COWES FLOATING BRIDGE F6
Operational Review

FINAL REPORT

Prepared for the Isle of Wight Council
by
3S Business Review Limited

November 2023

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Foreword

3S Business Review Limited comprises senior businessmen from various sectors of industry, including former directors of leading UK-based international engineering consultancy firms~~,~~ possessing extensive personal, commercial and technical experience in the specification, procurement and delivery of major, complex, custom-designed electrical and mechanical infrastructure systems for the public transportation and energy sectors.

However, 3S has no expertise in naval architecture and various concepts contained in this report are drawn from inputs received from authoritative sources in order to illustrate conclusions drawn from digital analysis of the performance of the present vessel FB6 rather than offered as engineering solutions.

Definitions

- Computerised Fluid Dynamics (CFD) model: a digital model constructed to replicate the behaviour of the vessel in response to hydrodynamic side forces.
- Hydrodynamic Side Forces: the total forces exerted on the side of the vessel facing adverse tidal or wind streams
- Hydrodynamic Side Wind Forces: the hydrodynamic forces exerted by wind
- Hydrodynamic Side Tidal Forces: the hydrodynamic forces exerted by tidal flows.
- Vessel Deflection: the deviation of the vessel from a straight transit path between its Eastern and Western berthing positions.
- Wetted Area: the nominal surface area of the submerged hull
- Longitudinal Wetted Area: the surface area of the submerged part of the hull directly facing the adverse tidal stream
- Longitudinal Topside Area: the surface area of the vessel's superstructure most directly facing the adverse wind.
- Maximum Draught: the nominal distance of the lowest point on the underside hull from water level
- Average Draught: the average nominal distance of any point on the underside of the hull from water level
- Displacement: the weight and volume of water displaced by the vessel under various load conditions
- Chain Clearance: the depth of water over the chains
- Minimum Chain Clearance: the minimum depth of water over the chains required by the Cowes Harbourmaster – specified as 1.5 metres in Appendix 10 hereto.

1 Introduction

In June 2023 a contract was awarded by the Isle of Wight Council, (IWC), to 3S Business Review Ltd to undertake a review of Floating Bridge 6, (FB6), focusing on the need to maintain Minimum Chain Clearance and day-to-day operational procedures.

This is part of a logical process to evaluate the present vessel and consider IWC's options as whether to retain the present vessel as currently operated, modify the present vessel in order to achieve its objectives as set out in the Business Case for its original procurement, or replace it with a vessel specified and designed to more completely satisfy operational requirements and environmental constraints.

This process is illustrated in the Flow Chart included as Appendix 1.

The scope of work was split into six key actions:-

- Key action 1 - Scope Computation Fluid Dynamic (CFD) work required and source third party suppliers
- Key action 2 - Obtain tidal data required for CFD
- Key action 3 - Work with IWC to gather, collate and validate technical information to populate the CFD model
- Key action 4 - Work with IWC and the specialist CFD supplier to populate CFD model to replicate the dynamics of FB5 and FB6
- Key action 5 - Review of the operation of FB6 in terms of vehicles, foot passengers and cyclists queuing, paying, loading, and unloading – identifying if and how this could be improved to increase the number of crossings per hour
- Key action 7 - Prepare a comprehensive paper setting out above findings and recommendations for IWC consideration and approval

An important finding from the operational review undertaken for Key Action 5 was that the crossing frequency between East and West Cowes could potentially be improved by changes to operational procedures. On the basis of this finding the contract was extended during October 2023 to include a cost benefit analysis quantifying the further additional revenue likely to be earned in comparison with the costs incurred from introducing a new staff position to take on some of the duties currently assigned to the Master. This work package was identified as Action 8.

Following review of the findings of key actions 1 – 5 it was agreed that 3S would go on to consider the commercial options available to IWC for the procurement of a replacement vessel, (FB7), the key performance requirements of FB7, and the opportunity for the profitable disposal of FB6.

This further work has been added to the above scope of work as Key Action 6.

This Paper has been prepared as the deliverable in response to Key Action 7 including 3S findings and recommendations in response to Key Action 6.

2 Executive Summary

3S findings and recommendations can be summarised as follows:-

2.1 Potential to increase crossing frequency (Key Actions 5 and 8)

- Due to the constraints placed on operation FB6 cannot achieve the 5 return crossings per hour required by the Business Case[1]. However, there is scope to streamline operational regimes in order to increase the average frequency from 3.4 to 4.4 return crossings per hour.

2.2 The Chain Depth Issue (Key Actions 1-4)

- The CFD model (Key Action 4) utilising Tidal Data obtained from a previous study commissioned by IWC (Key Action 2) and drawings and vessel technical data both supplied by IWC and obtained by IWC from the builder of FB6 (Key Action 3) indicates that, due to the basic design and construction of FB6, it cannot be modified so as to be capable of operation without the push boat at maximum ebb tide flow rate.
- In the absence of available drawings an attempt to test the ability of FB5 to cope with the Hydrodynamic Side Forces used in the CFD model assumed a similar underwater profile to FB6. Surprisingly, despite the considerably smaller waterline length and displacement of FB5, the CFD model predicts that Vessel Deflection at extreme Hydrodynamic Wind and Tidal Forces is sufficient for FB5 to also breach Minimum Chain Clearance.
- Accordingly, iterative computer runs were carried out at various values for Longitudinal Wetted Area and Longitudinal Topside Area and resulting Hydrodynamic Wind and Tidal Forces in order to establish whether it is possible to achieve the operational requirement for Minimum Chain Clearance by reducing the overall dimensions and weight of the vessel, or introducing an innovative low-drag hull design, or both.
- Surprisingly, this indicated that even at zero values for Longitudinal Wetted Area and Longitudinal Topside Area the vessel would deflect laterally by a significant amount, and also that the ferry would need to be substantially smaller even than FB5 in order to avoid breaching Minimum Chain Clearance when the ferry is midway[2].

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[1] Cowes Floating Bridge Final Revised Business Case dated 21 September 2018. Page 37. SRTM assumptions for FB6 (Do something).
Note that in the earlier document, “Floating Bridge Review Report Final for Scrutiny Committee” dated 09 January 2018, a requirement is stated to “Increase number of daily crossings (introduce timetable service 6 crossings per hour)”. Given that the Final Revised Business Case refers to FB5 being capable of “4.5 crossings per hour” the 6 crossings per hour target must have been intended to be return crossings - but that is not stated.

[2] The Wolfson Unit study concludes that, in comparison with FB6, “the characteristic ferry areas would need to be reduced by at least 50% before any meaningful change in chain clearance begins to occur, and something of the order of 75% in order to obtain 1.5m clearance over a significant span”.

- This in turn supports anecdotal evidence of a recent increase in the maximum ebb flow speed. However, whether this is so, and if so, whether due to the recent emplacement of the harbour entrance breakwater is yet to be empirically proven.
- CFD analysis therefore indicates the need for a fundamental review of conceptual vessel design, assisted by further use of the now established CFD model.
- In the event it is not possible to define a solution that achieves Minimum Chain Clearance it is recommended results be referred to the Cowes Harbourmaster for his further consideration, for which purpose it would be useful to obtain further empirical and anecdotal evidence of possible increase in maximum ebb flow rates.
- Whilst the findings of the CFD analysis might appear unhelpful in defining a ready solution to the chain depth issue, they demonstrate the value of carrying out such investigations before embarking on a further major capital expenditure programme, whether for replacement or radical modification of the existing vessel, and CFD provides a valuable tool for further development and use in future design reviews by suitably qualified naval architects and shipbuilders.

2.3 Procurement of a replacement vessel and disposal of FB6 (Key Action 6)

- Procurement of a replacement vessel will also provide the opportunity to:
    - Improve loading arrangements, including reducing vehicle approach and departure angles and segregating foot passenger from vehicle traffic, to increase frequency of service.
    - Upgrade from diesel to electrical motive power to increase available motive power, improve reliability, reduce maintenance costs and eliminate emissions
- Procurement of any replacement vessel must be carefully structured to ensure an appropriate balance of risk as between buyer and seller.
- Alternative procurement strategies might include leasing a vessel from an accredited builder, or the sale of a licence to an accredited builder to operate the service under strictly defined terms and conditions.
- In the event FB6 is replaced there is a large potential international market for its resale for operation in an environment more conducive to its basic design.

3 The Chain Depth Issue

3.1 Objectives

Three key objectives were agreed with IWC:-

- To understand the impact of extreme wind and tidal forces on Vessel Deflection.
- To predict the impact of available measures to counter extreme Hydrodynamic Side Tidal Forces and Hydrodynamic Side Wind Forces

- To identify any fundamental changes required to basic vessel design in order to achieve the performance criterial set out in the business case for FB6.

3.2 Methodology

3S produced a specification for the procurement of a CFD model from an accredited expert supplier to predict the impact of Hydrodynamic Side Wind and Hydrodynamic Side Tidal forces on Vessel Deflection. The Wolfson Unit at Southampton University was selected as the supplier.

The specification agreed for the scope of services to be provided by the Wolfson Unit used the diagram provided by 3S and included as Appendix 2 as its point of reference. The Wolfson Unit was advised that the parameters identified as items ‘C’, ‘D’, ‘E’, ‘N’, ‘O’, & ‘P’ could be set as fixed values.

3S approached the exercise keeping in mind the possibility of procuring a new floating bridge should it be concluded that FB6 cannot be made fit for service. Accordingly the specification for the model included provision for it to be used to facilitate the definition of a realistic set of targets for a new vessel consistent with maintaining Minimum Chain Clearance, (items ‘F’ & ‘G’ on the diagram). The outputs from the model would be used in defining the design envelope for size and shape, (e.g. weight, length, beam, and so on; exemplified by items ‘A’, ‘B’, ‘H’, & ‘Q’ on the diagram), together with an optimum value for chain configuration /weight, (item ‘J’ on the diagram – with due account taken of items ‘K’ & ‘L’).

The primary objective of CFD modelling was to achieve a better understanding of the operation of the existing vessel, FB6, in order to be able to evaluate possible improvements to its hydrodynamic performance. The initial goal was emphasised as maintaining Minimum Chain Clearance under all practical operating conditions.

Using FB6 data as the source for the key model inputs, IWC was tasked with providing design details from which a set of nominal values for variables ‘A’, ‘B’, ‘H’, and ‘Q’ could be ascertained along with a range of values for the average transit speed, item ‘M’. IWC also provided the chain characteristics for FB6. The Wolfson Unit proceeded to create the model with the results to be validated against observed performance. (Observed performance includes Vessel Deflection - item ‘X’ on the diagram – which is clearly directly impacted by the chain specification and design).

Having established a better understanding of current operations, the model was used to quantify the sensitivity of Minimum Chain Clearance to incremental changes in size and, shape of the vessel, and the weight and design characteristics of the chains.

The Wolfson Unit was also asked to consider modelling the performance of FB6 if fitted with a fixed tether anchored to a point upstream to limit Vessel Deflection in order to allow operations in fast flowing ebb-tide conditions without assistance by the push-boat. A diagram of the proposed arrangement was prepared and is included as Appendix 3.

3.3 Findings

The principal scenario modelled was at maximum wind/current velocity, with the ferry positioned at the mid-point of the river. A number of parameters were investigated in order to determine the effect of these conditions upon Vessel Deflection.

- Increasing the chain length was found to increase Vessel Deflection significantly. Chain Clearance also increased with increasing chain length, however very long chains were required to make a material difference.
- Increasing the water depth did not affect the lateral deflection because under maximum Hydrodynamic Side Tidal Forces the chains are suspended in the water and do not touch the river bed. For conditions with slower tidal current and wind speeds (i.e. where the chain is part resting on the river bed) increasing the water depth has been observed to reduce Vessel Deflection.
- Reducing Hydrodynamic Side Forces, either by modelling a smaller ferry or reducing wind speed or tidal flow speed, was found to reduce Vessel Deflection more slowly than expected. This is hypothesised to be because the lateral force exerted by the chain is weak at small deflection angles and increases significantly only when approaching the maximum lateral deflection.
- Increasing the chain mass reduces Vessel Deflection, but a significant increase in mass is required to impart a material difference; doubling the chain mass was observed to reduce Vessel Deflection by only 11%.
- Restraining Vessel Deflection by adding an inelastic tether between the hull of the vessel and a fixed upstream point on the river bed would reduce chain tension and increase Chain Clearance, however it would require a very long tether in order to reduce the maximum lateral deflection by a meaningful amount and this is likely to be impractical from operational standpoints, particularly concerning the movement of other river traffic.
- Predictions made for the ferry in dock under maximum wind/current loading indicate that Minimum Chain Clearance would be achieved for even very short chain lengths (i.e. 166m). Minimising the chain length would reduce Vessel Deflection, however the predictions also indicated that short chains would experience large tension, capable of lifting the East Cowes counterweights.

Since some of these findings were unexpected it was agreed that a second study should be undertaken. Whereas the first study was obtained by conducting CFD analysis on a 3D model which had been generated from 2D line plans the second study utilised 3D CAD files provided by the FB6 builder. The opportunity was taken to expand the study to cover a lighter vessel, initially based on available information for FB5 with the objective of establishing a clear understanding of the sensitivity to vessel weight, and the resulting Average Draught, to facilitate the preparation of an informed specification should the decision be taken to replace FB6. The second study used data for the two alternatives set out in the following table:-

Characteristic	FB6 Data	Alternative
Length	29.70m	26.67m
Width	14.00m	12.80m
Draught	1.40m	1.37m
Weight	333 tonnes	234 tonnes

On completion of the second study an amended report was produced by the Wolfson Unit. The Report is included as Appendix 4.

The key finding of the second study is that the conclusions of the original report are not changed fundamentally. For the scenarios tested, in which the side forces are very large and the chains are approaching 'taut' behaviour, the model is relatively insensitive to even significant changes in wind/current loading.

However, the accuracy of this second study was frustrated by the lack of drawings available for FB5, and a third study was therefore undertaken to establish the Vessel Deflection at various values for Longitudinal Wetted Area, consistent with maintaining Minimum Chain Clearance while maintaining the existing chain size.

In addition, the third study took account of the impact of reducing the Longitudinal Topside Area of FB6 by removal of the upper deck balustrade in order to reduce Hydrodynamic Side Forces in the worst-case adverse wind and tide scenario.

The key finding from the third study is that making the ferry smaller is not going to solve the problem of lateral deflection. The reasoning behind this conclusion is set out as an addendum to the Wolfson Unit Report at Appendix 4

4 FB6 Operational Performance

4.1 Objectives

The primary objective of Key Action 5 was to conduct a review of the operation of FB6 in terms of vehicles, foot passengers and cyclists queuing, paying, loading and unloading in order to identify whether and, if so, how, this could be improved to increase the number of crossings per hour.

The average crossing frequency achieved by FB6 is currently substantially below the target of 5 return crossings per hour set out in the Final Business Case.

4.2 Methodology

3S made strategically timed observations of current operating practice to identify opportunities for changes to deliver improvements in the frequency of return crossings between East and West Cowes.

Using video captures obtained from the floating bridge webcam located at West Cowes, 3S undertook a detailed data collection exercise to gain an understanding of the day-to-day FB6 operations. Data was collected for a total of 37 single crossings over several days in March 2023.

Analysis of the data focused on the time required for a single crossing broken down into the following components:-

- The turnaround time – the time taken between the completion of vehicle offloading for one crossing and the commencement of vehicle loading for the next.
- The time to load vehicles
- The delay between the completion of vehicle loading and the commencement of passenger boarding
- The time to board passengers
- The delay to departure once passenger boarding is complete
- The transit time from departure from one slipway to arrival at the other
- The time to for passengers to disembark
- The delay between the completion of passenger disembarkation and the commencement of vehicle offloading.
- The time to offload vehicles.

Average durations for each of these components were derived and the key reasons for the lower than required crossing frequency were identified.

4.3 Findings

The full performance review report is included as Appendix 5. The full set of averages for the single crossing timing components described above is reproduced here for ease of reference as table 1:-

Item	Timing component	Duration
1	Turnaround time	23 seconds
2	The combined time for passengers to board and disembark	41 seconds
3	The delay between vehicle boarding complete and passenger boarding commencing	11 seconds
4	The delay between passenger disembarkation complete and vehicle offloading commencing	11 seconds
5	Delay to departure once passenger boarding complete	150 seconds
	Sub-total	**236 seconds**

6	Transit time	203 seconds
7	The combined time for vehicles to load and offload	12 seconds per vehicle

Table 1 – Summary of average timing components for a single crossing of the Medina by FB6

Based on the data collected for the 37 crossings, and also considering other information on annual patronage, it can be shown that FB6 is operating with an overall average of approximately 8 vehicles per crossing. Using that figure along with the other average values shown in table 1 would result in a total time for a single crossing of 535 seconds or 8.9 minutes. That equates to a frequency of approximately 3.4 return crossings per hour.

The timing analysis considered the performance of FB6 in comparison with the alternative road journey via Newport, nominally estimated to be a 24 minute journey. Based on a worst case assessment for a vehicle intending to board but arriving at the slipway just as FB6 is about to depart, the journey time using FB6 would comprise waiting for the return crossing plus the time for a single crossing – the time for 3 single crossings in total. If the time for three crossings is greater than the time for the alternative road route via Newport then it could be argued that drivers will be less inclined to use the floating bridge. A single crossing time of 8 minutes (one third of the 24 minute time for the Newport route), would equate to a frequency of 3.75 return crossings per hour. However, FB6 is not achieving this frequency.

The performance report also addressed the question of segregation of foot passengers, cyclists, and vehicles on the slipway. If segregation could be implemented then average loading and unloading times could be improved by approximately 1 minute. However, in discussions with IWC, it was agreed that segregation cannot feasibly be implemented with the current vessel and infrastructure.

While the data was being collected for the timing analysis several instances were noted of vehicles experiencing difficulty boarding and disembarking due to the approach angle between the loading ramp and the slipway. The problem is particularly acute for vehicles with low ride height, and several instances of bumper scraping were noted. Further work would be required to determine whether FB6 could be cost effectively modified to address this issue. If improvements could be made this would almost certainly improve average loading and unloading times and would also probably increase revenue as more drivers become inclined to use the floating bridge.

The key variable relating to improvement in crossing frequency is the average delay to departure once passenger boarding is complete. It is believed there may be an opportunity for immediate improvements to reduce the delay to departure once boarding is complete from the observed average of 150 seconds shown in table 1 to, say, 60 seconds, in turn providing an immediate improvement in frequency from 3.4 to 4.0 return crossings per hour.

Under current procedures the Master assumes responsibility for closing the loading ramp and then walks back to the pilot house to prepare for departure. The resulting delay to departure could be reduced by introducing a change of duties to allow the Master to be at the pilot house and ready to depart as soon as boarding is complete. This would potentially require an additional staff post to undertake duties associated with raising the loading ramp prior to departure. It was therefore agreed that 3S should undertake a cost benefit analysis to determine the benefit cost ratio, (BCR), resulting from the additional revenue accrued from a higher crossing frequency in comparison with the costs of introducing the additional staff post.

The Cost Benefit Analysis is included as Appendix 6. The key conclusions were that:-

- The frequency could be increased from 4.0 to 4.4 return crossings per hour.
- Under this scenario potential annual revenue would increase to circa £91k but additional costs of circa £86k would be incurred. This equates to a BCR of 1.07.
- The estimated BCR is not sufficiently attractive to recommend the introduction of an additional Officer post.

The analysis also looked at the possibility of modifying the operational procedures without the need to introduce an additional staff post. It was reported that significant improvements could be made by introducing changes to the duties assigned to the Master while continuing to deploy the same number of staff posts. The conclusions reached were as follows:-

- If it is feasible to control raising of the ramp prior to departure from the pilot house then changes to the duties assigned to the Master could deliver a reduction in the delay to departure, and therefore an increase in crossing frequency and potential revenue, similar to that achieved by deploying an additional staff post.
- To achieve the improved delay to departure time may require a small amount of time to be devoted by the Mate to raising the ramp - depending on the sightlines from the pilot house.

5 Conclusions

5.1 The Chain Depth Issue

- FB6 cannot operate within the constraints on Minimum Chain Depth prescribed by the Cowes Harbour Master, or berth safely at extremes of tidal flow, without the assistance of a push-boat.
- The installation of a tether to limit Vessel Deflection during strong ebb tides is not feasible due to the long length of chain or cable that would be required to achieve an arc of travel sufficient to maintain Minimum Chain Depth.
- CFD analysis indicates the need for a fundamental review of conceptual vessel design, assisted by further use of the now established CFD model.

5.2 Operational Performance

The overall conclusions from the timing analysis are that:-

- The average frequency under current operations for FB6 is 3.4 return crossings per hour.
- A circa 20% improvement to an average of 4.0 return crossings per hour could be achieved by preparing FB6 for departure as soon as the last passenger has boarded.
- A further improvement to 4.4 return crossings per hour may be achievable depending on the feasibility of changing some of the duties currently assigned to the Master.
- In order to approach the business case target of 5 crossings per hour using the best case scenario under current operational procedures the transit time would have to reduce to circa 2 minutes. This is probably not achievable with FB6 as currently configured.
- Given that such a new vessel achieves the performance requirement set out in the final business case of 5 crossings per hour and acceptable levels of availability and reliability, it is believed that traffic could be significantly increased permitting a reduction in current fare levels in order to further increase passenger demand by arriving at the 'sweet spot' at which price maximises overall revenue.

6 Potential procurement of a replacement (FB7) for current vessel FB6

6.1 Background

New Key Action 6 is directed to considering how IWC might proceed with the replacement of the existing vessel with a new vessel designed to suit prevailing environmental conditions and IWC operational requirements.

As mentioned in Section 2.2 of this report, the results of CFD computer runs indicate that the basic conceptual design of FB5 and FB6 will not solve the chain depth issue, and that thought must therefore be given to alternative, and perhaps radically different design concepts.

However, it is believed that any successful design will rely upon a lighter vessel incorporating a more hydrodynamically efficient underwater profile and superstructure.

Accordingly, it is believed that in the design of any replacement vessel consideration should be given to several fundamental design characteristics.

6.2 Design Specification

6.2.1 Construction Material

CFD indicates that reducing Average Draught and hence Longitudinal Wetted Area will reduce Hydrodynamic Side Tidal Force albeit, based on present maximum tidal speed, not to the point where the vessel will no longer require the assistance of a push boat to maintain prescribed minimum chain depth and berth safely.

Whilst the specification for FB6 called exclusively for steel construction, other materials are not precluded by prevailing regulations. An aluminium hull would considerably lighten the vessel and thereby reduce draught in order to alleviate present Hydrodynamic Side Tidal Force. Advice obtained from local shipbuilder is that as a broad rule of thumb a wholly aluminium vessel offers a weight saving over steel of up to 30%.

Aluminium is widely used for the construction of smaller commercial vessels, for example, the present Red Jet fleet and the new fleet of hybrid diesel/electric passenger vessels being delivered for operation across the London ULEZ zone.

This would also open the market to a larger number of potential suppliers, including established local shipbuilders.

6.2.2 Motive Power

Whereas FB6 is propelled by conventional diesel engines there is a growing trend towards electrification of ferry vessels, originating in Scandinavia but now spreading rapidly worldwide.

Electrification will eliminate the need for refuelling and could provide a net weight saving thereby reducing displacement to further minimise Longitudinal Wetted Area

Additionally, electric motors can provide greater power than diesel engines and instant access to maximum torque. Therefore they are better able to provide the power required to deploy heavier chains in order to minimise Vessel Deflection under extreme Hydrodynamic Side Forces.

Electrification would not only better enable IWC to satisfy its objectives towards achieving Net Zero emissions, but also provide considerable improvements in operational performance and savings in routine maintenance downtime and outages for unscheduled repairs.

Preliminary calculations show that adequate power for a full day’s operational cycle can be provided by a relatively small battery pack. Alternatively, the vessel could maintain a shore connection via a trailing cable.

As compared to diesel engines, electric motors have very few moving parts, (essentially just one), and therefore require relatively low maintenance. For the same reason they are inherently highly reliable requiring very little unscheduled maintenance work.

And finally, electrification would provide a cleaner, quieter solution than current diesel units.

6.2.3 Wind Loading

FB6 provides an upper deck for passengers to enjoy the vista provided by the Medina River. However, during a 3-minute journey this is at the expense of a larger superstructure than its predecessor, which in turn gives rise to higher Hydrodynamic Side Wind Forces.

During peak holiday seasons it might also contribute to delays in loading and unloading passengers.

In specifying a new vessel, IWC might therefore consider reverting to lower deck only foot passenger accommodation.

6.2.4 Reduction of underwater profile to minimise drag

The Wolfson study concludes that hull shape plays an insignificant role in reducing forces imposed by the tide, and that the key variable Longitudinal Wetted Area.

However, subject to further engineering study, a possible impediment to minimising the Longitudinal Wetted Area is the need to accommodate 2-metre diameter chain wheels, which results in very similar Maximum Draughts for both FB5 and FB6. Clearly, reducing the size of the chain wheel will present issues both for drive stability and wheel wear. However, subject to further expert study one solution might be to replace the single wheel with twin wheels installed in tandem or other chain drive system offering greater economy of headroom.

Another possible innovation to reduce vessel Displacement and hence Average Draught suggested to 3S in the course of producing this report is replacement of the traditional vessel-mounted loading ramps by shore-mounted ‘funicular’ loading platforms incorporated into each slipway - illustrated by the sketch in Appendix 7. However, this would again require considerable design development.

6.2.5 Proven design

Notwithstanding references herein to innovative concepts to improve vessel performance, it is strongly recommended that wherever possible designers should adhere to proven technologies and design concepts.

In the event that project objectives and required performance cannot be achieved except by the introduction of new, innovative or repurposed technology, then this should be first proven by all available means including computer simulation, prototyping and practical trials before its incorporation into a final design.

Even then, the risk in any such technology should be placed entirely on the supplier of the end product, backed by his provision of a minimum 36-month warranty and appropriate performance and delivery guarantees, supported by an adequate balance sheet, or appropriate insurances providing adequate indemnity, or both.

6.3 Alternative Procurement Strategies

6.3.1 Direct Purchase

FB6 was directly purchased by IWC in a process involving three parties – the Council, the Naval Architect and the Ship Builder.

Within this arrangement IWC specified certain key parameters – for example, the overall length of the vessel. The naval architect carried out conceptual design and supervised detail design and construction, and the ship builder carried out detailed design and specification, and specification and procurement of various sub-systems.

In such a process involving multiple interfaces and interdependencies there is always potential for error, confusion and, ultimately the assumption of risk by the ultimate customer, (IWC), when it cannot be clearly allocated elsewhere.

The avoidance of such risk is a key skill in the procurement of major items of custom-built plant and equipment, and requires very careful structuring of supply contracts.

Key principles for the structuring of a conventional set of design and supply contracts for the procurement of FB7 are set out in Appendix 8a. This recommends that a single contract is let for both design and supply against a simple set of key performance criteria defined by IWC.

These performance criteria are then adopted by the supplier who has the responsibility to supply a vessel fit for its intended purpose or suffer damages for breach, or rejection or both.

One issue in this process is the time required to establish and execute the overall procurement process, which, as illustrated in Appendix 8b, could extend to 3 years for initial delivery.

One major drawback is the raising of funds to purchase the new vessel, including pending the sale of FB6.

Clearly, one very major requirement for initial planning and budgeting purposes will be to prepare a reliably accurate (plus or minus 10%) estimate of the cost of designing, building and administering the procurement of the vessel. As the estimator must first specify and prepare an outline design of the vessel, consult industry and compare resulting estimates with costs of the very few comparable vessels, this in itself will be an expensive exercise.

6.3.2 Leasing of Vessel, or Sale of Licence to Design, Build, Own, and Operate, (DBOO)

Lease

One means of avoiding additional IWC expenditure is to lease from a designer/builder a replacement vessel designed and constructed to achieve IWC's specified performance requirements.

It is understood that this method has been used by Red Funnel to procure vessels for its Red Jet service

Adequate relevant shipbuilding design and manufacturing capability is believed to exist on the Isle of Wight, in addition to the wider UK and international markets.

An informal expression of interest in such an arrangement has been expressed by a local designer/builder, and it is believed further such interest can be obtained in the wider market.

A disadvantage is that IWC will be required to operate and maintain the vessel, presenting obvious technical interfaces that must be carefully defined and managed to avoid IWC's exposure to technical and financial risk in the event of technical problems.

Design, Build Own and Operate.

An alternative approach is for IWC to invite bids for the purchase of a license for the operation of a franchise to operate a new service according to a performance specification prepared by IWC, as described in Appendix 9.

Under this arrangement the licensee assumes all responsibility for maintenance and operation and therefore relieves IWC of all responsibility and risk.

Again, an informal expression of interest in such an arrangement has been expressed by a local designer/builder, and it is believed further such interest can be obtained in the wider market.

To avoid the obvious downside of 'privatisation' this could be constructed as a public/private partnership in which the council prescribes and enforces minimum service requirements and maximum fare levels.

As it is believed a new and reliable vessel will attract considerably more revenue than presently enjoyed, such an arrangement could include an 'anti-embarrassment' provision whereby profits are jointly monitored by the licensee and IWC and any excess profits are shared with IWC.

Build programme

One major advantage of a lease or DBOO strategy is that the time for delivery of the vessel can be substantially reduced from the 3 years shown in Appendix 8b to the 12 to 18-month timeframe achieved for similar size passenger ferries recently delivered to other UK end clients.

7 Recommendations

7.1 Operational Regime

- Make identified changes to the present operational regime in order to increase crossing frequency.

7.2 Vessel Replacement

- Consider replacing the existing vessel with a replacement vessel designed with the aid of the CFD model in order to cope with specified maximum Hydrodynamic Side Wind Forces and Hydraulic Side Tidal Forces including:
    - Optimise hull shape and lighten construction in order to reduce Displacement and hence-Longitudinal Wetted Area to minimise Hydrodynamic Side Tidal Forces.
    - Optimise hull shape to further minimise Hydrodynamic Side Tidal Forces
    - Reduce Longitudinal Topside Area to minimise Hydrodynamic Side Wind Forces

- Take the opportunity of vessel redesign also to:
    - Minimise road vehicle approach and departure angles to avoid damage to vehicles and accelerate loading
    - Segregate passenger and vehicle traffic in order to permit concurrent boarding
    - Configure vessel driving position in order to optimise ergonomics to reduce turnaround time.

- Ensure that the Cowes Harbour Master is consulted as a key stakeholder prior to the finalisation of the specification for a replacement floating bridge.
    - Current guidance on maintaining adequate depth of water over the chains can be found in the Notice to Mariners included here as Appendix 10.
    - Clearances are required to be maintained at all times, including when the floating bridge is in motion. It could be argued that this constraint is overly onerous since mariners are advised “not to pass when the Chain Ferry is in motion”. The conclusion from the CFD modelling study that required clearances are achieved when docked, even with short chain lengths, adds weight to this stance.

  - Hence it is recommended that discussions are held with the Harbour Master to explore whether a compromise can be reached such that a more pragmatic specification can be reached for any replacement floating bridge[3].

7.3 Procurement Strategy for replacement Floating Bridge

- Consider alternative procurement and ownership strategies in order to:
  - Establish a single responsibility for conceptual and detailed design, and construction.
  - Limit the input of IWC to stating only operational performance characteristics to be achieved by the vessel.

- Consider inviting innovative utilisation of private capital for the supply of a suitable vessel under either:-
  - a term lease for the supply of a vessel for maintenance and operation by IWC, or,
  - the sale of a term licence to an owner-operator responsible for the design, supply and operation of the vessel according to specified performance and commercial criteria including maximum fare structure.

8 Disposal of FB6

In the event IWC decides to dispose of FB6 it is believed there should be a ready market for its resale to another operator.

It is believed FB6 is capable of providing a satisfactory service in a less aggressive and intense operating environment, precluding the extreme Hydrodynamic Side Forces presented by the Medina River.

Accordingly, it is believed good interest might be obtained from the more than 300 operators of chain and cable ferries around the world listed in Appendix 11.

Of these, many are small operations not requiring a vessel of this size, but the remaining available market should provide good opportunity for profitable disposal. If so, informal ball park estimates obtained of present value suggest an achievable resale price of between £1.0 and £1.5 million.

However, this depends entirely on the strength of the market, which IWC might choose to test particularly before embarking on a conventional direct purchase.

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[3] It is alleged that the new breakwater changed the characteristics of the river Medina by bottling up tidal outflow. This resulted in a higher current velocity at peak ebb tide. However, whilst the peak velocity of the ebb tide current may have increased the duration of the peak has apparently reduced significantly. This adds weight to the case for a compromise for a replacement floating bridge.

In any event it is recommended that FB6 should be retained as a standby vessel for at least 3 months following completion of commissioning of FB7.

9 Potential Further Studies

If the decision is taken to replace FB6 then a number of programme management tasks must be undertaken, including:-

- Assembly of an outline performance specification
- Preparation or solicitation of an outline technical specification

Depending on the selected procurement strategy and mechanism it may also be necessary to undertake the following further work:

- Preparation or solicitation of budget prices for turnkey design, supply, and commissioning
- Preparation of prequalification and enquiry documents
- Adjudication of expressions of interest and tenders
- Overall monitoring of any resulting contract for turnkey design, manufacture, commissioning, and initial maintenance /operation

APPENDICES

List of Appendices

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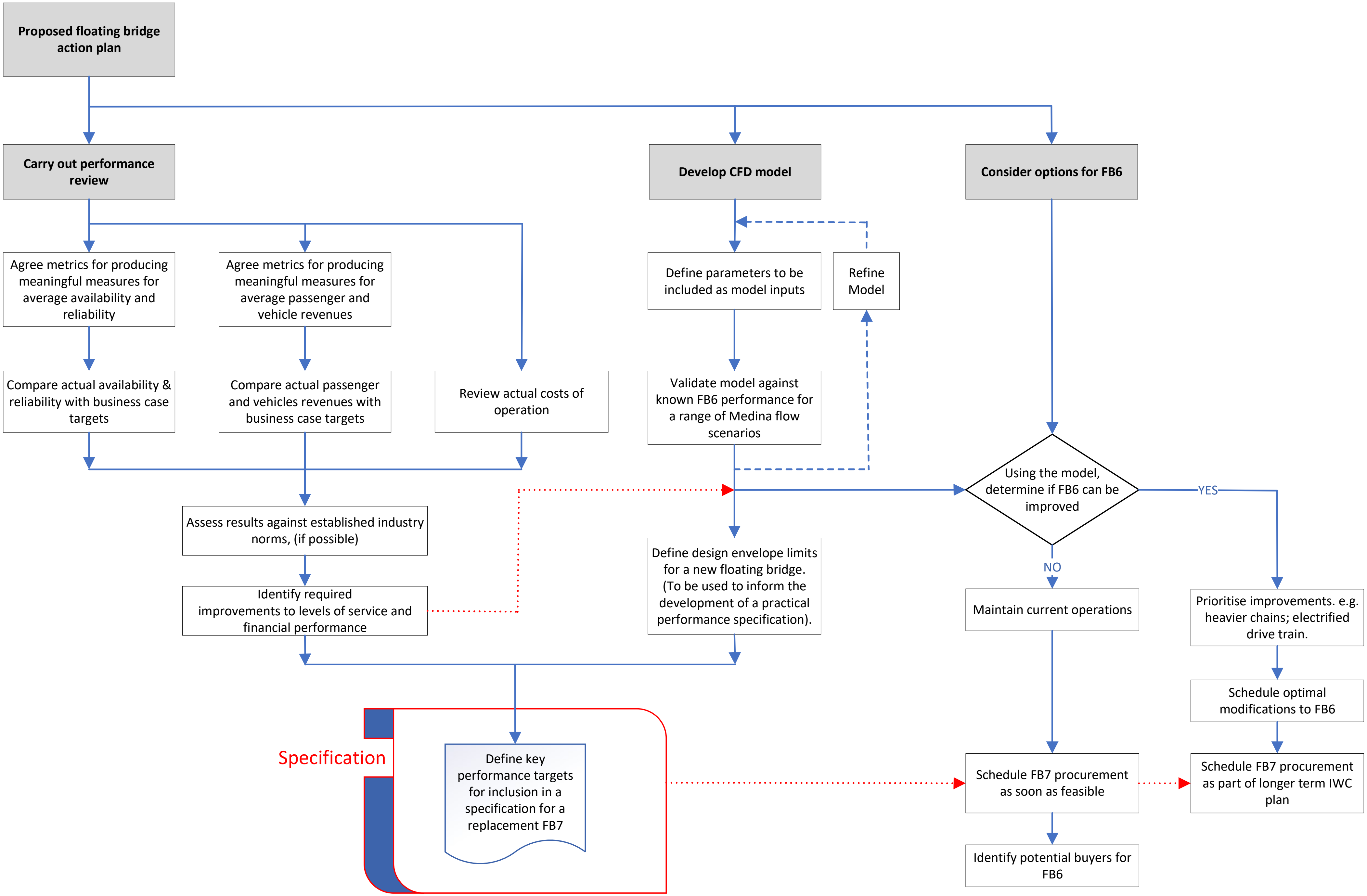
Appendix 10 – Notice to Mariners

Appendix 11 – Potential market for the profitable disposal of current vessel FB6

APPENDIX 1

FB6 Evaluation Process


Proposed floating bridge action plan
Carry out performance review
Develop CFD model
Consider options for FB6
Agree metrics for producing meaningful measures for average availability and reliability
Agree metrics for producing meaningful measures for average passenger and vehicle revenues
Define parameters to be included as model inputs
Refine Model
Compare actual availability & reliability with business case targets
Compare actual passenger and vehicles revenues with business case targets
Review actual costs of operation
Validate model against known FB6 performance for a range of Medina flow scenarios
Using the model, determine if FB6 can be improved
YES
NO
Assess results against established industry norms, (if possible)
Define design envelope limits for a new floating bridge. (To be used to inform the development of a practical performance specification).
Identify required improvements to levels of service and financial performance
Maintain current operations
Prioritise improvements. e.g. heavier chains; electrified drive train.
Schedule optimal modifications to FB6
Specification
Define key performance targets for inclusion in a specification for a replacement FB7
Schedule FB7 procurement as soon as feasible
Schedule FB7 procurement as part of longer term IWC plan
Identify potential buyers for FB6

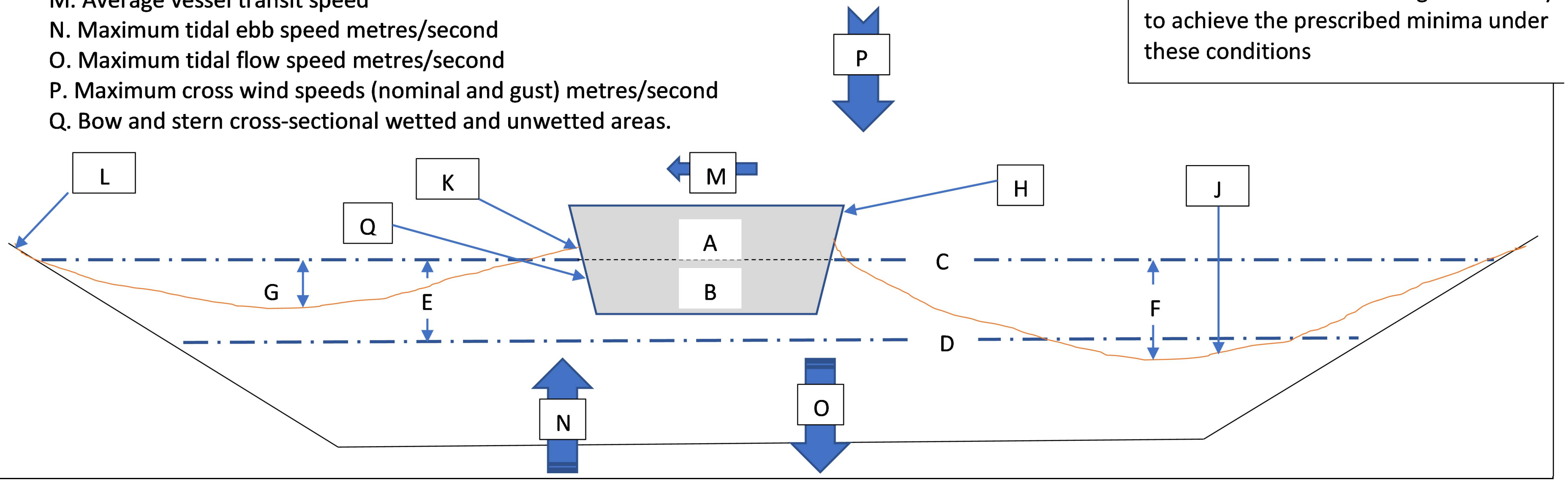
APPENDIX 2

CFD Modelling Reference Diagram

Appendix 1 Suggested main parameters for the construction of a CFD Model

A. Unwetted hull and superstructure area exposed to cross wind (square metres) - empty and fully laden
B. Wetted hull dimensions and area (square metres) exposed to tidal pressure - empty and fully laden.
C. Maximum transit distance
D. Minimum transit distance
E. Maximum tidal range
F. Minimum permitted depth of trailing chain below surface
G. Minimum permitted depth of leading chain below surface
H. Vessel mass maximum (fully loaded) and minimum (empty)
J. Chain link configuration (e.g. open or studded), mass kg/metre and surface area per metre length
K. Chain exit height above surface
L. Chain anchorage height above tide height at peak and bottom of tidal range
M. Average vessel transit speed
N. Maximum tidal ebb speed metres/second
O. Maximum tidal flow speed metres/second
P. Maximum cross wind speeds (nominal and gust) metres/second
Q. Bow and stern cross-sectional wetted and unwetted areas.

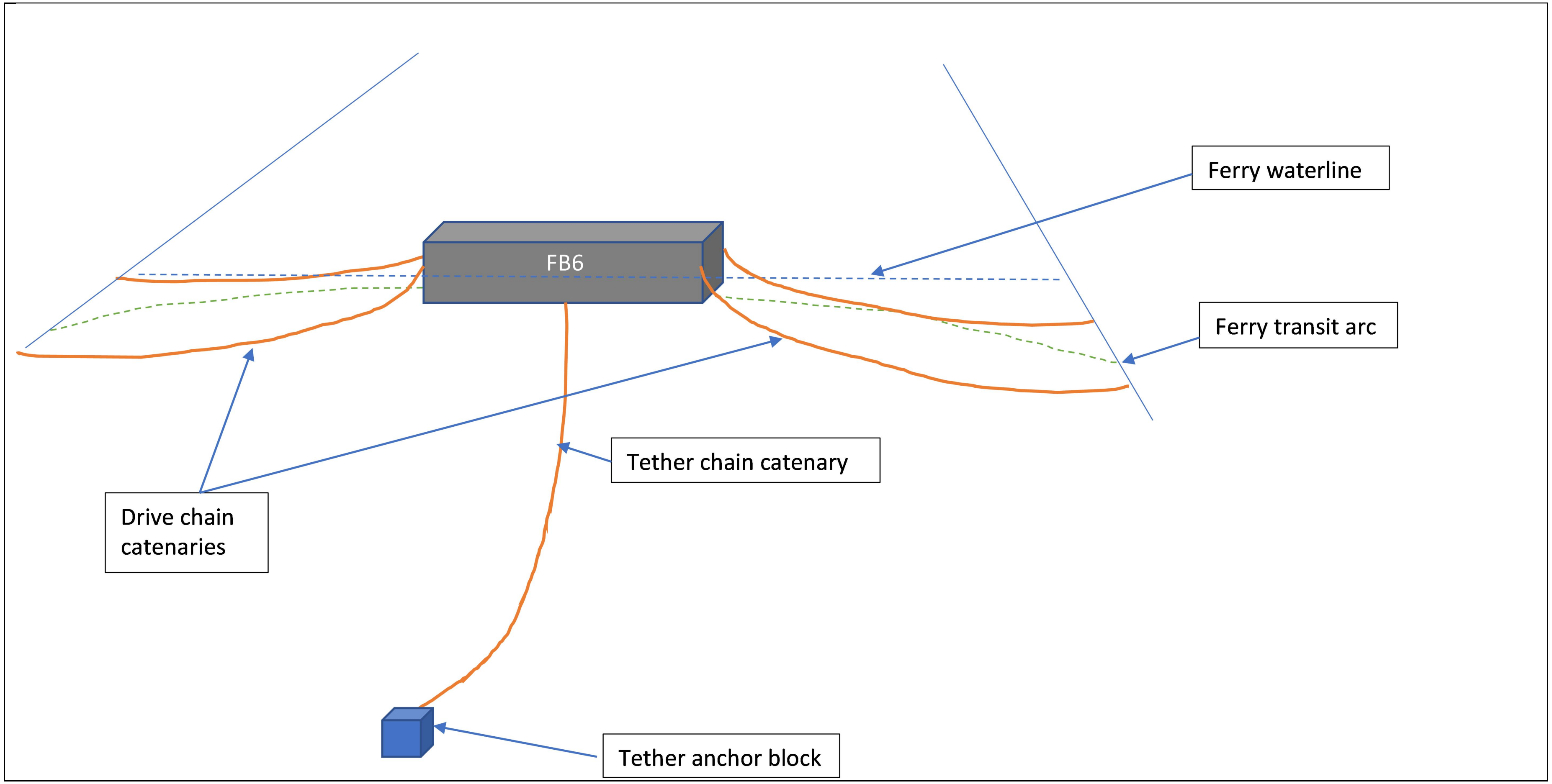
‘X’ = the deviation of the course of the vessel from its ‘no tide, no wind’ direct path under maximum and selected intermediate values for tide and wind speed. This will be reflected in differing actual values for F and G, enabling calculation of the chain length necessary to achieve the prescribed minima under these conditions



APPENDIX 3

Diagrammatic Illustration of Tether Concept

Appendix 2 Implementation of a tether as a substitute for the push-boat



APPENDIX 4

CFD Modelling Report

WOLFSON UNIT
FOR MARINE TECHNOLOGY &
INDUSTRIAL AERODYNAMICS

University of Southampton

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Date : October 2023

Report No. 2904

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Isle of Wight Council

Development and application of a numerical chain shape prediction tool for a RoRo chain ferry

1 INTRODUCTION

The Cowes floating bridge is a vehicular chain ferry that runs from East to West Cowes, crossing the River Medina. The current vessel (‘Bridge No. 6’) has been observed to deflect sideways under the influence of side current and wind loading and to approach the slipways at an angle to its intended trajectory. In order to better understand the mechanisms behind this behaviour, and with a view to mitigating it, a numerical tool has been written that predicts the chain deflection shapes under various scenarios by modelling the constituent physical processes. The chain shape prediction tool has been applied to a range of scenarios in order to better understand the parameters affecting lateral deflection of the ferry.

2 PROBLEM DEFINITION

The floating bridge departs/lands from slipways at East/West Cowes and runs on a set of two chains. At the West side the chains are permanently attached to the slipway. On the East side the chains run over pulleys and are attached to counterweights in underground pits, believed to weight nominally 3.5 tons each. The ferry hull (excluding ramps) is approximately 30m long with a beam of 14m, and travels at 2 knots forward speed.

The Isle of Wight Council (IOWC) have provided a number of documents specifying properties of the floating bridge. The distance between the chain tether points is determined to be 165m from CAD drawings contained within document ‘WLS.PTR.8.REV A.pdf’, the maximum tidal current was determined to be 2m/s from the document ‘R3614_Final_Cowes FloatingBridge_Tidal Survey_12July21 ABP Mer.pdf’ and the physical properties of the chain (dimensions, density) were determined from ‘Chain Specification-Report-001-rev-0 BCTQ.pdf’. IOWC also provided two dimensional drawings of the ferry, from which a 3D model was constructed using CAD software (Figure 1). Properties of the floating bridge used to model the chain deflection are included in Table 1. The chain drag coefficient is taken from reference [1].

Horizontal distance between chain tether points	165m
Forwards ferry speed	2 knots
Maximum lateral current speed	3.89 knots
Maximum lateral wind speed	34 knots
High, median and low tide	4.3, 2.4 and 0.5m above datum
Chain density	8000kg/m3
Chain volume (per unit length)	0.00261m3
Chain mass/unit length	20.84kg/m
Chain drag coefficient	2.2

Table 1 Floating bridge physical and environmental parameters

3 CHAIN SHAPE PREDICTION METHOD

The chain shape prediction tool has been written using Matlab and solves a system of equations in order to balance the internal chain tension against the forces acting upon the vessel. The program takes a series of input parameters describing the problem, including both constants (e,g. the span between the tether points) as well as user variable properties (such as the vessel position). The tool then predicts the lateral deflection of the ferry, the tension in the chains and the shape of the chains, including their depth below water and lateral deflection.

3.1 Modelling Assumptions

Schematics illustrating the coordinate system and key concepts of the chain deflection model are provided in Figure 2 and Figure 3. The x-direction corresponds to the horizontal line connecting the tether points of the chain. The z-direction is the vertical direction, and the y-direction is the lateral direction, 90 degrees to the shortest path of the ferry. Further assumptions are as follows.

- The forces acting upon the ferry are assumed to consist of:
  1. The hydrodynamic resistance to forwards motion, acting in opposition to the direction of motion (i.e. along the x-axis)
  2. The hydrodynamic sideforce due to the presence of lateral current, acting in the y-direction
  3. The aerodynamic sideforce due to the presence of lateral wind, acting in the y-direction
  4. The chain tension acting upon the ferry, at the point the chains enter the ferry, comprising both a horizontal (x) and lateral (y) force
- The chain is defined as possessing two ‘spans’. Span 1 is the length of chain between West Cowes and the ferry, span 2 is the length of chain between East Cowes and the ferry.
- Each chain span is assumed to be under tension
- The difference in the x-component of tension between the two chain spans is equal to the resistance of the vessel.
- The sum of the y-component of tension in the chains at the point at which they enter the vessel is equal to the sideforce acting upon the vessel.
- The chains are assumed to behave as catenaries in the x-z plane under the influence of gravity, and also in the x-y plane under the influence of the lateral current, when present.

- The vessel is permitted to deviate laterally from its intended path (or 'track'), but is not permitted to yaw
- Where the chain is resting upon the river bed, it is assumed that at the touchdown point the horizontal gradient of the chain will match the horizontal gradient of the river bed.
- The lateral current is assumed to be uniform, and to extend fully to the river bed
- The chain is assumed to be free to move laterally on the river bed, and the effect of friction is not modelled

3.2 Algorithm

The chain program first solves the equation system for the theoretical scenario in which there is no river bed and the chains are allowed to hang unimpeded. If it is determined that the chain would hang below the river bed the chain program then undertakes an iterative procedure to determine the shape of the chain whilst part resting on the river bed. This involves seeking the solution where the chain leaves the river bed at the same angle to the horizontal as the river bed itself.

The chain shape solutions are statically indeterminate, hence in order to solve the system of equations 'searching' functions, such as the secant method, are employed. If no physical solution is possible, for example if the chain length specified is too long to hang as a catenary but instead pools on the floor, the program may not find a solution.

3.3 Inputs

The chain program requires a number of inputs, some which are intended to be varied by the user and some which are required to model the problem in hand but are not expected to be changed.

3.3.1 User variable inputs

- Vessel location along route (measured from West Cowes)
- Vessel direction (i.e. West to East or vice versa)
- Lateral current speed
- Lateral wind speed
- Forwards speed of ferry
- Total chain length
- Tide height above datum
- Chain density
- Chain volume per unit length
- Chain drag coefficient
- Width of chain (n.b. 'bar diameter' not total chain diameter)
- Logical switch to 'fix' lateral deflection to user specified value

3.3.2 Problem specific constant inputs

- Horizontal distance between East and West chain tether points
- Horizontal distance between chain exit points on vessel
- Vertical distance above the waterline of the chain exit points on the vessel
- Number of chains
- Reference drag areas (aerodynamic and hydrodynamic) at 2 knots forward speed and zero leeway

- Reference drag area at maximum wind/current speed condition
- River bed elevation profile

3.3.3 Hydrodynamic and Aerodynamic Forces

The hydrodynamic and aerodynamic forces acting upon the vessel were predicted by conducting computational fluid dynamics (CFD), employing a 3D CAD model generated from the 2D drawings supplied by IOWC. Forces were predicted for two conditions:

1. The design forwards boat speed in the absence of lateral wind or current
2. The design forwards boat speed in the presence of the maximum lateral wind speed and current

Two CFD solvers were used to determine the required forces. A single-phase solver was used to conduct simulations of the vessel above the waterline to provide the aerodynamic windage (Figure 5. A hydrodynamic solver modelling the free-surface was used to conduct simulations of the hull only, in order to provide the hydrodynamic resistance and current forces (Figure 6). Results for the simulations are provided in Table 2.

It should be noted that whilst the chain shape tool is able to scale force data from the CFD simulations to estimate forces for intermediate conditions, the forces are only strictly valid for the conditions simulated.

Forwards Speed (kts)	Current Speed (kts)	Wind Speed (kts)	Hydrodynamic Drag (kN)	Aerodynamic Drag (kN)	Hydrodynamic Sideforce (kN)	Aerodynamic Sideforce (kN)
2.0	2.0	0.0	1.21	0.00	0.00	0.00
2.0	1.8	34.0	1.64	0.03	28.41	36.17

Table 2 Hydrodynamic and aerodynamic forces on the ferry as predicted by CFD

3.4 River bed topology

The river bed topology was determined by importing the file ‘Chain Extension Report Rev A BCTQ.pdf’ into CAD software and exporting the river bed as a series of elevation points. The distance between the East and West Cowes chain tether points was estimated by cross referencing drawings contained in the file ‘WLS.PTR.8.REV A.pdf’.

4 RESULTS AND DISCUSSION

4.1 Nomenclature

The lateral deflection of the ferry from its intended path is denoted Δy.

The chain tension (T) is defined as the horizontal tension in the chain at the apex (i.e. the lowest part of the chain). The chain tension at a point vertically higher on the chain will be greater, due to the weight of the chain below, however the horizontal component will be constant across the span and equal to this reference tension.

The chain tension in span 1 is denoted T1, the chain tension in span 2 is denoted T2. If the ferry is not in motion the tension both spans is equal, and denoted T.

The horizontal span for which the chain lies 1.5m below the water is provided and denoted L1 and L2 for span 1 and span 2 respectively.

4.2 Flow scenarios

Three flow scenarios have been considered, defined in Table 3. The principal performance metric is the lateral deflection in scenario 2.

Scenario	Vessel Position	Tide Height	Boat Speed (kts)	Current Speed (kts)	Wind Speed (kts)
1	Survey 14-4 West	2.4m	0	3.4	34
2	Mid-span	2.4m	2	3.89	34
3	In dock at West Cowes	2.4m	0	3.89	34

Table 3 Scenario definitions

4.3 Comparison to reported observations

The results from the chain shape prediction program have been compared to reported observations. Document “178005 IoWC Chain Assessment” provides survey data for a ferry position with midships nominally 36m from West Cowes (denoted survey 14-4 West). The document specifies a maximum current of 3.4 knots and a wind speed of 34 knots, and under these conditions the ferry is laterally deflected by approx. 6.9m at the midships, and the maximum chain deflection is approx. 10m.

The chain shape tool has been used to predict the chain behaviour under these conditions, as a function of chain length (Table 4, Figure 7). This table also includes the horizontal (i.e. xy plane) angle the chain makes to the vessel at the West side of the vessel, and the vertical (i.e. xz plane) angle the chain makes to the vessel at the East side. The results suggest that deflections comparable to the survey are observed for relatively short chain lengths, e.g. 167.5m. It is also noted that the chain tension is significantly higher (more than double) than that determined by document 178005. The total sideforce acting on the ferry used within this report is approx. 57.8kN (obtained by scaling the results in Table 2), which is larger than to that reported in document 178005 (approx.. 52kN), and furthermore in the chain shape model used here the sideforce is balanced almost entirely by the West-most chain span; the East chain leaves the vessel at a very shallow angle, and hence does not contribute to the restoring sideforce. This means that the lateral tension is shared between only two chains, whereas document 178005 assumes the tension is shared between four chains, accounting for the observed increase in chain tension.

It is also noted that the predicted chain tension exceeds the amount required to lift the counter weights in the East Cowes chain pits (estimated at 34kN). Possible reasons why the chain tension may be predicted to be higher than reality are suggested:

- In reality the ferry is able to yaw, and was observed to do so during the tidal survey. This will reduce the lateral sideforce due to both aerodynamic and hydrodynamic loading, and hence reduce the predicted chain tension.
- The maximum current reported by the harbourmaster was 3.4kts, however the current will decrease in proximity to the river bed and also in proximity to the river shore. It therefore seems feasible that the current velocity experienced by the ferry may have been lower than the peak value observed.
- The provenance of the wind speed specified in the report is not declared (e.g. where/when it was recorded, or assumed). In the absence of this information the wind speed is taken at face value, however even a modest reduction in wind speed may significantly affect the chain tension.
- The counterweight system likely possesses significant frictional resistance to motion due to the submerged chain path and its age.

To put the dependency upon wind/loading into context, for the 167.5m chain length case, if the current and wind speed are both reduced by 37% the predicted chain tension reduces to 34kN.

Despite the comparatively high predicted chain tension, a chain length of 167.5m was used for all subsequent calculations in this report (unless otherwise stated). This is a pragmatic choice made principally because this chain length yields similar magnitude lateral deflections to the reported observations, and considering the presence of uncertainties in the survey conditions.

Chain Length (m)	T (kN)	Horiz. Theta (deg)	Vert. Theta (deg)	Δy (m)	L1 D>1.5m (m)	L2 D>1.5m (m)
167.5	76.4	22.3	6.5	8.5	0.0	60.0
170	51.9	32.8	9.1	12.6	0.0	67.7
175	35.5	48.0	14.3	18.5	0.0	72.6
180	28.2	60.4	19.1	23.4	0.0	74.7

Table 4 Chain shape prediction results for Survey 14-4 conditions (scenario 1)

4.4 Effect of varying chain length

IOWC have indicated that a chain length of 185m was ordered for the ferry, however it is not known what length is deployed between the tether points and/or what length lies within the chain pits.

The effect of varying chain length from 167.5m to 185m has been investigated for the maximum wind/current load condition, scenario 2 (Table 5). Results for a 167.5m and 175m long chain are plotted graphically in Figure 8 and Figure 9. Both the lateral deflection and vertical chain clearance are strongly dependent upon the chain length. The lateral deflection increases with increasing chain length, which is undesirable, however the chain clearance increases with increasing chain length.

Under this onerous maximum side current/wind condition the chain sideforce is approximately 80% of the chain weight, and the chain does not contact the river bed for the majority of the span. As the chain length is increased, the vessel experiences more lateral deflection, the horizontal chain angle increases and less tension is required within the chain to balance the sideforce. Only at 185m length does the chain depth fall 1.5m below the waterline, however the lateral deflection is very large for this condition.

The lateral deflections predicted by the chain shape tool may seem large at first consideration, but are put into context by considering the maximum deflection achievable if the chain were to be pulled taut at the mid span. Such deflections may be calculated using Pythagoras (Table 6), and in the context of these values the predicted deflections appear reasonable.

Chain Length (m)	T1 (kN)	T2 (kN)	Δy (m)	L1 D>1.5m (m)	L2 D>1.5m (m)
167.5	112.5	113.4	12.8	0.0	0.0
170	79.3	80.2	18.2	0.0	0.0
175	55.9	56.9	25.9	0.0	0.0
180	45.3	46.2	32.2	0.0	0.0

Table 5 Chain shape prediction results for scenario 2 using various chain lengths

Chain Length (m)	Horizontal Span (m)	Maximum possible deflection at mid-span (via Pythagoras) (m)
165.5	165	6.4
166	165	9.1
167.5	165	14.4
170	165	20.5
175	165	29.2
180	165	36.0

Table 6 Maximum chain deflection at the mid-span as a function of chain length, assuming a taut/triangular deformation

4.5 Effect of increasing water depth

The effect of increasing water depth is investigated by varying the tide height relative to the bed topology. This is also equivalent to increasing the water depth by dredging the river bed. Due to the strong current/sideforce condition the chain does not touch the river bed (except where it lies above the waterline) and hence increasing the water depth does not materially affect the results (Table 7, Figure 10).

Analysis of conditions with reduced sideforce (not included here) suggests that, for situations where the chain part rests on the river bed, increasing the water depth will reduce lateral deflection slightly.

Tide Height (m)	T1 (kN)	T2 (kN)	Δy (m)	L1 D>1.5m (m)	L2 D>1.5m (m)
4.3	111.4	112.4	12.9	0.0	0.0
3.4	111.7	112.6	12.9	0.0	0.0
2.4	112.5	113.4	12.8	0.0	0.0
1.5	113.9	114.8	12.7	0.0	0.0
0.5	115.9	116.9	12.4	0.0	0.0

Table 7 Chain shape predictions for scenario 2 at different water depths

4.6 Effect of varying chain mass

The effect of varying chain mass was determined by increasing the chain density. Increasing the chain mass reduces the lateral deflection and increases the chain clearance (Figure 11), however the effect appears modest, noting that trebling the chain mass only reduces the lateral deflection by 8%.

In practice, increasing the chain mass requires either adding studs, or else increasing the chain diameter. Both of these changes will also increase the chain drag, which may reduce the effectiveness of increasing chain weight. DNV suggest that the chain drag coefficient will be increase by nominally 10% if studs are added [1].

Chain Mass (factor)	T1 (kN)	T2 (kN)	Δy (m)	L1 D>1.5m (m)	L2 D>1.5m (m)
1	112.5	113.4	12.8	0.0	0.0
1.1	113.3	114.3	12.7	0.0	0.0
1.25	113.2	114.1	12.7	0.0	0.0
1.5	115.3	116.2	12.5	0.0	0.0
2	117.3	118.3	12.3	0.0	0.0
3	122.4	123.4	11.8	0.0	0.0

Table 8 Chain shape predictions for scenario 3 varying chain mass

4.7 Effect of varying ferry area

The effect of reducing the ferry area has been investigated as a hypothetical exercise for scenario 2 (Table 9). Reducing the ferry area will reduce the resistance and sideforce acting upon the ferry proportionally, assuming the changes are small and the shape of the ferry remains the same. It should however be noted that although reducing the force acting upon the ferry will reduce the sideforce, it will not reduce the catenary effect of the drag upon the chain in the lateral direction.

Reducing the area of the ferry (and hence sideforce) has only a small effect upon the lateral deflection. This result is surprising, however it should be borne in mind that 1) the tension in the chain will vary little with lateral deflection until the slack in the chain is taken up and 2) the lateral component of tension is proportional to the horizontal angle at which the chain exits the ferry, which increases with lateral deflection. Combined, these factors mean that the sideways force exerted by the chain will be relatively weak until the ferry is near its maximum deflection, at which point it will increase rapidly with increasing deflection.

Area/Area_Ref (m)	T1 (kN)	T2 (kN)	Δy (m)	L1 D>1.5m (m)	L2 D>1.5m (m)
1	112.5	113.4	12.8	0.0	0.0
0.9	104.6	105.5	12.7	0.0	0.0
0.8	96.7	97.4	12.6	0.0	0.0
0.7	87.7	88.4	12.7	0.0	0.0
0.5	72.0	72.5	12.3	0.0	0.0

Table 9 Chain shape predictions for scenario 3 scaling the aero/hydrodynamic forces by hypothetical area changes

4.8 Effect of decreasing current and/or wind speed

The effect of decreasing wind and current speed independently is provided in Table 10 to Table 12. It can be seen that although the aero and hydrodynamic sideforce is similar in magnitude, reducing the current speed has the greater effect upon chain tension – this is hypothesised to be due to the horizontal catenary effect reducing the chain angle to the vessel. It is also apparent that the lateral deflection remains significant even at 50% current and wind speed (Figure 12). The observance of significant deflection at low current/wind speed is attributed to the same factors discussed in section 4.7.

Current Speed	Wind Speed	T1 (m)	T2 (kN)	Δy (kN)	L1 D>1.5m (m)	L2 D>1.5m (m)
100%	100%	112.5	113.4	12.8	0.0	0.0
90%	100%	100.5	101.4	12.8	0.0	0.0
75%	100%	85.3	86.2	12.7	0.0	0.0
50%	100%	65.8	66.6	12.5	0.0	0.0

Table 10 Chain shape predictions for scenario 3 for different current speeds

Current Speed	Wind Speed	T1 (m)	T2 (kN)	Δy (kN)	L1 D>1.5m (m)	L2 D>1.5m (m)
100%	100%	112.5	113.4	12.8	0.0	0.0
100%	90%	104.1	105.0	12.7	0.0	0.0
100%	75%	91.6	92.6	12.8	0.0	0.0
100%	50%	78.4	79.3	12.5	0.0	0.0

Table 11 Chain shape predictions for scenario 3 for different wind speeds

Current Speed	Wind Speed	T1 (m)	T2 (kN)	Δy (kN)	L1 D>1.5m (m)	L2 D>1.5m (m)
100%	100%	112.5	113.4	12.8	0.0	0.0
90%	90%	92.1	93.0	12.7	0.0	0.0
75%	75%	65.3	66.1	12.5	0.0	0.0
50%	50%	31.0	31.8	11.5	16.9	0.0

Table 12 Chain shape predictions for scenario 3 for different wind and current speeds

4.9 Effect of adding a tether

The effect of adding an inelastic tether is modelled by fixing the lateral position of the vessel in space and solving the chain shape algorithm (Table 13). When the vessel is not permitted to move laterally the chains are slackened. The chains thus hang lower, and ‘billow’ past the ferry under the action of the current (Figure 13). The chain tension is markedly lower than the untethered case, as the chains are no longer balancing the aero/hydrodynamic sideforce.

In order to limit the vessel deflection using an inelastic tether an arrangement similar to that shown in Figure 4 would be required. The distance up/downstream of the tether fixing point from the ferry path is indicated in Table 14 as a function of maximum permissible ferry deflection. It is apparent that an inelastic tether would likely be an impractical means of limiting maximum lateral deflection due to the large distance required between the tether point and the crossing. An alternative method would be a heavy chain catenary, however the effectiveness may be limited due to the shallow draft available.

Tether Offset (m)	T1 (kN)	T2 (kN)	Δy (m)	L1 D>1.5m (m)	L2 D>1.5m (m)
Free	112.5	113.4	12.8	0.0	0.0
10	31.9	32.8	10.0	14.4	0.0
7.5	23.5	24.5	7.5	28.0	17.3
5	21.4	22.4	5.0	32.6	19.8
2.5	20.3	21.2	2.5	33.4	20.2
0	19.3	20.3	0.1	33.8	21.0

Table 13 Chain shape predictions for scenario 3 with lateral deflection held constant

Maximum Lateral Deflection	Required tether distance
(m)	(m)
2.5	1360
5.0	678
10.0	450
15.0	335

Table 14 Distance from tether to ferry path required to limit the maximum lateral deflection

4.10 Chain clearance when docked

Results for scenario 2 almost exclusively show less than 1.5m vertical chain clearance across the span. Predictions have been made for the same wind and current conditions whilst the ferry is at West Cowes (scenario 2) in order to determine whether the vertical chain clearance increases when docked (Table 15).

The results show that even short chain lengths are predicted to yield greater than 1.5m chain clearance over significant spans when docked (Figure 14). The use of short chain lengths would directly limit the maximum lateral deflection possible, however reducing the chain length also increases the chain tension, particularly under high current and wind speed conditions, and the tensions predicted here significantly exceed those required to lift the counterweights.

Chain Length (m)	T1 (kN)	T2 (kN)	Δy (m)	L1 D>1.5m (m)	L2 D>1.5m (m)
165.5	186.6	186.6	3.0	0.0	0.0
166	132.2	132.2	4.3	0.0	0.0
166.5	104.4	104.4	5.4	0.0	49.9
167.5	80.9	80.9	7.0	0.0	71.2
170	53.7	53.7	10.5	0.0	74.1

Table 15 Chain shape predictions for scenario 2 for different chain lengths

5 CONCLUSION

A numerical tool has been written that predicts the chain shape and lateral deflection of the ferry for the Cowes floating bridge. Information provided by IOWC has been used to provide input parameters for the numerical model, however the chain length in particular remains unclear. The chain shape prediction tool has been applied to a number of scenarios.

When attempting to recreate behaviour observed during a survey, comparable results were predicted only when the chain was comparatively short relative to the span (167.5m), however the predicted chain tensions were higher than that required to lift the counterweights in the East Cowes chain pit. Factors that may reduce the chain tension in reality as compared to the modelled scenario were identified.

The principal scenario of interest was the maximum wind/current velocity condition, with the ferry positioned at the halfway point across the river. This is an onerous condition for which the sideforce acting upon the chain is calculated to be 80% of its weight due to gravity. For this condition the chains were, in general, predicted not to lie on the river bed but to be suspended in the water. A number of parameters were investigated in order to determine their effect upon the lateral deflection of the ferry.

Increasing the chain length was found to increase the lateral deflection significantly. The chain immersion also increased with increasing chain length, however very long chains were required to make a material difference.

Increasing the water depth did not affect the lateral deflection. This is because under the maximum sideforce condition the chains are suspended in the water and do not touch the river bed. For conditions with slower current/wind speeds (i.e where the chain is part resting on the river bed) increasing the water depth has been observed to reduce lateral deflection.

Reducing the sideforce acting upon the ferry, either by modelling a smaller ferry or reducing the wind/current directly, was found to reduce the lateral deflection more slowly than expected. This is hypothesised to be because the lateral force exerted by the chain is weak at small deflection angles and increases significantly only when approaching the maximum lateral deflection.

Increasing the chain mass reduces the lateral deflection, but a significant increase in mass is required to impart a material difference in lateral deflection; trebling the chain mass was observed to reduce the lateral deflection by only 8%.

Restraining the lateral deflection of the vessel by adding an inelastic tether would reduce chain tension and increase vertical chain clearance, however it would require a very long tether distance in order to reduce the maximum lateral deflection by a meaningful amount and this is likely to be impractical.

Predictions made for the ferry in dock under maximum wind/current loading indicate that 1.5m vertical chain clearance would occur for even short chain lengths. Minimising the chain length would reduce the maximum possible lateral deflection, however the predictions also indicated that short chains would experience large tension, capable of lifting the East Cowes counterweights.

6 FIGURES

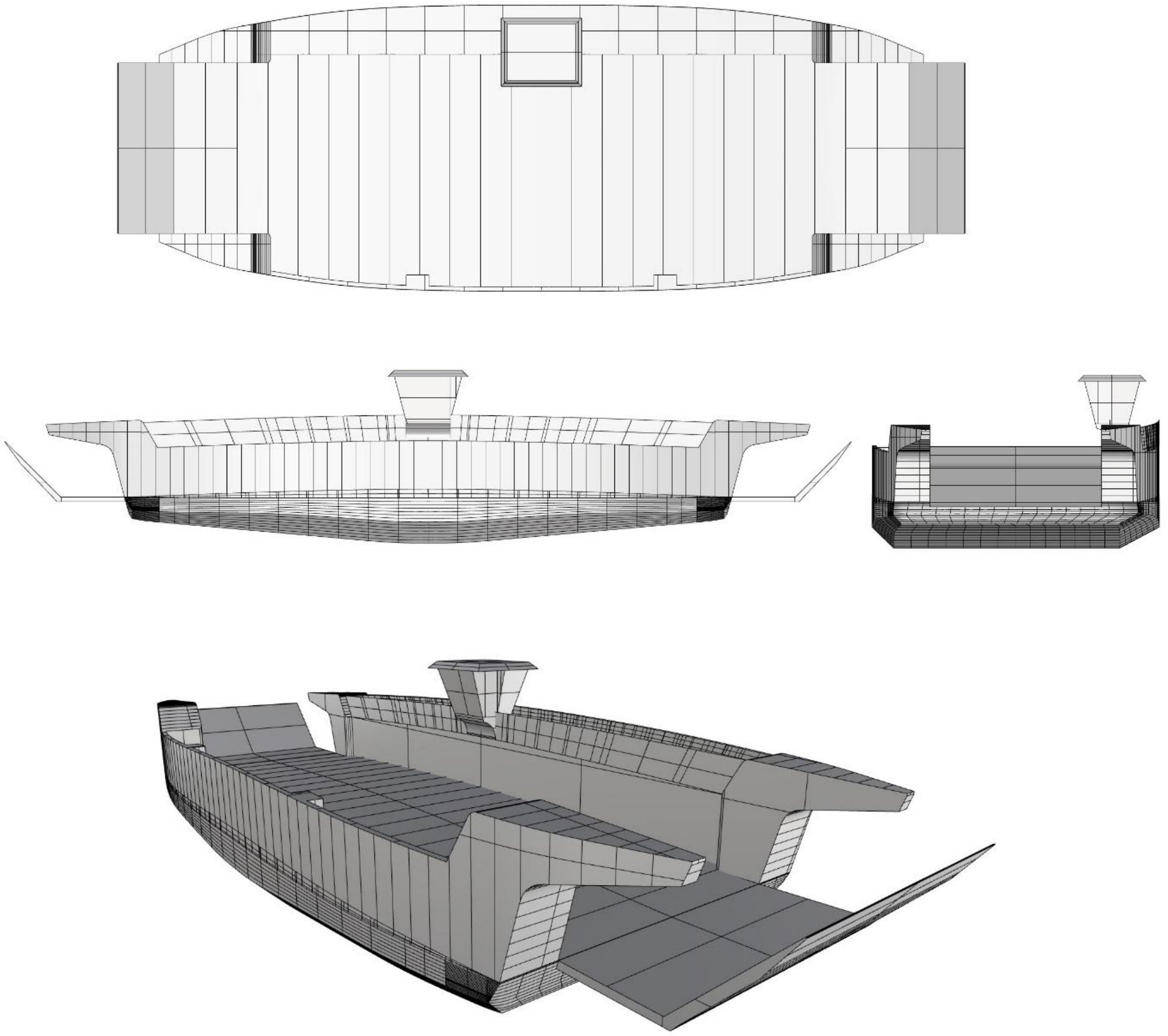

Figure 1 Illustration of the 3D CAD model produced from 2D drawings and used for the CFD analysis

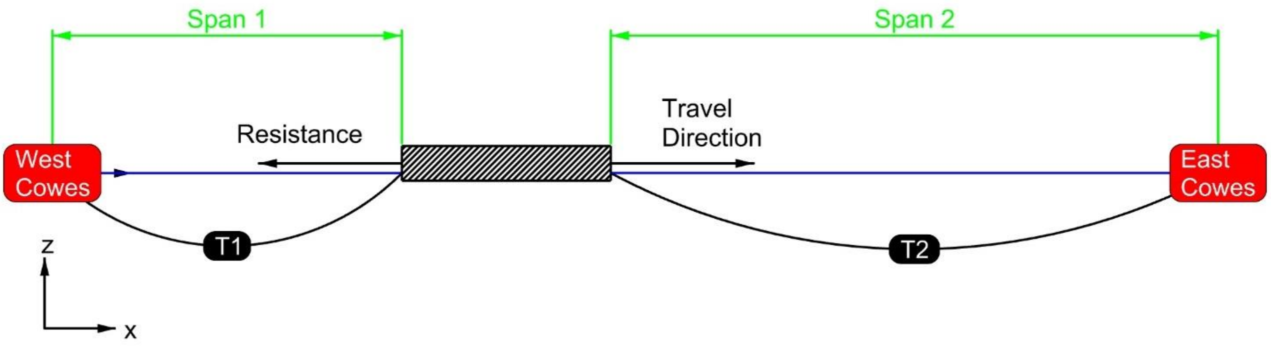

Figure 2 Schematic showing the chain deformation model in the x-z plane

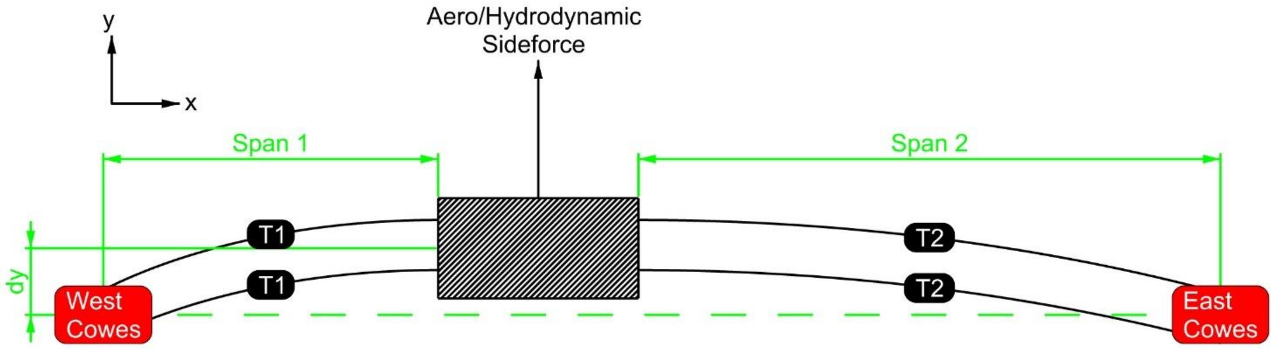

Figure 3 Schematic showing the chain deformation model in the x-y plane

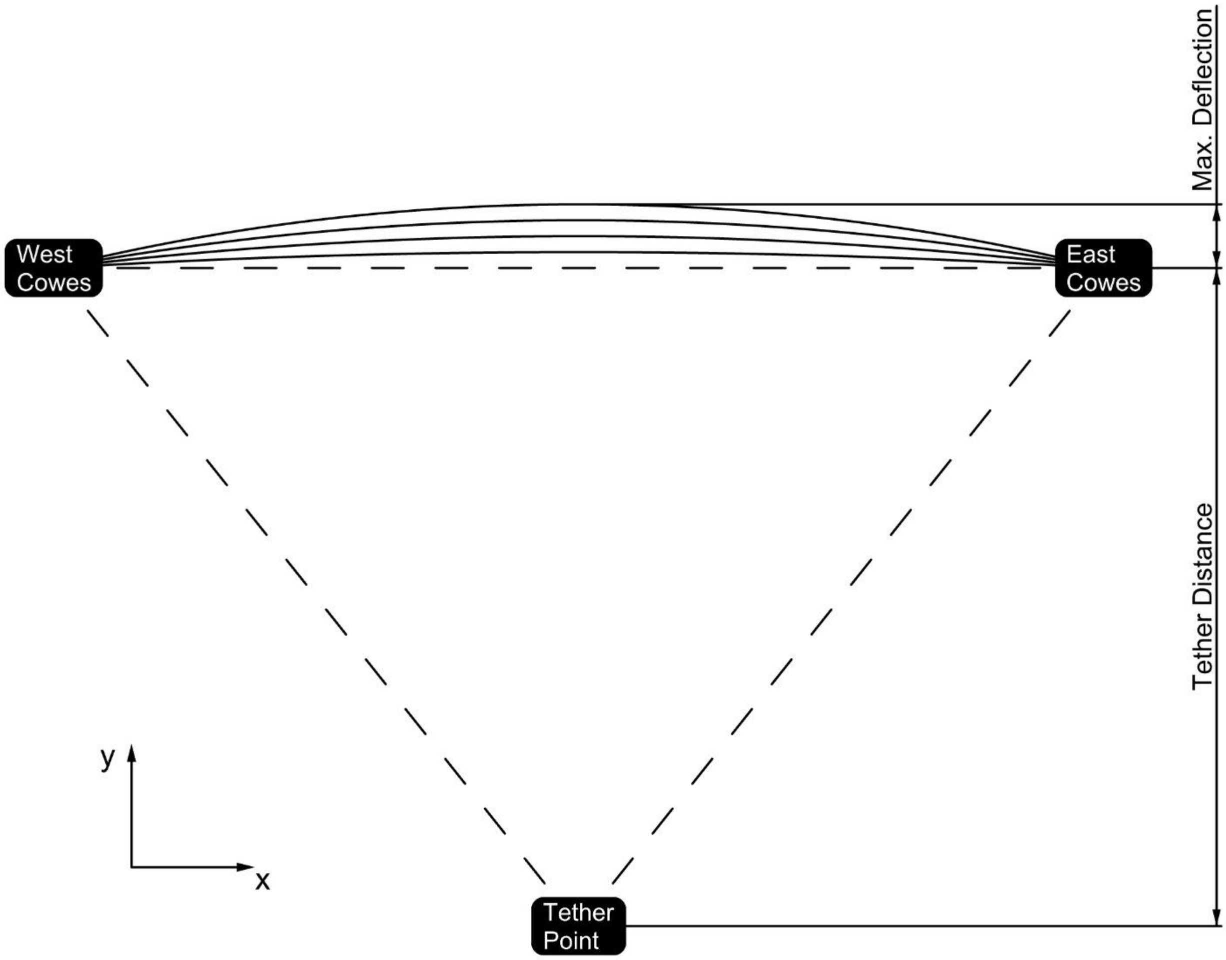

Figure 4 Schematic showing overhead view of the tether concept

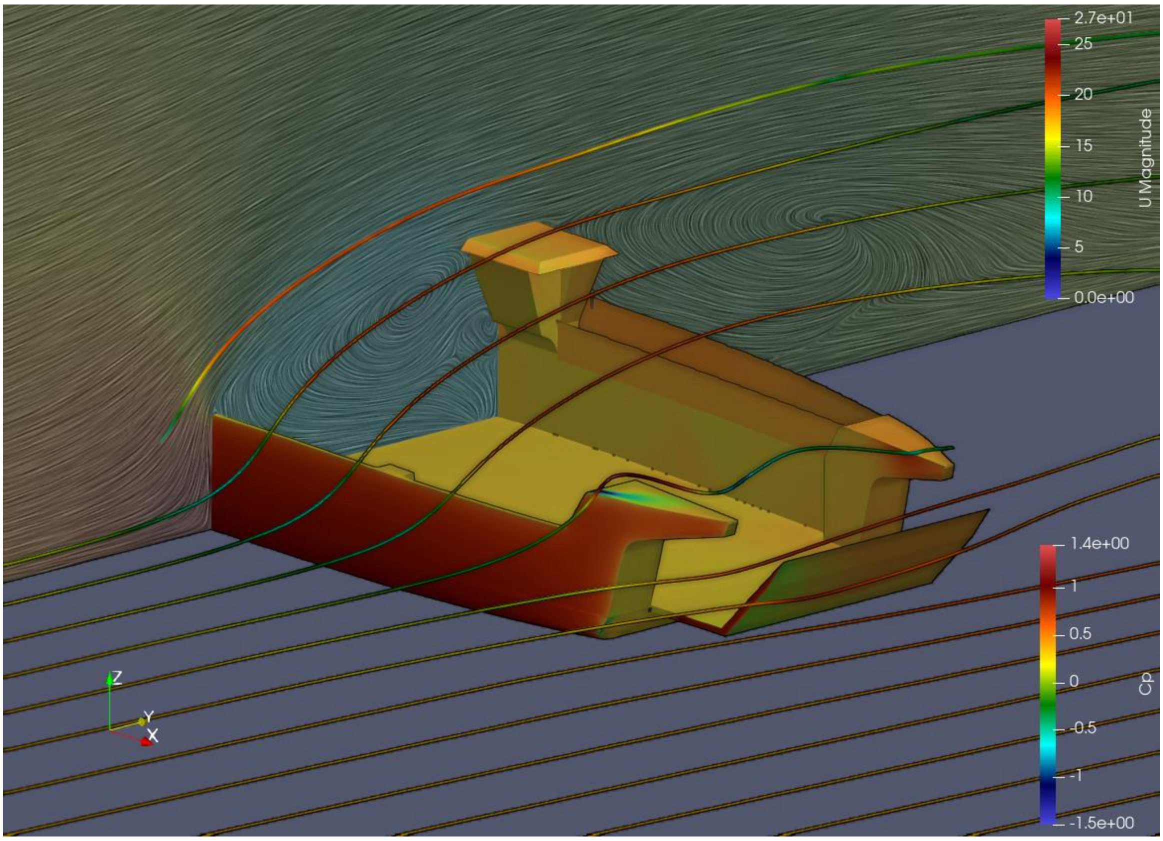

Figure 5 Flow visualisation from CFD analysis of the flow over the ferry at 34 knots wind speed

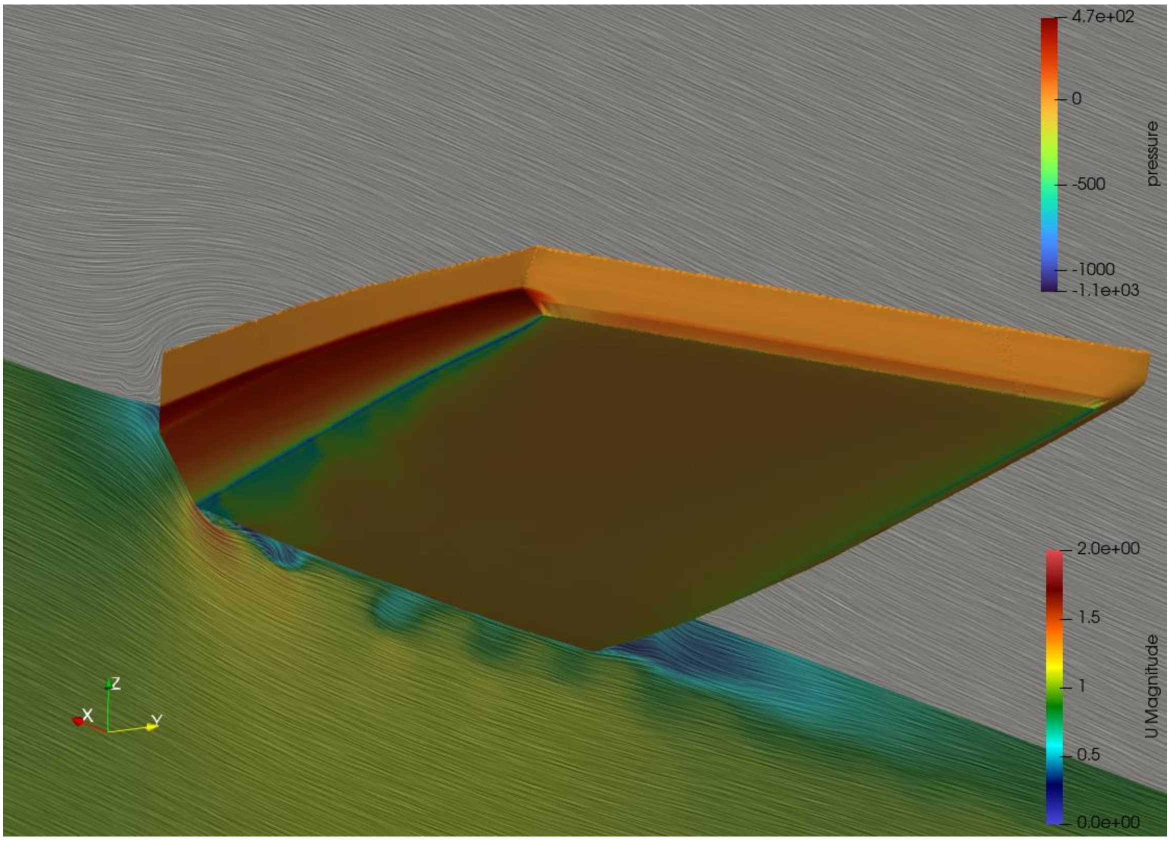

Figure 6 Flow visualisation from the free-surface CFD analysis showing the water flow under the ferry at 2 knots forward speed and 3.89 knots lateral current (approx. 63 degrees effective yaw)

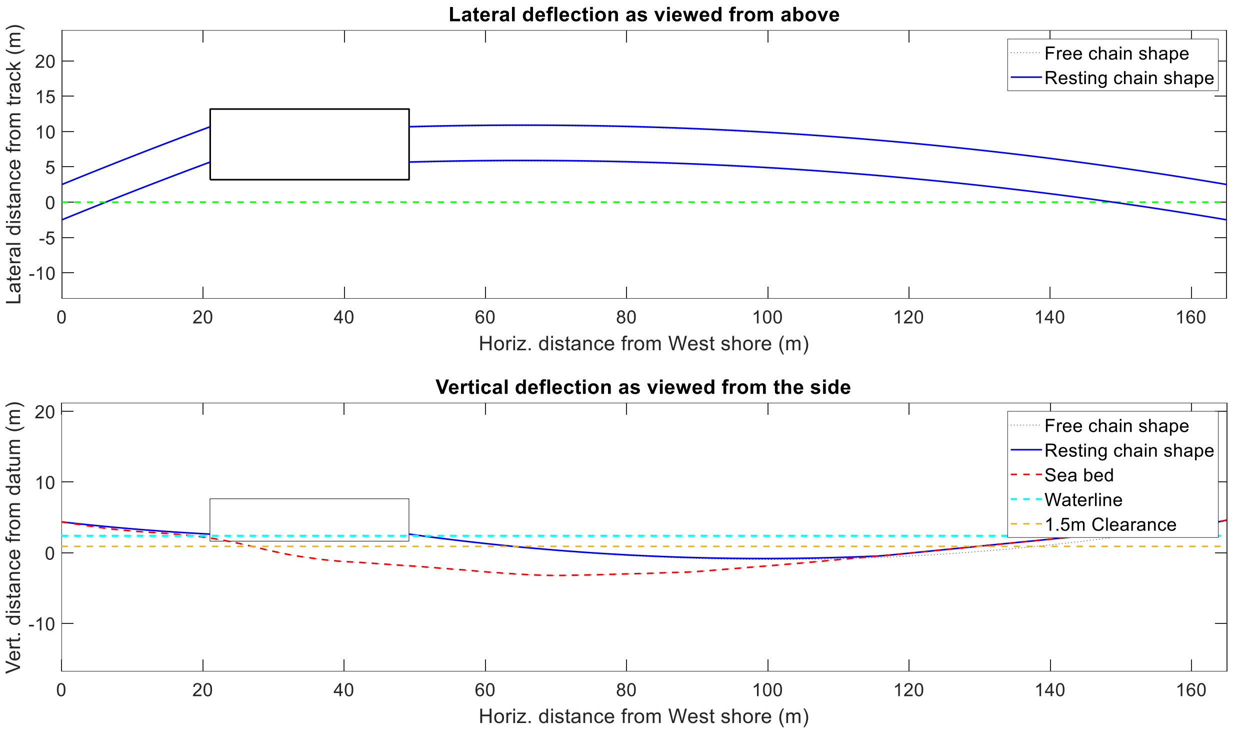

Figure 7 Chain shape prediction for survey 14-4 West condition (scenario 1) in conjunction with a 167.5m chain length

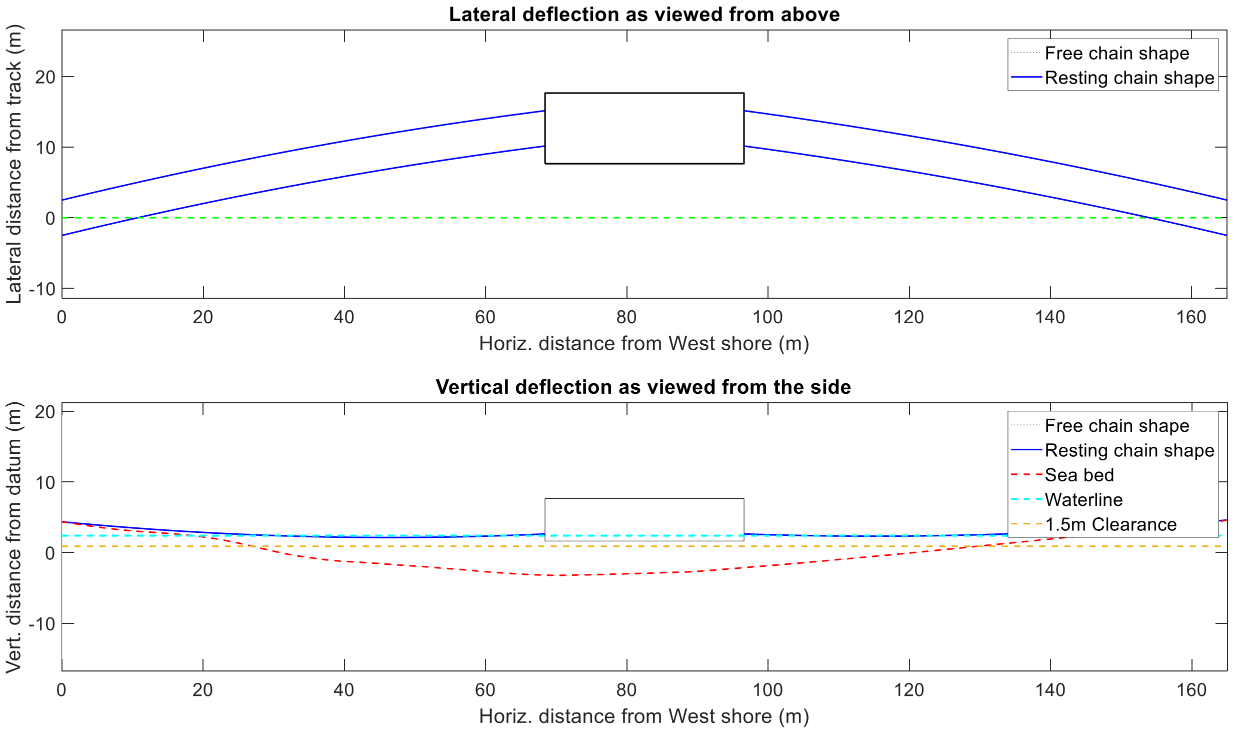

Figure 8 Chain shape prediction for scenario 2 (maximum wind/current) and a 167.5m chain length

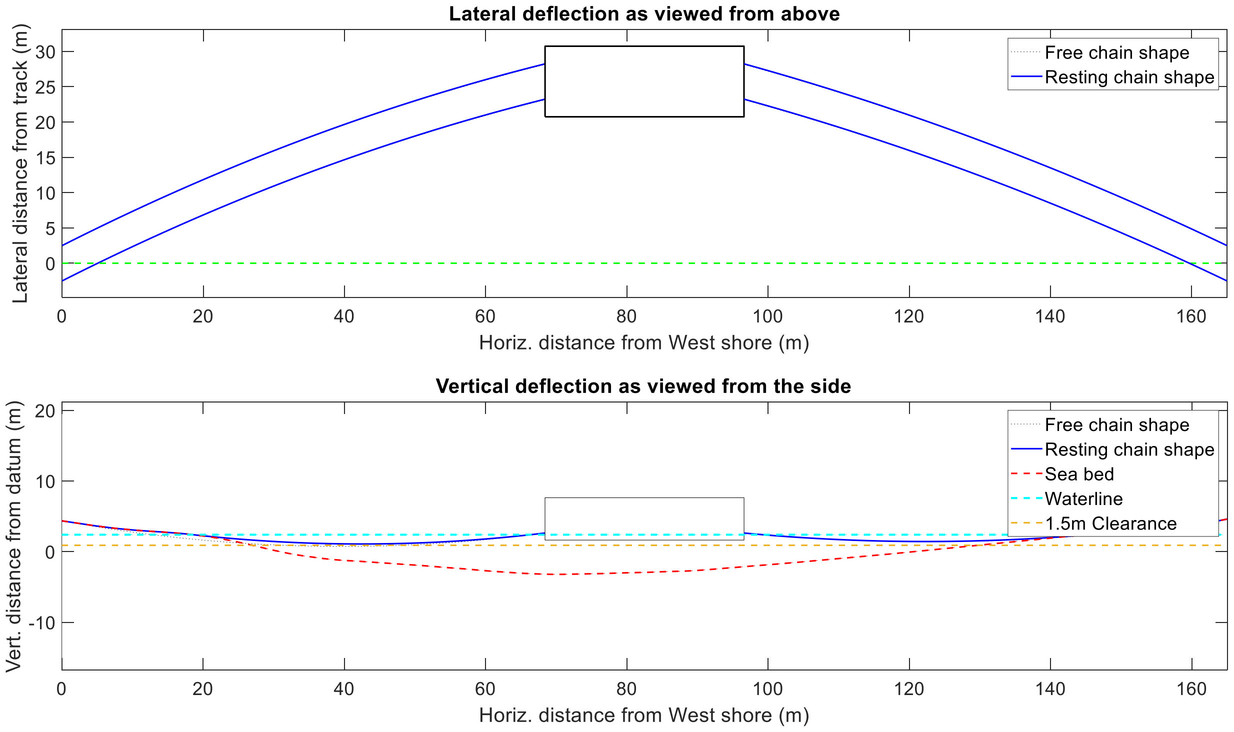

Figure 9 Chain shape prediction for the scenario 2 with a 175m long chain

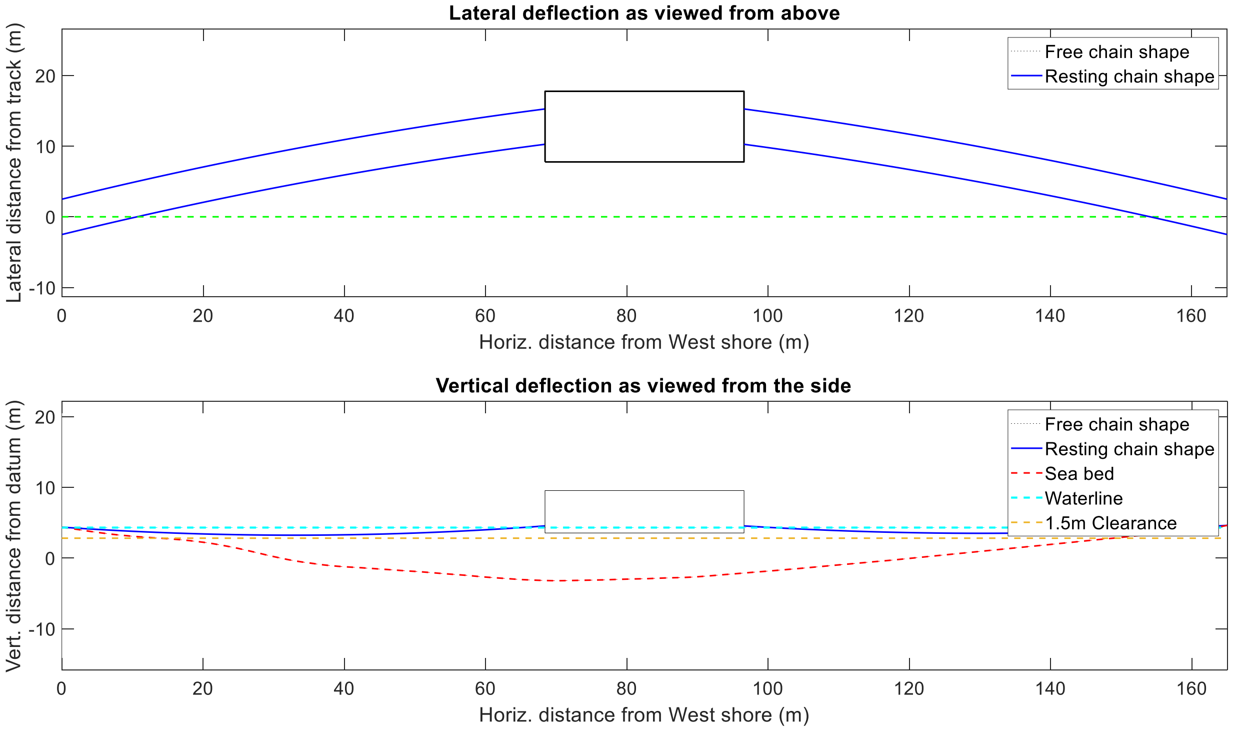

Figure 10 Chain shape prediction for the scenario 2 at high tide (4.3m) with a 167.5m chain

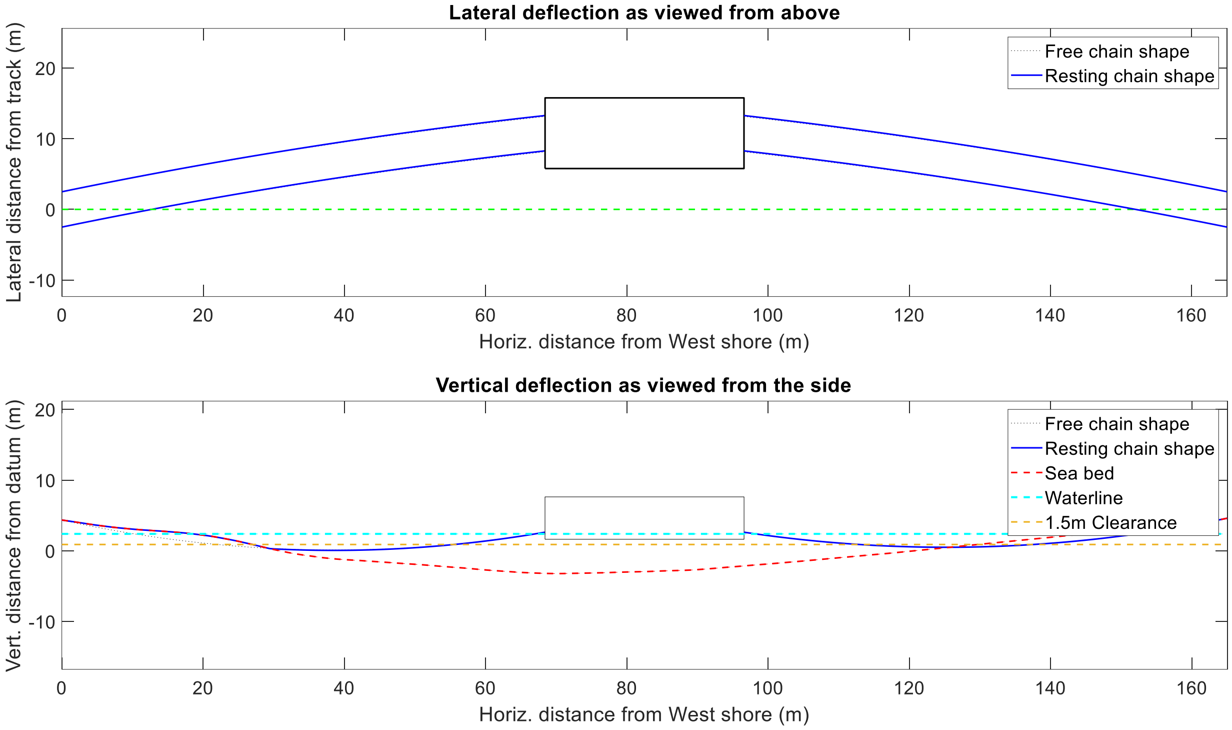

Figure 11 Chain shape prediction for scenario 2 with a 167.5m chain possessing three times the baseline chain mass

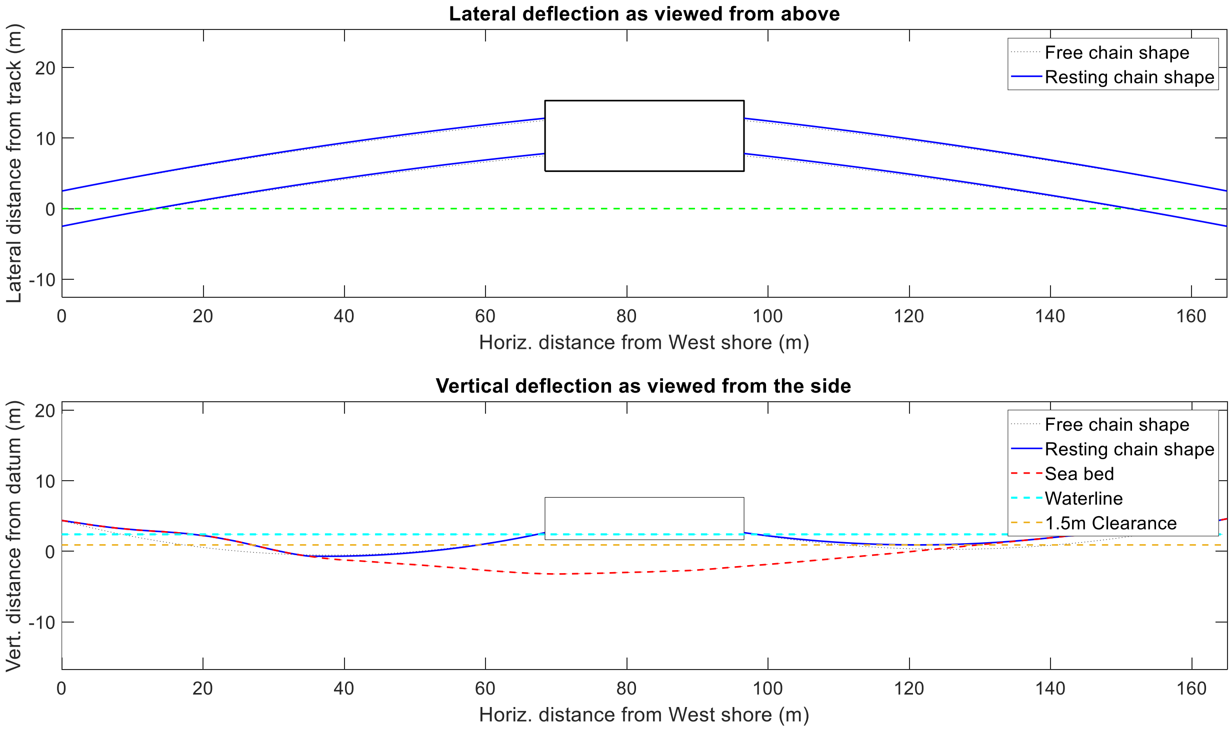

Figure 12 Chain shape prediction for scenario 2 with current and wind speed reduced by 50% and a 167.5m chain

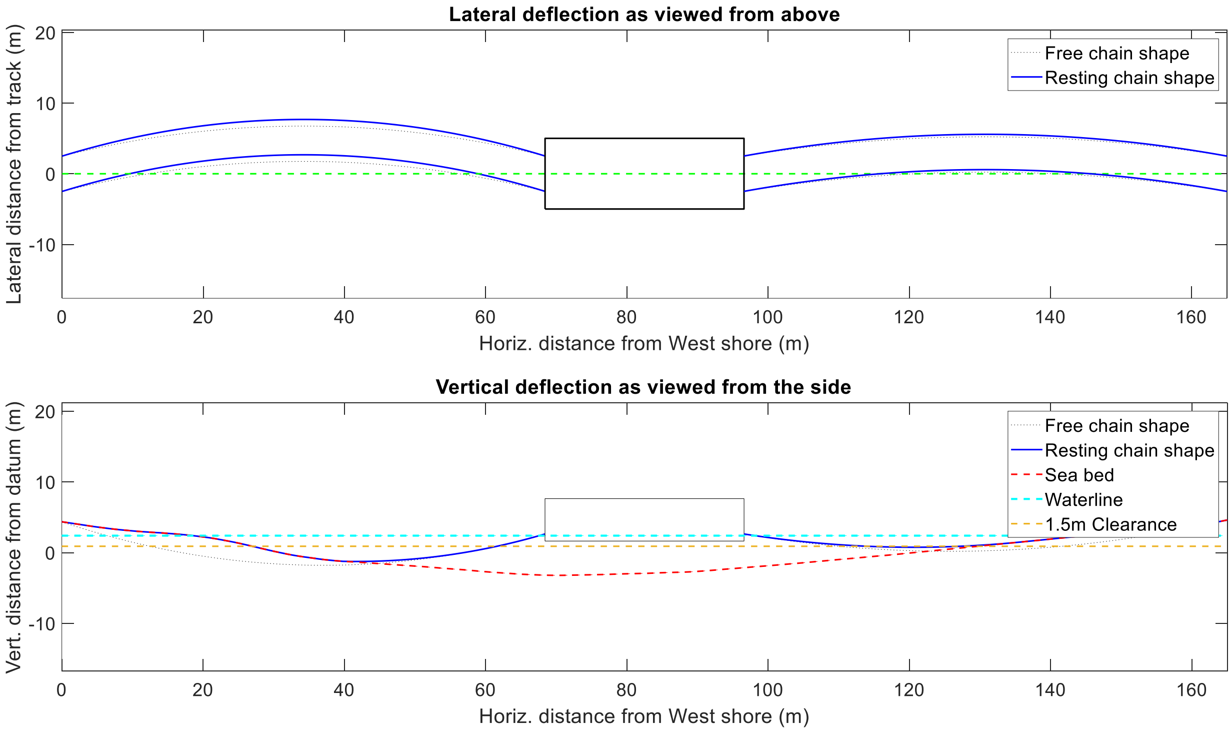

Figure 13 Chain shape prediction for the scenario 2 with the ferry restrained from moving in the lateral direction, representing the effect of adding an inelastic tether, with a 167.5m chain

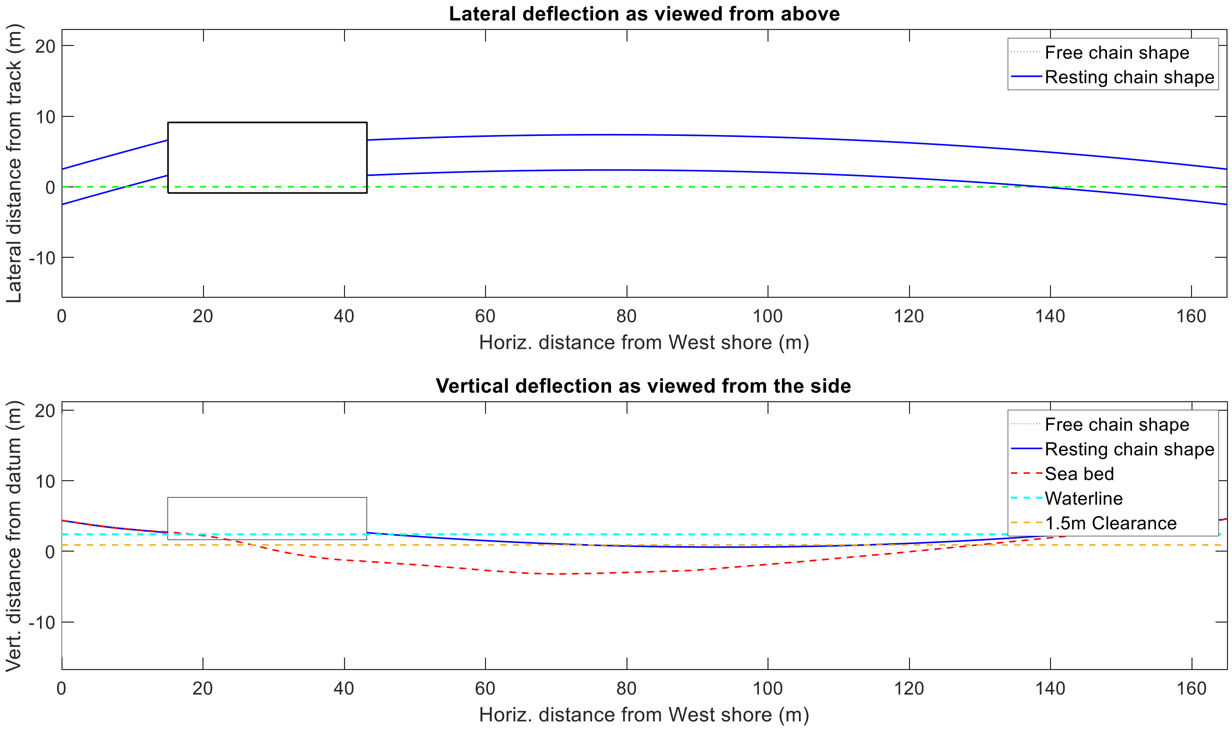

Figure 14 Chain shape prediction for maximum wind/current speed whilst the ferry is at West Cowes (scenario 3), using a short chain length of 166m

7 REFERENCES

[1] Recommended Practice DNV-RP-C205, Environmental Conditions and Environmental Loads (2007), Det Norske Veritas

8 APPENDIX A -GEOMETRY INVESTIGATION

On completion of the initial report it was requested by IOWC that the influence of the geometry upon the results should be investigated. In particular, it was noted that the 3D geometry used for force predictions was created manually, by manipulating 2D CAD drawings provided by IOWC. In order to minimise any uncertainty caused by the 2D to 3D conversion process, IOWC therefore obtained 3D models of the hull and superstructure from the ferry manufacturer, and the analysis was repeated for this geometry. In addition, the effect of operating a hypothetical smaller ferry was investigated by scaling the manufacturers 3D model, in accordance with the dimensions listed in Table 16.

This resulted in a total of three ferry geometries being analysed, denoted A,B and C, referring to the (original) 2D derived model, the manufacturers model and the scaled model respectively. Illustrations of the three CAD models are provided in Figure 15 to Figure 17, plotted at the same scale for comparison. It can be seen that whilst the 2D derived geometry is broadly similar to the manufacturers geometry, some differences exist; principally the shaping of the ramps.

Each geometry was simulated four times using CFD, consisting of two flow conditions using the hydrodynamic solver (forwards motion only and forwards motion plus maximum lateral current flow), and two flow conditions using the aerodynamic solver (forwards motion only and forwards motion plus maximum lateral wind speed). The results of the CFD simulations are provided in Table 17 and Table 18. The difference in maximum sideforce (summing current and wind force) between all simulations is noticeable but not significant, varying only between 58-65kN, with the relative difference in forces between geometries B and C reflecting the relative dimensional differences between the geometries.

The chain shape and lateral deflection for the new geometries were predicted using the chain prediction tool, and are provided in Table 19 to Table 21. The predicted lateral deflection for all three geometries is very similar, varying by a maximum of 0.3m between cases for a given chain length. The fact that the results do not vary much with the changes in geometry is due to a combination of 1) the geometries being predicted to produce relatively similar force magnitudes and 2) the model predicting only small changes in lateral deflection with changes in sideforce for this very high load case.

The reason the model predicts deflections that are so similar in magnitude is illustrated by plotting the lateral deflection of geometry A as a function of wind/current loading for scenario 2 (Figure 18) - results are provided both for the Cowes floating bridge 6 with representative sea bed topology, and also for a theoretical deep water scenario. It can be seen that as the wind/current speed increases from zero the lateral deflection initially increases rapidly, but that upon reaching approximately 60% of the maximum wind/current speed for scenario 2 the lateral deflection increases only slowly. Another way of interpreting this is that the ferry can be deflected sideways with comparatively little force, however once the chains approach being taut a significant change in sideforce is required in order to produce a meaningful change in lateral deflection.

The wind/current loading scenarios investigated in this report yield large sideforces that place the ferry in the regime where the chains are approaching being taut, hence the modest reduction in sideforce achieved by reducing the ferry size has only a small impact.

As an aside, it can be seen that the deep water prediction differs from the floating bridge 6 prediction only when the current/wind speed falls low enough for the chain to part-rest upon the sea bed, between zero and nominally 60% of the worst-case wind/current load. In this region the deep water prediction shows less lateral deflection.

9 APPENDIX A CONCLUSIONS

The comparison of different ferry geometries and geometry scales does not fundamentally change the conclusions of the original report. For the scenarios tested, in which the side forces are very large and the chains are approaching 'taut' behaviour, the model is relatively insensitive to even significant changes in wind/current loading. The only model property found to strongly influence/limit the lateral deflection thus far is the chain length, with the caveat that reducing chain length is likely to increase chain tension.

Property	FB6 (Geometry B)	Scaled Model (Geometry C)
Length (m)	29.70	26.67
Width (m)	14.00	12.80
Draught (m)	1.40	1.37
Weight (tonnes)	333	234

Table 16 Dimensions of the as-built ferry (geometry B) and hypothetical scaled ferry (geometry C)

Geometry	Condition	Forwards Speed (kts)	Current Speed (kts)	Wind Speed (kts)	Hydro. Drag (kN)	Aero. Drag (kN)	Hydro. Sideforce (kN)	Aero. Sideforce (kN)
A - From 2D	Fwd	2.0	0.0	0.0	1.21	0.03	28.41	36.17
B - From 3D	Fwd	2.0	0.0	0.0	1.17	0.03	28.63	33.74
C - 3D Scaled	Fwd	2.0	0.0	0.0	1.05	0.03	27.06	30.95

Table 17 Predicted hydrodynamic and aerodynamic forces for each ferry geometry – forwards boat speed only

Geometry	Condition	Forwards Speed (kts)	Current Speed (kts)	Wind Speed (kts)	Hydro. Drag (kN)	Aero. Drag (kN)	Hydro. Sideforce (kN)	Aero. Sideforce (kN)
A - From 2D	Max. Sideforce	2.0	1.8	34.0	1.64	0.0	28.41	36.17
B - From 3D	Max. Sideforce	2.0	1.8	34.0	1.79	0.0	28.63	33.74
C - 3D Scaled	Max. Sideforce	2.0	1.8	34.0	1.52	0.0	27.06	30.95

Table 18 Predicted hydrodynamic and aerodynamic forces for each ferry geometry – forwards boat speed with maximum wind and current side loading

Chain Length (m)	T1 (kN)	T2 (kN)	Δy (m)	L1 D>1.5m (m)	L2 D>1.5m (m)
167.5	112.5	113.4	12.8	0.0	0.0
170	79.3	80.2	18.2	0.0	0.0
175	55.9	56.9	25.9	0.0	0.0
180	45.3	46.2	32.2	0.0	0.0

Table 19 Chain shape prediction results for geometry A (2D derived) in scenario 3 using various chain lengths (duplicated from section 4.4)

Chain Length (m)	T1 (kN)	T2 (kN)	Δy (m)	L1 D>1.5m (m)	L2 D>1.5m (m)
167.5	109.8	110.7	12.8	0.0	0.0
170	77.4	78.3	18.2	0.0	0.0
175	54.8	55.7	25.8	0.0	0.0
180	44.3	45.2	32.0	0.0	0.0

Table 20 Chain shape prediction results for geometry B (manufacturers 3D geometry) in scenario 3 using various chain lengths (duplicated from section 4.4)

Chain Length (m)	T1 (kN)	T2 (kN)	Δy (m)	L1 D>1.5m (m)	L2 D>1.5m (m)
167.5	104.5	105.3	12.7	0.0	0.0
170	74.3	75.1	17.9	0.0	0.0
175	52.1	52.9	25.7	0.0	0.0
180	42.1	42.9	32.0	0.0	0.0

Table 21 Chain shape prediction results for geometry A (reduced size 3D geometry) in scenario 3 using various chain lengths (duplicated from section 4.4)

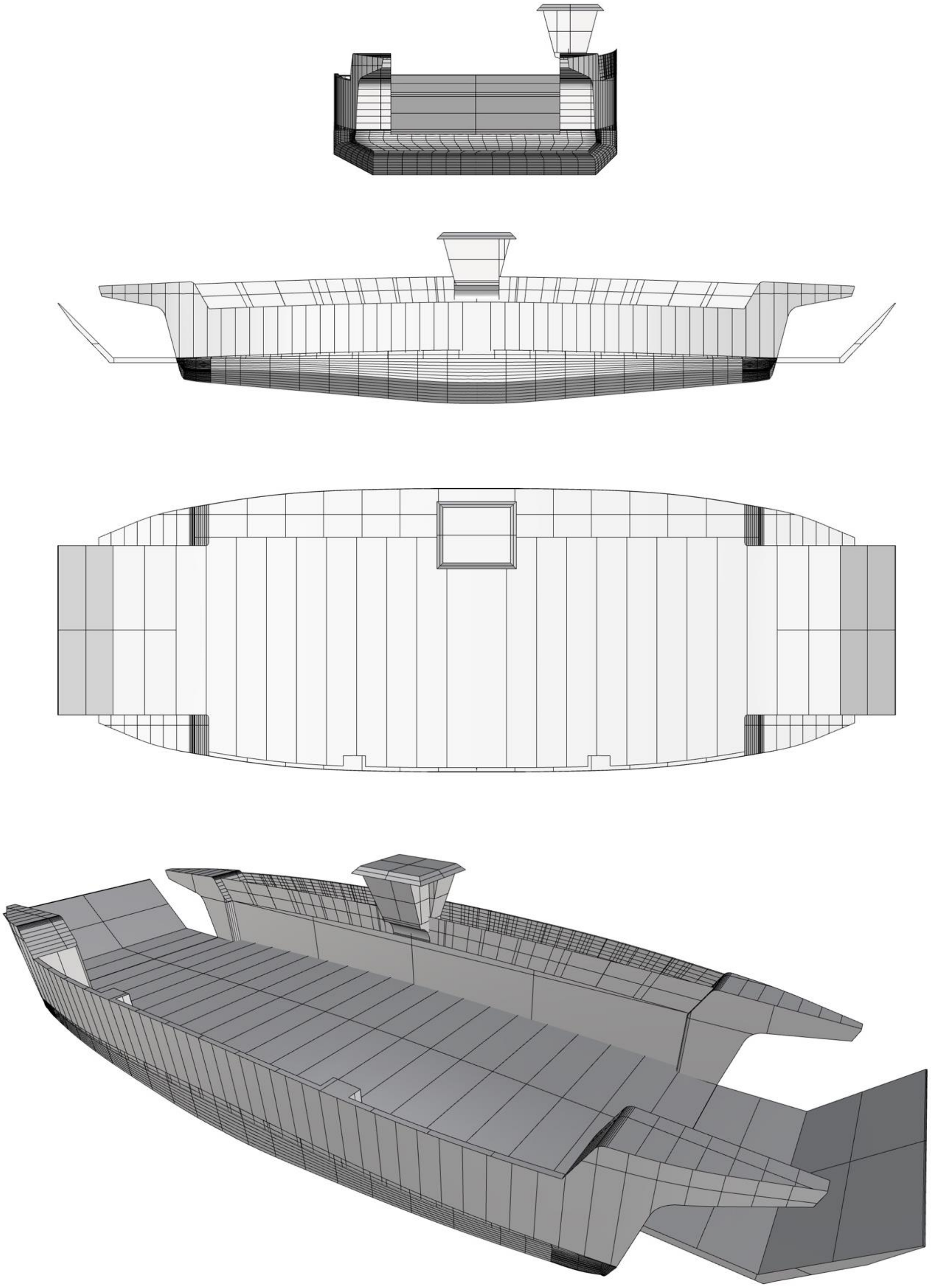

Figure 15 Geometry A - derived from 2D lines

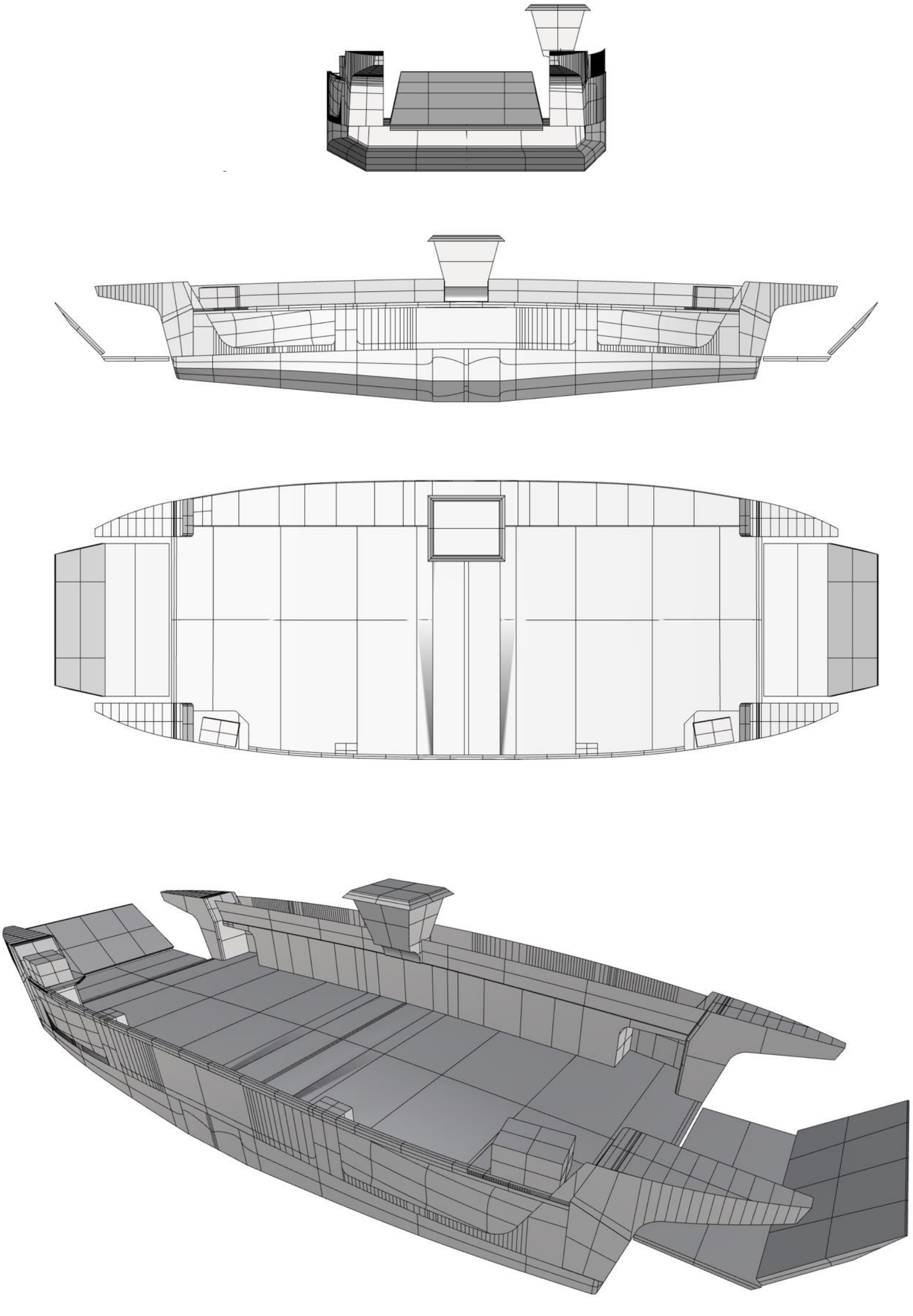

Figure 16 Geometry B - manufacturers 3D model

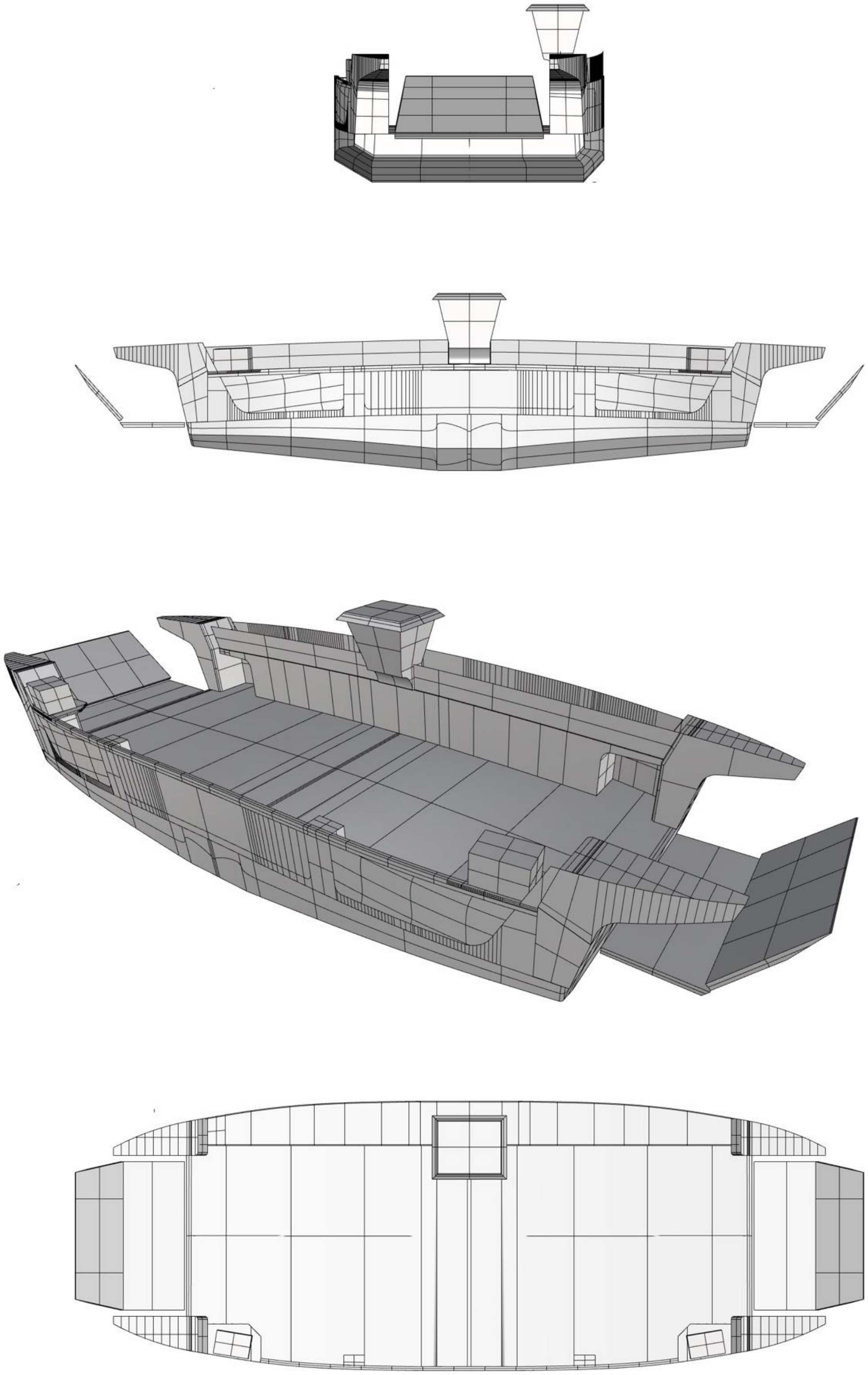

Figure 17 Geometry C - scaled manufacturers model

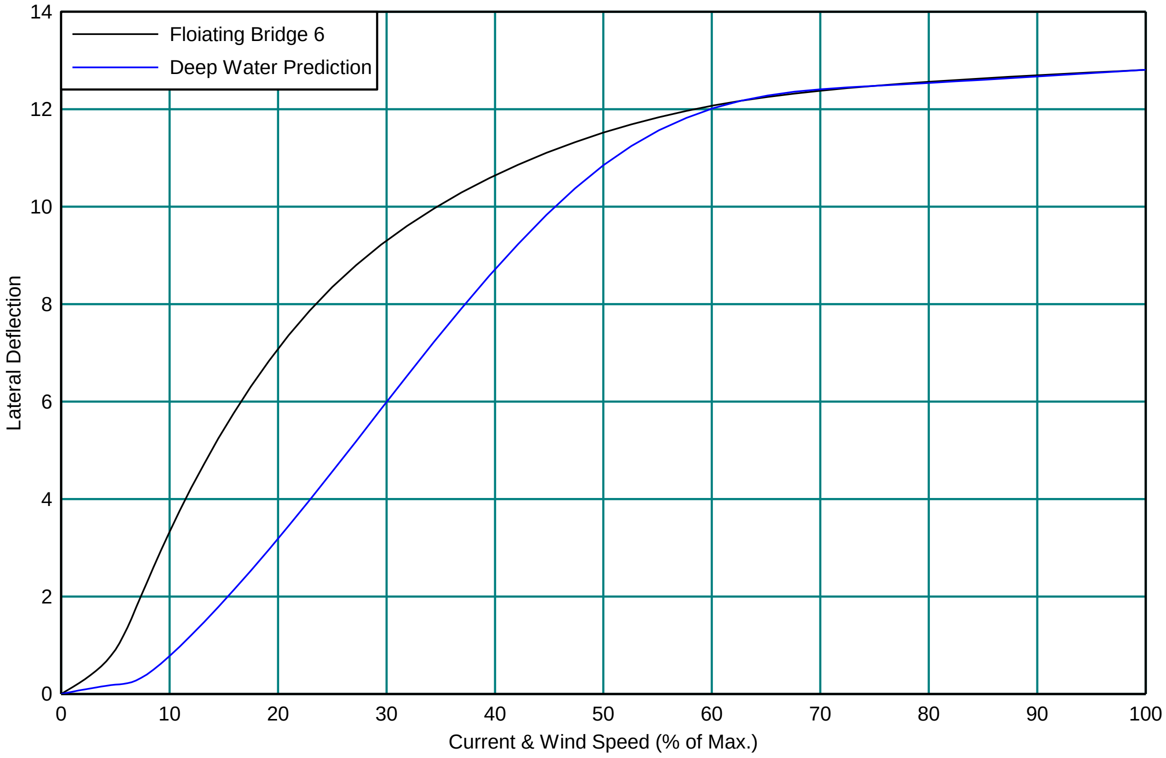

Figure 18 The effect of reducing the side current/wind loading upon lateral deflection, predicted for the Cowes floating bridge with shallow water depth and for a theoretical 'deep water' scenario

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Addendum to the Wolfson Unit Report

To investigate the impact of reducing ferry size on chain deflection the model was set up with the following conditions:-

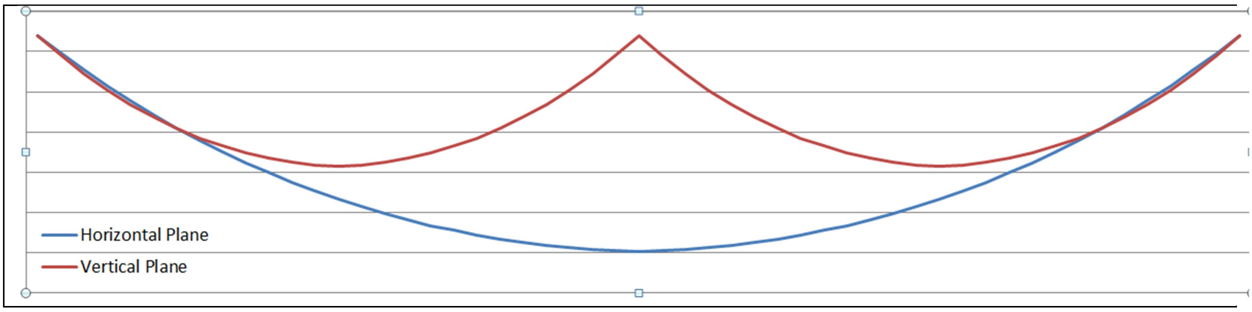
1. The chain length is specified as 167.7m
2. The current speed is specified as 2m/s
3. The effect of the chain weight upon chain shape is calculated
4. The effect of the current/drag upon chain shape is calculated
5. The effects of the wind/current sideforce on the vessel are NOT included

Effectively this is a theoretical scenario where the forces acting on the ferry are zero.

The findings from the Wolfson Unit are as follows:-

> "Under these conditions, with the ferry at mid-span and a current speed of nominally 2m/s, the model predicts a lateral chain deflection of approx. 9.7m and a vertical drop of approx. 2.8m. In other words, the model predicts that even if there are no forces acting on the ferry, for a current of 2m/s the lateral deflection will still be 9.7m".
>
> "I realise this may be surprising, however the maths appears to confirm this. The reason the lateral deflection is so large is because, when we consider the effect of chain weight, the chain is divided into two spans, however when we consider the effect of sideforce/current, the chain has a single span that is nominally 165m".
>
> "The chain weight is therefore opposed by four 'termination points' per chain, i.e. one at the end of each half-span, whereas the chain sideforce is countered by only two. Crucially, catenaries do not behave linearly, and this means the chain deflects significantly more in the sideways direction than the vertical direction per unit force (and the drag force here is approx. 80% of the weight for this current speed)".

In summary, in the vertical plane each chain forms two catenaries - between each slipway and the floating bridge - with the chain weight divided between the two spans. In the horizontal plane the tidal forces are effectively acting on the total length of the chain so the maximum lateral deflection, (based on the drag force under extreme ebb-tide conditions), is greater. The following diagram, (not to scale), provides an illustration of the conditions.



Based on the findings from the theoretical exercise described above, the model predicts that making the ferry smaller is not going to solve the problem of lateral deflection.

APPENDIX 5

FB6 Performance Review

1 Client Requirement

Contract Schedule 1 sets out a requirement for a "review of the operation of FB6 in terms of vehicles, foot passengers and cyclists queuing, paying, loading and unloading – identifying if and how this could be improved to increase the number of crossings per hour".

Contract Schedule 1 also identifies slow speed of loading and unloading as a key issue which "…directly impacts on the number of crossings per hour and the income generated". It is suggested that this is stems from "… the need to segregate foot passengers, cyclists, and vehicles.

This paper sets out the findings from a limited review of FB6 operations. A number of interim conclusions are presented for consideration as the basis for further discussion.

While carrying out the review problems came to light with loading and unloading of some classes of vehicle at very low tides. A draft proposal for an additional package of work to undertake a thorough review of this issue is included as Section 7.

Throughout the paper the term "crossing time" refers to the overall duration for a single crossing between East Cowes and West Cowes or vice /versa. The term "crossings per hour" refers to the number of crossings per hour starting from either East Cowes or West Cowes. To clarify, a crossing time of 10 minutes would equate to 3 crossings per hour.

2 Available Data

We have undertaken some initial data collection on operational timings using observations of the FB6 webcam feed. Overall crossing times have been assessed by considering five key components:-

1. The transit time from departure from one slipway to arrival at the other
2. The combined time for boarding and offloading of passengers
3. The combined time for boarding and offloading of vehicles
4. The delay to departure; i.e. the delay between boarding complete and departure from the slipway.
5. Total other delays[1], which comprise:-
    a. The turnaround delay; i.e. the delay between completion of vehicle offloading for the previous crossing and commencement of vehicle boarding.
    b. The delay from completion of vehicle boarding to commencement of passenger boarding.
    c. The delay from completion of passenger offloading to commencement of vehicle offloading.

Timings have been assessed from six batches of data covering 37 crossings in total:-

- 4 crossings starting at 15:14 on 09 March 2023

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[1] On occasion further delays may be incurred due to the passage of other river traffic, although these should be infrequent and usually of short duration.

- 6 crossings starting at 18:12 on 09 March 2023
- 5 crossings starting at 08:56 on 10 March 2023.
- 5 crossings starting at 16:19 on 13 March 2023.
- 5 crossings starting at 08:13 on 14 March 2023.
- 12 crossings starting at 06:50 on 16 March 2023

3 Data Analysis

Chart 1 is a column chart comparing the average times for the five key timing components for each of the six batches of data.

Initial observations:-

- The variation in the average combined timings for boarding and offloading of passengers is small.
- The variation in the average timings for other delays is small.
- The average transit time is generally in excess of three minutes, with some significant variations. The variations are to be expected as the transit time is dependent on several factors, notably the state of the tide and the impact of turbulent currents on docking.

The variation in the average combined timings for boarding and offloading of vehicles has been investigated in more detail.

Chart 2 shows the combined timings for boarding and offloading of vehicles expressed as a time per vehicle for each crossing. It can be concluded that there is only a small variance across all 37 crossings from the average timing of approximately 12 seconds per vehicle.

The variation in the average combined timings for the delays to start has also been investigated in more detail.

Chart 3 shows the timings for the delay to departure for each crossing. It can be concluded that there is a large variation in the timings across all 37 crossings.

There is no obvious explanation for the large variation in the delay to departure timings unless FB6 is being operated for much of the day against a target number of crossings per hour? **Chart 4** which shows the average crossing times for each of the six batches of data tends to support this explanation.

4 Derivation of the "Best-case" Number of Crossings per hour

4.1 Current operations – no segregation of foot passengers, cyclists, and vehicles

Based on the data analysis, an estimate has been prepared for the "best-case" crossing time under the current operating procedures for crossings during the core 12 hour period[2]

---

[2] The "core 12 hour period" is defined in the 21 Sep 2018 Final Business Case at page 41.

outside off-peak hours[3]. Using the data collected for the 37 crossings the best case average crossing time has been assessed as the sum of:-

- The average transit time. (3 minutes 23 seconds).
- The average combined timing for boarding and offloading of passengers. (41 seconds).
- A time of 1 minute 36 seconds for the combined timing for the boarding and offloading of vehicles. This figure has been arrived at using an average of 12 seconds per vehicle with an average of 8 vehicles per crossing[4]
- A nominal time of 1 minute for the delay to departure variable. This figure is proposed as a reasonable minimum based on observations from the 37 crossings. If the driver were to return to the cab while the loading ramp was being raised following completion of boarding this time could be reduced[5].
- The average time for other delays. (45 seconds).

Chart 5 shows this best-case scenario of 7 minutes 25 seconds in comparison with the observed timings from **Chart 4**.

4.2 Operations with segregation of foot passengers, cyclists, and vehicles

If it were possible to segregate foot passengers, cyclists, and vehicles then:-

1. The average combined time of 41 seconds highlighted above for boarding and offloading of foot passengers could be removed from the best case total of 7 minutes 25 seconds since all boarding and offloading could be completed within the time window of 1 minute 36 seconds allowed for the combined timing for the boarding and offloading of vehicles.
2. The delay from completion of vehicle boarding to commencement of passenger boarding, (11 seconds) would be eliminated.
3. The delay from completion of passenger offloading to commencement of vehicle offloading, (11 seconds) would be eliminated.

The best case scenario would then become 6 minutes 22 seconds.

Further discussion is required with IWC to establish whether segregation is indeed feasible, taking into consideration the following observations:-

---

[3] It appears that off-peak operations can achieve much shorter crossing times, as shown at Chart 4 for the batch of crossings commencing at 18:12 on 09 March. Even shorter crossing times have been observed. For example, an average crossing time of approximately 6mins 30 secs for 5 crossings commencing with the 06:58 crossing on 16 March. Primarily due to the much reduced times for boarding and offloading reflecting the low numbers of passengers and vehicles carried.

[4] The 21 Sep 2018 Final Business Case at page 51 presents an "observed total vehicle demand" for March 2018 of 12,000 vehicles. Using the concept of the "core 12 hour period" defined at page 41 with 3 crossings per hour, and using the business case daily demand framework, this March 2018 figure would equate to just over 7 vehicles per crossing. The average number of vehicles per crossing from the relatively small set of data reviewed for this report is approximately 8.5. An average of 8 has been used here as a reasonable overall figure which should avoid arriving at too short a time for boarding and offloading vehicles.

[5] Recognising that current operational procedures may prevent the driver leaving the vehicle deck before the loading ramp is raised.

1. The Sandbanks chain ferry appears to operate with coincident loading or unloading of all classes, as shown on screenshot taken from the Sandbanks webcam feed included in Appendix 1. Two Google maps screenshots are also included in Appendix 1. These show the Sandbanks slipway with the foot passenger lane, (beyond the initial barrier), divided from the vehicle lanes with a solid white line for part of the distance to the ferry ramp.
2. The Sandbanks slipways are wider but would it be feasible to introduce segregation at East & West Cowes by installing a painted "corridor" on the slipways together with appropriate signage to direct foot passengers, cyclists, and vehicles?
3. If segregation were achieved with a painted corridor foot passengers waiting for the next ferry would not be required to cross a lane of traffic to board given the location of the shelters at the tops of the slipways.
4. At West Cowes disembarking cyclists are routed across the ramp in the face of the vehicles in order to exit on the left of the slipway but the time penalty is minimal[6].

Pending the outcome of discussions with IWC on these items the best case scenario timing of 7 minutes 25 seconds has been retained for use in the assessment of findings set out in Section 5.

5 Assessment of the Findings

Table 1 provides an analysis focused on the number of crossings per hour and the number of vehicles per hour for the current operation of FB6 as observed from the webcam stream together with the results that could be achieved from the "best case" described above. The analysis considers operation at full capacity and under average loading conditions. The commentary sets out the case for the values used in the table.

Table 1 also sets out the findings for a related key metric:- the worst case waiting time experienced by car drivers in the queue to board. If FB6 has just departed this waiting time, (for the next crossing), will be twice the overall crossing time. Clearly the waiting time is a major factor in determining the time to the destination which, in the worst case, will be the worst case waiting time plus the crossing time:- equivalent to three times the crossing time.

Ideally the worst case time to the destination should be less than the nominal time for the road journey via Newport. If this time is assumed to be 24 minutes the crossing time should, therefore, be less than 8 minutes – equivalent to 3.75 crossings per hour. Clearly if crossing times routinely exceed this 8 minute threshold vehicle drivers will be less inclined to queue to use the floating bridge.

Considering the data for average timings, table 1 shows that the items with the most significant impact on crossings per hour are:

1. The transit time
2. The delay to departure after boarding complete
3. The combined vehicle boarding and offloading time

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[6] The average number of cyclists in this data set is less than 1.2 per crossing and under the current procedures all cycles clear the slipway quickly

Using the average time of 12 seconds per car for the combined boarding and offloading time and an average FB6 transit time of 3 minutes 23 seconds, the number of crossings per hour under current operations varies between 2.7 and 3.4. (Operating at capacity and at average loading).

Reducing the delay to departure after boarding complete from the current average of circa 2 minutes 30 seconds to a "best case" 1 minute would improve these figures to between 3.1 and 4.0 crossings per hour.

A tentative comparison set of values for FB5 is included in Table 1, although very little concrete data is available in the public realm so the values shown should be treated with caution, subject to validation if data are available from other IWC sources.

In the case of FB5 it appears the Medina transit could be completed comfortably in 2 minutes. With a number of assumptions as set out in table 1 for other timings the number of crossings per hour at capacity would be 4.26 and 5.5 at an assumed average loading of 7 vehicles.

The Final Business Case dated 21 September 2018 presents an average of 4.5 crossings per hour for FB5[7]. This is consistent with the findings shown in Table 1. The requirement for FB6 is set at 5 crossings per hour. Clearly this is not currently being met.

6 Interim Conclusions

1. The average number of crossings per hour required to deliver a minimum level of service is 3.75.
2. The average number of crossings per hour under current operations for FB6 is 3.4
3. The analysis suggests that a 20% improvement to an average of 4 crossings per hour would be achieved by preparing FB6 for departure as soon as the last passenger has boarded[8].
4. In order to approach the business case target of 5 crossings per hour using the best case scenario under current operational procedures the transit time would have to reduce to circa 2 minutes. This is probably not achievable with FB6 as currently configured.
5. Alternatively, if segregation of foot passengers, cyclists, and vehicles can be implemented then average loading and unloading times could be improved by circa 1 minute, meaning that an average of 5 crossings per hour could be delivered if an average transit time of 3 minutes could be achieved.

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[7] Page 37. Table titled "Revised Business Case – SRTM Assumptions for FB6 (Do Something)

[8] It may be that greater control of queuing passengers is required to prevent late-comers delaying the raising of the ramp.

7 Proposed Additional Work Package – Ramp Transition Angle Review

7.1 Overview

While reviewing the video captures to gain an understanding of the factors determining the number of crossings per hour several examples of a problem with the loading and unloading of vehicles at very low tides became apparent.

3S decided to trial the loading of a vehicle onto FB6 at an extreme state of the tide. This confirmed that under certain conditions adoption of a direct loading path presented a transition angle between the vessel loading ramp and concrete ramp that challenged even the 3S 4WD off-road vehicle designed to accommodate unusually large approach and departure angles.

Private cars plainly need to take a less direct course in order to avoid grounding, which can significantly slow loading and unloading, particularly in the event of a grounding resulting in vehicle damage.

It is noted from diagram reference BCP/J/10384/00[9] super-imposing the dimensions of FB6 on FB5, that the loading ramp hinges of FB5 are significantly closer to the waterline than those of FB6. Hence, FB5 could achieve a much smaller transition angle between the vessel loading ramp and concrete slipway than FB6.

The relative disadvantage of FB6 is then further increased at states of the tide where it might be obliged by its greater draught to berth further from the water line, particularly if there is a change in slope of the concrete slipway.

Clearly this is a problem that attracted a lot of early bad press and we understand it has been mitigated to an extent, albeit we suspect that more than a few drivers instead drive around rather than risk damage. However, if the problem can be further mitigated then it can only improve public perception.

Accordingly, the recommendations set out at Section 7.2 are tabled for consideration by IWC

7.2 Recommendations

1. 3S to interview the operating staff to establish whether the impediments to loading and unloading vehicles at extremes of tide are sufficiently significant, particularly noting the impact on loading /unloading times.

If the impediments are significant, then:-

2. Identify all contributory factors, including:-
   a. Berthing constraints at extremes of tide and consequent operating regimes
   b. The value of transition angle at which loading problems become significant
   c. The reasons for variation of transition angles at various states of tide

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[9] Included in the document pack provided by IWC by email dated 16 July 2023

3. Draw up a task specification for the recruitment of a data logger to determine whether resulting revenue loss and user inconvenience is sufficiently significant to warrant further study.
4. If further study is warranted, then set out in concept possible operational and engineering solutions for consideration.
    a. One potential means of reducing the transition angle is by increasing the lengths of the loading ramps, such as presently fitted to the Sandbanks vessel.

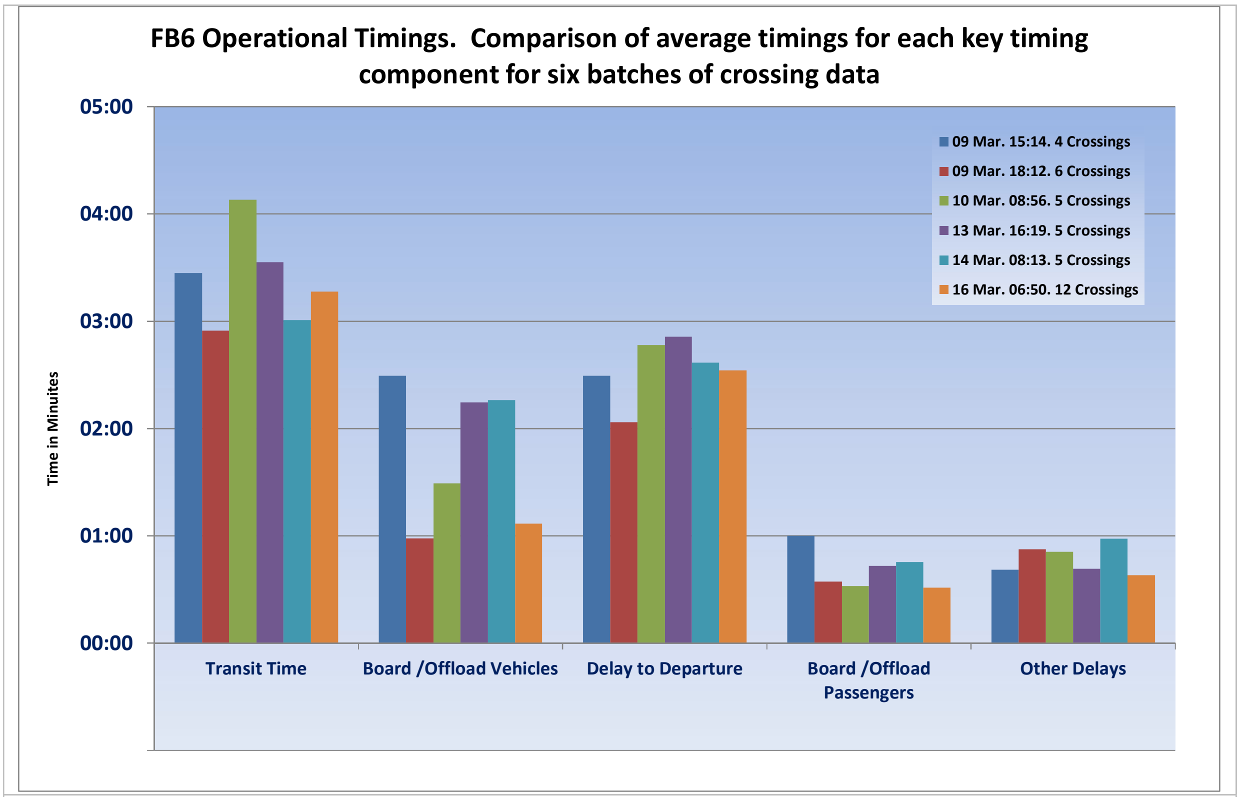

Chart 1

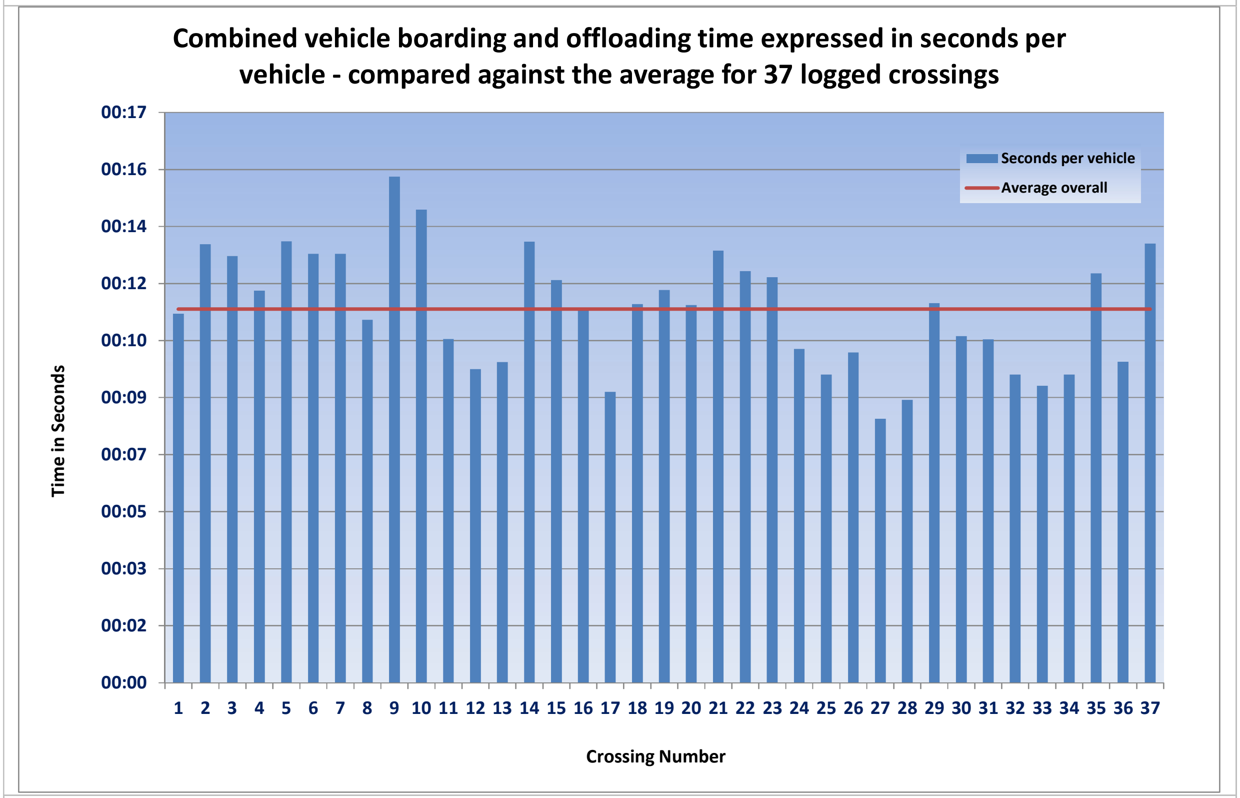

Chart 2

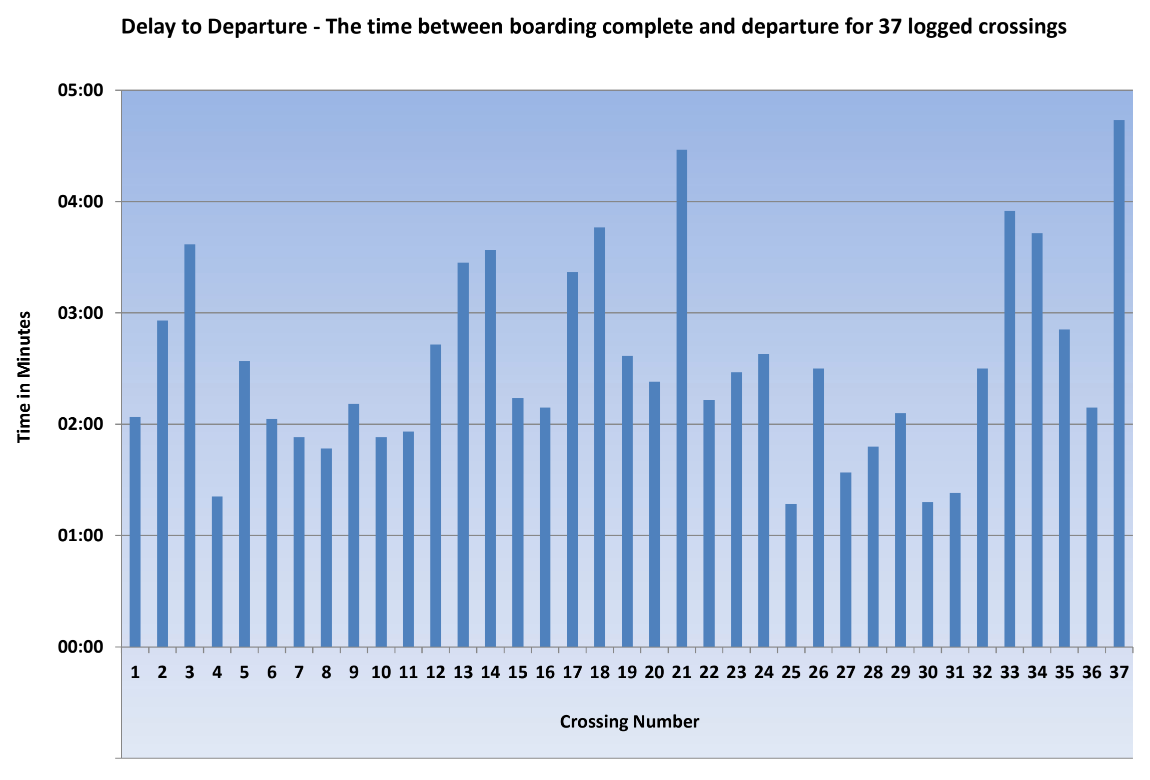

Chart 3

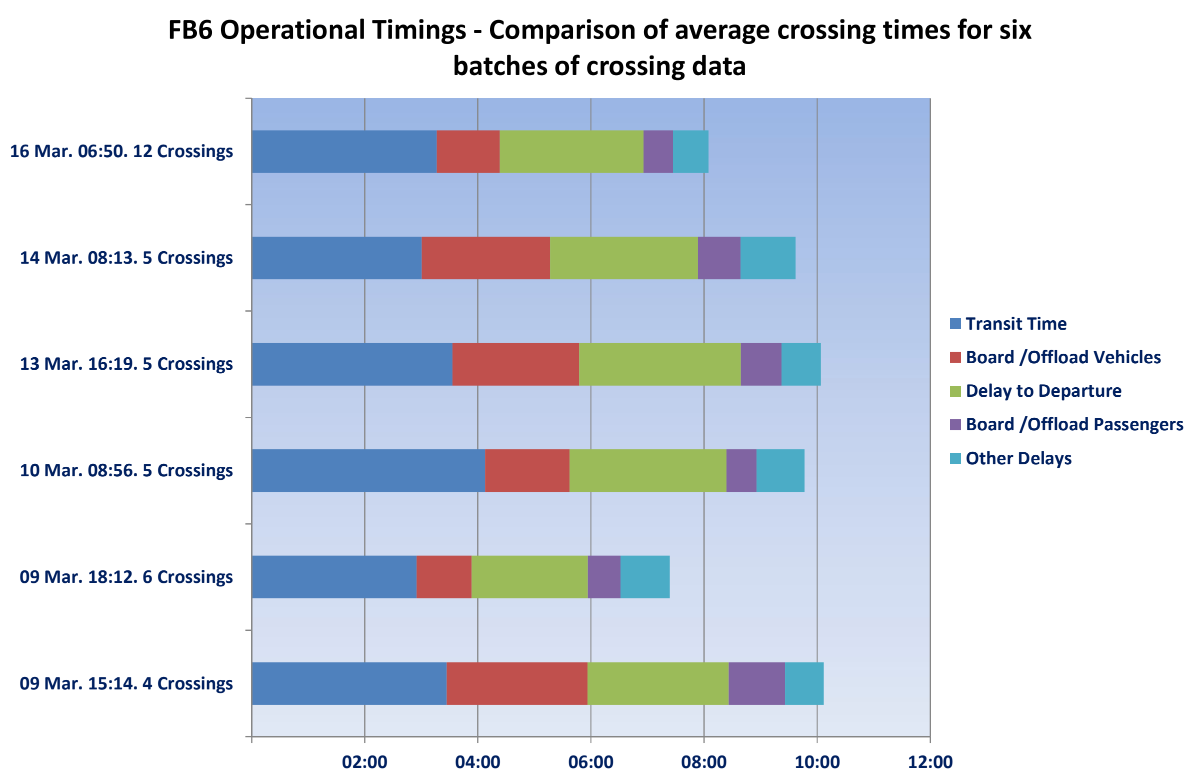

Chart 4

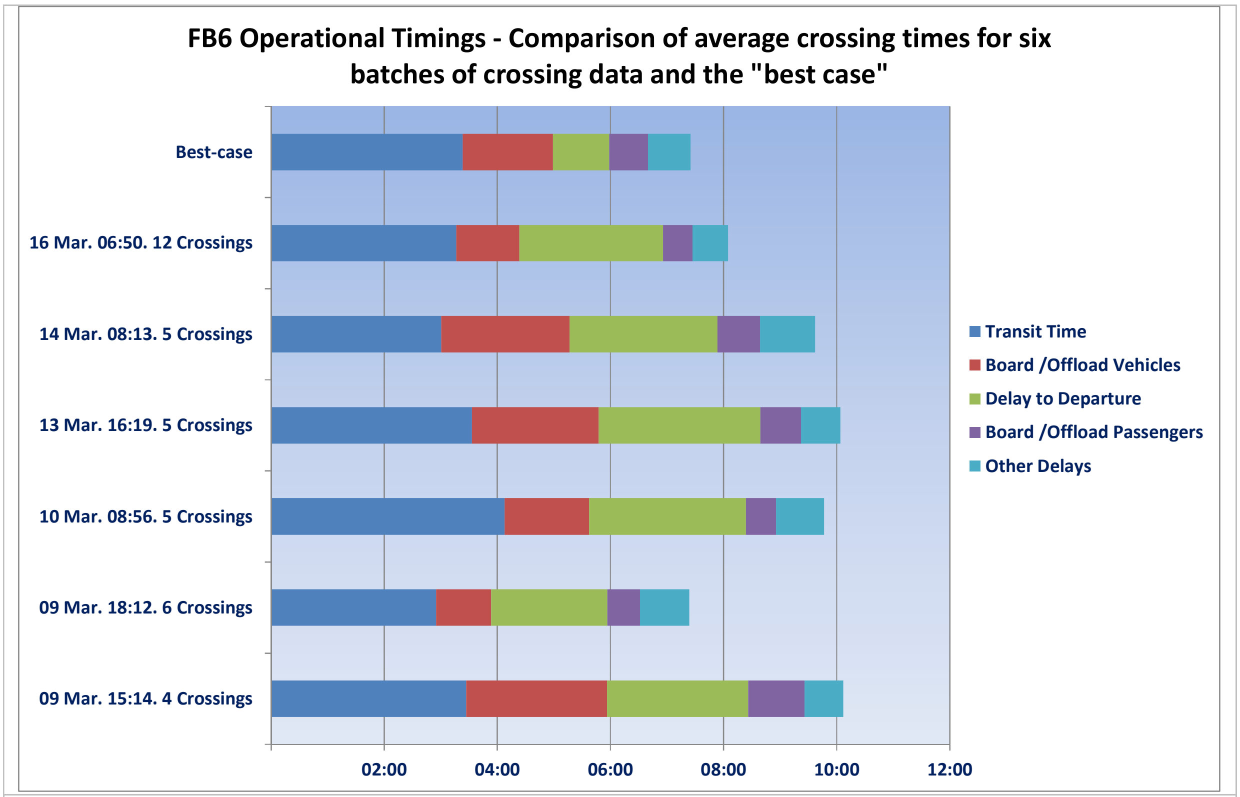
FB6 Operational Timings - Comparison of average crossing times for six batches of crossing data and the "best case"
Best-case
16 Mar. 06:50. 12 Crossings
14 Mar. 08:13. 5 Crossings
13 Mar. 16:19. 5 Crossings
10 Mar. 08:56. 5 Crossings
09 Mar. 18:12. 6 Crossings
09 Mar. 15:14. 4 Crossings
02:00
04:00
06:00
08:00
10:00
12:00
Transit Time
Board /Offload Vehicles
Delay to Departure
Board /Offload Passengers
Other Delays

Chart 5

Measure	FB6				FB5		Comments
	Current		"Best Case"		Estimated		
	Capacity	Average	Capacity	Average	Capacity	Average	
Vehicles carried	19	8	19	8	15	7	
Vehicle board /offload	03:48	01:36	03:48	01:36	03:00	01:24	12 seconds per car
Turnaround	00:23	00:23	00:23	00:23	00:23	00:23	Turnaround time is a characteristic of the approach road arrangements rather than the vessel
Passenger board /offload	00:41	00:41	00:41	00:41	00:41	00:41	Whilst boarding times will vary as a function of the number of passengers, average boarding times are also strongly influenced by the operating procedures which allow bunching of passengers on the slipway prior to boarding and on the vessel at the exit gate prior to offloading. Timings may have been longer on FB5 due to the tighter spacing, but perhaps not substantially so?
Delay to departure	02:30	02:30	01:00	01:00	00:30	00:30	This time would probably have been shorter on FB5 due to the shorter distance to the drivers cab?
Transit time	03:23	03:23	03:23	03:23	02:00	02:00	Based on measured averages for the current FB6 figures and small numbers of observations for FB5
Delay from completion of vehicle boarding to commencement of passenger boarding	00:11	00:11	00:11	00:11	00:11	00:11	Essentially the time for the first passenger to walk down the slipway from the waiting point to the loading ramp.
Delay from completion of passenger offloading to commencment of vehicle offloading	00:11	00:11	00:11	00:11	00:11	00:11	Essentially the time for the last passenger departing the loading ramp to clear the slipway.
Overall crossing time	**11:07**	**08:55**	**09:37**	**07:25**	**06:56**	**05:20**	
Crossings per hour	2.7	3.4	3.1	4.0	4.3	5.6	
Vehicles per hour	51	27	59	32	65	39	
Worst-case waiting time	22:14	17:50	19:14	14:50	13:52	10:40	
Worst-case time to destination	33:21	26:45	28:51	22:15	20:48	16:00	


Ferry Way
Poole, England
Google Street View
Jul 2019
See more dates
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OVER 3500 KGS GVW £9.00
+17 SEATS MAX 2 AXLES £9.00
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APPENDIX 6

Cost Benefit Analysis

Cost Benefit Analysis for the Deployment of an Additional Staff Position to improve FB6 Crossing Frequency

1 Client Requirement

IWC has instructed 3S to prepare a cost benefit analysis for the possible deployment of additional staff to improve FB6 crossing frequency.

Under current operating procedures there is a significant delay to departure once boarding of vehicles, cycles, and passengers is complete. This delay arises in large part because the Master stays on the vehicle deck until boarding is complete and then raises the loading ramp using the control panel adjacent to the ramp before walking up to the pilot house. IWC has requested that 3S undertakes a review to determine whether it would be beneficial to introduce an additional staff position such that the Master could remain at the pilot house at all times and be ready for an immediate departure from the slipway once boarding is complete. This would allow more crossings per hour to be operated with a potential increase in revenue. This report provides an assessment of the potential increase in revenue and whether that increase would justify the costs of introducing an additional staff position.

The report also considers the opportunities for changes to operating procedures which may offer a more cost effective solution to delivering additional revenue.

The report takes as its point of reference the FB6 Operations Review report produced by 3S dated 30 June 2023. As previously, the term “crossing time” refers to the overall duration for a single crossing between East Cowes and West Cowes or vice /versa. The term “crossings per hour” refers to the number of crossings per hour starting from either East Cowes or West Cowes. To clarify, a crossing time of 10 minutes would equate to 3 crossings per hour.

2 Current Operations

Chart 1 is based on the chart included in the earlier FB6 Operations Review report showing the delays to departure observed for each of the 37 crossings studied for the review. A dotted line has been added to highlight the minimum delay to departure:- 1 minute 13 seconds, (73 seconds).

Table 1 provides an extract of the data presented in the FB6 performance review which derived an average crossing frequency of 3.36 return crossings per hour under current operating procedures. The average delay to departure observed for the 37 crossings was 2 minutes 30 seconds.

Table 1 shows that the average crossing frequency can be improved from 3.36 to 3.93 if the delay to departure is set as the minimum observed time, (73 seconds). In principle there is no reason why all crossings cannot achieve the same, or a similar, delay time so this value of 73 seconds is used as the baseline in this report for any improvements calculated for the cost benefit analysis.

Table 2 provides a detailed breakdown of the 73 second delay to departure for the crossing in question. (The 09:00 departure from West Cowes on 14 March 2023). Note that the first phase of ramp raising is controlled by the rams acting around the deck hinge point while the second phase is controlled by the lifting chains.

3 Operations with the Master at the Pilot house throughout

The delay to departure could be reduced if the Master were at the pilot house when passenger boarding is complete. This could be achieved by introducing an additional staff position to undertake the duties currently performed by the Master on the vehicle deck, notably assisting with vehicle loading and taking responsibility for raising the loading ramp prior to departure using the control panel adjacent to the ramp.

On the basis that the additional staff position would be assuming some of the duties previously assigned to the Master it is assumed that this position would be appointed as a Floating Bridge Officer at Grade 6 – in common with the positions of Master and Mate.

It may be feasible to define the duties assigned to the additional Officer differently if safe working can be assured with the Master taking responsibility for raising the ramp prior to departure using the control panel in the pilot house[1]. If raising the ramp from the pilot house is deemed acceptable, the precise nature of the duties to be assigned to the additional Officer depends on the sightlines from the pilot house:-

a. If the sightlines from the pilot house are adequate for the Master to take the decision on when to raise the ramp then the duties of the additional Officer can be fully focused on assisting with operations on the vehicle deck.
b. If the sightlines are not sufficiently good then the duties would additionally include the responsibility to stand by the ramp and communicate to the pilot house that the ramp can safely be raised.

In either case the introduction of the additional Officer would allow the Master to remain at the pilot house throughout, (or to make short visits to the vehicle deck to carry out any necessary inspections, returning to the pilot house comfortably in advance of the completion of passenger loading).

If the Master were at the pilot house throughout then all preparations for departure could be completed well before passenger boarding is complete. With reference to table 2 the delay to departure after passenger boarding complete could, therefore, be reduced to 28 seconds if the vehicle gates were closed as the last passenger boarded. 28 seconds being the sum of:-

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[1] This should be consistent with the Master controlling the ramp from the pilot house on arrival, initially by partial lowering of the ramp approximately one minute out from the slipway and then with full lowering to allow offloading once docked?

The time to close the vehicle gates	12 seconds
The time to raise the ramp	14 seconds
The time between the vehicle gates being closed and commencement of ramp raising	2 seconds

Table 3 shows an alternative set of timings based on the vehicle gates being closed as soon as the last vehicle has boarded, (rather than waiting until all passengers have boarded). In this scenario the delay to departure could be reduced to the time to raise the ramp. In this case 14 seconds[2].

Pending review of the full findings of this report 20 seconds is proposed as a more cautious value for the delay to departure, likely to represent a reasonable average duration across the range of expected operating scenarios and not overly optimistic for use in a practical cost benefit analysis. A figure of 20 seconds also provides for closure of the vehicle gates to be delayed slightly to allow for any cyclists to complete boarding.

Table 4 shows the improvement in return crossings per hour from 3.93 to 4.44 which could be achieved by reducing the delay to departure to 20 seconds. i.e. an improvement of 0.51 crossings per hour.

4 Potential Additional Revenue

Table 5 shows three sets of figures for the annual numbers of vehicles and passengers:-

1. Estimated figures derived from the average loadings observed for the 37 crossings described above and using the business case concept of the core 12 hour period[3] as set out in the June 2023 FB6 Operations Review report.
2. Actual figures logged for the twelve months commencing May 2022
3. Actual figures logged for the twelve months commencing May 2022 adjusted to account for periods of less than 100% availability.

The estimates are slightly higher than the actual figures for both vehicles and passengers but, encouragingly, the values are in close agreement.

Table 6 provides an estimate of revenue earned by FB6 using the adjusted logged numbers for vehicles and passengers and with assumptions on the proportion of saver and non-saver fares collected.

Arguably the greater part of any increase in revenue as a consequence of operating more frequent crossings will result from an increased number of vehicles as it becomes more attractive to use the service. It is unlikely that passenger numbers will increase significantly

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[2] Prior to arrival at the slipway the ramp is partially lowered while FB6 is in motion. Whilst it would perhaps be feasible to depart from the slipway on completion of the 1st phase of the ramp raising – thereby saving time – this option has not been considered since it would require the Master to deal with events both fore and aft.

[3] The 21 Sep 2018 Final Business Case at page 51 presents defines at page 41 the "core 12 hour period".

from the established baseline, at least in the short-term. Hence the estimated increase in annual revenue from an average improvement of 0.51 crossings per hour against the current reference point of 3.36 crossings per hour can be calculated for vehicles as:-

£602092 x (0.51 /3.36) = **£91,389**

This calculation assumes that average loadings can be maintained. This should be a conservative assumption given that average loadings are likely to increase over time for a more frequent service.

5 The costs of introducing an additional staff position

The following referenced extracts from the Isle of Wight Pay Policy dated March 2023 have been taken account of in arriving at an estimated cost for introducing the additional Officer position.

1. The annual salary for the required grade 6 position ranges from £22,777 at point A through to £24,054 at point E[4].
2. Annual working hours are 1,633 per annum, full time equivalent[5].
3. Core hours are determined by managers according to the specific needs of the service and will cover a period of 14 hours between 6am and 10pm. Work carried out within core hours is paid at plain time rates unless specified otherwise[6].
4. Pension contributions. As scheme members, employees pay contributions and the council pays in the balance of the cost of providing accrued benefits after taking into account investment returns. Every three years, an independent actuary calculates how much the council should contribute to the scheme. The amount will vary, but the current level of contribution made by the council is 23.5 per cent[7].
5. Shift Allowance. Plain time rates only apply to shifts whose start and finish times fall within designated core hours for the service[8].

Table 7 provides a cost estimate using the above guidance for the Grade 6 salary mid-point C and based on two-shift working for 365 days per annum.

The calculation derives an hourly effective rate based on the sum of the salary, pension, and employer’s NI costs apportioned over the FTE 1633 hours per annum. This rate is then applied to the two-shift working pattern which equates to 4380 working hours per annum. (The two shifts being 07:00 to 13:00 and 13:00 to 19:00 each day as advised by IWC).

The total additional annual cost is estimated at **£85,415**.

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[4] Ref Appendix A
[5] Ref Section 5.2
[6] Ref Section 5.2.
[7] Ref Section 5.17
[8] Ref Section 8.4

This assessment assumes the additional post is added to the FB6 Officer pool so no additional provisions need to be made for training, sickness, and absence.

6 An alternative scenario under modified operational procedures

If safe operating practice allows the ramp to be raised from the pilot house prior to departure then consideration should be given to modifying the current operating procedures and changing the duties assigned to the Master.

Currently the Master leaves the pilot house after arrival at the slipway and descends to the car deck to assist with vehicle unloading and unloading. This element of the procedure would remain.

Rather than waiting until all boarding is complete the Master could return to the pilot house on completion of vehicle boarding and prepare for departure. Having prepared for departure he would then be in a position to raise the ramp if passenger boarding had been completed by that point – or wait the short time until boarding was complete.

If the sightlines from the pilot house are not good enough to allow the ramp to be raised safely by the Master in isolation it would be necessary for the Mate to attend at the ramp for a short period of time following completion of boarding and to communicate with the pilot house to advise when the ramp can be raised.

Table 8 sets out the results from this possible alternative approach using the same durations presented in Table 2 for the elements which have to be considered in arriving at an overall delay to departure. The results are shown as a set of notional times which would have been logged had this procedure been adopted for the crossing in question:-

- The Master departs for the pilot house at 08:58:18 on completion of vehicle boarding
- While en route the vehicle gates are closed and passenger boarding commences
- Having taken 28 seconds to walk to the pilot house the Master takes a further 10 seconds to prepare for departure.
- For this sample crossing, by the time the Master has prepared for departure all passengers have boarded – by 08:58:47, taking 17 seconds to do so.
- Having checked boarding is complete the Master raises the ramp which takes 14 seconds
- FB6 is then ready to depart at 08:59:10.

The delay to departure once passenger boarding is complete for this sample crossing is 23 seconds. If the average duration of circa 20 seconds were used instead[9] the delay to departure once passenger boarding is complete would reduce to 20 seconds.

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[9] Ref table 1.

7 Conclusions

Scenario 1. The introduction of an additional Officer position to improve crossing frequency

- Under this scenario annual revenue increases to circa £91k but additional costs of circa £86k are incurred. This equates to a benefit cost ratio, (BCR), of 1.07.
- The expected BCR is not sufficiently attractive to recommend the introduction of an additional Officer post[10].

Scenario 2. Changes to the duties assigned to the Master

- If it is feasible to control raising of the ramp prior to departure from the pilot house then changes to the duties assigned to the Master as set out in section 6 above would deliver a reduction in the delay to departure similar to that achieved under scenario 1 above.
- To achieve the improved delay to departure time may require a small amount of time to be devoted by the Mate to raising the ramp - depending on the sightlines from the pilot house.
- Appendix 1 contains a set of three photographs taken from the upper passenger deck of FB6. The photographs looking east and west were taken from positions on the guard rail as close to the pilot house as possible. The actual sightlines from the pilot house will be better since the pilot house extends out over the car deck but the photographs nevertheless provide a useful view of the conditions under which the Master operates.
- If this scenario 2 can be implemented then similar improvements in annual revenue to those which could be achieved under scenario 1 could be expected; without the costs incurred by introducing an additional Officer post.

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[10] It may be that the additional; post could be introduced at a lower salary point than grade 6. However, even with a grade 1 point A salary the BCR only improves to 1.21.

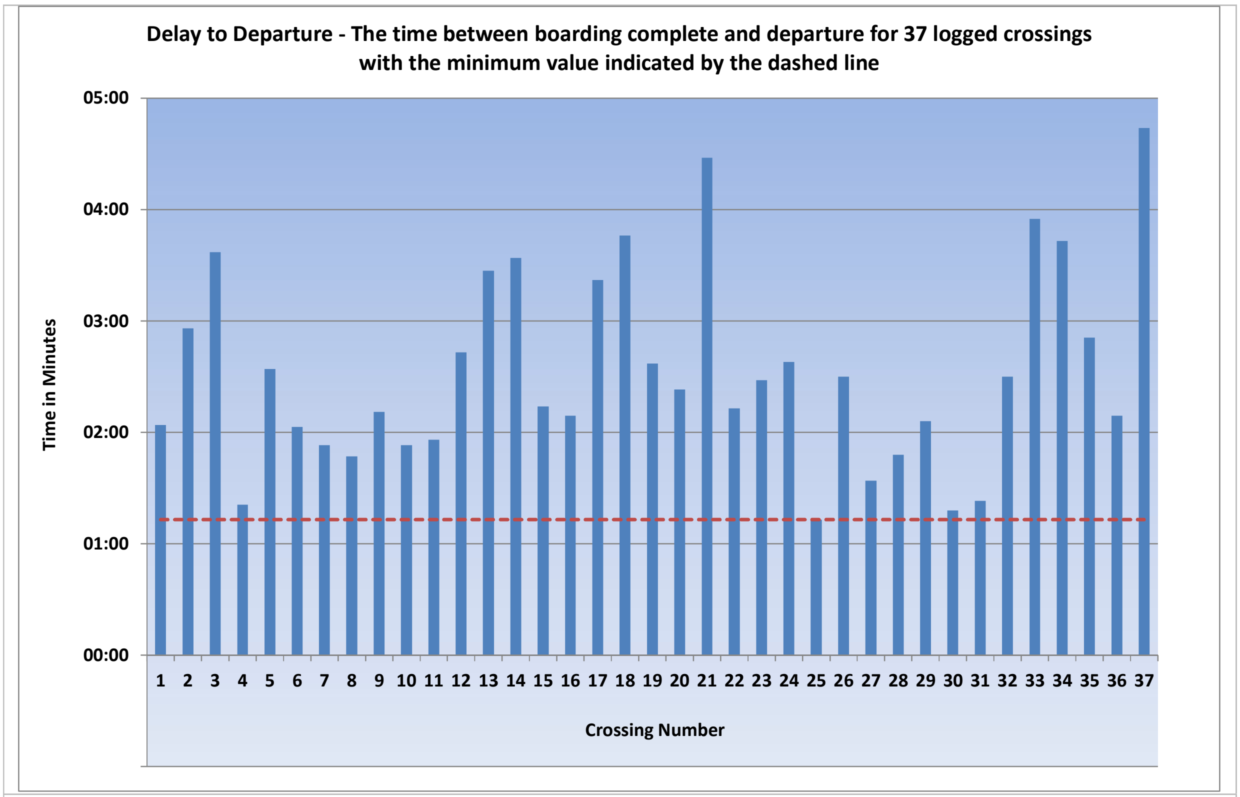


Chart 1 Delay to departure under current operations

Measure	Units		Average Values	
			Current	Best-case
Vehicles carried	Number		8	8
Vehicle board /offload	Seconds		96	96
Turnaround	Seconds		23	23
Passenger board /offload	Seconds		41	41
Delay to departure	Seconds		150	73
Transit	Seconds		203	203
Delay vehicle board to passenger board	Seconds		11	11
Delay passenger offload to vehicle offload	Seconds		11	11
Total	**Seconds**		**535**	**458**
Overall crossing time	Minutes		08:55	07:38
Crossings /hour	**Number**		**3.36**	**3.93**

Table 1 Crossings per hour under current operations

Event		**Time**	**Durations**		
Board Vehicles	Start	08:57:38			
	End	08:58:18		00:00:12	
Board Passengers	Start	08:58:30	*00:00:17*		
	End	08:58:47		00:00:07	00:01:13
Vehicle gates close	Start	08:58:54	00:00:12		
	End	08:59:06		00:00:02	
Ramp raise	Start	08:59:08	00:00:14		
	1st phase end	08:59:15			
	2nd phase end	08:59:22			
Master walks to pilot house	Start	08:59:22	00:00:28		
	End	08:59:50			
Prepare to depart	Start	08:59:50	00:00:10		
	End	09:00:00			
Depart		09:00:00			

Table 2 Detailed breakdown of the minimum observed delay to departure

Event		**Equivalent Times**			**Duration**
Board Vehicles	Start	08:57:38			
	End	08:58:18			
Vehicle gates close	Start		08:58:18		
	End		08:58:30		
Board passengers	Start			08:58:30	
	End			08:58:47	00:00:14
Ramp raise	Start			08:58:47	
	1st phase end			08:58:54	
	2nd phase end			08:59:01	
Depart				08:59:01	

Table 3 Breakdown of the delay to departure if the Master were at the pilot house throughout

Measure	Units	Average Values			
		Current	Best-case	Target	Improvement
Vehicles carried	Number	8	8	8	
Vehicle board /offload	Seconds	96	96	96	
Turnaround	Seconds	23	23	23	
Passenger board /offload	Seconds	41	41	41	
Delay to departure	Seconds	150	73	20	
Transit	Seconds	203	203	203	
Delay vehicle board to passenger board	Seconds	11	11	11	
Delay passenger offload to vehicle offload	Seconds	11	11	11	
Total	**Seconds**	**535**	**458**	**405**	
Overall crossing time	Minutes	08:55	07:38	06:45	
Crossings /hour	**Number**	**3.36**	**3.93**	**4.44**	**0.51**

Table 4 Crossing frequency improvement with a 20 seconds delay to departure value

Class	Estimated values based on FB6 Performance Review				Logged totals	Adjusted Logged totals
	Average Loading	Return Crossings per hour	Operating Hours	Estimated annual totals		
Vehicles	8	3.36	12	235469	226000	231574
Passengers	11			323770	304000	312260

Table 5 Vehicle and passenger loadings

Fares						
Car	Saver	£2.50				
	Non-saver	£3.00				
Passenger	Saver	£0.50				
	Non-saver	£1.00				
Class	Logged Annual Totals		Saver	Non-Saver	Weighted Fare	Annual Revenue
Vehicle	231574		80%	20%	£2.60	£602,092
Passenger	304000		80%	20%	£0.60	£182,400
						£784,492

Table 6 Estimated annual revenue with 80% of fares being saver fares

Employment Costs					FTE Hours	Hourly cost	Hours required	Total cost
Position	Salary	Pension	NI	Total				
		23.5%	13.8%					
Grade 6	£24,054	£5,653	£3,319	£33,026	1633	£20.22	4,380	**£88,582**

Table 7 Additional costs

Event		Equivalent Times				Duration
Board Vehicles	Start	08:57:38				
	End	08:58:18				
Master departs for pilot house					08:58:18	
Vehicle gates close	Start		08:58:18			
	End		08:58:30			
Board passengers	Start			08:58:30		
	End			08:58:47		00:00:23
Master arrives at pilot house					08:58:46	
Prepare to depart	Start				08:58:46	
	End				08:58:56	
Ramp raise	Start			08:58:56		
	1st phase end			08:59:03		
	2nd phase end			08:59:10		
Depart				08:59:10		

Table 8 An alternative operations scenario

Appendix 1 Photographs from the upper passenger deck on FB6

Photo 1 Pilot House

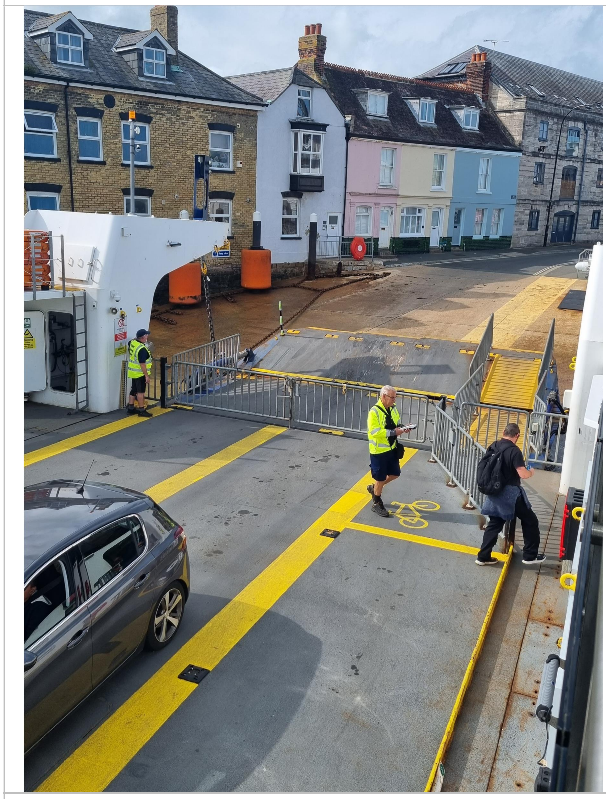


Photo 2 Looking West

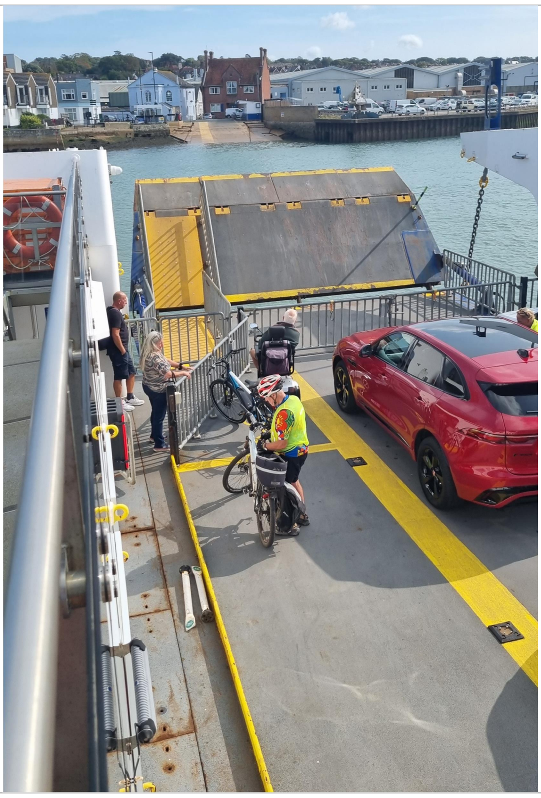


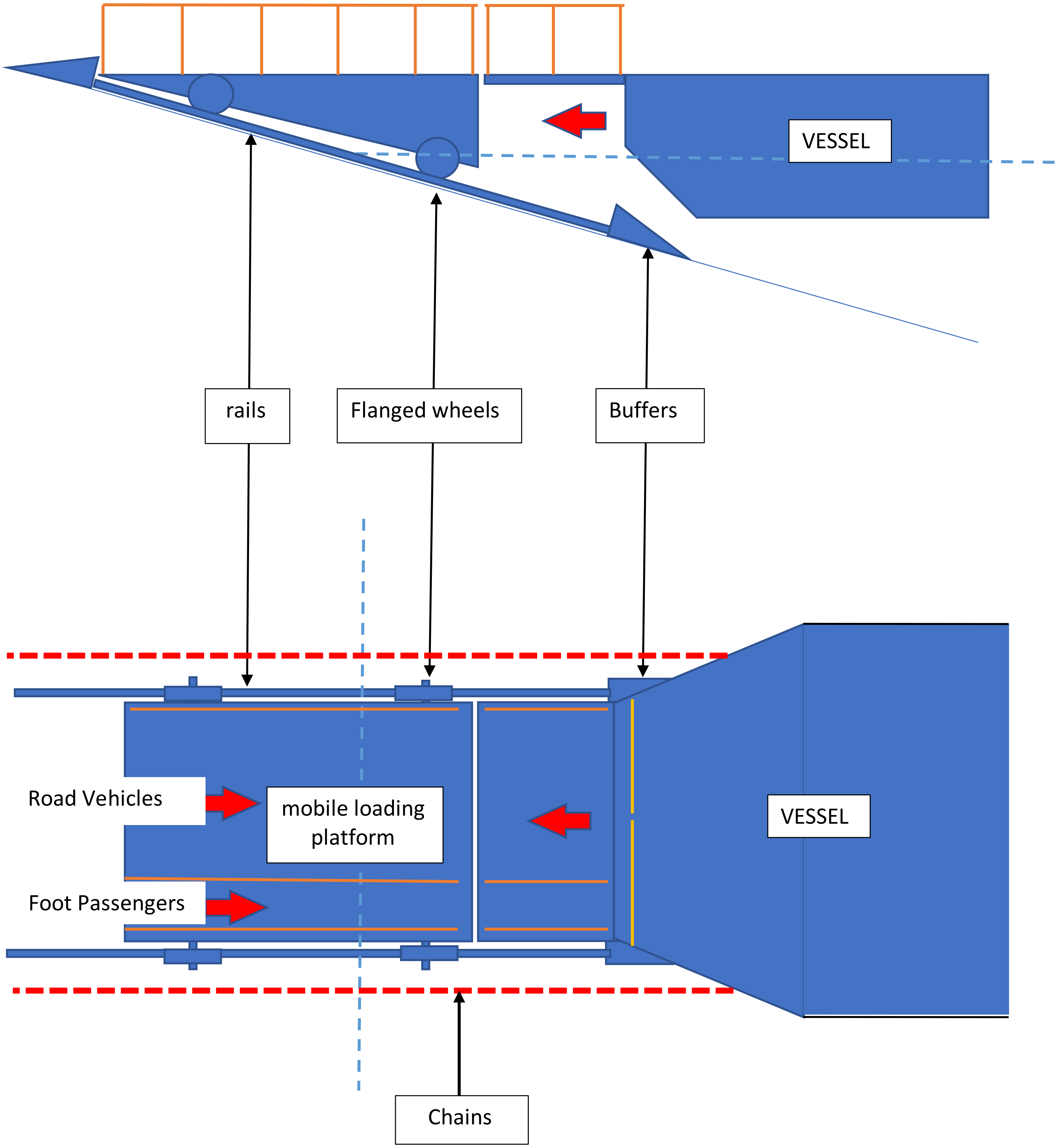
Photo 3 Looking East

APPENDIX 7

“Funicular” Loading Platform

FB7 - POSSIBLE INNOVATIVE DOCKING ARRANGEMENT

General arrangement sketch



APPENDIX 8

Conventional Procurement Strategies for FB7

Appendix 8a

Principles for purchase of new vessel by IWC

Appendix 8b

Illustrative procurement timeline for purchase of a new vessel by IWC

Floating Bridge 7 Procurement

A. PURPOSE

This paper sets out a proposed high-level strategy for the procurement of a new floating bridge, (FB7), prepared against the background of continuous operational and maintenance problems experienced with FB6, on the premise that the replacement of FB6 represents the only cost-effective long-term solution.

B. ASSUMPTIONS

- A chain ferry must continue to operate between Cowes and East Cowes as an integral part of a thriving local economy, serving the needs both of local businesses and residents.

- FB7 will feature a fully electrified drive train, probably powered by high-capacity batteries. Electric drive technology has advanced rapidly since commencement of design of FB6 and provides the most attractive and cost-effective option in terms of motive power, fuel efficiency, reliability, and routine maintenance requirements.

C. FORM OF CONTRACT

Many of the problems that have arisen with FB6 can be traced back to a procurement strategy within which both the Designer and Builder were contracted under separate agreements, thereby giving rise to potential confusion of responsibilities that left considerable risk with IWC. In addition, IWC prescribed hardware characteristics that further compromised contractor accountability.

Accordingly, it is proposed that FB7 should be procured via a single design/build contract that places sole accountability for delivery on one contractor based upon a client specification that sets out only the client’s minimum performance requirements. Such an approach is essential to avoid compromising contractor responsibilities, and to best protect IWC in the event problems materialise when FB7 is commissioned into service.

It is envisaged that standard IWC contract procedures will be followed, with tenders invited from a prequalified list of financially robust and technically competent organisations. It is recommended that as part of the prequalification process potential contractors be invited to submit their detailed assessments of the underlying causes of the problems experienced with FB6, and to compare and evaluate the different operating experience of FB5 and FB6, stating their conclusions. This process will allow IWC greater confidence in its identification of contractors best able to deliver FB7 to specification, time and budget.

D. PERFORMANCE SPECIFICATION

The performance specification will set out the key operational requirements to be met by FB7. In this, the fundamental requirement is the total daily number of available vehicle and foot passenger movements between Cowes and East Cowes.

The contract specification for FB6 prescribed the vessel's physical carrying capacity for vehicles and foot passengers. The specified capacity required a significant increase in the longitudinal underwater profile of the vessel compared to FB5, thereby creating increased drag which compromised the operator's ability to maintain adequate depth of water over the chains in all tidal conditions. This has, in turn, necessitated the deployment of a push boat during extreme monthly tidal flows.

It is therefore proposed that the performance specification for FB7 should focus on the available capacity of the chain ferry system over a daily operating cycle, rather than the physical capacity of the vessel, including its ability to provide an adequate service at periods of peak demand. Temporal capacity will reflect the efficiency with which vehicles can be loaded and unloaded, and the vessel's average transit time. This will permit compliant offers for the delivery of smaller, lighter vessels able to satisfy capacity requirements within the range of tidal conditions at the operating location. Operations can then be optimised to meet demand through the day by increasing crossing frequency at peak times.

It is recommended that a localised, time-limited hydraulic survey be commissioned by IWC to provide bidders with broadly representative data as to the general range of conditions to be expected in operating a chain ferry at this location on the River Medina. The results of this survey will be provided as part of the Request For Proposals process, and the successful contractor will be required either adopt the survey at his own risk, or commission his own survey for his design of FB7.

Bidders will also be required to define and price any civil work to ramps and chain pits, if any, that it deems necessary in order to permit consistently successful landings and the avoidance of groundings in unexceptional conditions.

Table 1 sets out a number of topics which must be addressed in the composition of a full set of operational requirements. The list proposed is deliberately non-exhaustive on the understanding that an agreed set of quantified requirements will be produced as an early first step in the procurement process, ideally by consulting with a wide range of stakeholders.

Table 1 also sets out some of the secondary constraints, (those beyond the primary constraint addressed above relating to tidal conditions), which must be allowed for in the final design.

Balancing requirements and constraints is critical to overall success. Once the successful contractor has arrived at a conceptual design it will be possible to define the number of vehicles carried per crossing. This will dictate the optimum frequency of operation to meet the expected demand. However this frequency may have to be reduced at certain times to deliver minimum disruption to other river traffic. On the other hand, inadequate frequency may result in unacceptable queuing times on the approach roads. Clearly consultation will be required once the contractor's conceptual design is complete to in order to define and agree the optimum solution.

E. OPERATION AND MAINTENANCE

Bidders will be required to:

- provide full training for the operation and routine maintenance of the vessel and ancillary supporting systems.
- quantify and price all special maintenance tools and equipment and minimum spares holdings necessary for three years operation from date of delivery.
- provide a three-year routine maintenance schedule and state approximate intervals for the replacement and refurbishment of main components, stating current replacement costs

F. PROGRAMME

Agreement must be reached on a target programme date for entry into service for incorporation in the prequalification invitation. An early assessment of schedule risks must be undertaken, (making use of experience gained with the procurement of FB6), to allow key dates to be advertised to the general public with a high level of confidence that they can be achieved or bettered.

Table 1. Requirements and Constraints:- Topics for Consideration

Requirements	Constraints
Environmental	
Noise reduction	
Carbon emissions reduction	
Energy efficiency improvements	
Finance	
Ticketing systems & pricing	Source of funding /affordability
Advertising opportunities	
People Management /Health & Safety	
Incorporation of the relevant standards for chain ferry design and operation	
Staffing levels optimisation	Separation of foot passengers and vehicles
	Comfortable accommodation for foot passengers
Operations	
Vehicles carried per day	Impact on other river traffic
Foot passengers carried per day	Impact on highways traffic
Operating hours	
Crossing times	
Waiting times	
Maximum vehicle size /weight	
Maintenance scheduling	
Spares holding	
Minimum vehicle approach and departure angles at extreme tidal conditions	
Technical	
Electrical systems definition. (Including, as appropriate battery sizing and charging cycle assessment)	

Illustrative procurement timeline for purchase of a new vessel by IWC

Task	Start	End	Months																																						
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Form executive steering group	1	1	🟥																																						
Appoint procurement advisors (3S)	1	1	🟥																																						
Appoint Project Team	1	1	🟥																																						
Interpret procurement regulations for major capital purchase	1	2	🟥	🟥																																					
Define procurement strategy and general process	2	3		🟥	🟥																																				
Identify requirements for external technical advice and appoint advisors	2	3		🟥	🟥																																				
Prepare outline budget for internal and external supply costs	3	4			🟥	🟥																																			
Prepare procurement plan and detailed timeline	3	4			🟥	🟥																																			
Prepare schedule of key performance criteria	3	6			🟥	🟥	🟥	🟥																																	
Prepare Performance specification	4	7				🟥	🟥	🟥	🟥																																
Updated business case review and sign-off	7	8							🟥	🟥																															
Prepare pre-qualification criteria for FB7 design/build companies	7	9							🟥	🟥	🟥																														
Advertise for or approach potential FB7 design/build companies	7	9							🟥	🟥	🟥																														
Advertise or approach suppliers of key sub-systems for FB7 (e.g. electric drives)	7	9							🟥	🟥	🟥																														
Commission limited hydraulic survey of tidal flow at operating site	7	9							🟥	🟥	🟥																														
Interview and appraise potential suppliers of identified critical sub-systems	7	9							🟥	🟥	🟥																														
Prepare prequalification invitation for design/build contractors	7	9							🟥	🟥	🟥																														
Prepare terms and conditions for design and supply of FB7	7	9							🟥	🟥	🟥																														
Issue prequalification invitations and receive responses and select potential bidders	10	11										🟥	🟥																												
Prepare RFP including hydrological data and nominated potential suppliers.	9	11									🟥	🟥	🟥																												
Receive and evaluate bids	11	13											🟥	🟥	🟥																										
Request additional data from short listed contractors (incl. computer models)	13	15													🟥	🟥	🟥																								
Negotiate design build/contract	15	16															🟥	🟥																							
Conceptual design	16	19																🟥	🟥	🟥	🟥																				
Conceptual design review and approval	17	20																	🟥	🟥	🟥	🟥																			
Detailed design	20	25																			🟥	🟥	🟥	🟥	🟥	🟥															
Detailed design review and approval	21	27																				🟥	🟥	🟥	🟥	🟥	🟥	🟥													
Build	27	35																										🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥	🟥					
Deliver and Commission	35	37																																	🟥	🟥	🟥				
Trial running, operator training, initial operations	37	40																																			🟥	🟥	🟥	🟥
Final handover	40	40																																						🟥

APPENDIX 9

Lease of vessel or sale of a license to design build own and operate (DBOO)

Cowes Floating Bridge

Design, Build, Own, Operate (DBOO) Procurement Model

General principles

Prospective Licensees will tender for payment of a fixed basic fee for provision by the Isle of Wight Council (the Licensor) of a licence to operate a replacement vessel, (FB7), of the Licensee's design, supply, ownership and operation for a pre-defined period, according to a performance specification defined by Isle of Wight Council.

The Licensee's responsibility will, at his own cost, include the supply or procurement and maintenance of all shore facilities required for the operation of the service and, in the event of electrification, shore distribution and/or battery charging facilities.

IWC 's objective is to transfer the responsibility, cost and risk of operating the service to the private sector without incurring the loss of control and profiteering often associated with the privatisation of public services.

In this model, IWC therefore prescribes the service frequency, fare structure, maximum fares and operating requirements it believes necessary to best serve the public and local economy, and the Licensee bids to operate the system within these constraints in return for a licence fee.

Thereafter, it is in the Licensee's interest to maximise the attractiveness and availability of the service in order to build revenues, recognising that consumers can alternatively drive to Cowes, thereby negating monopoly pricing and encouraging the Licensee to reduce price to a level that maximises overall revenue.

However, should the Licensee succeed in building revenues to unforeseen levels, an 'anti-embarrassment' provision enables IWC to share in this commercial success.

A major benefit of this model to IWC is that the compensation previously secured in respect of the under-performance of FB6 can be largely retained, together with the resale value of FB6, which could operate quite successfully in a less tidal environment, bearing in mind the very many cable and chain ferries operated around the World.

(See attached list of currently operating cable and chain ferries)

A. Bidding Process

The bidding process will be in two phases:

1. Prequalification to bid for the Design, Build, Ownership and Operation of Floating Bridge 7
    - Applications for prequalification to be based upon a draft performance specification and contract structure
    - Adjudication will consider applicants' relevant capability and financial status
2. Firm priced bids against a final performance specification and contract structure
    - IWC will offer a licence to operate FB7 for 25 years.
    - Bidders must offer a compliant main bid, and may also offer additional, alternative non-compliant bids
    - Alternative bids may, for example, propose variations to
        - Licence period
        - Performance criteria
        - Commercial terms
    - For fully compliant bids, financial adjudication will focus firstly on the licence fee offered by the Bidder (subject only for adjustment for inflation according to a formula set out in the enquiry).
    - IWC will not be bound to accept the highest license fee, or any bid.

B. Performance and operational specification

IWC will prescribe only key characteristics and operating criteria, rather than vessel dimensions, constructional materials or technical specifications.

The Performance Specification will prescribe:

1. **Service requirements**

- Annual availability (maximum number of daily cycles lost due to outages for repairs, surveys, approvals and routine maintenance)
- Service Hours per day
- Minimum number of return crossings per hour
- Minimum number of return crossings within a daily operating cycle
- Maximum return journey cycle time
- Vessel capacity (minimum number of vehicles and foot passengers)
- Maximum vehicular access constraints (approach and departure angles)

2. **Environmental criteria**

- Maximum permitted noise level
- Maximum permitted daily emissions

3. **Safety requirements**

- Minimum clearance over chains at specified states of the tide
- Easy passenger egress from vehicles in emergency conditions
- Physical segregation of vehicles and foot passengers

4. **Fare structure and fare levels**
   IWC will specify fare structure, and maximum fares to be charged for vehicles and foot passengers during the first 12 months of operation, thereby freeing the licensee free to reduce fare levels in order to increase demand to the point where and overall revenues are maximised.

   Thereafter, at each anniversary, fares may be adjusted for inflation to the maximum calculated by application of an agreed formula reflecting national inflation indices.

5. **Required Availability**

- **Operating hours**
- Mon - Sat = 5am until 12.30am = 19.5 hours a day
  Sun = 6.30am until 12.30am = 18 hours a day
  Average number hours per day = 19.29 hours

- **Service requirement** 6 return journeys per hour

- **Routine annual servicing outages maximum of** 15 days per annum

C. Parties obligations and responsibilities

1. Licensee's responsibilities

The Licensee will:

- Validate and adopt at his sole risk all criteria specified and information supplied by IWC for incorporation in his design of a vessel fit for the intended purpose and duty.

- Validate and adopt at his sole risk all environmental and climatic data obtained from third party sources or agencies.

- Validate and adopt at his sole risk all statistical information supplied by IWC concerning the patronage and revenues achieved by the existing and previous vessels.

- Accept full responsibility for any and all changes in operating conditions and other circumstances impacting achievement of performance criteria

- On or before commencement of commissioning of the vessel the Licensee will:

    - accept the transfer of all IWC operational personnel according to the Transfer of Undertakings (Protection of Employment) Regulations (TUPE) in order to protect employees against any loss of rights and benefits by reason of their transfer.

    - employ or compensate former IWC employees in accordance with TUPE regulations.

2. IWC's responsibilities

IWC will have no ongoing obligations to the licensee for the operation of the facility

D. Breach of terms of licence

1. Non-critical breaches

In the event of temporary failure to achieve non-critical contracted performance criteria during any daily operating cycle the Licensee will pay prescribed penalties to IWC.

Non-critical failures will include temporary reductions in:

- frequency
- capacity
- availability

Provided that the Licensee will be excused service interruptions resulting from agreed instances of Force Majeure.

2. Critical breaches

In the event of failure to achieve critical performance criteria the service will be suspended pending resolution, and the Licensee will pay contracted penalties for each day the service is not available.

The Licensee will also make his best endeavours to provide at his own cost adequate alternative facilities for foot passengers at no greater fare.

Critical failures will include non-achievement of:

- Environmental criteria (e.g. emissions, noise)
- Safety standards (in contravention of specified criteria or statutory regulations)
- Minimum chain depth
- Safety criteria

3. Fundamental Breach

In the event the Licensee fails to resolve non-critical or critical failures within a period of, say, 90 days, IWC will have the right to serve notice of termination.

In this event the Licensee will pay liquidated damages for breach for each day the service remains unavailable pending re-commencement of a compliant service by IWC or another Licensee appointed by IWC.

E. Calculation of Licence Fee

The Licensee will propose a fixed annual license fee based on his sole assessment of:

- Capital costs
- Servicing and maintenance costs
- Operating costs
- Revenue secured from vehicle and passenger traffic at contracted fare levels
- Environmental and operating conditions.
- Any and all contingent risks, costs and liabilities

Plus, the Licensee’s requirement for Overhead and Profit.

IWC will provide any requested and available historical cost and revenue statistics in his possession, and free access to the provider of any Computerised Fluid Dynamics models, but the validity and interpretation of this information and any predictions as to increases in passenger demand will be at the sole risk of the Licensee.

The License Fee will be adjusted annually for inflation coincident and commensurate with formulaic adjustments to fare levels.

F. Anti-embarrassment provision

In the event that annual revenues in any year exceed an agreed threshold level, for each increment of annual revenue in excess of this level the Licensee shall pay IWC a supplemental fee equal to the percentage increase of Actual Revenue over Threshold Revenue x Annual Licence Fee x an agreed uplift factor, adjusted for inflation incurred since date of contract by reference to the fares escalation formula. i.e. (ignoring cost escalation).

$$\frac{AR - PR}{PR} \times 100 \times AF \times UF$$

Where
AR = Actual Revenue
PR = Prescribed Threshold Revenue
AF = Annual Licence Fee
UF = Uplift Factor

To the extent the Uplift Factor is less than 1, the Licensee has additional incentive to grow revenues.

Worked example:
AR = £2,000k
PR = £1,000k
AF = £200k
UF = 0.5

$$\text{Supplemental Fee} = \frac{\text{£}2000\text{k} - \text{£}1000\text{k}}{\text{£}1000\text{k}} \times \text{£}200\text{k} \times 0.5 = \text{£}100\text{k}$$

So, in this example the total License Fee payable for the year in question would be £300k.

In the event that, in any one year, AR is equal to or less than PR, the Licensee receives for that year only the contracted basic fee plus calculated inflation.

G. Revenue model

An indicative estimate of annual revenue has been prepared based in traffic recorded in the previous Floating Bridge from 2011 to 2016 in order to avoid accounting and correcting for disruption and consequent adverse impact of traffic between 2017 and 2023 resulting from technical issues and the pandemic.

Comparison of the average 2011 – 2016 traffic recorded in Appendix 2 with the histogram for May 2022 to May 2023 in Appendix 1 suggests a reduction of around 33% in vehicles carried from around 330,000 in 2011 to 2016 to around 220,000 in 2022/23.

Accordingly, the total annual revenue calculated in Appendix 5 reasonably assumes that, given also the general increase in traffic levels since 2016, revenues can be rebuilt to previous 2011-2016 levels.

On this basis the ongoing annual revenue of around £1,000 000 predicted in Appendix 5 might be considered both achievable and robust.

It will nevertheless be the sole responsibility of the Bidder to assess the traffic levels and revenue to be reflected in his bid.

The indicative ongoing revenue calculation, parameters and data base are contained in the following Appendices.

Appendix 1
FB6 Traffic from May 2022 to May 2023

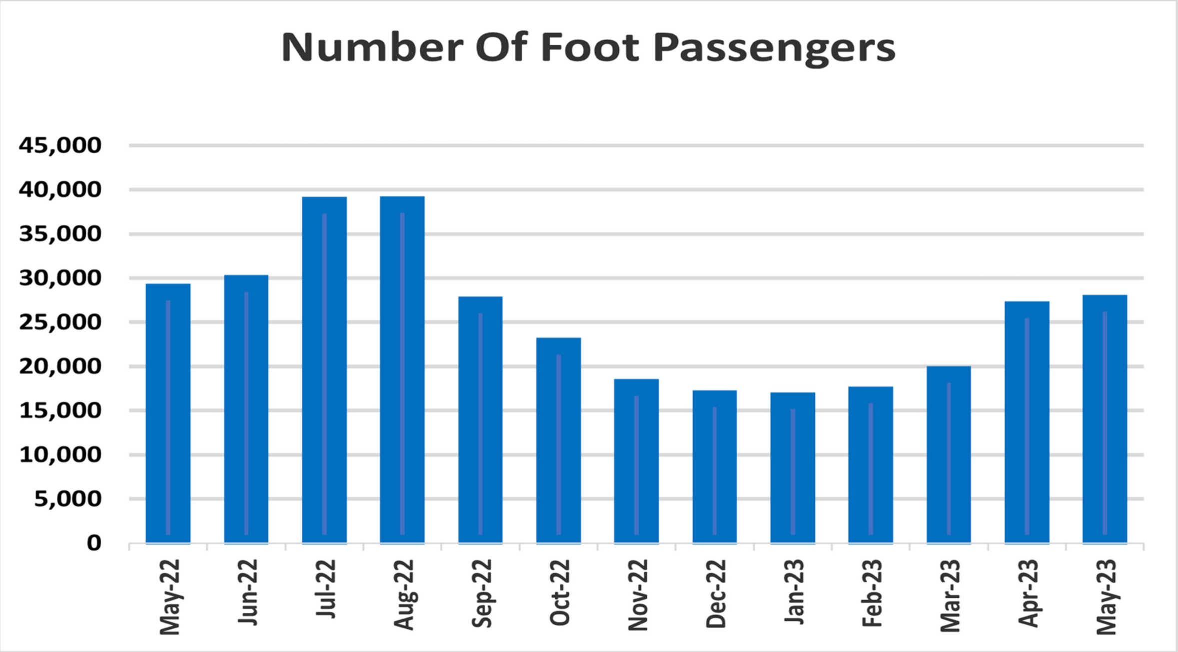
Appendix 2
FB5 Traffic for years 2011 to 2016

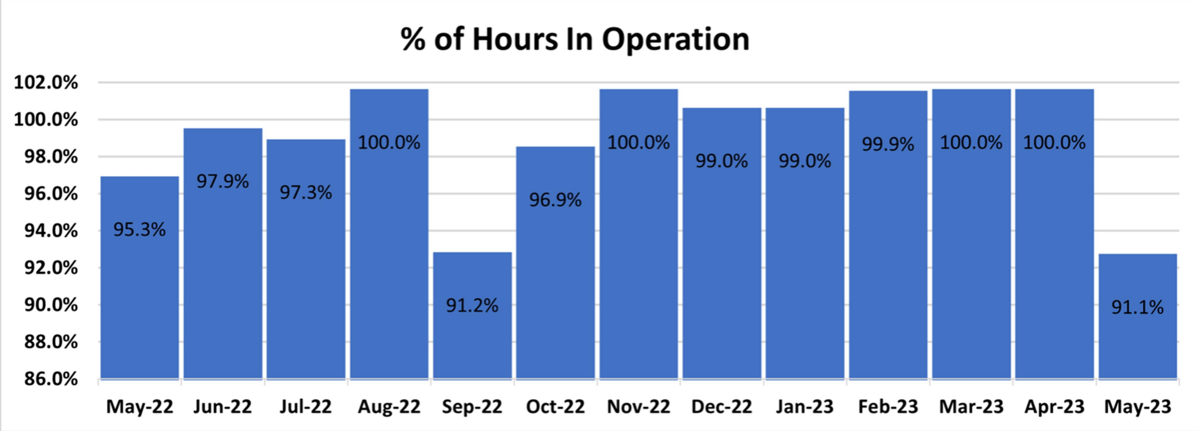
Appendix 3
Impact of fare increases in demand and overall revenue 2006 to 2016

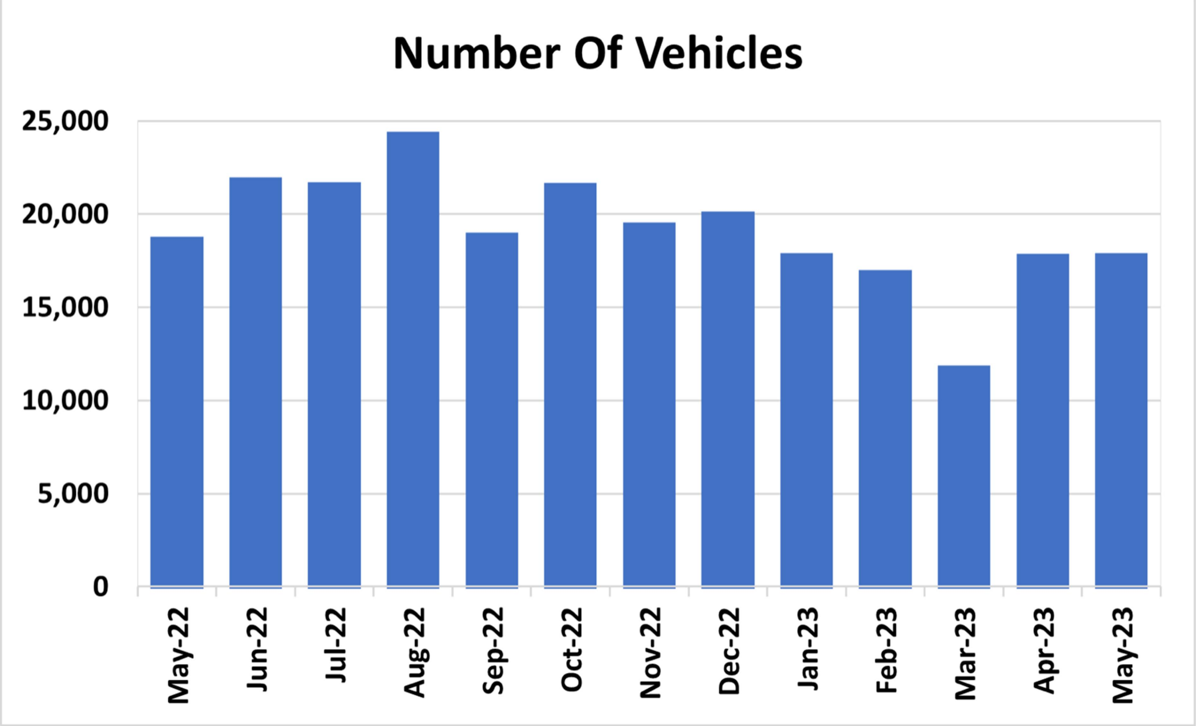
Appendix 4
Present (2023) fare structure

Appendix 5
Indicative annual revenue calculation based on 2011 – 2016 traffic and 2023 fares

APPENDIX 1 FB6 Statistics May 2022 to May 2023







Appendix 2 - FB5 Traffic for years 2011 to 2016

Month	Cars	Disabled	Lorries	Lorries + trailer	Motorbikes	Large vans	Free travel
Jan-11	16507	408	9	0	174	1550	366
Feb	22383	669	20	0	252	2068	485
Mar	22041	519	16	0	331	2382	396
Apr	11497	50	5	0	208	893	65
May	26652	103	21	0	483	2432	176
Jun	30375	102	16	0	545	2837	240
Jul	30813	87	11	3	467	2618	257
Aug	31529	61	24	0	718	2738	184
Sep	27985	74	11	1	528	2580	262
Oct	27292	70	7	2	352	2320	235
Nov	22780	43	15	4	226	2540	189
Dec	23337	46	26	3	193	2120	207
Total	293191	2232	181	13	4477	27078	3062

Month	Cars	Disabled	Lorries	Lorries + trailer	Motorbikes	Large vans	Free travel
Jan-12	22047	22	17	4	225	2319	217
Feb	21711	35	20	1	214	2335	161
Mar	14985	14	27	1	193	1421	121
Apr	24852	33	18	2	252	2115	126
May	23771	35	23	2	324	2390	145
Jun	29736	55	18	1	456	2715	199
Jul	28465	30	17	4	427	2568	195
Aug	29902	20	15	6	586	2527	161
Sep	29369	26	14	2	473	2337	180
Oct	27979	30	31	2	303	2270	164
Nov	24840	36	24	2	311	2144	197
Dec	23557	24	28	3	195	1755	182
Total	301214	360	252	30	3959	26896	2048

Month	Cars	Disabled	Lorries	Lorries + trailer	Motorbikes	Large vans	Free travel
Jan-13	19538	22	20	3	162	1659	206
Feb	20943	20	14	2	165	1781	251
Mar	30515	19	19	2	217	2581	255
Apr	17141	5	12	3	167	1246	155
May	27601	22	18	1	420	1972	213
Jun	26955	11	20	3	470	2157	194
Jul	30114	24	17	7	387	2247	260
Aug	30958	20	22	5	706	2319	233
Sep	27886	18	25	2	307	2136	227
Oct	27157	15	22	3	234	2066	250
Nov	22910	17	22	3	166	1863	264
Dec	21409	9	13	9	197	1507	217
Total	303127	202	224	43	3598	23534	2725

Month	Cars	Disabled	Lorries	Lorries + trailer	Motorbikes	Large vans	Free travel
Jan-14	19456	10	18	4	178	1620	246
Feb	20856	24	17	8	176	1718	253
Mar	13082	16	40	11	238	1168	185
Apr	13799						103
May	22272						208
Jun	27676	11	22	22	502	2346	296
Jul	27842	8	25	15	433	2292	284

Aug	29481	6	19	8	594	2315	220
Sep	24626	9	30	5	488	2136	268
Oct	23279	10	27	33	351	2006	355
Nov	20657	4	24	17	271	1822	324
Dec	22587	12	43	30	279	1868	349
Total	265613	110	265	153	3510	19291	3091

Month	**Cars**	**Disabled**	**Lorries**	**Lorries + trailer**	**Motorbikes**	**Large vans**	**Free travel**
Jan-15	19811	29	34	24	276	1814	342
Feb	18532	12	25	31	311	1832	279
Mar	21403	19	27	34	375	2115	283
Apr	20174	11	26	10	370	1725	147
May	25064	16	41	23	438	2037	196
Jun	25688	29	53	31	534	2416	210
Jul	25782	14	31	13	485	2308	160
Aug	22994	9	36	9	511	1900	132
Sep	21129	38	20	6	369	1824	147
Oct	21784	22	23	8	399	1848	128
Nov	17404	14	25	9	280	1552	146
Dec	11870	2	7	4	175	998	84
Total	251635	215	348	202	4523	22369	2254

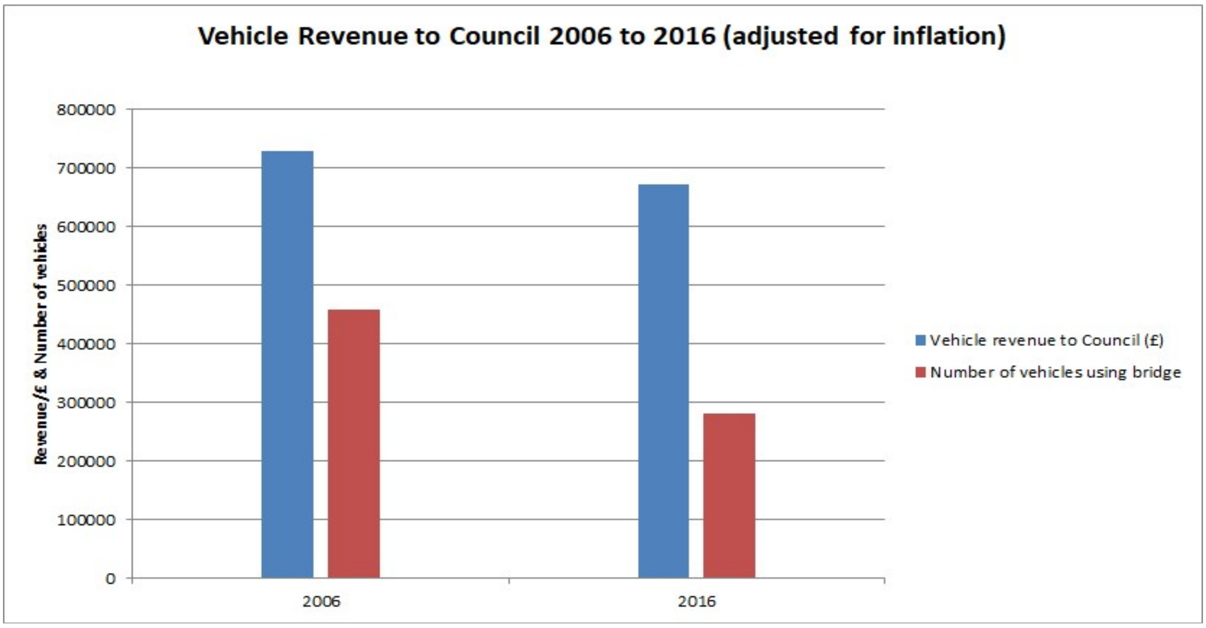
Month	**Cars**	**Disabled**	**Lorries**	**Lorries + trailer**	**Motorbikes**	**Large vans**	**Free travel**
Jan-16	9934	3	8	1	157	904	88
Feb	18281	8	21	10	306	1695	174
Mar	18574	3	16	10	387	1734	158
Apr	22215	4	16	5	368	2038	195
May	16411	6	17	5	392	1543	101
Jun	23653	6	22	8	523	2206	176
Jul	23255	7	26	11	565	1901	160
Aug	23854	6	22	3	581	2014	134
Sep	22076	10	21	4	463	1827	176
Oct	20514	11	24	0	24	6	90
Nov	19876	6	19	6	377	1587	145
Dec	19876	6	19	6	377	1587	145
Total	238519	76	231	69	4520	19042	1742

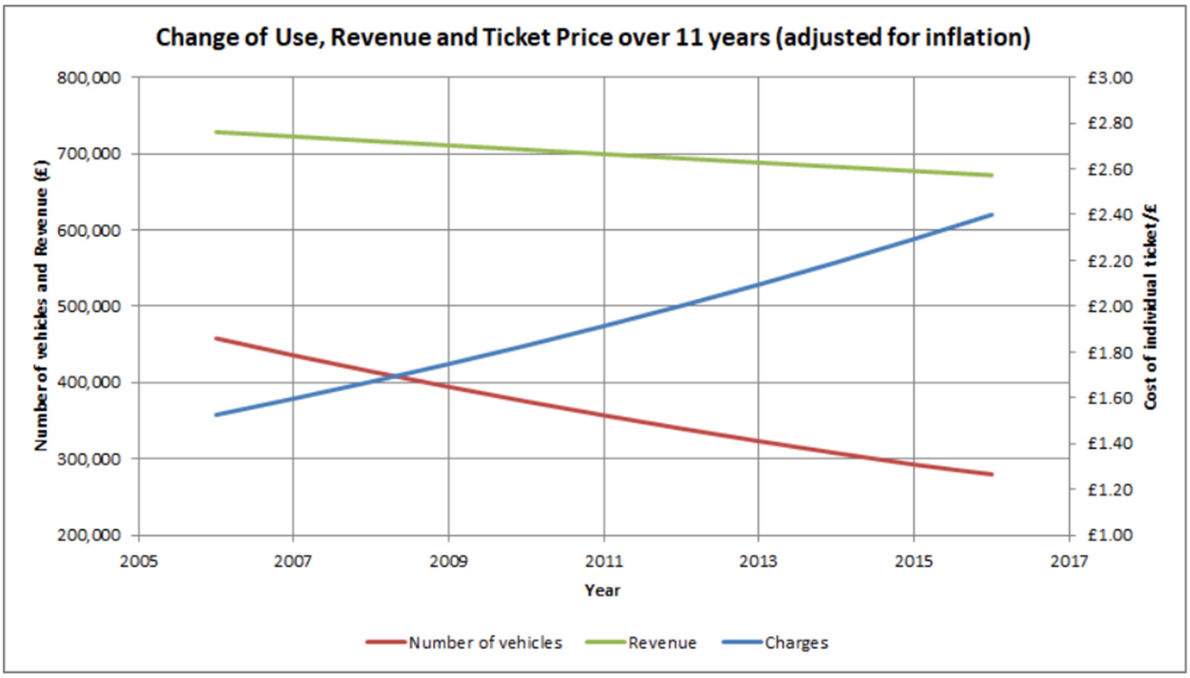
Grand Total	1653299	3195	1501	510	24587	138210	14922

Average Annual Total	275550	533	250	85	4098	23035	2487

APPENDIX 3

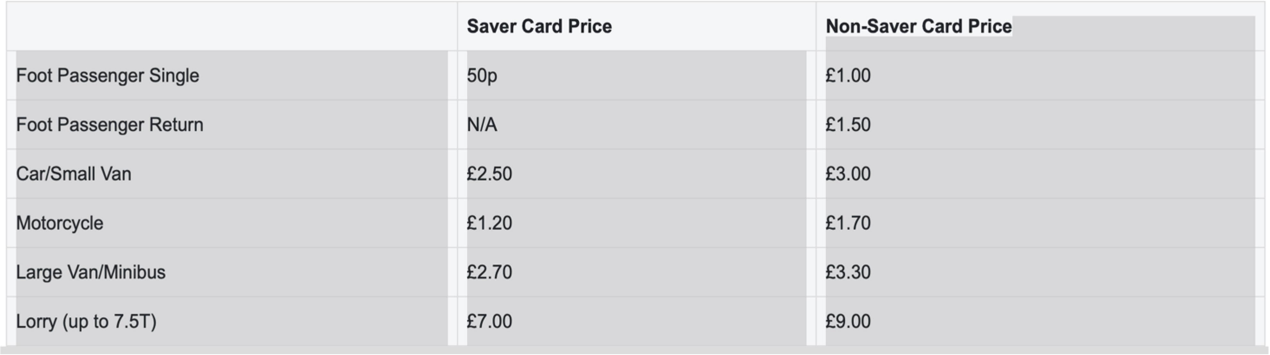
Impact of fare changes on overall demand between 2006 and 2016





APPENDIX 4

Cowes Floating Bridge
2023 Fare Structure



	Saver Card Price	Non-Saver Card Price
Foot Passenger Single	50p	£1.00
Foot Passenger Return	N/A	£1.50
Car/Small Van	£2.50	£3.00
Motorcycle	£1.20	£1.70
Large Van/Minibus	£2.70	£3.30
Lorry (up to 7.5T)	£7.00	£9.00

APPENDIX 5

Indicative Annual Revenue Calculation based on FB5 traffic from 2011 to 2016 (from statistics in Appendix 2)

Traffic assumptions
Appendix 2 contains obvious unrectified minor anomalies and items of missing data.
Total lack of data for November and December 2016 has been addressed by extrapolating the preceding 10 months.
Whilst the schedule contains no foot passenger data, from the histogram in Appendix 1 this is assumed to be 23,000 users per annum.
However, the schedule is otherwise believed to provide a good general record of traffic over the 6-year period.

Fare assumptions:

- 50% of vehicle users and 75% of foot passengers enjoy the saver discount

User type	**Number p.a.**	**Ave fare paid** £	**Annual Revenue** £
Car	275,550	2.75	757,763
Lorry	250	8.00	2,000
Lorry with trailer.	85	12.00	1,020
Motorcycle	4,098	1.50	6,147
Large van	23,035	3.00	69,105
Foot Passenger	276,000	0.60	165,600
Total annual revenue			**1,001,635**

APPENDIX 10

Notice to Mariners

COWES HARBOUR
COMMISSION

LOCAL NOTICE TO MARINERS No. 08 of 2022

Cowes Chain Ferry – Safety Advice

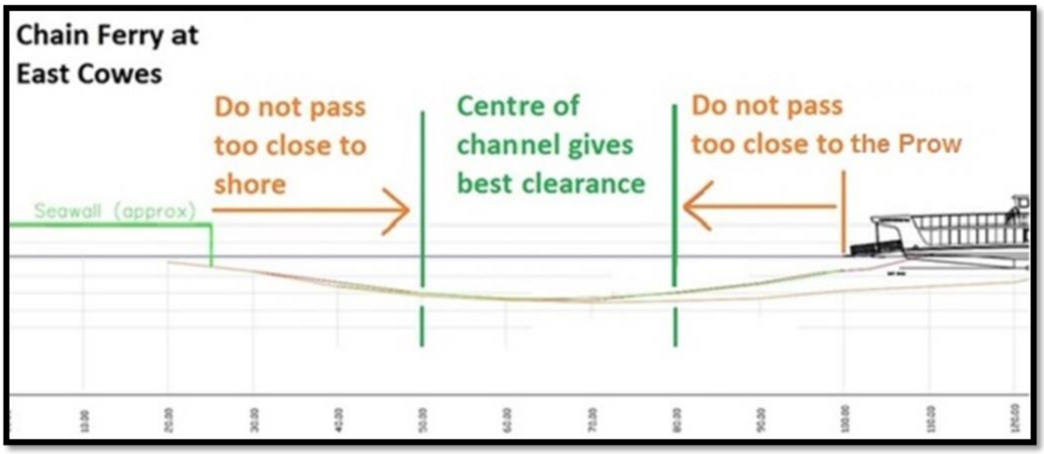
(This notice replaces Local Notice to Mariners 04 of 2021 and 09 of 2021 which are hereby cancelled)

Notice is hereby given that all mariners should be aware of the following safety information when navigating in the vicinity of the Cowes Chain Ferry.

All mariners are reminded of the contents of Cowes Harbour General Directions **Section 6** with specific reference to paragraphs 6.1 and 6.5 which refer to the **right of way.**

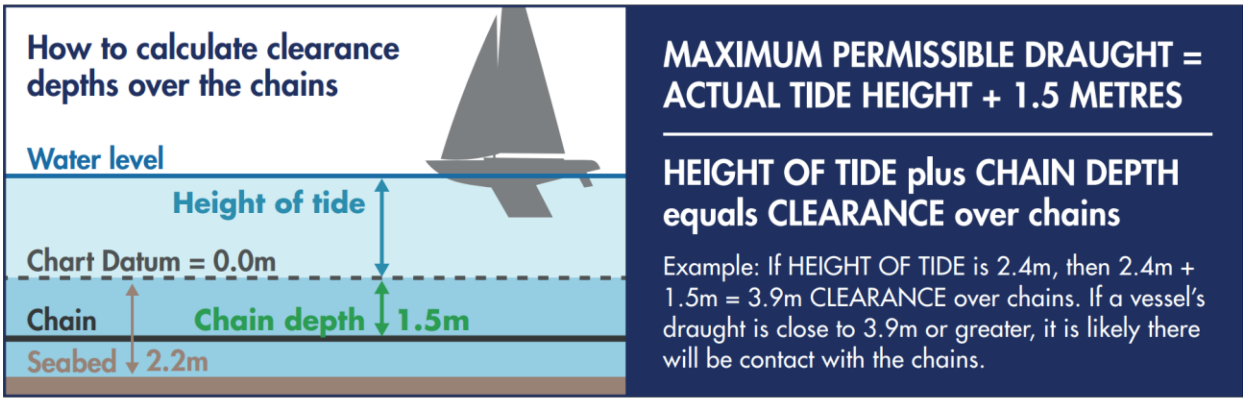
All mariners are advised that when passing the Cowes Chain Ferry, they shall navigate with particular caution. The following points shall be borne in mind when planning your passage and making your approach:

1. The Chain Ferry has right of way over all river traffic, unless you contact them on VHF Ch. 69 to arrange an unimpeded passage, which must be done in advance and acknowledged by the Chain Ferry,
2. The Chain Ferry is situated on a blind bend at the narrowest stretch of the river,
3. If the yellow lights are flashing, the ferry is about to move or is already moving, therefore you must give way,
4. Do not pass the Chain Ferry when it is in motion as clearances over the chains are reduced,
5. Be aware of strong tidal flows, especially spring tides, if travelling in the direction of tide and be prepared to give way to the Chain Ferry in plenty of time,
6. If you must pass the Chain Ferry on strong ebb tides, please do so at slow speed and pass in the centre of the gap between the ferry and the shore.
7. Do not pass too close to the Chain Ferry or too close to the shore



Calculating clearance over the chains

For calculating your clearance over the chains please use the following diagram:



MAXIMUM PERMISSIBLE DRAUGHT = ACTUAL TIDE HEIGHT + 1.5 METRES

HEIGHT OF TIDE plus CHAIN DEPTH equals CLEARANCE over chains

Example: If HEIGHT OF TIDE is 2.4m, then 2.4m + 1.5m = 3.9m CLEARANCE over chains. If a vessel's draught is close to 3.9m or greater, it is likely there will be contact with the chains.

When within 0.8 metres of the maximum permissible draught, the Chain Ferry **with adequate notice** shall be instructed to wait on the **EAST bank** for the transit of the vessel

To assist you in calculating your clearance over the Chain Ferry, Cowes Harbour Commission website displays daily tidal information as well as monthly tide tables.

In addition, there are numerous tide boards located around the harbour where the height of tide can be found:

- Shrape Beacon
- Watchhouse Beacon
- 4A Beacon
- North Outer Wall of Cowes Yacht Haven
- North end of Medina Wharf

This local notice to mariners will remain in force until further notice.

Ed Walker

Harbour Master, Harbour Office, Town Quay, Cowes, Isle of Wight, PO31 7AS
Email: chc@cowes.co.uk Website: www.cowesharbourcommission.co.uk

4th January 2022

Owners, Agents, Charterers, Marinas, Yacht Clubs and Recreational Sailing Organisations should ensure that the contents of this Notice are made known to the masters or persons in charge of their vessels or craft.

APPENDIX 11

Potential market for the profitable disposal of current vessel FB6

LIST OF CHAIN AND CABLE FERRIES OPERATED WORLDWIDE

Albania

- Butrint Ferry, across the Vivari Channel near Butrint[8]

Australia

- Berowra Waters Ferry, at Berowra Waters in New South Wales
- Blanchetown Punt[9]
- Bombah Point Ferry, at Bombah Point[10]
- Cadell Ferry, across the Murray River at Cadell, South Australia[11]
- Daintree River Ferry, across the Daintree River in Queensland
- Hibbard Ferry, across the Hastings River near Port Macquarie, New South Wales[12][13]
- Lawrence Ferry, across the Clarence River in New South Wales[14][15]
- Lower Portland Ferry, across the Hawkesbury River near the village of Lower Portland, New South Wales
- Lyrup Ferry, across the Murray River at Lyrup, South Australia[11]
- Mannum Ferry, across the Murray River at Mannum, South Australia (two parallel ferries)[11]
- Moggill Ferry, across the Brisbane River near Ipswich, Queensland[16]
- Morgan Ferry, across the Murray River in Morgan, South Australia[11]
- Mortlake Ferry, across the Parramatta River in Sydney, New South Wales
- Narrung Ferry, across the Murray River at Narrung, South Australia[11][17]
- Noosa River Ferry, across the Noosa River in Queensland[18]
- Purnong Ferry, across the Murray River in Purnong, South Australia[11]
- Raymond Island Ferry, chain ferry from Paynesville to Raymond Island in Victoria
- Sackville Ferry, across the Hawkesbury River near the village of Sackville, New South Wales
- Settlement Point Ferry, across the Hastings River near Port Macquarie, New South Wales[12][13]
- Speewa Ferry, across the Murray River between New South Wales and Victoria at Speewa
- Swan Reach Ferry, across the Murray River in Swan Reach, South Australia[11]
- Tailem Bend Ferry, across the Murray River in Tailem Bend, South Australia[11]
- Ulmarra Ferry, across the Clarence River in New South Wales[15]
- Waikerie Ferry, across the Murray River in Waikerie, South Australia[11]
- Walker Flat Ferry, across the Murray River in Walker Flat, South Australia[11]
- Webbs Creek Ferry, across the Hawkesbury River in the village of Wisemans Ferry, New South Wales
- Wellington Ferry, across the Murray River in Wellington, South Australia[11]
- Wisemans Ferry, across the Hawkesbury River in the village of Wisemans Ferry, New South Wales
- Wymah Ferry, across the Murray River between New South Wales and Victoria

- The Mannum Ferry.
- The Moggill Ferry
- Wisemans Ferry

Austria

- Rollfähre Klosterneuburg, across the Danube River at Klosterneuburg
- Drahtseilbrücke Ottensheim, across the Danube River at Ottensheim

Belize

- Xunantunich Ferry, across the Mopan River at Xunantunich

Canada

- Adams Lake Cable Ferry, across Adams Lake in British Columbia[19]
- Baynes Sound Connector, across Baynes Sound from Buckley Bay to Denman Island in British Columbia. The longest cable ferry in the world at the time of its opening.[20]
- Belleisle Bay Ferry, across Belleisle Bay in New Brunswick
- Big Bar Ferry, across the Fraser River at Big Bar, British Columbia
- Bleriot Ferry, across the Red Deer River near Drumheller, Alberta[21]
- Clarkboro Ferry, across the South Saskatchewan River near Saskatoon, Saskatchewan
- Country Harbour Ferry, across Country Harbour near Port Bickerton, Nova Scotia.
- Crowfoot Ferry, across the Bow River in Alberta[21]
- Ecolos Ferry, across Ottawa River between Clarence-Rockland ON and Thurso QC
- Englishtown Ferry, across the mouth of St. Anns Bay in Nova Scotia
- Estuary Ferry, across the South Saskatchewan River near Estuary, Saskatchewan
- Evandale Ferry, across the Saint John River in New Brunswick
- Finnegan Ferry, across the Red Deer River in Alberta[21]
- Gagetown Ferry, across the Saint John River in New Brunswick
- GladeFerry, across the Kootenay River in British Columbia[19]
- Gondola Point Ferry, across the Kennebecasis River in New Brunswick
- Hampstead Ferry, across the Saint John River in New Brunswick
- Harrop Cable Ferry, across Kootenay Lake in British Columbia[19]
- Howe Island ferries, across the Bateau Channel, St Lawrence River, Ontario
- Kennebecasis Island Ferry, across the Kennebecasis River in New Brunswick
- Klondyke Ferry, across the Athabasca River in Alberta[21]
- LaHave Cable Ferry, across the LaHave River in Nova Scotia
- Lancer Ferry, across the South Saskatchewan River near Lancer, Saskatchewan
- Laval-sur-le-Lac Île-Bizard Ferry, across the Rivière des Prairies between Montreal and Laval, Quebec
- Lemsford Ferry, across the South Saskatchewan River near Lemsford, Saskatchewan
- Little Fort Ferry, across the North Thompson River in British Columbia[19]
- Little Narrows Cable Ferry, across the Little Narrows of Whycocomagh Bay in Nova Scotia
- Low Bar Ferry, across the Fraser River at High Bar, British Columbia
- Lytton Ferry, across the Fraser River at Lytton, British Columbia
- McLure Ferry, across the North Thompson River in British Columbia[19]
- Needles Cable Ferry, across Lower Arrow Lake in British Columbia
- Quyon Ferry, across Ottawa River between Fitzroy Harbour ON & Quyon, QC
- Riverhurst Ferry, across Lake Diefenbaker, Saskatchewan
- Rosevear Ferry, across the McLeod River near Edson, Alberta[21]
- Simcoe Island Ferry, between Wolfe Island and Simcoe Island, St Lawrence River, Ontario
- Usk Ferry, across the Skeena River at Usk, British Columbia[19]
- Westfield Ferry, across the Saint John River in New Brunswick

- Lytton Ferry (Fraser River)
- Needles Cable Ferry (Arrow Lakes)
- Riverhurst Ferry
- Laval-sur-le-Lac–Île-Bizard Ferry

Chile

- Balseo de San Javier, across San Pedro River, Los Ríos Region.[22]

Croatia

- Medsave cable ferryMedsave Ferry, across the Sava River (Medsave–Zaprešić) in Zagreb County, overhead cable
- Otočanka Ferry, across the Sava River (Otok Samoborski–Savski Marof) in Zagreb County, overhead cable
- Oborovo, across the Sava River (Oborovo–Vrbovo Posavsko) in Zagreb County, overhead cable
- Martinska ves, across the Sava River (Dubrovčak Lijevi–Dubrovčak Desni) in Sisak-Moslavina County, overhead cable
- Tišina, across the Sava River (Tišina Kaptolska–Tišina Erdedska) in Sisak-Moslavina County, overhead cable
- Sunjanka, across the Sava River (Graduša Posavska–Lukavec Posavski) in Sisak-Moslavina County, overhead cable
- Kratečko, across the Sava River (Kratečko–Sunjsko Selište) in Sisak-Moslavina County, overhead cable
- Pitomača Jelkuš Ferry, across the Drava River, in Virovitica–Podravina County
- Pitomača Križnica, across the Drava River, in Virovitica–Podravina County
- Osijek Zoološki vrt, across the Drava River, Osijek-Baranja County

Czech Republic

- Dolní Žleb Ferry, reactive ferry across the Elbe at Dolní Žleb near Děčín, lower cable
- Vrané nad Vltavou – Strnady, reactive ferry across the Vltava before Prague, with overhead cable
- Klecánky – Roztoky ferry over the Vltava under Prague, secured by overhead cable
- Máslovice, Dol - Libčice ferry over the Vltava under Prague, secured by lower cable
- Lužec nad Vltavou ferry over the Vltava, secured by overhead cable
- Zlenice - Senohraby swimming pool, ferry over the Sázava river, overhead security cable installed but usually unused
- Oseček ferry, Elbe river, formerly secured by overhead cable, now without it
- Kazín ferry, Berounka river, 1992–2007 propelled through lower chain, since 2015 unsecured boat
- Nadryby ferry, Berounka river, secured by the overhead cable
- Darová ferry, Berounka river, propelled through the overhead cable

Denmark

- Østre Ferry, across Isefjord between Hammer Bakke and Orø. Uses cables for steering, but propellers for propulsion.
- Udbyhøj Ferry, across Randers Fjord.

Estonia

- Kavastu Ferry, across Emajõgi in Kavastu (manual mechanism, more than century old flywheel)

Finland

- Ahvionsaari Ferry, from Kiviapaja to Ahvionsaari in Savonlinna
- Alassalmi Ferry, across Alassalmi strait on lake Oulujärvi between Manamansalo island and mainland
- Arvinsalmi Ferry, across Arvinsalmi strait between the municipalities of Rääkkylä and Liperi
- Barösund Ferry, across Barösund strait between Barölandet and Orslandetislands
- Bergö Ferry, in Bergö

- Eskilsö Ferry
- Föri in Turku
- Hanhivirta Ferry, in Enonkoski
- Haukkasalo Ferry
- Hirvisalmi Ferry, across Hirvisalmi strait between the mainland and Paalasmaa island in Juuka
- Hämmärönsalmi Ferry, across Hämmärönsalmi strait (Rimito-Hanka) in Rimito, Nådendal (part of r. road 1890)
- Högsar Ferry, between Högsar and Storlandet islands in Nagu, Pargas(part of r. road 12019)
- Karhun Cable Ferry, between the mainland and the island of Karhu, Ii
- Keistiö Ferry, between Keistiö and Iniö islands in Iniö, Pargas
- Kietävälänvirta Ferry, between Partalansaari and Viljakansaari in Puumala(part of road 15176)
- Koivukanta Ferry, to Kesamonsaari in Savonlinna
- Kokonsaari Ferry, from Kesamonsaari to Kokonsaari in Savanlinna
- Kivimo Ferry, between Roslax on mainland Houtskär and Kivimo islands in Houtskär, Pargas
- Kokkila Ferry, between Kokkila on the mainland and Angelniemi on Kimitoön (part of r. road 1835)
- Kuparonvirta Ferry, between Hirvensalo and Anttola in Mikkeli (part of road 15147)
- Kyläniemi Ferry, between Utula and Kyläniemi
- Mossala Ferry, between Björkö and Mossala islands in Houtskär, Pargas(part of regional road 12003)
- Pellinki Ferry, between the mainland and the island of Pellinki
- Pettu Ferry, between Pettu and Utö islands in Finby, Salo
- Pikkarala Ferry, across Oulujoki river in Pikkarala, Oulu
- Potkusalmi Ferry, to Ritosaari in Savonlinna
- Puutossalmi Ferry, in Kuopio
- Rongonsalmi Ferry, between Viljakansaari and Lieviskä in Puumala, (part of road 15170)
- Saverkeit Ferry, between mainland Houtskär and Västra Saverkeit islands in Houtskär, Pargas (part of r. road 12005)
- Skagen Ferry, between Jumo and Iniö islands in Iniö, Pargas (part of r. road 12230)
- Skåldö Ferry, between Degerö and Skåldö islands in Ekenäs, Raseborg
- Tappuvirta Ferry, Tappuvirrantie
- Tuohisaari Ferry, from Liistonsaari to Tuohisaari in Savonlinna
- Vartsala Ferry, between Vartsala and Kivimaa islands in Kustavi (part of r. road 192)
- Vånö Ferry, between Vånö and Attu islands in Pargas (part of r. road 12027)

- Alassalmi cable ferry
- Karhun cable ferry
- Koivukanta ferry in winter and parallel ice road for lighter vehicles
- Pikkarala ferry wintering on the shore of Oulujoki.

Åland

- Björkölinjen, across Björkösund strait between the islands of Korsö (in Kumlinge municipality) and Bockholm (in Brändö m.)
- Embarsundlinjen, across Embarsund strait in Föglö municipality, between the islands of Finholma and Jyddö
- Töftölinjen, across Prästösund strait between the islands of Töftö (in Vårdömunicipality) and Prästö (in Sund m.)
- Seglingelinjen, across the strait between the islands of Seglinge and Snäckö (both in Seglinge village in Kumlinge municipality)
- Simskälalinjen, across the strait between the islands of Alören and Östra Simskäla (both in Vårdö municipality)

- Ängsösundlinjen, across Ängösund strait between the islands of Lumparland (in Lumparland municipality) and Ängö (in Vårdö m.)

France

- Bac du Sauvage Ferry, across a branch of the Rhône in the Camargue

Gambia

- Bansang Ferry, across the River Gambia at Bansang in the Central River Division

Germany

- Aken Ferry, across the Elbe at Aken in Saxony-Anhalt
- Barby Ferry, across the Elbe at Barby in Saxony-Anhalt
- Caputh Ferry, across the Havel at Caputh in Brandenburg
- Coswig Ferry, across the Elbe at Coswig in Saxony-Anhalt
- Ellikon–Nack Ferry [de], across the Rhine from Lottstetten in Baden-Württemberg to Marthalen in Switzerland
- Ferchland Grieben Ferry, across the Elbe between Ferchland and Griebenin Saxony-Anhalt
- Gräpel Cable Ferry [de], across the Oste at Gräpel in Lower Saxony
- Ketzin Cable Ferry, across the Havel at Ketzin in Brandenburg
- Kiewitt Ferry, across the Havel at Potsdam in Brandenburg
- Maintal–Dörnigheim Ferry, across the Main near Maintal in Hesse
- Friesenheimer Insel – Sandhofen Ferry, across an old arm of the Rhine in Mannheim
- Pritzerbe Ferry, across the Havel between Havelsee and Kützkow in Brandenburg
- Rathen Ferry, across the Elbe at Rathen in Saxony
- Räbel Ferry, across the Elbe between Räbel and Havelberg in Saxony-Anhalt
- Rothenburg Ferry, across the Saale at Rothenburg in Saxony-Anhalt
- Sandau Ferry, across the Elbe at Sandau in Saxony-Anhalt
- Straussee Ferry, across the Straussee at Strausberg in Brandenburg
- Teterower See Ferry, to an island in the Teterower See in Mecklenburg-Vorpommern
- Veckerhagen Ferry, across the Weser between Veckerhagen in Hesse and Hemeln in Lower Saxony
- Westerhüsen Ferry, across the Elbe at Magdeburg in Saxony-Anhalt

- The Pritzerbe Ferry
- The Rathen Ferry

Hong Kong

- Nam Sang Wai Ferry, Hong Kong

- Nam Sang Wai Ferry, at Nam Sang Wai in northwestern New Territories

Hungary

- Cable ferry crossing the river Tisza between Tiszatardos and Tiszalök, Hungary.

- One cable ferry across the Danubebetween Csepel and Soroksár, in Budapest[23]
- A cable ferry crosses the Tisza between Tiszalök and Tiszatardos

Ireland

- A cable ferry serves Little Island and Waterford Castle in the River Suir

Italy

- Two cable ferries across the port of Cesenatico, in Romagna
- One cable ferry across the port of Bellaria-Igea Marina, in Romagna
- An engineless cable ferry (Traghetto di Leonardo) between Imbersago(Lecco) e Villa d'Adda (Bergamo), in Lombardia, in the Ecomuseo Adda di Leonardo da Vinci river museum
- Another "Traghetto di Leonardo" across the Tevere river, in Lazio, in the Riserva Naturale di Nazzano natural reserve

Mozambique

- Ferry across Shire River, 37 km south of Malawi's southernmost border

Netherlands

- Cuijk ferry, across the Meuse at Cuijk
- Genemuiden ferry, across the Zwarte Water at Genemuiden
- Jonen ferry, across the Walengracht at Jonen, only taking foot passengers and cyclists, winched to the other bank by an electric motor on one of the banks.
- Lexkesveer, across the Nederrijn near Wageningen,
- Oijen Ferry, across the Meuse at Oijen
- Wijhe Ferry, across the IJssel at Wijhe
- Wijk bij Duurstede ferry, across the Lek. This one uses a floating cable.

New Zealand

- Tuapeka Mouth Ferry, in Tuapeka – South Island, on the Clutha River

Norway

- Fjone ferry, across lake Nisser in Nissedal, Telemark[25]
- Espevær Ferry, in Bømlo, Hordaland
- Duesund–Masfjordnes, in Nordhordland
- Mjånes-Hisarøy, in Gulen, Sogn og Fjordane[26]

Poland

- Biechowy Ferry, across the Warta between Biechowy and Piersk[27]
- Borusowa Ferry, across the Vistula between Borusowa and Nowy Korczynroad no. 973[28]
- Brody Ferry, across the Oder at Brody road no. 280[29]
- Brzeg Dolny Ferry, across the Oder between Brzeg Dolny and Głoska
- Ciszyca Ferry, across the Vistula between Tarnobrzeg and Ciszyca road no. 758
- Czchów Ferry, across the Dunajec between Czchów and Piaski Drużków
- Czeszewo Ferry, across the Warta at Czeszewo
- Dębno Ferry, across the Warta between Dębno and Orzechowo
- Gniew Ferry, across the Vistula between Gniew and Janowo road no. 510
- Grzegorzowice Ferry, across the Oder between Grzerorzowice and Ciechowice road no. 421
- Janowiec Ferry, across the Vistula between Kazimierz Dolny and Janowiec
- Korzeniewo Ferry, across the Vistula between Korzeniewo and Opalenieroad no. 232
- Kozubów Ferry, across the Warta between Kozubów and Osina
- Krzemienna Ferry, across the San between Krzemienna and Jabłonica Ruska

- Milsko Ferry, across the Oder between Milsko and Przewóz road no. 282
- Nozdrzec Ferry, across the San between Nozdrzec and Dąbrówka Starzeńska
- Opatowiec Ferry, across the Vistula between Opatowiec and Ujście Jezuickie
- Otfinów Ferry, across the Dunajec between Otfinów and Pasieka Otfinowska
- Pogorzelica Ferry, across the Warta between Pogorzelica and Nowa Wieś Podgórna
- Połaniec Ferry, across the Vistula between Połaniec and Gliny Małe
- Połęcko Ferry, across the Oder between Połęcko and Chlebowo road no. 138
- Pomorsko Ferry, across the Oder at Pomorsko road no. 281
- Siedliszowice Ferry, across the Dunajec between Siedliszowice and Wietrzychowice
- Sławsk Ferry, across the Warta between Sławsk and Węglewskie Holendry
- Świniary Ferry, across the Vistula between Baranów Sandomierski and Świniary road no. 872
- Waki Ferry, across the Warta at Waki

- Ferry in Kazimierz Dolny-Janowiec (Poland – Vistula river)
- Ferry in Gniew (Poland, Vistula river)
- High-rope ferry in Borusowa on the Vistula River

Slovakia

- Perec Ferry, across the Perec distributary of the river Hron, between Starý Tekov and Nový Tekov in Levice district - Foot ferry, came into use in the late 18th century and ceased operations in 2014, replaced by a bridge.

South Africa

Malgas Ferry on the Breede River, Western Cape, South Africa

- Malgas Ferry, across the Breede River at Malgas, Western Cape

South Korea

- Abai village ferry in Sokcho[30]

Spain

- Pas de barca de Flix, across the Ebro river, in Flix, Catalonia
- Pas de barca de Miravet, across the Ebro river, in Miravet, Catalonia

Sweden

- Adelsön Ferry [sv], in Lake Mälaren from Munsö to Adelsö[31]
- Ammerö Ferry [sv], in Lake Revsund from Ammer to Stavre[32]
- Ängö Ferry [sv], between Ängön and Fruvik on Bokenäset[33]
- Arnö Ferry [sv], in Lake Mälaren from Oknö to Arnö[34]
- Avan Ferry [sv], across Lule River from Avan to Norra Sunderbyn[35]
- Boheden Ferry [sv], across Djupträsket from Sandudden to Boheden[36]
- Bohus Malmön Ferry [sv], from Malmön to Roparöbacken[37]
- Bojarkilen Ferry, across Bojarkilen in Strömstad[38]
- Bolmsö Ferry [sv], across Lake Bolmen from Sunnaryd to Bolmsö[39]
- Hamburgsund Ferry [sv], across Hamburgsund from Hamburgsund to Hamburgön[40]
- Högmarsö Ferry, from Högmarsö to Svartnö[41]
- Högsäter Ferry [sv], across Byälven from Högsäter to Fryxnäs[42]
- Isö Ferry [sv], across Storsjön from Isön to Norderön[43]

- Ivö Ferry [sv], across Ivö Lake between Barum and Ivö Island[44]
- Kornhall Ferry [sv], across the Nordre älv between Kornhall and Brunnstorpsnäs[45]
- Kostersundet Ferry, across Kostersundet from Nordkoster to Sydkoster[46]
- Lyr Ferry [sv], between the islands of Lyr and Orust[47]
- Malö Ferry [sv], between the islands of Malö and Orust[48]
- Rödupp Ferry [sv], across the Kalix river at Rödupp[49]
- Stegeborg Ferry [sv], across the Slätbaken between Slottsholmen and Norrkrog[50]
- Sund-Jaren Ferry [sv], across the Stora Le lake[48]
- Töreboda Ferry, across the Göta Canal in Töreboda[51]
- Torpön Ferry, across Lake Sommen from Torpön to Blåvik[52]
- Vaxholmen Ferry, from the town of Vaxholm to Vaxholm Castle
- Ytterö Ferry, from Ytterön to Yttre park[53]

- The Swedish ferry *Saga* on the Hamburgsund route. The Swedish ferry *Vaxholmen* with its destination, Vaxholm Castle, in the Stockholm Archipelago.

Switzerland

- Basel Ferries [de], four routes across the Rhine in the city of Basel
- Ellikon–Nack Ferry [de], across the Rhine from Marthalen to Lottstetten in Germany
- Fahr Abbey Ferry [de], across the Limmat river at Fahr Abbey

United Kingdom

- Butts Ferry, across the River Exe in Exeter, Devon

- Cowes Floating Bridge, across the River Medina on the Isle of Wight
- Dartmouth Higher Ferry, across the River Dart in Devon
- Hampton Ferry, across the River Avonnear Evesham in Worcestershire
- Hampton Loade Ferry, across the River Severn in Shropshire (closed 2016)
- King Harry Ferry, across the River Fal in Cornwall
- Normanton-on-Soar Chain Ferry, across the River Soar in Nottinghamshire
- Reedham Ferry, across the River Yare in Norfolk
- Sandbanks Ferry, across the entrance to Poole Harbour in Dorset
- Stratford-upon-Avon Ferry, across the River Avon at Stratford-upon-Avonin Warwickshire
- Symonds Yat river crossings, a pair of hand powered ferries across the River Wye in Herefordshire
- Torpoint Ferry, across the River Tamar between Devon and Cornwall.
- Trowlock Island Ferry, a hand powered ferry to Trowlock Island in the River Thames in south-western Greater London
- Windermere Ferry, across Windermere in Cumbria

United States

- Akers Ferry, across the Current River near Salem in Missouri
- Avoca Island Ferry, across the intracoastal waterway to Avoca Island near Morgan City in Louisiana
- Bemus Point-Stow Ferry, across Chautauqua Lake in New York
- Buena Vista Ferry, across the Willamette River in Oregon
- Canby Ferry, across the Willamette River in Oregon
- Los Ebanos Ferry, across the Rio Grande between Los Ebanos, Texas and Gustavo Díaz Ordaz, Tamaulipas
- Elwell Ferry, across the Cape Fear River in North Carolina
- Fredericktown Ferry, closed in 2013 across the Monongahela River in southwestern Pennsylvania[54]

- Green River Ferry, across the Green River in Mammoth Cave National Park
- Hatton Ferry, across the James River in Virginia
- Ironton Ferry, across an arm of Lake Charlevoix in Michigan
- J-Mack Ferry, across an arm of the Sacramento River in California[55][56]
- Merrimac Ferry, across the Wisconsin River in Wisconsin
- Merry Point Ferry, across the Corrotoman River in Virginia
- Parker's Ferry, across the Meherrin River in North Carolina
- Princeton Ferry, across the Sacramento River in California[56]
- Reed's Ferry, across the Green River northeast of Rochester, KY
- Rochester Ferry, across the Green River in Rochester, KY
- Sans Souci Ferry, across the Cashie River in North Carolina
- Saugatuck Chain Ferry, across the Kalamazoo River in Michigan
- Sunnybank Ferry, across the Little Wicomico River in Virginia
- Sycamore Island Ferry, across the Potomac River in Maryland
- Ticonderoga Ferry, across Lake Champlain between Ticonderoga, New York and Shoreham, Vermont
- Upper Ferry, across the Wicomico River in Maryland[57]
- Valley View Ferry, across the Kentucky River in Kentucky
- Wheatland Ferry, across the Willamette River in Oregon
- White's Ferry, across the Potomac River in Maryland
- Whitehaven Ferry, across the Wicomico River at Whitehaven, Maryland[57]
- Woodland Ferry, across the Nanticoke River in Delaware[57]

- Canby Ferry
- White's Ferry on the Potomac River
- Wheatland Ferry
- Princeton Ferry (undergoing renovation)

Zambia

- Chambeshi Ferry, across the Chambeshi River near Mbesuma
- Kabompo Ferry, across the Kabompo River 80 km south-east of Kabompo
- Kafue Ferry, across the Kafue River 4.5 km west of the Zambezi

Zimbabwe

- Ekusileni Ferry, across the Insiza River downstream of Filabusi