Second Mersey Crossing at Runcorn

Review of Options

June 1999
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Background

The Mersey Crossing Group, comprising the Mersey Metropolitan Borough Councils of Liverpool, Knowsley, Wirral, Sefton, St.Helens, Halton and Warrington commissioned a study to investigate a new strategic crossing of the Mersey (in the vicinity of the existing Runcorn-Widnes Bridge) in December 1995.

The study has been on-going since that date. A draft report covering the conclusions of Stage 2 of the Study, where three options were refined, was submitted in March 1999.

The Western Option approximately 1 mile downstream of the existing crossing would cross an environmentally sensitive section of the Mersey, prescribing a crossing form that minimised the number of piers in the river. A two span suspension bridge was proposed. The cost of this option was assessed to be £148.3M (£111.5M bridge, £33.8M highways, £3M property).

The Central Option, comprising construction of a new bridge immediately adjacent to the existing road crossing, and sandwiched between it and the existing railway bridge. This is the shortest crossing, and the form of construction considered was 3 No 100m spans to match those of the railway bridge, with 55m long approach spans on the Widnes and Runcorn sides of the river. The assessed cost of this option was £44M (£39.7M bridge, £2.3M highways, £2M property).

The Eastern Option approximately ¾ mile upstream of the existing bridge would require a 1.25km crossing. The option proposed comprised 18 spans of 100m, requiring 15 piers to be located within the river. The assessed cost of this scheme was £72.5M (£59.5 bridge, £10M highways, £3M property).

The draft report recommended the Central Option for progression.

It is widely acknowledged that Government are unlikely to support a strategic crossing of the Mersey, but that support will potentially be given to a more localised, integrated transport crossing serving Runcorn and Widnes. Halton Borough Council have therefore been investigating such an option and this report has been commissioned to give advice on certain specific aspects – the potential form of construction of the crossing and the order of magnitude of cost.

Assumptions and Constraints

Carriageway cross-section. The Transport Policy Section of the Council has considered the conceptual design of the crossing and has reported on its conclusions in a memo dated 20 October 1998 (copy attached as Appendix A).

The crossing would make provision for 4 traffic lanes, a dedicated busway, and a footway / cycleway. Various cross-sectional arrangements to provide for such were examined. For the purposes of this review the 2-lane single carriageway of Figure 3.1 has been assumed as the base cross-section as it provides the minimum cross-section (and therefore cost) compatible with the minimum traffic and bus requirements for the Crossing. In broad terms (and within the accuracy of current estimating) the cost of the wide single carriageway option of Figure 3.2 of that report can be taken to be 25% greater than the options considered herein.

Carriageway design speed. A design speed of 40 mph has been assumed to be acceptable as it is compatible with the local road system.

Reclamation of the North bank of the River Mersey. Reclamation of the North bank of
the Mersey adjacent to Widnes Warth was the subject of a study undertaken for Halton Borough Council in 1987. At that time it was proposed to construct a water-borne leisure facility within such a reclamation. It is currently assumed that reclamation of the North bank of the river would be undertaken in conjunction with any new crossing, to enable the shortest possible crossing and to potentially provide land for development purposes. The cost of this reclamation is taken to be that provided in the 1987 report, escalated for inflation (£26M being the escalated estimated cost of £17.735M from that report – the escalation factor being 1.45).

A reclamation will change the flow characteristics of the river and the 1987 study, therefore, considered the hydrological implications of the various options utilising model tests. For the current study of the crossing the extent and alignment of the edge of the reclamation of the North bank is assumed to be in accordance with the recommended option of the 1987 Study. This, therefore, ensures that the reclamation assumed as part of the crossing within this study is acceptable from environmental considerations.

Manchester Ship Canal. Despite the decline in shipping using the canal, any crossing of the canal must protect the Manchester Ship Canal Company’s statutory requirements to provide ‘right of passage’ of commercial shipping and leisure craft along the Canal.

At the site of the Parkway/M602 link lift bridge it is documented that a minimum air draft of 22.9m has been provided. The Manchester Ship Canal Company have been consulted and have defined the minimum acceptable clearance for a fixed bridge to be 28.63m AOD (reference their letter of 4 June 1999).

River Mersey. There is no commercial activity on the Mersey at the location of the proposed crossing and navigation issues will therefore be confined to leisure activity. There appears to be no clear definition of clearance required for such activity at this time. The minutes of Halton Borough Council’s meeting of 25 March with the Mersey Conservancy suggests that a clearance of 20m above mean high water level could be required, although such rights could be rescinded by Act of Parliament.

Therefore, for the purpose of this study it is generally assumed that a navigation channel will be required over some portion of the river with a clearance of 20m, but that outside of this channel a clearance of, say, 4m would be acceptable. The navigation channel is assumed to be on the south side of the river.

Proximity to Liverpool Airport. The height of obstructions is controlled within the proximity of an airport for safety reasons. The assessment and treatment of obstacles is controlled by CAP168 (Licensing of Aerodromes). Serco Aviation Services have been consulted on the issue of obstructions and have provided a copy of the relevant portion of CAP 168 with their letter of 27 May 1998.

CAP 168 defines surfaces around an airport above which new objects should not extend. These surfaces comprise an approach surface, a take off surface and a horizontal surface (at elevation 150m above the runway) that extends outside of the approach and take off surfaces for a distance of 15km around an airport. The take off surface is flatter than the approach surface.

Liverpool Airport has a code 4 runway, for which the take off climb surface is inclined at 1.6 degrees. This surface intersects the 150m horizontal surface approximately 5.4km from the runway end. Further away from the airport it is the horizontal surface, 150m height above the runway, that governs obstacle height limitations. The take off
climb surface for Liverpool airport is shown in Figure 1.

The location of the proposed crossing is approximately 7.5 km east of the airport and therefore the maximum allowable height of any obstruction is 150 m above the runway. As the runway level is 24-25 m AOD, the height of any bridge tower at the location of the proposed crossing would be limited to 174-175 m AOD. For the purposes of this review a limit of 170 m AOD has been assumed. A cable-stayed bridge would therefore be feasible.

**Geology.** The 1:50,000 geology maps indicate that the underlying solid geology beneath the area of interest comprises an alternating faulted sequence of Upper Mottled Sandstone and Pebble Beds, both of which belong to the Sherwood Sandstone Group. The sides of the Mersey estuary in this area display a meandering pattern, and in most cases the distinct promontories are formed by the Pebble Beds, suggesting that these are the more resistant (stronger) of the two formations (for example, as at the site of the existing bridge crossings).

The maps indicate that marine / estuarine alluvium overlies these rock formations. However, elsewhere along the estuary, broad tracts of wind-blown sand are present, so it is possible that this may underlie the alluvium in the area of interest. Further away from the estuary edges, boulder clay overlies the bedrock.

From the general geological setting, it could be anticipated that the depth to rockhead could be considerable in the centre of the estuary.

A review of the British Geological Survey data base of borehole records has been undertaken for the area in the vicinity of the proposed crossing. There are no existing boreholes that have specific relevance to the alignments of the proposed crossing. A number of boreholes exist at the site of the old Kemel Chemical factory some distance to the east of the crossing on a promontory lying to the river side of the Ship Canal. Clearly this is an area of high rock head, and not of particular relevance to the proposed alignment of the crossing.

Borehole 23, carried out in 1928 from a ground level of 35 ft AOD (10.6 m) encountered 48 ft (14.6 m) of boulder clay overlying 200 m of sandstone. Sandstone was therefore encountered at a level of -4 m AOD.

Numerous boreholes exist within the industrial area adjacent to the Widnes Warth on the north side of the river. These are some distance land side of the crossing and are again not of particular relevance.

Three borehole logs have been obtained from BGS, as they were considered to be the most applicable to this report. Their locations are shown on figure 2. They are all some distance away from the proposed alignments.

Borehole 77, on the south bank of the river, immediately to the north of the Ship Canal, was carried out in 1993 by Exploration Associates, for the Commission for the New Towns' Wigg Island Scheme. Ground level is 8.5 m AOD. The log records 8 m of made ground, overlying 4 m of silty fine sand. The borehole terminates at this depth (-2.9 m AOD) without encountering rock, or other suitable founding strata.

Borehole 76, carried out at the same time as no. 77. This borehole is within Runcorn Sands towards the south bank of the river. Ground level is 9.7 m AOD. This shows nearly 5 m of made ground overlying 6 m of silty fine sand. The borehole terminates at this level (-4.7 m AOD) without encountering rock or other suitable founding strata. Contamination (oil) was encountered in the lower levels of the fill and the upper levels of the silty sand.
Borehole 20 was carried out in 1887 for the Widnes Alkali Company. It is on the north side of the river about 550 yards south of the Widnes Town Hall, and some distance, therefore, to the north of the crossing. Ground surface was about 20ft (6m AOD). The hole encountered 156 ft (47.5m) of boulder clay overlying 444 ft (135m) of red sandstone. Sandstone was therefore encountered at approximately −41m AOD.

The conclusions that can be drawn from the sparse information available are that:

- The level of rock head in the general vicinity of the crossing is highly variable (−4m AOD upstream to −41m AOD to the north). Founding level for piles to any bridge piers could, therefore, be at significant depth (say up to −40m AOD) if foundations had to be taken down to sandstone level. It is conceivable that founding piles could be designed to terminate within the boulder clay, but this could only be assessed with the aid of detailed site investigation data.

- The strata within the river show signs of contamination. The impact of this on foundation construction (spoil disposal) and founding level (leaching of contaminants into the sandstone aquifer) would need detailed examination in any further investigation of the crossing. This issue could also be of importance if river bed materials were to be used for the north shore reclamation.

For the purpose of this study, therefore, founding level for any piles is assumed to be −40m AOD for the main crossing, and, say, −20m AOD on the southern approaches.

**Connection to the Daresbury Expressway.** It is assumed that the southern starting point of the crossing is the existing Astmoor interchange. The Expressway is elevated over top of the distributor road system. As in previous studies it is assumed that the interchange for the new crossing would be elevated overtop of the existing interchange, and would therefore be at high level. (For any further, more detailed studies, it would, however, be appropriate to examine (in detail) whether the new crossing could utilise the existing interchange arrangement, with limited modification. This would allow the crossing approach to be under the Expressway).

For the purposes of this study the approach to the crossing, therefore, is assumed to lie overtop of the existing Astmoor Road, on viaduct.

**Horizontal Alignments**

Five options for horizontal alignment have been considered and these are illustrated on Figure 3. The horizontal and vertical alignments are shown in detail on drawings number 54023/NWD/001-005.

**Option 1.** From the south, the crossing approaches would be elevated above Astmoor Road, crossing above the Manchester Ship Canal on a gentle left hand horizontal curve so that the alignment across the Mersey would be substantially perpendicular to the river course. This would result in minimisation of impact on river flow of any piers in the river.

The high level interchange with the Daresbury Expressway ensures that, even with the crossing approaches falling at a gradient of 1.5% towards the river, the elevation over top of the Ship Canal is sufficient to give clearance to the canal without the introduction of a lifting bridge. Road level above the ship canal would be approximately 32m AOD.

The crossing over the Mersey could remain substantially at this elevation (but with a gentle longitudinal fall) until it reaches the northern reclamation and then descend rapidly to reclamation level. This results in a vertical profile for the road, which would
lend itself to any form of construction for the bridge crossing, and would ensure a 20m navigation clearance for, substantially, the full width of the Mersey. This vertical alignment is identified as Option 1A in Figure 4.

Alternatively, the road could remain at 32m elevation across the Ship Canal and the southern most 150m of the Mersey to provide a navigation channel, and then descend at 6% gradient to a level of 12.6m AOD across the rest of the Mersey, and land on the north reclamation at approximately reclamation level. This would retain navigation clearances and minimise the length of structure, but would result in a vertical profile that was not wholly ideal for any form of bridge construction and would realistically preclude forms such as a cable stayed bridge, but would be acceptable for viaduct type structures. This alignment is identified as Option 1B in figure 4.

A final option, 1C, embraces a high level crossing of the Ship Canal at 32m elevation and then immediately descends at 6% gradient. This option makes no allowance for a full height navigation channel in the southern 100m of the Mersey, but would in reality provide variable clearance of 13-19m over this portion of the river. As with Option 1B, this vertical alignment would be compatible with a viaduct form of construction but not with a long span structure.

**Option 2.** The approach to the crossing away from the interchange with the expressway is aligned such that the crossing of the Ship Canal is perpendicular to the canal axis. The elevation of the road overtop of the canal is as in Option 1.

Immediately having crossed the canal the road falls downwards to the east, in a single spiral, onto the ground of the Astmoor salt marshes. The crossing of the Mersey would then be perpendicular to the river flow, at 12.6m elevation. The vertical alignment is shown on figure 5.

The advantage of this option is that it would enable the crossing of the Mersey to be at low level, minimising foundation costs, and length of the crossing. It would also produce a vertical profile for the crossing that was suitable for all forms of bridge construction. It does, however, introduce the additional length of the spiral into the crossing.

This option would however, result in clearance of only 6-7m over the Mersey, potentially impeding navigation clearances.

**Option 3.** As Option 2, except that the spiral connecting the crossing of the Ship Canal and the main crossing is replaced by a gentle sweep down onto Astmoor salt marshes to a roundabout. This option would allow road access to be provided onto the salt marshes, potentially facilitating their development.

**Option 4** is as Option 2 for the portion crossing the Ship Canal and the spiral down onto the salt marshes. The alignment then proceeds at ground level westwards on reclamation adjacent to the riverside wall of the Ship Canal, crossing the Mersey on a relatively short bridge at 12.6m AOD elevation. This option would probably be on an alignment that took advantage of the highest rock head levels and therefore generate the shortest founding piles for bridge piers and, also, would not necessarily be reliant upon full reclamation of the north shore of the Mersey.

As with Options 2 and 3 the crossing of the Mersey would be at an elevation of 12.6m AOD, giving a reduced navigation clearance over the river of 6-7m. The vertical alignment of Option 4 is shown on Figure 6.

**Option 5.** A perpendicular crossing of the Ship Canal. The alignment continues on a straight projection of this bearing for a crossing of the Mersey to the eastern end of the north shore reclamation. The options for vertical alignment would be similar to
Option 1, and are designated Options 5A, 5B and 5C, and are shown on Figure 7.

The advantage of this alignment is that with a high level constant elevation vertical profile, a long span bridge could be provided with its back-span abutment located to the south of the Ship Canal, generating the minimum number of supporting piers. This could be beneficial given the expected large depth to rock head and would minimise impacts on river flow and therefore minimise environmental issues.

**Forms of Construction.**

Environmental considerations are assumed to prescribe that the number of piers in the river be minimised (this is to minimise the impact on river flow and, therefore, the impact on downstream ecology). This, in itself, therefore, will in all likelihood preclude the adoption of short span (30 – 60m) structures for the crossing of the river. Whilst such short span structural arrangements would be notionally cheaper for this crossing than longer span arrangements of 100m (by 6-7% for the estimates for this crossing) they would require a large number of foundations. Schemes that include large numbers of foundations would maximise adverse environmental impacts given that there are indications of contaminants within the river bed sediments, and they are, therefore, probably best avoided.

The realistically viable options for crossing the Mersey are therefore constrained to medium (100-150m) and long span structures. The latter minimising the number of piers in the river.

Medium span structures would be viaducts. Typically adopted span arrangements are of the order of 100m, with precast concrete segmental deck sections (post tensioned using external tendons) and built in balanced cantilever, often using a launching girder. Section details for such a viaduct are illustrated in figure 8. For a 100m span arrangement the depth of the deck would be of the order of 4m for a prismatic section and 3 to 6m for a launched arrangement.

Quantities for both 45m and 100m span viaducts have been estimated and extended to costing, which when calibrated against completed projects yield cost estimates of £1250 per sq.m for a 45m span viaduct and £1350 per sq.m for a 100m span viaduct. Bored piles 45m long have been assumed when generating these costings. If shorter piles of, say 20m length, are feasible (as will be the case for landward spans) these overall costs reduce by 7-8% to £1150 and £1250, respectively.

A further reduction in structure cost of the order of 2% (for 45m span arrangements) and 4% (for 100m span arrangements) could arise as a consequence of shorter piers if carriageway level could be reduced from 32m AOD to 12.6m AOD.

Structural form for long span arrangements would be either cable stayed or suspension. The length of the crossing over the Mersey is 750m (options 1, 2, 3) to 1000m (option 5), and a suspension bridge would be uneconomic at this length. The crossing length is within the economic range of a cable stayed structure. Potential span arrangements are illustrated in figure 9 and 10 for alignment options 1 and 5, respectively. The depth of the deck for a cable stayed structure would be of the order of 2.5m.

For a crossing of overall length 750m (Options 1 and 2) a main span of 350m with backspans of 150m would be appropriate. For the 1000m crossing of Option 5 a main span of 525m with back spans of 225m would be appropriate with tower height 160m AOD, just below the obstruction height surface for Liverpool Airport.

It is generally acknowledged that for spans in the range 200-400m a concrete deck is more economic than a composite deck and
that for greater span lengths a composite deck is more economic. Additional economy can be achieved within the span range 350-600m by using a hybrid combination of concrete back span and composite main span.

For the smaller, 350m span cable stayed configuration, harp or fan arrangements for the stay cables would be equally economic and deck construction either wholly concrete or wholly steel. For the longer 525m span, a fan arrangement would be more economic and therefore appropriate. For longer spans cable cost becomes predominant. For the 525m span minimisation of deck weight would be essential (to minimise cable costs) and, therefore, a composite steel/concrete deck would be appropriate.

For either cable stayed option of span length, a prestressed concrete back span would be adopted to provide anchorage weight for the stay cables. In the case of the 525m span structure an intermediate pier would be provided in the back span to facilitate construction of this portion of the deck.

Comparative quantities have been prepared for these cable stayed options and extended to costings, which have been calibrated against known projects.

On the basis of this calibration, costs of £2750 and £3000 per sq.m have been derived for the 350m and 525m span options, respectively.

**Lift Bridge.** The high level interchange with the Daresbury Expressway dictates a high level crossing over the Manchester Ship canal. Navigation clearance to the canal is therefore automatically provided for, and a lift or swing bridge is not required. In the event that a low level interchange and therefore an overall lower vertical alignment were feasible a lift bridge may be required. Such a structure would cost of the order of £5,000 per sq.m of deck, approximately 4 times the cost of a conventional structure.

Option 4 has been investigated to test the comparative economics of a scheme adopting a reclamation on the south side of the river, alongside the existing ship canal wall. The crossing of the Mersey would then be on a low level viaduct. This would offer the shortest bridge crossing of the river.

Figure 11 shows indicative details of the potential reclamation in front of the canal wall. The approach road to the crossing would be constructed on the reclamation.

It has not been possible in the time available for this study to fully investigate the engineering works in the immediate vicinity of the canal wall that might be necessary to preserve its integrity. It is likely that some additional works, over and above those shown on the Figure, would be necessary to minimise and relieve loads on the canal wall. For the details shown the reclamation has been estimated to cost of the order of £21M.

**Scheme Castings**

Costs have been estimated for the various options considered. These castings must be considered to be preliminary as they are based upon limited and incomplete site investigation data (and in the case of the reclamation adjacent to the canal wall, incomplete engineering detail). They have been prepared for a 21.2m wide structure, and the actual width has yet to be confirmed. The castings do however rank the various options and provide evidence as to those that are, perhaps, worthy of further investigation.

The estimated costs of the options considered are given below. These are exclusive of the cost of both the interchange with the Daresbury Expressway (£5M) and the North Shore reclamation (£26M), both of which are common to all options considered.

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Mott MacDonald
<table>
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<tr>
<th>Horizontal Alignment Option</th>
<th>Vertical Alignment</th>
<th>Form of Construction of Crossing of the Mersey</th>
<th>Bridge Cost</th>
<th>North Shore Roadworks</th>
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The evidence indicates that viaduct forms of construction are significantly more cost-effective for the proposed crossing than are longer span (cable stayed) structures. The ability to adopt a viaduct form of construction does, however, presume that locating numbers of piers and foundations within the river course will be acceptable in relation to the impact upon downstream ecology. This has yet to be proven. It also presumes that it will be environmentally acceptable to excavate into and construct piles through the apparently contaminated river bed sediments, and that it will be cost effective to do so.

A viaduct with 100m spans will require 9 piers and foundations within the river.

A viaduct with 45m spans will be approximately 5% cheaper than the 100m span alternative. This would, however, require 20 piers and foundations within the river. This number of piers would be expected to have significantly greater impact upon river flow and contamination issues than would the 100m span option.

Adopting a vertical alignment that keeps road carriageway level over the Mersey as low as possible could result in further economies of approximately 5-10%. The ability to achieve these economies will be dependent upon clarifying navigation clearances over the Mersey.

In the event that environmental constraints will not allow for numbers of piers being constructed in the river channel, a short span cable stayed bridge would offer significant cost benefits over a longer 525m structure (£13M). A cable stayed structure would be approximately 50% more expensive than a viaduct, representing a cost penalty of some £15-17M.

The minimum cost solution, with reasonable expectations of being environmentally acceptable, is a viaduct with 100m spans, and costing £32M. In the event that a 27m
wide structure has to be adopted the cost of the crossing would rise to £40M.

It should be noted that the overall enhanced provisions of Figure 3.2 of Halton Borough Council’s memo of 20 October 1998 could be accommodated on an approximately 22m wide structure if the footway / cycleway were located in the space below the cantilever top flange of the viaduct.

This would be feasible and would have the potential benefit of separating pedestrians and vehicular traffic.

The cost of both the interchange with the Daresbury Expressway and the north shore reclamation have to be added to the crossing cost to generate the total scheme cost. Then being £65M - £73M.

It is of note that some 40% of the total scheme cost is attributable to the north shore reclamation. The scheme could potentially proceed independently of full reclamation of the north shore if the northern approaches were constructed on a reclaimed causeway. This would have significant initial financial advantage, perhaps saving in excess of £15 - 20M, with a resultant scheme cost of £45 - £55M.

Conclusions

The scheme does appear to be feasible.

Horizontal alignments similar to Option 1 appear to offer the most economic scheme.

A viaduct form of construction for the crossing appears to be the most economic form. Spans of approximately 100m are economic.

There may be significant cost advantage if the crossing proceeded independently of the north shore reclamation. The northern approaches could then be constructed on a reclaimed causeway.

Recommendations if the Scheme is to be Refined and Progressed.

1. Establish a better understanding of the geotechnical conditions and contamination of the river bed sediments. An initial site investigation comprising 4 boreholes would be expected to cost of the order of £30,000.

2. Establish the exact navigation requirements over the River Mersey.

3. Confirm the width of the carriageway to be adopted.

4. Establish the environmental constraints and whether a large number of piers constructed within the river would be acceptable.

5. Confirm the obstacle height limits in relation to Liverpool Airport.

6. Assess the feasibility and cost benefit of implementing the crossing independently of the north shore reclamation, constructing the northern approaches either on a causeway or on viaduct.

7. Undertake a topographic survey.

8. Investigate the options for the new interchange with the Daresbury Expressway.
Option 2 - M02C

FIGURE - 5
OPTION 2: VERTICAL ALIGNMENT
TYPICAL VIADUCT CROSS-SECTION
(OVER SUPPORTS)

TYPICAL VIADUCT CROSS-SECTION
(MIDSPAN)

FIGURE - 8
VIADUCT CROSS SECTIONS
100 m SPAN
SECOND RUNCORN CROSSING
OPTION 1A - HARP ARRANGEMENT

SECOND RUNCORN CROSSING
OPTION 1B - FAN ARRANGEMENT

FIGURE - 9
350m SPAN CABLE STAYED BRIDGE
SECOND RUNCORN CROSSING
OPTION 5A - VARYING DECK DEPTH

SECOND RUNCORN CROSSING
OPTION 5B - CONSTANT DECK DEPTH

FIGURE - 10
525m SPAN CABLE STAYED BRIDGE
New Mersey Crossing, Conceptual Design

Following our initial meeting 2 October '98, I have had the opportunity to briefly investigate the possibilities for a new low level river crossing. These initial ideas are detailed in the attached report which is intended for discussion purposes.

Copies of this report have also been supplied to the other members of the New Crossing Working Group.

S. Eccles

c.c. Glyn Smith
    John Knight
    Andrew Pannell
    Andy Cairns
NEW MERSEY CROSSING
CONCEPTUAL DESIGN

1.0 Introduction

1.1 The existing Silver Jubilee Bridge carries 79,000 vehicles AADT. (AADT = Annual Average Daily Traffic, that is total annual traffic divided by 365). This value was determined in 1997 and the flow may currently exceed 80,000 vehicles per day.

1.2 The bridge is a 40ft (12.2 metre) wide four lane single carriageway with lane widths of 10ft (3.05 metres), this is somewhat narrow compared with a standard lane width of 3.65 metres.

1.3 The normal practical capacity of a standard 3.65 wide lane is 1500 vehicles per hour. Peak hour flows of around 1750 vehicles per lane have however been observed. The existing bridge therefore is substantially over capacity at morning and evening peaks. Should traffic flows continue to increase then longer queues will form at times of peak demand and traffic will become heavier off peak. Weekday traffic between the am and pm peaks still is in the order of 1000 to 1300 vehicles per lane per hour hence indicating there is little spare daytime off peak capacity.

1.4 Currently there are a number of factors which could directly induce additional traffic over the bridge such as further economic development of the Borough and external factors such as the M62 new junction 8 and widening J8-9 or Liverpool Airport expansion. A new bridge crossing is therefore required to maintain transport links between the North and South of the Borough.

2.0 Design Standards and Assumptions

2.1 Option G detailed in the Oscar Faber "Mersey Crossing Study" Stage 1 Report gives the optimum balance between cost, environment, value for money and regeneration potential. Option G will therefore provide the basic route alignment for the purposes of this conceptual design.

2.2 The Design Manual for Roads and Bridges TA 46/97 - Traffic Flow Ranges for Use in the Assessment of New Rural Roads will be used as a starting point in the determination of the capacity of the new crossing. Although the new crossing may be subject to a speed restriction in whole or part, its layout with limited access will be appropriate to rural standards.

2.3 The Oscar Faber Report indicated that the design year flows in 2016 (15 years after opening) would be for Option G:

63,000 - 74,000 vehicles AADT for the Silver Jubilee Bridge, and
56,000 - 65,000 vehicles AADT for the New Mersey Crossing.

Assuming that the combined flows of the two bridges would be 80,000 vehicles AADT in the opening year, the flows would be split:
42,000 vehicles AADT for the Silver Jubilee Bridge; and
38,000 vehicles AADT for the New Mersey Crossing.

Note, opening year traffic flows are now the initial basis for design as described in TA 46/97 and replace design year flows.

2.4 If it is assumed that the new crossing would cater only for public transport, cyclists, pedestrians and local traffic, then substitute design criteria may apply. 28% of vehicles using the existing crossing start and finish their journey within the Borough and therefore can be deemed to be local traffic. Should this 28% of local traffic divert onto the new crossing then its opening year flow would be 22,400 vehicles AADT. Many other factors however could cause variance to this prediction.

2.5 The following table has been extracted from TA 46/97 and gives an indication of design standards related to traffic flow.

<table>
<thead>
<tr>
<th>(Carriageway Standard)</th>
<th>Opening Year AADT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minimum</td>
</tr>
<tr>
<td>Single 7.3m (S2)</td>
<td></td>
</tr>
<tr>
<td>Wide single 10m (WS2)</td>
<td>6,000</td>
</tr>
<tr>
<td>Dual 2 lane all purpose (D2AP)</td>
<td>11,000</td>
</tr>
<tr>
<td>Dual 3 lane all purpose (D3AP)</td>
<td>23,000</td>
</tr>
<tr>
<td>Motorway</td>
<td></td>
</tr>
<tr>
<td>Dual 2 lane motorway (D2M)</td>
<td></td>
</tr>
<tr>
<td>Dual 3 lane motorway (D3M)</td>
<td>25,000</td>
</tr>
<tr>
<td>Dual 4 lane motorway (D4M)</td>
<td>52,000</td>
</tr>
</tbody>
</table>

TA 46/97 also provides guidance on “Congestion Reference Flows” which is the AADT threshold which if exceeded a breakdown of traffic flow could occur leading to queuing. The Congestion Reference Flows for the various standards of road are as follows:

<table>
<thead>
<tr>
<th>(Carriageway Standard)</th>
<th>Trunk Road</th>
<th>Principal Road</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single 7.3m (S2)</td>
<td>22,000</td>
<td>23,000</td>
</tr>
<tr>
<td>Wide single 10m (WS2)</td>
<td>32,000</td>
<td>33,000</td>
</tr>
<tr>
<td>Dual 2 lane all purpose (D2AP)</td>
<td>68,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Dual 3 lane all purpose (D3AP)</td>
<td>103,000</td>
<td>104,000</td>
</tr>
<tr>
<td>Motorway</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual 2 lane motorway (D2M)</td>
<td></td>
<td>65,000</td>
</tr>
<tr>
<td>Dual 3 lane motorway (D3M)</td>
<td></td>
<td>97,000</td>
</tr>
<tr>
<td>Dual 4 lane motorway (D4M)</td>
<td></td>
<td>130,000</td>
</tr>
</tbody>
</table>
The Congestion Reference Flows given are only a guide and local conditions should be taken into account. Should a degree of congestion during peak hours be acceptable then flows in excess of those stated could be achieved. Note, for example Department of Transport advise that for a 12.3m wide four lane single carriageway, similar to the Silver Jubilee Bridge, only 1250 vehicles per lane per hour can be carried. In practice however up to 1750 vehicles per lane per hour are being carried but with a degree of delay in per hours. At times between am and pm peaks traffic is free flowing at around the theoretical maximum of 1250 vehicles per lane per hour.

2.6 The 24 hour AADT for a road is normally around 10 times the maximum peak hour flow. As stated in paragraph 1.3 the capacity of a standard 3.65m wide lane is 1500 vehicles per hour. The two way flow for a 7.3m wide 2 lane single carriage is therefore 3000 vehicles per hour. Multiply this figure by a factor of 10 and an AADT of 30,000 vehicles is achieved. There is therefore a range of design flows for a given standard of road, for example for a 7.3m wide single carriageway there is:

(i) opening year AADT of 13,000;

(ii) a congestion reference flow of 23,000; and

(iii) an AADT of 30,000 based upon maximum hourly flows. From observations described in para. 2.5 relating to the Silver Jubilee Bridge such a flow could be achieved without significant congestion.

2.7 For the purposes of this design exercise it is to be assumed that the river crossing will be a low level structure using multiple short spans for the purpose of economy. The bridge would need to cross over the Manchester Ship Canal and a navigation channel in the Mersey and overhead clearance would need to be taken into account. At the location of the ship canal a lifting or swing bridge may need to be provided.

2.8 At the Widnes side of the river crossing part of the estuary may be reclaimed for purposes such as a water park or for a mixture of leisure and housing. Within the reclamation area the crossing could be constructed on causeway.

2.9 Notable examples of such causeway/low level viaduct crossings of tidal waters are the Bahrain Causeway and the Florida Keys Expressway. British examples include the A87 crossing of Loch Long at Dornie and the A9 crossing of the Dornoch Firth, both located in the Highland Region of Scotland, constructed in or around 1991.

2.10 It is intended that the crossing will carry a bus lane in each direction to link the Runcorn Busway into Widnes. Currently the busway has a normal carriageway width of 6.7m i.e. a 3.35m lane width. In this design a standard lane width of 3.65m has been assumed for the busway.

2.11 The crossing will carry a footway and cycleway and it is assumed that at this stage it will be combined or perhaps separated by a kerb. Such a combined footway and cycleway should a minimum width of 3m, however 4m would be desirable in view of the anticipated level of usage.

2.12 Where the busway is segregated from the highway but runs closely alongside it, then a visual screen between the two will be required to avoid confusion to drivers. This is particularly important during hours of darkness as headlamp glare would present a problem.
2.13 In order to determine outline details of the crossing’s sub-structure, river bed level information and geological data will be required.

3.0 Construction Options for the Crossing

3.1 Three basic construction options for the river crossing are to be considered, these are:

(a) single carriageway 7.3m wide with bus lanes either side plus a footway/cycleway;

(b) wide 10m single carriageway with 1m wide hard strips, a segregated 7.3m wide 2 lane busway and a footway/cycleway; and

(c) dual 2 lane all purpose carriageway with segregated 7.3m wide 2 lane busway and a footway/cycleway.

Cross sections of these proposals are illustrated as in figures 3.1, 3.2 and 3.3 respectively.

3.2 Option (a), Fig. 3.1 is the most minimal crossing proposal at least in terms of highway provision. Cross sectional width for the busway and footway/cycleway remains essentially the same throughout the proposals. Should only current local traffic be provided for (22,400 vehicles AADT) then this proposal would allow near capacity but free flowing conditions, however if traffic was to exceed 30,000 vehicles then congestion would occur. This option would however not cater for the demand predicted in the Oscar Faber Stage 1 Report, i.e. 56,000 - 65,000 vehicles AADT in 2016 or even the opening year flow if around 38,000 vehicles AADT. With the highway approaching capacity even at the time of opening there could be a tendency for the unsegregated busway to be used illegally. A segregated busway could be used with this option but would add up to 2 metres to the bridge deck width.

3.3 Option (b) Fig. 3.2 provides a wide single carriageway of 10 metres with 1 metre wide hard strips either side. TA 46/97 recommends that the opening year AADT for such a road should not exceed 21,000 vehicles which is not dissimilar to the opening year local traffic of 22,400 vehicles AADT. A free flow approaching capacity of 33,000 vehicles AADT is possible with this option. Congestion conditions would occur probably around 40,000 vehicles AADT in the peak hour periods. Wide single carriageway offers greatly enhanced overtaking potential as three vehicles can pass in one instance but this also can create careless overtaking manoeuvres. Should this occur then chatching and road studs could be provided in the centre of the carriageway to limit this. This option may just cope with the opening year flow based upon Oscar Faber assumptions of 38,000 vehicles AADT, however design year flows would well exceed capacity. Option (b) does however have the possibility to convert the wide single carriageway into four substandard lanes of 3 metres. This could be widened to 3.15m wide lanes by a shift of the central reserve of 0.6m, hence narrowing the busway to 6.7m which is the current standard for the Runcorn Busway. This substandard four lane single carriageway would at least have the same capacity as the existing Silver Jubilee Bridge. The central reserve would require a visual/anti dazzle screen in order to avoid the appearance of a dual carriageway. Option (b) would be 4-6 metres wider than option (a) depending on whether option (a) had a segregated busway or not.
3.4 Option (c), Figure 3.3 is a dual 2 lane carriageway with segregated busway and footway/cycleway. Such a standard of road according to TA 46/97 could have an opening year AADT of up to 39,000 Vehicles and the Congestion Reference Flow is 70,000 vehicles AADT. This therefore would cope with all predicted traffic flows. Conversely the ability of this crossing to carry more vehicles than the existing bridge may precipitate traffic problems elsewhere. For example in Widnes, should free flowing conditions be permitted then complex junction provision may be required in proximity of the A557 Relief Road traffic signal controlled junctions. Should congestion occur in Widnes then the full capacity of the bridge would prove counter productive.

4.0 Alignment Options

4.1 The start point to the south of the river is the same for all options, this being the Astmoor Junction on the Bridgewater Expressway. It is intended that the busway in proximity of this junction also link onto the river crossing. Details of the junction layout need to be determined.

4.2 It is desirable that the busway links in with South Widnes, whereas it is advantageous that the all purpose road links directly with the Commercial Centre of Widnes. Various options for termination points in Widnes for roadway and busway have been investigated, this in turn has led to differing alignments.

4.3 Three basic route corridors have been superficially investigated, these being;

(i) the Westerly Option where the road ties in with Widnes Eastern Bypass to the south of Ashley Way using a traffic signal controlled junction. Alternatively a roundabout junction could be provided. It is intended that grade separation of the existing A557/Fiddlers Ferry Road Junction be provided due to existing congestion. The busway would link in with Constance Way in South Widnes, refer to Fig 4.1;

(ii) the Central Option which provides a grade separated link onto the Eastern Relief Road for non local traffic and a link onto Tanhouse Lane for local traffic. The busway would also link to Tanhouse Lane but could also link to other termination points. Existing development would present an obstacle to this alignment, refer to Figure 4.2; and

(iii) the Easterly Option which brings the combined road and bus route along Tanhouse Lane. Traffic could either head west or east along Fiddlers Ferry Road or continue north eventually linking with Bradley Way via a new bridge over the eastern bypass, refer Figure 4.3.

Various further permutations can be made of these basic options, these will be detailed in the following paragraphs. It should also be noted that where a segregated roadway and busway is chosen as an option for the river crossing then segregated termination points or traffic signal control would need to be provided.

4.4 Assuming that the busway crossing will join South Widnes and the road will provide just for local traffic and feed into Central Widnes the following options illustrated in Figures 4.4 to 4.6 have been considered.
5.0 Cost Estimates

5.1 The cost of the water park to the north side of the estuary as detailed in the report Halton Water was £17.7m at 1987 prices. This therefore is a significant item of the project. If however a large proportion of the reclaimed land was filled with inert tip material, then costs would be significantly less.

5.2 The overall cost of the bridge structure would be in the order of £1,500/m² (to be confirmed with Bridges Section). The shortest crossing is about 850 metres long and the width of the narrowest option is 21.2m. The cost of such a crossing would therefore be in the order of £27m. The cost of a crossing without providing the Water Park is about 1600m long would be around £51m. The difference in cost of £24m would substantially offset to the construction cost of the Water Park, (say £30m at current prices).

5.3 The cost of the lifting/swing bridge is to be determined.

5.4 The construction cost of a single carriageway busway or roadway would be in the order of £1m/km, excluding structures, land and stats diversions. The bridge crossing over the Widnes Eastern Relief Road would be in the order of £0.75m and provision of grade separation at the Relief Road/Fiddlers Ferry Road Junction would be around £2m.

6.0 Discussion

6.1 Three options for the standard of the crossing have been investigated these are:

(i) 2 lane single carriageway with busway lanes to the sides or segregated busway plus footway/cycleway, refer to Figure 3.1;

(ii) wide 2 lane single carriageway with segregated busway and footway/cycleway refer to Figure 3.2; and

(iii) dual 2 lane carriageway with segregated busway and footway/cycleway, refer to Figure 3.3.

Should provision be made for predicted traffic flows then dual 2 lane carriageway should be provided. Historically failure to meet accepted standards has provided justification to objections in that a full solution was not being proposed and an additional crossing would be required in future years. This however is not the case as the highway authority now is expected to manage traffic demand. In view of this a single carriageway option should be provided. The wide single probably would be the most desirable as four lanes of traffic could be accommodated on the carriageway during full or partial closures of the Silver Jubilee Bridge whilst maintaining separate flow on the busway. If normal single carriageway is opted for, then it would be advisable to have a non segregated busway in order that the bus lanes could be used by general traffic during maintenance of the Silver Jubilee Bridge.

6.2 Of the alignments indicated in Figures 4.1 to 4.6 the most suitable busway link into Widnes may be via Constance Way with the road linking onto Bradley Way over the Eastern Relief Road. Buses however could use the roadway and a road link could be provided as well directly onto the Relief Road.
Figure 3.1
River Crossing with 7.3m Carriageway

Scale 1:100
Figure 3.2
River Crossing with 10.0m Carriageway

Possible long term conversion to 4 lane single carriageway with 3.0m wide lanes which could be increased to 3.15m should the busway be narrowed to 6.7m.

Total width=27.1m
Figure 3.3
River Crossing with 14.6m Dual Carriageway

Scale 1:150