

PRESENTATION
MADE BY
KEN FOX OF ART ANDERSON ASSOCIATES
OF THEIR
VESSEL OPTIMIZATION STUDY
FOR THE
WOODS HOLE, MARTHA'S VINEYARD AND NANTUCKET STEAMSHIP AUTHORITY

October 31, 1996

[Cross-Referenced To The Transparencies Used By Mr. Fox
During His Presentation, Which Are Attached Hereto]

As Mr. Tiberio mentioned, Art Anderson Associates is not just a company of naval architects. Rather, we are a full service marine design corporation, going into everything from route studies where we look at the feasibility of ferry systems right down to designing ships and shore facilities. We have about seventy employees, half of whom are civil engineers and the other half naval architects.

[Page 2] For this particular vessel optimization study, the scope of work which we were asked to undertake was to consider all the factors affecting the Authority's operations, including its shore side facilities, routes and schedules, and to identify the characteristics of the optimum vessel to replace the M/V Islander if the decision is made to replace her.

[Page 3] One assumption and primary consideration of the study was to base it on the service year of 2005 so that our work would be in sync with the study that KJS Associates, Inc. did for the Authority on traffic projections. In fact, as part of our work we had Joseph Savage of KJS review our conclusions to see if they were consistent with the traffic levels KJS had projected. We also based our study on what KJS referred to as "constrained" and "unconstrained" levels of service. In simple terms, as you may remember, the "constrained" level of service represents a level of service that accepts the fact that a certain amount of pent-up demand will not be met, while the "unconstrained" level of service assumes that the Authority will carry every vehicle which shows up.

We also have assumed that flexibility of resources is important, in that whatever vessel we come up with should be able to work on either route. In fact, we agree with that assumption, because when you only have four vessels you are always faced with the possibility that one of them will be out of service and you will still have to serve both routes. Therefore, it is important that the vessel be flexible for both routes.

[Page 4] Our method and approach were quite simple. First, we obtained all of the paperwork from the Authority. We reviewed all of the sailing directions, the weather, the ports, the terminals and the traffic. Then we visited here for a few days and talked to the operators, managers, and as many travelers as possible. We witnessed the entire operation and then went back to try to optimize the service for each of the two routes, selecting the characteristics that would best work primarily for the Vineyard route but would also be acceptable for Nantucket service.

[Page 5] One of the first things we found were some limiting conditions. (Incidentally, compared to other areas, I think that this service is one of the most difficult we have witnessed. The weather, the nature of the routes, the traffic that you have, and the restricted areas in the channel make this a real challenge for running a ferry system.) We found a length limit of about 230 feet in the Hyannis channel, but that length limit is also dictated by the limited maneuvering room you have in all four ports. The beam is limited to less than 65 feet by the mooring slip configurations and, in fact, it may be a foot or two less than that. With respect to the vessel's draft, the channels are dredged to a maximum of 12 feet and, because we are conservative about this subject, we are not really comfortable with any draft greater than 10-1/2 feet. Finally, because of the wind conditions and narrow channels, we believe that 2-1/2 decks is as high as you want to go. All of these are things that I know the ferry system has worked with over the years.

[Page 7] Based upon KJS's predictions, we also assumed that fourteen percent of the Authority's annual traffic will occur in each of the months of July and August. Dividing those numbers by the number of days in a month, we arrived at the following approximate figures: for Nantucket, each day the Authority will need to carry 255 automobiles on an unconstrained demand basis (or 230 on a constrained basis), 52 trucks and 1,900 passengers. Comparing that with the Vineyard route, you will notice that there are about three times as many automobiles going to Martha's Vineyard, twice as many trucks, and around four times as many passengers. There is thus a little difference in the mix between the Vineyard and Nantucket routes, and that played into our analysis later on.

Using these numbers, we then calculated the number of trips the Authority will have to make each day in order to meet the

demand. [Page 9] With respect to the Nantucket run, which currently has each of its two vessels making six one-way trips each day, it looks like we will be able to handle the service requirements in the year 2005 with the existing vessels. [Page 10] However, the picture is not quite as good for the Vineyard run, which currently has its vessels making thirteen one-way trips each day. It appears that, in order to meet even the constrained demand, an increase in capacity will be required on the order of one more one-way trip per day, so that each of the two vessels on that route would make seven round trips per day.

[Page 11] Similarly, with respect to passenger capacity, the Nantucket service will probably be adequate with the vessels you have today. [Page 12] However, the Vineyard service will require additional passenger capacity as well. (In this regard, I note that these figures are based on an average demand, assuming that you are going to have the same number of vehicles and passengers at 5:30 in the morning that you are going to have at noon, and we know that is not so. Therefore, we have to allow for the fact that we want to have more capacity than the average predicted so we do not leave any passengers sitting on the pier.)

[Page 13] We then have to figure out what the numbers mean in terms of lane feet. When we design a ferry we don't think in terms of vehicles as much as we do in terms of the number of lane feet of capacity that is required. For example, the European automobile is about thirteen feet long and an American car is around seventeen feet long. When you factor in the number that are towing trailers or boats, we generally average about twenty feet per automobile. We work all of this out in terms of lane feet rather than vehicles and, roughly, a 230-foot ferry is going to have around 1,270 lane feet of capacity. [Page 14] Accordingly, when you look at the Vineyard service where we have our larger traffic predictions for 2005, with 1,270 lane feet of capacity per vessel, it looks like you will have to make at least fourteen trips per day to meet the constrained demand, and even then you are going to be somewhat short on capacity.

[Page 15] The other variable that we can work with is the vessel's speed or, in other words, how much faster a vessel has to go in order to make more trips per day. In this regard, we assumed an 18-hour operating day with about forty minutes on each end of the day for getting the vessel in shape, starting up, et cetera. As we all know, if you are dealing with a thirty mile trip, you cannot say that you are going to make the trip in an hour with a 30-knot vessel. Rather, we conduct our speed analysis by adding together the following time periods:

First, we take the time it takes to get underway from your first port or, in other words, the time it takes to back away and get clear in the channel, which generally runs two or three minutes. This is Time "A."

Time "B" is the time it takes to moor at the second port, which is generally about the same two or three minutes.

Time "C" is the time we spend at slow speeds in channels, and around here that is significant, more than any place that we have reviewed. You have some narrow, shallow channels here where you simply can't get up to speed because you have traffic, tidal conditions and weather. You also have some pretty difficult maneuvering areas where you are restricted to a certain speed, particularly in low wake watch areas.

Time "D" is our open water time where you can take the distance you have to go at your maximum speed. This is where an increase in a vessel's speed capability will save you some time.

We then normally add an allowance of five percent for weather, extra traffic, tidal conditions, and anything else that might be unusual.

[Page 16] So this formula that we use for travel time will give you something that you can use in a schedule so that you can state how many trips you will run each day and at what times they will sail.

[Page 17] Using this speed analysis, we then calculated the travel time for each of the two routes. In this regard, although the Nantucket route is 24.7 nautical miles, there are only 19.8 miles where you can really get up to speed. Similarly, while the Vineyard route is 6.7 nautical miles, there are only 5 miles where you can get up to speed. Based upon these numbers, we decided that the 19.8 miles of open water on the Nantucket run makes speed significant for that route. However, with respect to the Vineyard run, it is pretty hard to do anything that would make an impact.

To put it in a little better perspective, remember that the Authority is restricted to about thirty minutes on each end of a trip for loading and unloading. Therefore, when you look to see whether a faster speed will allow you to run more trips, you have to look at not just the time the vessel spends in transit, but the total time the vessel spends in port plus the time she spends at various speeds on the water. Accordingly, because of the amount of time a vessel spends between Hyannis and Nantucket, an increase in speed makes quite a difference. On the other hand, when you look at the Vineyard route, even a difference in speed between ten knots and thirty knots is not that significant overall. Currently, your vessels are running at around thirteen knots; so, as you can see, the difference between thirteen knots and twenty knots doesn't save you a lot. Most significantly, it

does not allow you an extra trip a day, and that is what we are looking for.

Consequently, we calculated the optimum speeds for each of these runs. [Page 18] For the Hyannis to Nantucket run, in order to get four trips a day, you have to get up to 22 knots. But four trips are not required at this time, although they may be in the future if you are looking beyond the year 2005. Therefore, if we were defining a vessel specifically to run between Hyannis and Nantucket, we would recommend a 22-knot vessel. It would be an entirely different hull form than those you are currently considering; but it would allow you the additional capacity which in the future would probably pay off.

[Page 19] However, for the Woods Hole to Martha's Vineyard run, a very modest increase up to sixteen knots would allow you seven trips a day. To get eight trips you would have to get up to a much higher speed and that would not be cost effective. Accordingly, in our study we are recommending that, in the future, there should be a slight increase in power and speed for the Vineyard run so that you can comfortably maintain seven trips per day in an eighteen hour day.

[Page 21] Now, with respect to the hull form, there are three basic issues to answer. Should we go with another double-ender like the Islander or a drive through single-ender like the Martha's Vineyard? How many car lanes should it have? How many truck lanes? How many passengers should we carry?

The double-ender/single-ender issue gave us a lot of thought and boiled down to this: With a double-ender, you save about one minute on each end of the trip as far as mooring and unmooring. The problems you have with a double-ender for this particular route are:

- (1) Maneuverability in the channel. In order to have a vessel that can maneuver in the long, restricted, shallow channels that you have on both of these routes, you have to put in an omni-directional propulsion system which would add quite a bit to the expense.
- (2) The double-enders are going to be more expensive because you have duplicate equipment, duplicate steering and duplicate propulsion controls systems, and that also adds quite a bit to the expense of the vessel.
- (3) Double-enders will not have the seaworthiness that is required for the Hyannis-Nantucket run. Wherever you find double-enders operating successfully in the world, they are either in very protected waters or they have extensive, sophisticated, omni-directional propulsion systems. They are usually on short runs as well, and

the Nantucket run is not a cost effective route for a double-ender because of the sea conditions and its length.

[Page 22] With respect to the number of car lanes and passengers, I would like to go into a little more detailed discussion. This drawing gives you a rough idea of how your current ferries are configured (although the Nantucket has three truck lanes, not two as shown). You now have very narrow lanes - actually, lanes that are too narrow. Indeed, people traveling on the Islander complained that they are frequently stuck in their cars because they cannot get their doors open. The problem with the Martha's Vineyard arrangement is that the truck lanes are really too narrow and one car lane is too tight. The Nantucket is similar and, moreover, is slow to load and unload. (That is an interesting observation we made. Washington State Ferries is able to load and unload a car every two seconds. British Columbia is able to do it every one second. The Alaska ferry system runs about one car every fifteen to twenty seconds, and you are running around ten seconds per vehicle. A lot of the problem is that once the vehicle gets off the vessel it is constrained by traffic conditions within the towns, and that is something you can't do much about. But we did try to configure our design so that the vessels will be able to load and unload as rapidly as possible.) The Eagle has a very good traffic pattern, but it has other problems. To be blunt about it, the Eagle is a cork floating on the water.

[Page 23] With respect to our proposed arrangement, the first thing we are recommending is to increase the vessel's beam by just a few feet (three feet more than the beam of the Martha's Vineyard), which will give you a lot more space on either side. As you can see from this drawing, we recommend having curbs on either end, which is fairly common, and 24 inches between lanes. We are very comfortable with the car lanes. I actually measured these on one of the most spacious ferries in existence today running on Washington State Ferries, and the car lanes we are comfortable with. The truck lanes are still a little narrow and I would like to see 64-foot beams if in fact the slips can handle them, so that we could have an extra foot between the two truck lanes. But this is the kind of arrangement that we would like to have. (You will also notice that we kept the island to a minimum amount of space, about the same that you have on the Martha's Vineyard today.)

[Page 24] On this drawing, the dotted line represents the outline of the Martha's Vineyard, so you can see that by increasing the beam just a little bit, the vessel becomes a lot more comfortable. The other thing I forgot to mention is that by putting in two car lanes on each end, we will increase the width of the mezzanine deck, which gives us much greater enclosed passenger seating. With this arrangement, I figure we will have roughly 6,000 square feet of enclosed passenger seating which, at

10 square feet per passenger, will allow you to have around 600 passengers seated within the vessel. If you remember, the average number of passengers per trip that we were predicting was around 500, and there will be peak times when you are going to have a lot more than that. But this idea of having four car lanes solves two problems: it gives us increased automobile capacity and also gives us a lot more passenger capacity. It leaves us, however, with a limitation on the number of trucks to six or seven "semi's" per trip.

[Page 25] I want to go over this summary of our optimum characteristics study to show why the configuration we prepared is the best for the Vineyard route as well as the best for providing flexible service. Looking at overall length, we stayed at 230 feet. You might be able to go a little higher than that on the Vineyard route, but because of the maneuvering problem I think that most of your operating masters would be very uncomfortable with anything over 230 feet. I quite frankly don't see how some of them do it, particularly in Vineyard Haven where it really is restricted. They have very little maneuvering room, coming within 15 to 20 feet of some of the boats that are moored there.

The vessel should have a beam of 63 feet. Being conservative, I think that is optimum. As I said, I would like to see another foot if we could squeeze it in.

As to draft restrictions, you could possibly go to eleven feet on the Vineyard run, but 10-1/2 feet is about what you could handle in the Hyannis channel, so that is what we are recommending.

As I mentioned, for the Nantucket run, a speed of 22 knots would allow you to make four trips per day, but in the year 2005 16 knots will suffice. Because speed costs money, we are recommending that you stay with a 16-knot vessel.

Maneuverability is very important. We are recommending a twin-screw, conventional bow/stern vessel with a good bow thruster like the one you have on the Martha's Vineyard. This type of vessel will give you the maneuverability you require at slow speed in the channels.

With respect to the mix of automobiles to trucks, you have a higher car to truck mix on the Vineyard run, as well as a higher passenger to car mix. You also need enclosed spaces for an average of around five hundred passengers per trip on the Vineyard run, and I think that our recommended vessel would accommodate that.

With respect to hull form, a double-ender would work on the Vineyard run, but it is more expensive. For overall flexibility, the twin screw conventional hull with moderate responsiveness

would be the best. The ferry system is very comfortable with the service and maintenance they have received on their EMD engines, and I would recommend that they stay with those engines, although they should try to get more power to obtain a speed of 16 knots so that they can get the extra run per day for Martha's Vineyard.

Seakeeping, which is the ability to provide a comfortable and safe transit, is very important. For this reason, a shallow Vee, chine hull is our recommendation.

[Page 26] In conclusion, our recommendation is to design and build a new ferry. Looking at the Islander's machinery, it appears to be in good condition. What we recommend is to put the Islander in dock and do a good hull survey to see what the condition of her hull is. If it is in good condition, it might be worthwhile to convert her into strictly a truck ferry in order to handle all the truck traffic that is continuing to build up for both routes. By taking out the mezzanine decks and replacing them with a simple lounge with reduced capacity, you could raise the height and allow you to carry a lot of trucks that you cannot carry today.

Overall, we think the ferry system recognizes that it has to improve vehicle handling both on shore and on the vessel, and we think we can do that by using a vehicle deck arrangement closer to the Eagle than the current one. The Americans with Disabilities Act has never been interpreted in connection with ferry systems, but it is just around the corner. In this regard, if the law were applied to ferry systems today, every ferry system in the country, including this one, would be in trouble because no one meets its requirements. The Authority has made a good effort towards that, but there is a lot more to be done in order to handle people with disabilities.

The last thing I looked at was your competition and the increase in the passenger traffic, particularly for Martha's Vineyard, as well as what I perceive to be an effort on the part of both islands to keep the cars and trucks off and get more people to come over by foot. In this environment, I see a potential advantage in getting a high speed catamaran that could make many trips a day. It would be less expensive, it would not require a whole lot in the way of facilities, and I think it could take a lot of pressure off in terms of foot traffic for both Martha's Vineyard and Nantucket.

Study of Replacement Vessel for M/V ISLANDER

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Scope of Work

“Consider all factors affecting the Authority’s operations, including shoreside facilities, shoreside support facilities, routes and schedules, operating conditions, and traffic projections.”

“Identify the characteristics of the optimum vessel to replace M/V ISLANDER.”

Assumptions and Primary Considerations

- **The service year 2005 is the basis of the traffic assumptions**
- **The levels of service to be analyzed will be both unconstrained Service (all traffic) and constrained (a predetermined level of traffic) level of service**
- **It was assumed that flexibility of resources between the Nantucket and Martha's Vineyard routes will be preferred over a vessel designed for a specific route.**

Method and Approach

- “Paper study” of the route, the vessels, the weather, the ports, the terminals, and the traffic
- Inspect all of the above, talk to the operators and managers, listen to the travelers, witness the operation
- Optimize the service for each route
- Pick the best characteristics for BOTH routes.

Limiting Conditions

- Length limited to ~ 230' by Hyannis Channel and maneuvering room.
- Beam limited to ~ 65' by mooring slip configuration
- Draft limited to ~ <12' by dredged channels
- Height limited to ~ 2 ½ decks to reduce sail area owing to heavy winds, and limited maneuvering area.

Capacity (Daily Requirement-2005)		
Mode	Hy/Nantucket	W. Hole/M.V.
Autos	255	785
(Unconstrained)		
Autos	230	760
(Constrained)		
Trucks	52	102
Passengers	1,900	8,200

Vehicle Capacity per vessel against number of daily trips required to meet predicted daily demand Hyannis/Nantucket Service

Number of Daily Trips	6	7	8	9	10
Unconstrained	51	44	38	34	31
Constrained	47	40	35	31	28
Current	39	33	29	26	23

Vehicle Capacity per vessel against number of daily trips required to meet predicted daily demand Woods Hole/Martha's Vineyard Service

Number of Trips	13	14	15	16	17	18
Unconstrained	68	63	59	55	52	49
Constrained	66	62	57	54	51	48
Current	64	60	56	52	49	46

Passenger Capacity per vessel against number of daily trips required to meet predicted daily demand Hyannis/Nantucket

Number of one way Trips	6	7	8	9	10
Unconstrained	317	271	238	211	190
Constrained	317	271	238	211	190
Current	250	214	188	167	150

Passenger Capacity per vessel against number of daily trips required to meet predicted daily demand Woods Hole/Martha's Vineyard

Number of one way Trips	13	14	15	16	17	18
Unconstrained	630	586	547	513	482	456
Constrained	630	586	547	513	482	456
Current	446	414	387	363	341	322

Hyannis/Nantucket

13

What does this mean in terms of “Lane Feet”?

Wood’s Hole/Martha’s Vineyard

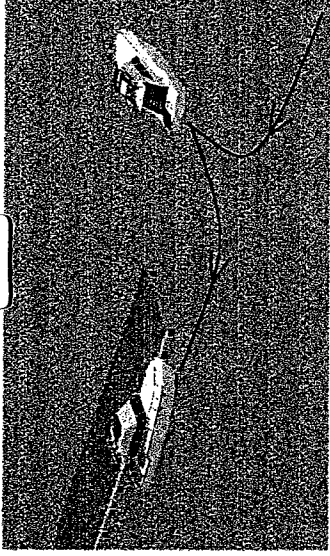
# of Daily Trips	Autos	Trucks	Lane Feet Required Unconst'd	# of Daily Trips	Autos	Trucks	Lane Feet Required Constr'd
13	60	8	1496	13	58	8	1456
14	56	7	1379	14	54	7	1339
15	52	7	1299	15	50	7	1259
16	49	6	1202	16	48	6	1182
17	46	6	1142	17	45	6	1122
18	44	6	1102	18	42	6	1062
UNCONSTRAINED				CONSTRAINED			

Speed Analysis

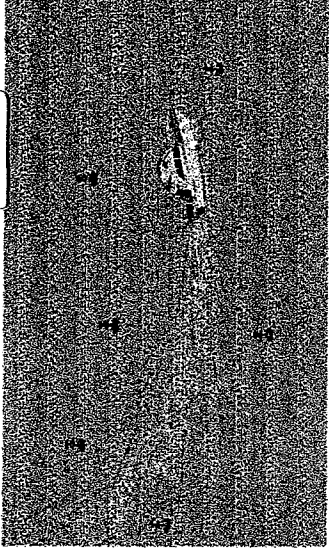
(What is the Cost of increasing Service to more trips per day?)



Ⓐ Time to get underway from point one.



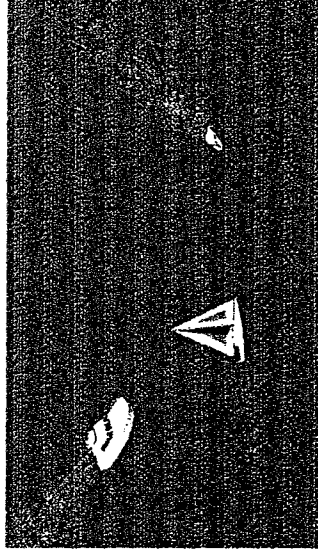
Ⓑ Time to moor at point two.



Ⓒ Time spent at slow speed in channels.



Ⓓ Open water time.



Ⓔ Allowance for weather, traffic, unforeseen problems.

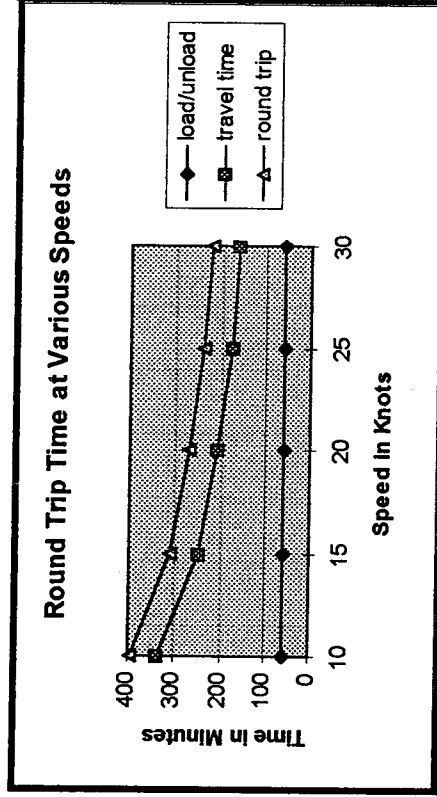
$$\text{Travel Time} = (A+B+C + \frac{\text{Distance D}}{\text{Speed}})1.05$$

TRAVEL TIME CHART

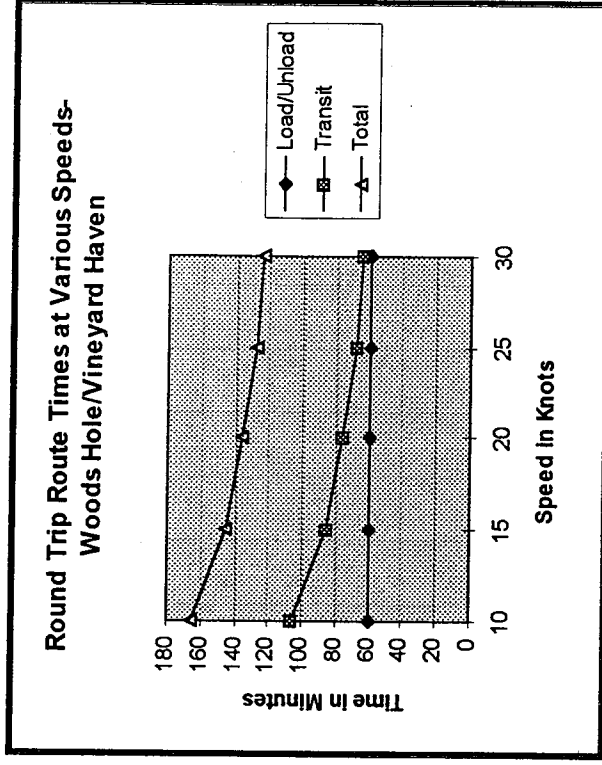
A	B	C	D	E
Time to get clear of pier	Time to tie up	Time at low Speed	Open Water Speed	Delay Allowance
H/N 3 (24.7 nm)	3	29	19.8 ÷ Speed	.05 x Σ (A-D)
WH/MV2 (6.7 nm)	2	15	5.0 ÷ Speed	.05 x Σ (A-D)

$$\text{One Way Travel Time} = \Sigma (A-E)$$

Round Trip Travel Time



Round Trip Time at Various
Speeds
Hyannis/Nantucket



Round Trip Time at Various
Speeds
Woods Hole/Vineyard Haven

Choices to be Considered for Vessel Speed **Hyannis/Nantucket**

NUMBER OF TRIPS	OPERATIONAL SPEED (FULLY LOADED)	PROBABLE MAXIMUM SPEED (FULLY LOADED)
THREE TRIPS/ DAY	11.8 KNOTS	13 KNOTS
FOUR TRIPS/ DAY	20.5 KNOTS	22 KNOTS

Operational Speeds Required for Several Round Trips per Vessel Each Day

Choices to be Considered for Vessel Speed Woods Hole/Vineyard Haven

NUMBER OF TRIPS	OPERATIONAL SPEED (FULLY LOADED)	PROBABLE MAXIMUM SPEED (FULLY LOADED)
SIX TRIPS/ DAY	10 KNOTS	12 KNOTS
SEVEN TRIPS/ DAY	15 KNOTS	16 KNOTS
EIGHT TRIPS/ DAY	30 KNOTS	32 KNOTS

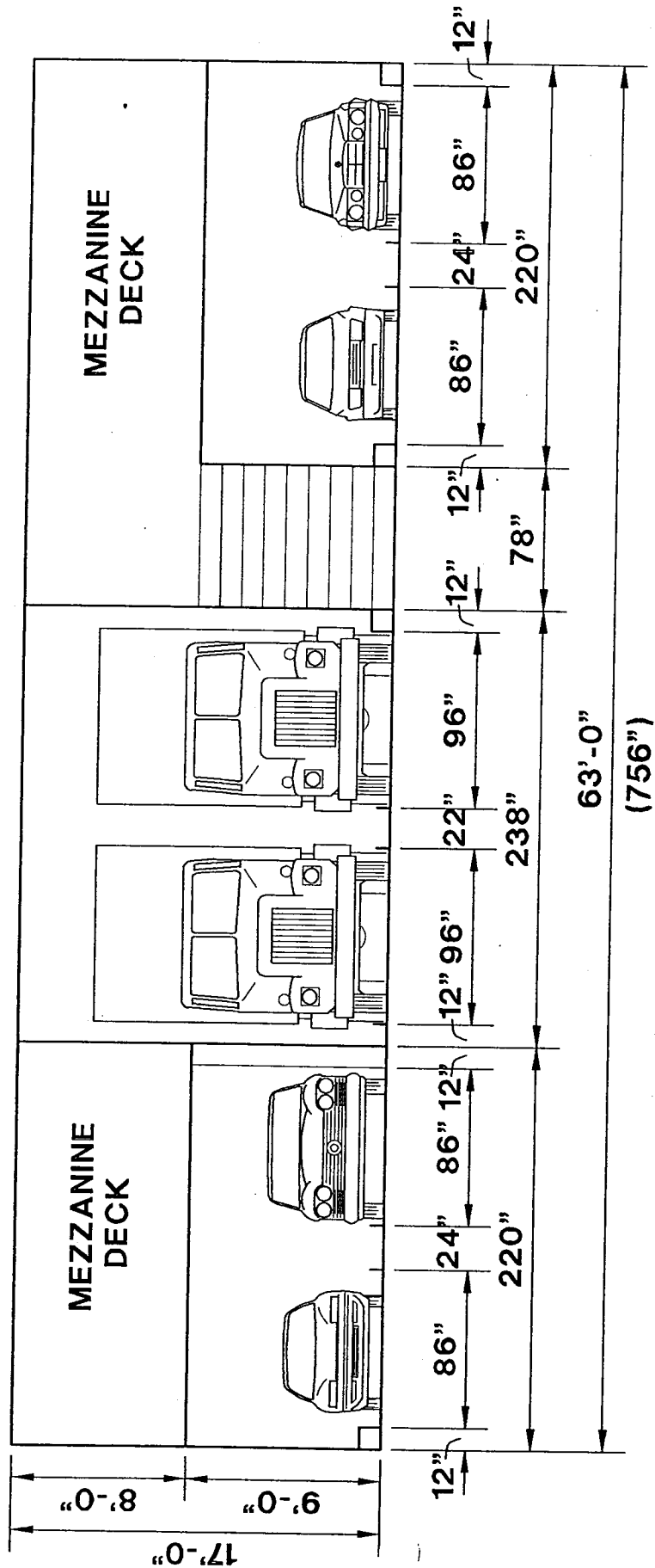
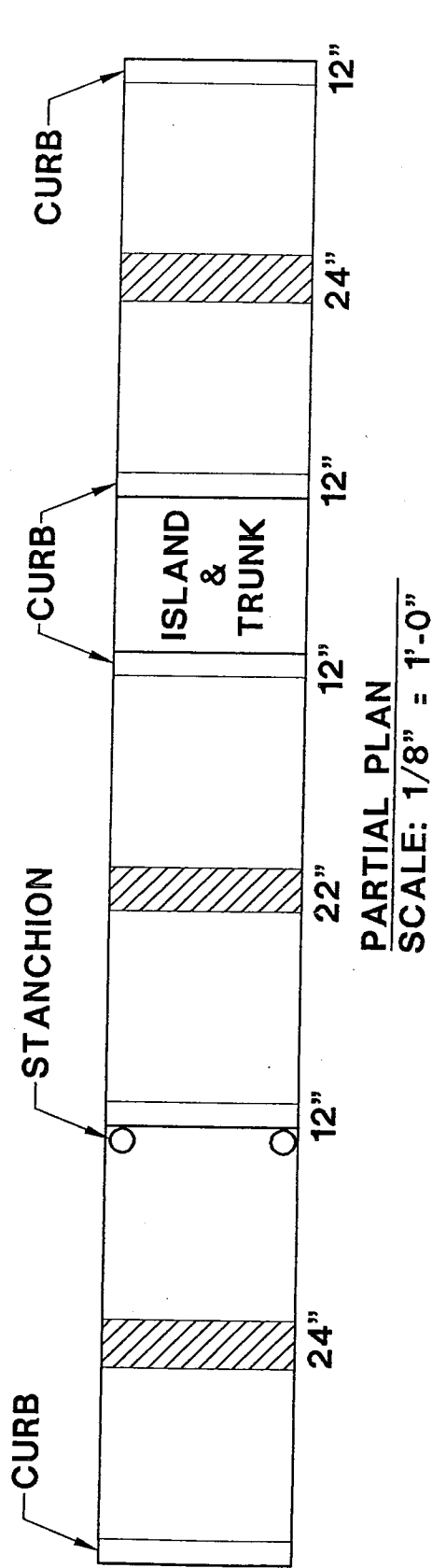
Operational Speeds Required for Several Round Trips per Vessel Each Day

Hull Form

- Double Ender or “Drive-through Single ender?”
- How many car lanes, how many truck lanes?
- How many passengers should we carry?

Vessel ↓ Lane →	1	2	3	4	5	6	7	Key
ISLANDER	a	a/T	T	I	T	a/T	a	a-auto lane T Truck lane I Service Island restricted passenger space, slow to load and unload
MARTHA'S VINEYARD	a	T	T	T	I	a		truck spaces too narrow, port auto lane very tight
NANTUCKET	a	I	T	T	T	I	⊕	slow to load and unload
EAGLE	a	T	T	T	I	a		restricted passenger space truck lanes too narrow
<i>Recommended for new vessel</i>	a	a	T	T	I	a	a	<i>more passenger space in mezzanines, wider auto lanes, 8-10 truck spaces 3 ft more beam</i>

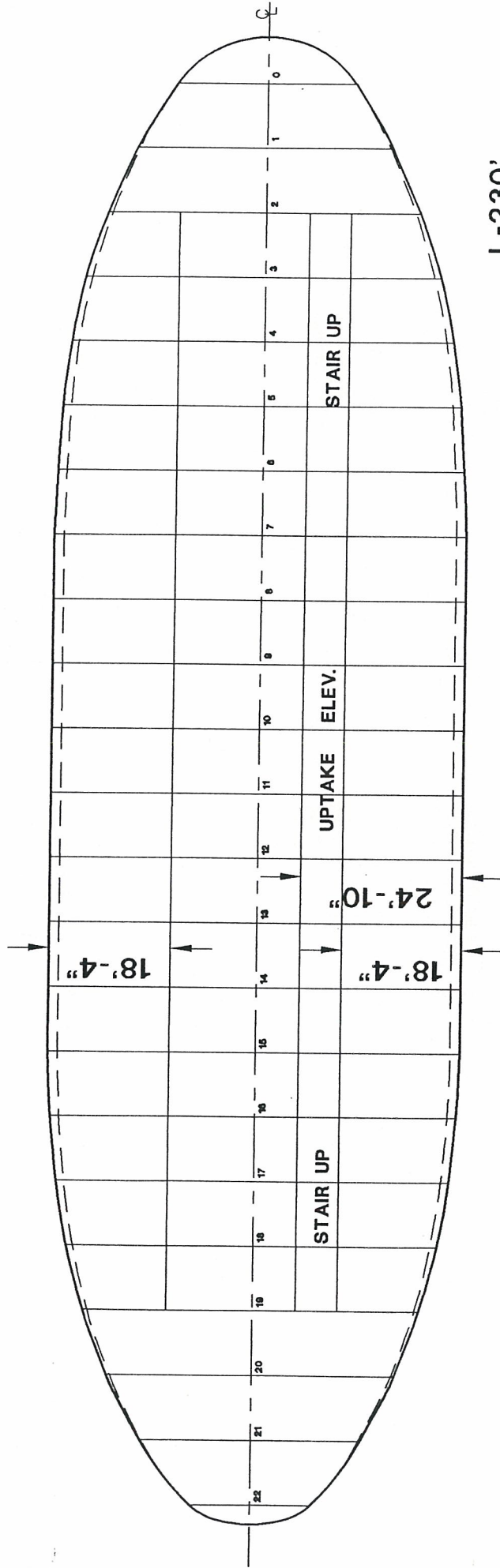
Auto/ Truck Lane arrangement of SSA Ferries (port to starboard)



CROSS SECTION THROUGH VEHICLE DECK
SCALE: 1/8" = 1'-0"



VEHICLE ACCESS AREAS



L=230'
BEAM=63'

PROPOSED DECK PLAN
SCALE: 1" = 25'-0"

____ PROPOSED PLAN
--- CURRENT PLAN

Attribute	Nantucket Service	Martha's Vineyard Service	Flexible Service
Length overall	230 feet limit	Should not exceed 250 feet	230 feet
Beam	63 feet Optimum	63 feet Optimum	63 feet Optimum
Draft Restriction	10'6" for shallow chan'l-dredged to 14'	Could be 11'0"	10'6"
Speed	22 Knots (would allow four trips/ day)	16 knots (provides seven round trips per day)	16 knots (limiting Nantucket service to 3 trips/ day)
Maneuverability	very important-	more important-need exceptional twist capability	Twin Screw, more power, with good bow thruster required
Auto/Truck Mix	4.9:1	7.7:1(indicates emphasis on more auto capacity)	Martha's Vineyard requires more truck <i>auto</i> capacity
Passenger/ Auto Mix	7.5:1	10.4:1	Martha's Vineyard requires more passenger capacity
Passenger Spaces	Need spaces for 1900 passengers per day. (~300 per trip average)	Need spaces for 8200 passengers per day (~500 per trip average)	Require enclosed passenger deck
Hull form	Twin screw, conventional bow/stern vessel, Double-ender will be poor in sea keeping, and maneuvering	Double ender with cycloidal prop and bow thrusters will work as well as twin screw drive.	Twin Screw, conventional bow/stern vessel. Shallow Vee, hard chine, moderate sponson
Propulsion	EMD's to achieve 22 knots + EW bow thrusters	EMD's to achieve 16 knots + EW bow thrusters	EMD's to achieve 16 knots + EW bow thrusters
Sea keeping	more important	important but not controlling	Shallow Vee, chine hull

Optimum Characteristics for Three Service Plans

Conclusions & Recommendations

- **Design and Build a New Ferry**
- **Investigate Conversion of M/V Islander into a Truck Ferry**
- **Improvements for Vehicle Handling**
- **Improvement for Persons with Disabilities**
- **Follow passenger trends and then investigate procurement of a High Speed Low Wash Catamaran for Passenger Only Service**