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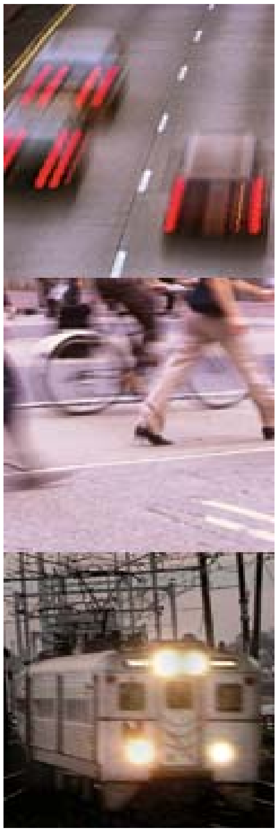

An Evaluation of Public-Private Incentives to Reduce Emissions from Regional Ferries

Synthesis Report

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Background

Ferry services play an important and critical part of the overall transportation network in New York Harbor. Over the past 2 decades, New York and New Jersey have coordinated policy approaches to the public and private ferry services operating in the region. Events on September 11, 2001 impacted the northern New Jersey and lower Manhattan transportation infrastructure and network in significant ways. Subsequent to a massive emergency evacuation effort by all regional ferries and other harbor watercraft, ferry services added vessels and routes to substitute for lost transit mobility, and have been a significant contributor to new commute patterns. The Federal Government recognized the important flexibility ferries provided when critical infrastructure, roads and railways, were not available. In response, $100 million in federal funds were committed to the region for improvements to ferry facilities; part of this funding was targeted at mitigating environmental impacts of ferry services.

These federal funds were targeted to significantly enhance and improve existing services, to enable new services to start-up, and to improve dock-side facilities for ferry riders. While some of the additional ferry routes and vessels served a temporary need to meet a shifting travel pattern during reconstruction of lost infrastructure (PATH service to lower Manhattan), ferry services continue to offer a flexible and extremely cost effective alternative to additional road and rail transit infrastructure.

However, environmental impacts, particularly air pollution, from ferry services are not trivial. Regional ferry vessels account for a significant proportion of emissions from commercial vessels based on recent emissions inventory reports for the Port Authority of New York and New Jersey. For example, ferries are estimated to contribute approximately 17% of oxides of nitrogen (NO_x) emissions and approximately 10% of particulate matter (PM) emissions from commercial marine totals for the region.

Mitigating ferry emissions represents a complex technology-policy problem. Emissions reductions of existing ferries are needed to offset emissions that may result from other necessary projects in the New York Harbor such as the harbor deepening (dredging) to accommodate container vessels serving the New York Harbor. Reductions in emissions from both existing and new ferries may enable expansion of ferry service and overall regional mobility (for both passengers and freight) while still meeting air quality objectives required under the Clean Air Act (2003). And importantly, ferry emissions reductions may contribute to net reduction of air pollution that benefits human health and the environment.

Reducing emissions from ferries in New York Harbor requires participation from the private sector, because approximately 97% of the total ferry route miles are served by private owner-operators. Moreover, these ferry services operate between two states that have different governance, approaches, and degree of control over ferry operations. Because of these unique control and governance conditions, public decisions to reduce emissions must consider both government incentives and regulations to achieve reduction goals. Different combinations of incentive instruments, control technologies, and emission reduction targets will vary in terms of public cost, private cost, and emission reductions achieved through incentives versus regulation.

In an effort to identify ways to achieve air emission reductions from the unregulated ferry fleet in the New York Harbor, environmental considerations were included early in discussions about the emergency ferry funding allocated to the region to accommodate increased ferry service during the time it would take to bring PATH service back to lower Manhattan after the destruction to the transportation links between New York and lower Manhattan. The Federal Transit Administration (FTA) provided funding to the Rutgers/ University of Delaware team to evaluate incentive options which could encourage private ferry operators to participate in a retrofit program. Funds are also being provided to the New York State Energy Research and Development Authority (NYSERDA) for a complementary project to test, retrofit, and post-test selected emissions reduction technologies. The Rutgers/University of Delaware research project is designed to assist decision-makers by providing information about market and economic incentives used to motivate polluters to reduce environmental impacts and to conduct an independent evaluation of various technology/policy combinations that could encourage private operators to effectively reduce emissions from their fleets of vessels in support of emissions reductions goals.

Goals

The overall goal of the NYSERDA and Rutgers' projects, as stated during the joint press conference of September 16, 2003, at Pier 11 in New York, is to meet the environmental stewardship commitment, which will ultimately be achieved through the NYSERDA Private Ferry Vessels Retrofit Program. While both NYSERDA's and the Rutgers'/University of Delaware's goals are to cut between 150 and 300 tons of smog-inducing oxides of nitrogen (NOx) and between 30 and 90 tons of particulate matter (PM) each year, based on a per-engine reduction of at least 15% to 30% for NOx, and 20% to 60% of PM, the Rutgers' team discusses how economic incentives can be used to meet such environmental performance goals.

The Rutgers/University of Delaware project takes these goals and applies an analysis tool designed to help predict emissions reductions from each of the actual vessels in the fleets to assist in understanding how incentives might best be applied to the privately owned ferry fleet. This work uses the same information that the NYSERDA testing produced, including age of vessel, make of engine of vessel, the duty cycles (how long the vessel idles, travels at speed, decelerates etc), as well as the length of the route.

The results of the Rutgers/University of Delaware project can assist the NYSERDA team as they develop their field implementation plan, in direct support of the environmental stewardship commitment to reduce private ferry emissions in the New York Harbor. It is to be expected that there are differences between the Rutgers/University of Delaware research which seeks to identify the optimum mix of technologies based on cost and performance, versus the NYSERDA field study which will demonstrate and test several technologies before a full deployment is implemented.

Overview

The work described in this Synthesis Report identifies and ranks both technology and policy incentive strategies and examines them as they might be applied to the NYSERDA project. Incentives can be a cost-effective way to implement publicly funded emissions control technologies in a private ferry fleet, particularly where jurisdictional limits prevent prescriptive policy action. This project evaluated alternatives and potential policy incentive concepts.

To fully understand the potential of the FTA-funded NYSERDA retrofit incentive program, we also evaluated potential (and/or proposed) technology rollout strategies to predict their performance according to specified emissions criteria. Our study adopted a common baseline of vessel data, route characteristics, and technology options to the NYSERDA project, to estimate the costs and emissions reductions that may be expected. We incorporated a technology framework that represents the region's ferry fleets to the greatest extent possible. We built upon prior and ongoing analyses through coordination and communication with the Port Authority of New York and New Jersey, and with other agencies and contractors (particularly NYSERDA) engaged in proposed retrofit incentive program. NYSERDA's New York Harbor Private Ferry Emissions Reduction Program design currently proposes a voluntary program. That is, a small-scale demonstration of 4 selected retrofits will be applied by one or more of the four fleet owners on a voluntary basis, and a fleetwide voluntary deployment program will follow the demonstration.

Primary results of the Rutgers/University of Delaware work include identification of the most feasible technologies for emissions reduction available to the marine sector, arrayed against a variety of public and private incentives. Public agencies can use these results in making decisions regarding appropriate incentives for ferry operators within the region. This synthesis report presents the final rankings and recommendations from our evaluation as applied to the NYSERDA Project.

Summary of Technical Memoranda One and Two

Technical Memorandum One

Evaluation Framework

Technical Memorandum One discusses the decision framework for identifying and evaluating emission control alternatives in a long-term implementation program for private ferries. Three decision elements are reviewed, including objective-setting, alternative analysis, and the criteria or attributes to judge preferences for one alternative versus another. Table 1 below presents this decision framework. Column 1 lists the key objectives for the project: reduce emissions, maximize private ferry participation in applying retrofits, reduce costs, and reduce the time it might take to achieve reductions. Column 2 identifies technology-based criteria or metrics that can be used to evaluate those objectives; column 3 identifies public policy-based criteria or metrics that can be used to evaluate those objectives.

Table 1 Summary of Criteria for Considering Incentive Scenarios

PROGRAM OBJECTIVES (PRIMARY AND SECONDARY)	TECHNOLOGY-BASED CRITERIA	PUBLIC POLICY BASED CRITERIA
Reduce private ferry fleet emissions. 1. Minimize emission per vessel 2. Minimize fleet emissions 3. Achieve fleet-wide emissions target	1.Emissions reduction per vessel 2. n/a 3. Fleet-wide emissions reduction	1. n/a 2. n/a 3. n/a
Maximize private ferry fleet participation 1. Maximize the numbers of vessels 2. Maximize operator participation	1. n/a 2. n/a	1. Vessels adopting controls 2. Operators adopting controls
Minimize total cost (public and private) 1. Minimize capital cost 2. Minimize annual cost 3. Minimize private sector share of cost	1. Capital Cost 2. Annual Cost 3. n/a	1. Net-present-value of capital cost 2. Net-present value of annual cost 3. Cost-share between public/private
Reduce time to achieve reductions 1. Achieve reductions before regulation 2. Achieve program goals within period of FTA funding 3. Sustain reductions over long term	1.Time to install/adopt technology 2. n/a 3. n/a.	1. n/a 2. Time to implement incentives 3. Compare private ferry cost burden over various scenarios

Program Objectives

Technical Memorandum One documents the four primary objectives identified by the New York Harbor Private Ferry Emissions Reduction Program [NYSERDA, 2003]. For each of the primary objectives, we clarified how they were carried through our evaluation.

1. *Reduce private ferry fleet emissions.* The overall NY York Harbor Private Ferry Emissions Reduction Program goal is to cut between 150 and 300 tons of smog-inducing oxides of nitrogen and between 30 and 90 tons of PM each year, based on a per-engine reduction of at least 15% to 30% for NOx, and 20% to 60% of PM. For the purposes of the Rutgers/University of Delaware project and evaluation, the objective can be defined either as maximizing emissions reductions from ferries, or as achieving a target reduction level. This is measured by emission reduction per vessel and a fleet-wide emissions reduction.

2. *Maximize participation of the private ferry fleet.* Currently, all private ferry operators serving transit routes are participating in the NYSERDA demonstration project; in this regard the demonstration project has achieved full participation. When the technology deployment phase begins, NYSERDA's goal is to involve up to 29 boats; at the time of this study, some 45 ferry vessels actively served commuter routes. For our evaluation purposes**,** the objective can be defined as maximizing the number of vessels that participate in the incentive program to reduce emissions.

3. *Minimize total cost (public and private).* The NYSERDA Program anticipates using a voluntary subscription-based incentive program. Funds are intended to offset the capital costs of achieving emissions reductions on private ferries, and help the fleet reduce emission. However, total costs of installing and operating emission reduction technologies over the long term may be greater than available funds. For our evaluation purposes, minimizing the total cost of achieving reductions will maximize the publicly available funds which may provide greater incentive for private ferry participation, and long-term operation of emissions control technologies may be achieved.

4. *Reduce time to achieve reductions.* Federal regulatory action currently limits emissions from commercial marine engines [*Environmental Protection Agency*, 2003]. However, these emission standards follow the regulatory model for all other mobile source emissions (except locomotives); they require new engines to achieve lower standards and do not address emissions from existing engines. For our evaluation purposes, the objective can be defined as minimizing the time to achieve the above goals.

Technical Memorandum Two

Incentives

Technical Memorandum Two identifies the kinds of incentives to be evaluated, including both policy and economic instruments, from the purely voluntary to the regulatory. Market-based instruments are policy approaches that encourage behavior through market signals rather than through explicit directives regarding pollution control levels or methods. They aim to modify environmental behaviors to reduce the impact of human activities on natural resources and the environment by harnessing the power of market incentives. Economic incentives are defined broadly by the US Environmental Protection Agency (EPA) as "instruments that use financial means to motivate polluters to reduce the health and environmental risks posed by their facilities, processes, or products" (EPA 2001).

Several descriptions of key types of economic instruments used in environmental policy follow.

- Pollution ***charge systems*** assess ***a fee or tax*** on the amount of pollution that a firm or source generates. These are prices paid for discharges of pollutants to the environment, based on the quantity and/or quality of the pollutant. To be most effective, the charge is levied directly on the quantity of pollution ('emissions tax or charge'), though if this is difficult to measure or monitor, it may be necessary to levy a charge on a proxy for emissions; typically this is on the resource that causes the pollution ('product tax or charge').

- A ***tradable permit*** is similar to charges and taxes except that it operates by fixing an aggregate quantity of emissions rather than charging a price for each unit of emissions. Instead of being charged for releases, a 'permit' is required to emit or discharge. World wide, tradable permits fall into two basic types: ***credit programs and cap-and-trade systems***. Under credit programs, credits are assigned (created) when a source reduces emissions below that which is required by existing, source specific limits; these credits can enable the same or another firm to meet its control target. Under a cap-and-trade system, an allowable overall level of pollution is established and allocated among firms in the form of permits, which can be freely exchanged among sources.

- The ***quantity-based permit*** approach and a ***price-based charge or tax approach*** can be blended to try to harness their different strengths while avoiding their weaknesses. ***Charge-permit hybrids*** attempt to control on the basis of quantity, which is the most desirable goal, while creating an 'escape valve' should costs rise too high.

- ***Subsidies*** are payments or tax concessions that provide financial assistance for pollution reduction, or plans to mitigate pollution in the future. Where taxes or charges can be used as a penalty on discharges, subsidies can be used to reward the reduction of discharges in a similar manner.

- ***Market-barrier reductions*** can also serve as market-based policy instruments, by removing existing barriers to market activity. Three types of market barrier reductions stand out: (1) market creation, as with measures that facilitate the voluntary exchange of water rights and thus promote more efficient allocation and use of scarce water supplies; (2) liability rules that encourage firms to consider the potential environmental damages of their decisions; and (3) information programs disclosing to final consumers environmental performance, such as energy efficiency product labeling requirements, or eco-labeling.

Lessons Learned- Example Programs

The Rutgers/University of Delaware team reviewed the lessons learned from experiences with economic incentives in other industry sectors. Specific attention turned to the maritime industry experience where economic incentives are being used to achieve better environmental performance sooner than command-and-control regulation. Examples reviewed and their brief descriptions below, illustrate a range of options:

> Environmental taxes on sulfur and Carbon Dioxide emissions - "Green Award" developed in collaboration with the Port of Rotterdam and some ports in Portugal and South Africa. A 'green award' is a certification procedure that includes a demonstration of environmental and safety awareness.
>
> Emissions Trading applied by the European Community - as a financial incentive for the reduction of sulfur dioxide and nitrogen oxides emissions, the maritime industry participates in voluntary trading. Shipowners are encouraged to make investments to create emissions reductions, since the selling of emission reduction credits will generate an additional payback.
>
> Carl Moyer Memorial Air Quality Standards Attainment Program – started in 1998, this is a California subsidy program that provides funds on an incentive basis for the incremental cost of cleaner than required engines and equipment. New purchases, repowers (including diesel to diesel), and retrofits of all marine vessels including ferries, tug/tow/push boats, fishing boats, bulk carrier, passenger ships are eligible. In the first three years of the Carl Moyer Program (CMP), funded projects reduced NOx emissions by more than 11 tons per day (tons/day) at an average cost-effectiveness of approximately $4,000 per ton of NOx reduced. 182 marine vessel projects accounted for about 8% (698 tons/year) of the total program NOx reductions. This cost-effectiveness compares favorably to other air pollution control programs in California.

Considerations for Developing Incentive Programs

Implementation of any incentive program can succeed better if the potential pros and cons of each incentive are considered during design phase of such a program. Table 2 outlines lessons learned from other industries and illustrates several pros and cons associated with the ranked incentives (Table 3). Further detail is included in Technical Memorandum Two and can inform policy makers on potential issues found in other industries using pollution reduction incentive strategies.

Table 2. Pros and Cons of Incentives Used by Other Industries

Incentive	Examples from other industries	Pros & Cons
Pollution Charges and Taxes	Emission Charges; Effluent charges; Solid Waste charges; Sewage charges	**Pros:** stimulates new technology; useful when damage per unit of pollution varies little with the quantity of pollution **Cons:** potentially large distributional effects; uncertain environmental effects; generally requires monitoring data
Subsidies, capital and/or annual	Municipal Sewage Plants; Land use by farmers; Industrial pollution	**Pros:** politically popular, targets specific activities **Cons:** financial impact on government budgets; may stimulate too much activity; uncertain effects
Market-based allowance trading with cap-and-trade feature	Emissions Fisheries access Effluents	**Pros:** provides limits to pollution; effective when damage per unit of pollution varies with the amount of pollution; provides stimulus to technological change **Cons:** potentially high transaction costs; requires variation in marginal control costs
Certification or Green Labeling	EnergyStar; 33/50	**Pros:** can promote early action that fit business goals, promotes adoption of current best practices **Cons:** uncertain participation, may reward minimal improvement
Input or Output taxes & Charges Terminal Fee Adjustment	Leaded gasoline tax; Carbon tax; Water user charges; Pesticide tax; Virgin material tax; Fertilizer tax	**Pros:** administratively simple; does not require monitoring data; raises revenue; effective when sources of pollution are numerous and damage per unit of pollution varies little with the quantity of pollution **Cons:** often weak link to pollution; uncertain environmental effects
Mandatory Monitoring and Reporting	Proposition 65; Sara Title III	**Pros:** flexible, low cost **Cons:** impacts may be hard to predict; applicable only when damage per unit of pollution does not depend on the quantity of pollution emitted
Regulatory Mandate	Emissions standards; technology use requirements	**Pros:** certainty of compliance **Cons:** difficult to implement locally, may require federal (or state or local) action

Overall Evaluation and Summary of Findings

The project team evaluated the factors affecting the success of one or more incentive actions across the existing fleet, addressing public costs, private costs, participation and the potential policy motivations or barriers. The rankings in Table 3 are derived from the combination of: in-depth literature search on incentives used in pollution control around the world; discussions and coordination with the NYSERDA team; discussions with ferry operators and other stakeholders; application of a model to test a variety of scenarios and, the considerable marine expertise of the team.

Table 3 rankings range from 1-7, with "1" being the "best" and "7" being the "worst." Different incentive programs can be designed according to the weights or values that decision makers may place on each of these objectives. For example, requiring a mandatory emissions reduction for all operators would reduce emissions and require participation of private ferry operators, although the private costs would be high and implementation time for mandatory programs can take longer than other incentives (e.g. 'green award') to implement. Alternatively, if the public policy goal is to maximize fleet participation, then the 'green label' is low-cost, and can be implemented immediately; however, it is not certain that actual emissions reductions would result from such a program. To be most effective, combinations of incentive strategies can be packaged (e.g., combining capital cost and annual cost grants) and uniquely designed by policy makers.

Table 3. Ranking of Policy Incentive Alternatives Based on Four Criteria

Incentive	Emissions Reduced, from NYSERDA pre and post tests	Private ferry operator participation	Total Cost		Time to Implement
			Public Cost	Private Cost	
Capital Cost Subsidy, Grant, or Rebate	4	6	6	6	2
Annual Cost Subsidy, Grant, or Rebate	3	5	7	5	5
Market-based allowance trading with cap-and-trade feature	2	4	4	3	6
Certification or Green Labeling	6	3	1	1	1
Terminal Fee Adjustment	5	7	5	4	4
Mandatory Monitoring and Reporting	7	2	3	2	3
Regulatory Mandate Emissions quota Emissions standards	1	1	2	7	7

To rank the various incentives, the team employed an evaluation tool, the Marine Emissions Optimization Model (MEOM) to explicitly track the estimated emissions reductions per vessel and fleet-wide, to identify which vessels and operators may adopt certain controls (and in which order vessels may be retrofit at least cost to meet emission control targets). The capital and annual costs were tracked and the net-present-value of these costs was also computed. Technical Memorandum Two provides detail on the scenarios that were designed and analyzed in MEOM to help evaluate the list of incentives.

Table 4 expands and adds detail concerning the cost elements ('Total Cost' column above) critical to the overall ranking of incentives shown in Table 3. Each of the potential retrofit technologies were ranked according to a 10 year long-term roll-out, including all capital and operating costs associated with applying that technology over a 10 year time frame. A 7% cost escalator was included. The cost ratios identify the least costly alternative first, represented by a cost ratio of 1.00. The alternatives were then ranked according to how they compare to the least costly technology option. For example, Intake Air Fumigation (IAF) is identified as the least cost retrofit for NOx reduction with a cost ratio of 1.00, as compared to the Selective Catalytic Reduction (SCR) technology which can cost between six and eight times more than the IAF technology. Note that with the 10 year roll-out phase, it is expected that the region will convert to ultra-low sulfur diesel (ULSD) fuel, and for the purposes of this analysis, ULSD is the default assumption. It should be noted however, that ULSD is not currently widely available, and this may be significant to NYSERDA's deployment program, as it relates to retrofit technologies and their performance when using different grades of fuels.

Table 4 Technology Cost Ratios for Roll-out Phase

NOx Technologies ranked according to long-term roll-out cost	Recommendation to minimize private-sector burden and facilitate incentive performance	Cost Ratio[1]
Intake Air Fumigation (IAF)	IAF technology was the least costly on a per-vessel basis, and was most often chosen by our least-cost analysis. IAF should be widely promoted if the demonstration phase confirms feasibility.	1.00
Fuel Intake Equipment (FIE)	On average, FIE is expected to cost about twice as much as IAF during the technology roll-out period. We understand that FIE is not among those to be considered by NYSERDA for the demonstration phase, and therefore do not recommend it for the technology roll-out phase.	2.12
Exhaust Gas Recirculation (EGR)	On average EGR is expected to cost about three times as much as IAF during the technology roll-out period; it may be a feasible alternative where IAF presents technical barriers for specific vessels.	3.11
Lean-NOx Catalyst (LNC)	On average, LNC costs about four times as much as IAF during the technology roll-out period. We understand that NYSERDA did not receive any vendor proposals to demonstrate LNC in a marine engine application on private ferries; therefore, LNC is not recommended for the roll-out phase of the program.	3.80
Selective Catalytic Reduction (SCR)	On average, SCR can cost six to eight times as much (per vessel) as IAF during the technology roll-out period; however, under stringent fleet-wide emissions reduction targets or where the associated fuel penalty can be minimized, SCR provides an important means to achieve fleet-wide reductions that may meet least-cost goals. Our analysis does not recommended SCR under a vessel-by-vessel emission control strategy.	8.05
Fuel-borne Catalyst (FBC)[2]	The potential cost differential of including FBC should be evaluated carefully against implementing IAF alone or an EGR package; however, cost differences may be minor over a long roll-out period,	Not modeled
PM technologies in rank order preference by cost	**Recommendation to minimize private-sector burden and facilitate incentive performance**	**Cost Ratio[1]**
Diesel Oxidation Catalyst (DOC)	On average, DOC is very cost-effective during the roll-out period and should be widely promoted, unless associated NOx technology installations require diesel particulate filters as part of a package installation.	1.00
Diesel Particulate Filter (DPF)	On average DPF costs about 18 times as much as DOC during the technology roll-out period; DPF may be recommended where required as a part of a vender package, such as for EGR installations.	18.26

1. Cost ratios represent alternative costs over ten-year roll-out period divided by the least costly technology.
2. Not modeled due to uncertainties among vendors and catalyst recipes, following several coordination meetings NYSERDA team (see Technical Memorandum Three, Section 5.2). However, NYSERDA reports that FBC was included in some of the demonstration phase vendor proposals, coupled with IAF and/or DOC technologies.

Summary Project Findings

The Rutgers/University of Delaware project was designed to provide information and evaluation tools to assist policy makers in their determinations when considering the development and design of an incentive program to reduce emissions from the ferry fleet operating in the New York Harbor. The evaluation explored a number of incentive options that could achieve various emissions reduction targets. Through our analysis, we were able to evaluate the costs and benefits of these programs. We were also able to identify the types of technologies that ferries would need to implement in order to achieve emissions reductions at least costs, consistent with the set of technologies that might be tested and demonstrated by NYSERDA.

Based on our research, the overall project finding is that the least-cost approach that also achieves emissions reduction goals would be a fleet-wide emissions reduction target, as opposed to a vessel-by-vessel emissions reduction target. Further, meeting the emission reduction target can be achieved by implementing a single or combination of the incentives reviewed and discussed in the Rutgers/University of Delaware reports. The rankings from Table 3 suggest that the combination of several incentive strategies would be most effective in meeting the stated objectives of emissions reduced at least overall cost in a timely fashion best. However, given that jurisdiction limits local mandates on emissions standards, and given that ferry funding programs do not include annual operating subsidies, policy makers responsible for design should consider either a program that applies terminal or per-passenger fees or a program that establishes a market for trading ferry reductions, at least among the fleet. These two incentive strategies may be the best options to consider when developing an incentive program to reduce emissions from the New York Harbor ferry fleet.