load the rack with their gear, and on exit would pick their gear before alighting. This generally doe not create an internal circulation bottleneck within the vehicle. Having an external luggage compartment would increase the length and turning radius of the vehicle, would require the driver to exit the vehicle to assist the passenger, and is not advisable even if feasible. Storage of day packs under the seats is also not advisable since it tends to obstruct internal flow of passengers within the vehicle. So too it is not advisable to have overhead luggage (problems with internal circulation within the vehicle), and also because it would block views to the landscape.

Q. What about external noise, particularly during idling when the AC is on? Do the windows open? Is there ventilation? Will road dust be a problem?

A. With the vehicle stationary and the engine, accessories, and air conditioning on, the New Yellow Bus averaged 59.5 dB(A) at low idle[38]. This is reasonably quiet since as a basis for comparison, the APTA Stand Bus Procurement Technical Specification allows bus-generated noise at curb idle to not exceed 65 dB(A). Whether the bus needs to run idle at the landing will depend on ambient temperatures and wind conditions. This document has specified operable 'transom' windows and two roof vents for natural ventilation (in addition to AC), although it is also noted in the report that natural ventilation to be effective requires the forward motion of the vehicle (thereby creating a differential in air pressure and air buoyancy (see pp. 17-18). The report has specified upper 'transom' windows to be operable (as opposed to the bottom side windows) precisely to minimize dust intrusion, and exterior noise.

[38] The Pennsylvania Transportation Institute, *STURAA Test: 10 Year 350,000 Mile Bus from TMC Group Inc, Model Ameritrans*, July 2006,p.107.

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12. DISTRIBUTION/AVAILABILITY STATEMENT
Public distribution/availability.

13. SUPPLEMENTARY NOTES
This report addresses alternative transportation decision factors as indicated below (Y/N/NA):
(NA) Non-construction options; (NA) park carrying capacity; (Y) life-cycle/ops. & maintenance costs; (Y) cost-effectiveness.

14. ABSTRACT
This document serves as technical substantiation in support of a procurement for a fleet of vehicles to be used to operate a scheduled shuttle operation with multiple stops at North Cascades National Park Service Complex (NOCA), in the Stehekin Valley, located at the northern terminus of Lake Chelan in central Washington State, and an interpretative tour and ad-hoc group tours.

15. SUBJECT TERMS
Vehicle requirements, vehicle selection, shuttle operations, interpretative tour

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
None	None	None	NA	49	Gary T. Ritter

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As the nation's principal conservation agency, the Department of the Interior has the responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our parks and historic places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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