

**Environment Agency
Jubilee River
Post 2003 Recommendations
Closure Report**

January 2007

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GLOSSARY OF TERMS

<i>Term</i>	<i>Meaning / Definition</i>
LFP	Lewin Fryer Partnership
EA	Environment Agency
m AOD	Metres above Ordnance Datum
LiDAR	Light detection and ranging
FLI-MAP	Fast Laser Imaging, Mapping and Profiling
LHB	Left Hand Bank (Looking downstream)
RHB	Right Hand Bank (Looking downstream)
DTM	Digital Terrain Model
S105	Section 105 Flood Risk Mapping Project
MWEFAS	Maidenhead, Windsor & Eton Flood Alleviation Scheme
Q65	1 in 65 year flow event on the River Thames
Q100	1 in 100 year flow event on the River Thames

1 Executive Summary

The purpose of this report and the study work undertaken as part of this report has been to appraise the recommendations made in a series of documents produced after the January 2003 flood event. The event in January 2003 revealed a number of failures in the design and identified some performance issues of the newly opened Maidenhead Windsor and Eton Flood Alleviation Scheme (MWEFAS) and specifically the Jubilee River element of that scheme.

A number of reports were provided for assessment and evaluation and this report tracks the recommendations made in those various reports through to their conclusion. This report aims to help the reader follow the progression of reporting and recommendations made since 2003 to the present day.

Initial reports focussed on the most critical requirements for repair or reconstruction of the damaged areas of the Jubilee River together with aspects requiring further study or data. Later reports concentrated on examining solutions for identified weaknesses

Following repair and remedial works and the gathering of data the focus of attention moved to the capacity of the Jubilee River both in relation to its original design and specification and to its interface with the River Thames. There were recommendations made for bank raising works to develop the capacity of the Jubilee River up to its original design however it was recognised during the development process that this was not a straightforwardly achievable objective.

Studies concluded that the design capacity originally envisaged was not achievable through construction of the works as designed. This has been made clear by the use of improved modelling techniques and the availability of new hydraulic data which have altered the understanding of the influence the River Thames downstream condition has on predicted water levels in the Jubilee River.

As a consequence of this acknowledgement the project team agreed that the most appropriate way forward to conclude the remedial works to the Jubilee River was to ensure embankment levels were set at the originally modelled LFP 1 in 65 year water level plus 300mm freeboard and within the original planning permission granted for the scheme.

The hydraulic modelling upon which analysis to date is based has not been formally calibrated against a real measured event. Data gathered through future operation of the Jubilee River will be used to further verify and improve the hydraulic model.

Works have now been undertaken to raise all those embankments where the above criterion, within a 50mm tolerance margin, was not met. The final phase of the remedial works was completed in September 2006.

In addition to the various remedial works, studies and surveys, the Environment Agency has agreed processes for gathering further data to monitor and evaluate the performance of the Jubilee River in the future and also to liaise with stakeholders in a timely manner. These are not addressed in this report.

2 Introduction

2.1 Background

Between the 4th and 8th January 2003, the River Thames catchment experienced the largest flood event since 1947. To prevent flooding of Maidenhead, Windsor and Eton approximately 140m³/s were diverted from the River Thames into the Jubilee River, via the Taplow Sluice in accordance with the operation rules.

During passage of this flow, a number of structures and areas of embankment along the Jubilee River suffered significant damage. Since 2003, Jacobs and Atkins have been working with the Environment Agency on studies and remedial works to restore the Jubilee River to its design requirement.

Atkins was commissioned by the Environment Agency to carry out a condition assessment report, which was issued in April 2003. Based on this and subsequent reports as well as both hydraulic and physical modelling results, a series of works has been recommended either in the form of remedial works to repair damage, or raising bank heights to increase the capacity of the Scheme nearer to its original design intent.

2.2 Closure Objectives/Brief

The main objectives of this report are listed below:

1. To list the recommendations made by Atkins and others in the reports post 2003.
2. To provide a summary of the works undertaken to implement the recommendations of those reports.
3. To clearly show the logical links between all recommendations, including the decision-making process behind their development.
4. To provide a clear chronological account of the estimates of changes to the capacity of the Jubilee River.
5. To verify that the remedial works have been carried out in accordance with the recommendations made since the 2003 flood event.

The report covers the entire length of the Jubilee River from the River Thames upstream of Boulter's weir (Maidenhead) to its confluence with the River Thames downstream of Romney weir (Windsor).

2.3 Chainage

It is important to note that the chainage of the Jubilee River has evolved from the initial Lewin Fryer and Partners (LFP) design to that used for the majority of the post event analysis and reporting. During this analysis, Atkins decided to use the reverse chainage to that used by LFP during the original design to reflect modelling best practice. The approach to the chainage system is detailed in Report Ref. 3 Appendix C. There has been confusion in the use of place names in some reports; here the agreed chainage will be used as the key reference point together with the recognised place name.

For clarity and information the following table is provided giving agreed chainage and place name;

Chainage	Location
0	Jubilee River upstream boundary with the River Thames
1030	Taplow Sluice/Mill Lane Bridge
1250	Berry Hill Foot Bridge
1789	A4 Road Bridge
1924	Dorney Rail Bridge
2250	Amerden Lane Bridge
3262	Marsh Lane Weir
4000	West Town Farm Service Bridge
4277	M4 Road Bridge
5050	Ashford Lane Foot Bridge
5332	Lake End Road Bridge
5800	Dorney Foot Bridge
6000	STW Access Bridge
6930	Manor Farm Weir
7300	Bridleway Bridge
8729	A335 Bridge
9281	Chalvey Rail Bridge
9665	Slough Road Weir
9839	A332 Slough Road Bridge
10650	Myrke Foot Bridge
11123	Pococks Lane Road Bridge
11200	Black Potts Foot Bridge
11340	Black Potts Weir
11650	River Thames

2.4 Reports Considered

This closure report considers some 13 reports produced following the flood event of 2003. The reports focus on recommendations for post event capacity studies and associated remedial works. They do not include the reports concerning the repair works completed on the major individual structures which have been repaired since 2003.

Appendix A provides the detailed references. Referencing of these particular documents within this closure report will use the reference number given in the appendix.

3 Report Recommendations

The large number of reports considered in this analysis and the detailed recommendations made in them are too numerous to list in this section.

Details of the recommendations and conclusions (including follow up details/actions where recommendations were not made as required in point 1 of 2.2 above), are detailed in Appendix B. The report reference number noted in the table below refers to the reports as listed in Appendix B which establishes how each recommendation has been implemented and confirms its completion. The table below is a summary of Appendix B.

The table below provides an overview of each of the reports' main recommendations and their background:

Report Ref.	Report Title	Date	Purpose	Main Findings
1.	Jubilee River Investigation, Condition Assessment Report	April 2003	The brief was to undertake a condition survey.	Identification of areas of erosion following the 2003 event.
2.	Jubilee River – Technical Review	July 2004	Independent technical review.	Identified shortcomings in the Jubilee River scheme and identified a series of actions to mitigate these shortcomings.
3.	Jubilee River – Hydraulic Review	July 2004	To establish the capacity of the Jubilee River and identify capacity shortcomings.	A new topographical survey was recommended, including as built verification. Reduced capacity of the channel was highlighted. Physical modelling of key structures was recommended. Options to investigate increasing capacity were recommended.
4.	Review of Atkins Jubilee River Modelling Work	August 2004	An independent check of the findings of the Hydraulic Review by Jacobs. (Ref 3)	The report supported the findings of the Hydraulic Review and made recommendations concerning further survey work, completion of physical models and installation of water level recorders.
5.	Modelling of Bank Improvements Downstream of Manor Farm Weir	August 2005	Determine potential capacity of the Jubilee River post remedial works using new topographical data.	Post remedial works estimates of capacity provided. Capacity in the Jubilee River now related to flow in the River Thames and hence better understanding of the impact of the River Thames levels on the Jubilee River
6.	Summary of Bank Raising based on Manor Farm Report	April 2005	Initial identification of low points based on water levels from the Jacobs ISIS hydraulic model	Specific reaches for bank raising identified

Report Ref.	Report Title	Date	Purpose	Main Findings
7.	Jubilee River: Final Remedial Works, Recommendations Report	August 2005	To identify final remedial works to deliver scheme as originally specified.	Identification of reach for bank raising.
8.	Jubilee River: Bank Raising Works, Recommendations Report	January 2006	To confirm bank raising work based on original LFP 1 in 65 yr water level plus 300mm.	Areas identified for bank raising. Report also concluded that overall capacity of the Jubilee River would be 190m ³ /s.
9.	Comments on Downstream Levels – Included at back of Hydraulic Review, (Extract)		Paper reviewing upper and lower bounds of predicted water levels in the Jubilee River relating to River Thames levels.	Noted that water levels in the Jubilee down stream of Manor Farm are influenced by the River Thames.
10.	Preliminary Review of the Marsh Lane Topographic Survey Results, Technical Note – (Draft for discussion only),	September 2005	Review available survey data and comment on variability and accuracy.	Investigation and more detailed survey highlighted variability and inaccuracies concluding that some works previously identified were not actually required.
11.	Taplow Intake Structure, Jubilee River, Physical Model Study	January 2005	Detailed modelling recommended to increase knowledge of performance characteristics.	Existing rip rap only adequate up to 120m ³ /s with existing planned gate movements. With modified gate movements rip rap would be OK for all flows, Recommendations for rip rap size made. Gate operation above 160m ³ /s should be non sequential.
12.	Black Potts Viaduct and Pockocks Lane Bridge, Jubilee River, Physical Model Study	September 2005	Detailed modelling recommended to increase knowledge of performance characteristics	Viaduct capable of freely discharging flows up to 250m ³ /s and the rip rap will be stable under maximum velocities predicted.
13.	Marsh Lane Flow Control Structure, Jubilee River, Physical Model Study	March 2006	Detailed modelling recommended to increase knowledge of performance characteristics	Upstream banks stable under predicted maximum velocities and downstream gabion works stable under predicted maximum velocities.

4 Summary of Works

4.1 Introduction

This section provides a summary of the works undertaken to implement the recommendations of the various reports, as noted in point 2 of 2.2 above. In addition the linkage between the works undertaken and the recommendations made in Section 3 above is reviewed.

Many recommendations were made for bank raising works to develop the capacity of the Jubilee River up to its original design however it was recognised later in the development process that this was not a straightforward objective. The various studies, in particular the detailed hydraulic modelling of the impact of the Thames water levels on the flow capacity of the Jubilee River, led to the conclusion that the design capacity originally envisaged was not achievable through construction of the works as designed.

As a consequence of this acknowledgement the project team agreed that the most appropriate way forward to conclude the remedial works to the Jubilee River was to ensure embankment levels were set at the originally modelled LFP 1 in 65 year water level plus 300mm freeboard as permitted by the original planning permission. The freeboard provides a margin of safety to allow for fluctuations in the bank levels due to settlement, higher than predicted water levels and for any surface waves breaking on the bank.

Additional work was carried out to look at options to further increase the capacity of the channel as part of the Enhanced Capacity Study. It was decided that these options will not be developed any further at the present time. The options will be reviewed following the completion of the Lower Thames Strategy which is currently being developed.

The following data were assessed for the bank raising works:

- The water levels were taken from the LFP HecRAS model, latest version 2.11 dated October 2001, and earliest version 1.99 dated August 1998.
- The design bank levels were taken from the original LFP design drawings dated October 1997.
- The existing bank levels were taken from the topographic surveys completed in 2004 and 2005.

The following assumptions were made during the assessment of bank raising works:

- The dataset used was the best available.
- Where the actual bank level is less than 50mm below the LFP 1 in 65 year water level plus 300mm freeboard (i.e. within settlement tolerance) no further action would be required.
- The bank raising works at Eton Right Bank should retain the previously incorporated preferential spillway.
- The recommended bank levels for the works should not exceed those approved by the original planning permission.

All the recommended works are now completed.

4.2 Mill Lane Road Bridge, July 2003 (Chainage 1050)

These were emergency works post the January 2003 event to repair the structural failures. Works were undertaken in July 2003 and consisted of the placing of rock armour on the river bed to fill a post event scour hole, rock armour reinforcement to the left bank revetment and gabion reinforcement to the right bank revetments. This work is not specifically identified in any of the reference reports.

4.3 Manor Farm Weir, July 2003 (Chainage 6900)

These were emergency works to repair failures post event. Works were undertaken in July 2003 and consisted of repairs to both left and right banks including steel sheet piling and rock armour work. The weir structure was also re-built.

4.4 Myrke Embankment, September 2004 (Chainage 10600)

Works were undertaken in September 2004 to rebuild the embankment and raise it by 300mm, as recommended in Ref.2. The final level for this work was 20.50m AOD. The embankment is situated between the Jubilee River and the Myrke Ditch.

4.5 Chalvey Left and Right Banks, October 2004 (Chainage 7300 to 8750)

Works here were undertaken in October 2004 and included the raising of a total of 640m length of embankment to a level of between 20.80 and 20.85 m AOD. Chainages were LHB 8000 to 8750 and RHB 7300 to 8500. This work is not identified in any of the reference reports but was undertaken as an addition to the Myrke Embankment contract commenced in the summer of 2004. This addition to the Myrke Embankment contract was instigated at site level following hydraulic modelling and topographical data becoming available regarding low levels in this section of the defences and funds also becoming available.

4.6 Slough Road Weir, September 2005 (Chainage 9750)

During September 2005 the weir crest and apron were re-formed and some bank protection works were completed nearby. The design of these works was noted as recommendations in Ref. 2.

4.7 West Town Farm Service Bridge, December 2005 (Chainage 4000)

The defence level was raised on the LHB to 21.90 m AOD over a length of approximately 100m in December 2005. Works comprised installation of pre-cast concrete edgings with concrete footings to form the final level, backfilled riverward and landward. Works are as recommended in Ref.6.

4.8 Mill Lane Road Bridge, March 2006 (Chainage 1050)

Works were undertaken to fill holes in the bank revetment during January and February 2006. The filling was achieved by the placing of concrete mattressing. A geotextile was placed on the RHB to aid vegetation establishment. Report Ref.10 noted the requirement to develop a physical model of the structure; however the reference reports do not indicate the requirement for work in this location.

4.9 Chalvey Rail Bridge, August 2006 (Chainage 9250)

An 18m length of defence on the right hand bank has been made up to a level of 20.50 m AOD using pre-cast concrete edgings back filled with suitable materials. The work was undertaken in August 2006. Work requirements to this section of the river embankment are noted in Ref. 6 and 8. Additional survey work confirmed that this section needed to be raised and it has now been raised to the maximum level permitted under the existing planning consent.

4.10 Myrke Footbridge, August 2006 (Chainage 10600)

A 16m length of defence on the left hand bank immediately d/s of the footbridge has been made up to a level of 20.18 m AOD using pre-cast concrete edgings backfilled with suitable materials. This work is now complete. Works requirements to this section of the river embankment are noted in Refs. 7 and 8.

4.11 Eton, August 2006 (Chainage 10746-10906)

Works on the right hand bank, including re-grading and reinforcing of the spillway to a level of 20.02 m AOD over a length of 150m adjacent to an area known as Agars' Plough, is complete. A further 60m of embankment d/s of this location has been raised. Work requirements to this section of the river embankment are noted in Refs. 6 and 7.

4.12 Black Potts, August 2006 (Chainage 11350)

A 50m reach downstream of the viaduct on the left bank was raised to a level of 18.80 m AOD in August 2006. The works are now complete and comprise trench sheets with a concrete capping. The sheeting forms a retaining structure to allow re-grading of the adjacent footpath. Though not part of the original LFP MWEFAS design, the requirement for these works was identified in Refs. 4 and 7.

4.13 A4 Road Bridge, August 2006 (Chainage 1582)

A 30m section of defence on the right bank upstream of the bridge was raised to a level of 23.00 m AOD in August 2006. The works comprise pre-cast concrete edgings adjacent to the public footpath, backfilled with suitable material. This work raises the overall capacity of the Jubilee River since it was a particularly significant low point. The requirement for these works was identified in Ref. 7.

4.14 Timeline, Works, Reports, Surveys.

The following table provides a time line of project development since the 2003 event:

Date	Report	Survey/Modelling	Works
January 2003		Environment Agency emergency LiDAR	Emergency repairs to Manor Farm bank
April 2003	Condition Assessment Report, Ref 1.	Environment Agency FLI-MAP	
May 2003		Maltby Land Surveys. Topographical land survey	Holding repairs to Manor Farm weir
July 2003			Channel reinforcement works at Taplow (Mill Lane Road Bridge) Permanent repair works at Manor Farm Weir Temporary repairs to Slough Road Weir Bank repairs at Marsh Lane
December 2003		Atkins Survey. Topographical land survey	
July 2004	Technical Review, Ref 2. Hydraulic Review, Ref 3.		
August 2004	Review of Atkins Jubilee River Modelling Work, Ref 4.		
September 2004			Rebuild and raising of the Myrke Embankment Roundmoor Ditch Bank Temporary Bund at Blackpotts Viaduct

Date	Report	Survey/Modelling	Works
October 2004			Raising of the Chalvey left and right banks
November 2005		Taplow Intake Structure physical model	
April 2005	Identification of low points, Ref 6.		
August 2005	Modelling of bank improvement works d/s of Manor Farm Weir, Ref 5. Final remedial work recommendations, Ref 7.		
September 2005	Review of Marsh Lane topographical survey, Ref 10.	Black Potts Viaduct and Pockocks Lane Bridge physical model	Permanent repairs at Slough Road Weir
December 2005			Raising of left bank at West Town Farm Service Bridge
January 2006	Bank raising works recommendations, Ref 8.		
March 2006		Marsh Lane Flow Control Structure physical model	Reinforcement of bank revetment and repair of scour holes in bed at Taplow (Mill Lane Road Bridge)
August 2006			Raising of right bank at Chalvey Rail Bridge Raising of left bank at Myrke Footbridge Raising of right bank at Eton Construction of permanent flood defence on left bank, downstream of Black Potts viaduct Raising of right bank upstream of A4 Road Bridge.

5 Key Considerations

As understanding and knowledge of the capacity of and constraints to the Jubilee River increased over the post event period it was necessary to modify some of the recommendations. This section details these **critical changes** and how they impacted on the final works.

5.1 LFP Design Capacity

The original design and modelling work for the Jubilee River was undertaken in the 1991 using data and techniques available at that time. This included the use of the HecRAS steady state model. The planning application stated that the scheme would be capable of accommodating 515m³/s. This was made up of 300m³/s in the River Thames (including 17m³/s in the Maidenhead Ditch) and 215m³/s in the Jubilee River. This capacity equated to an estimated 1 in 65 year return period event.

5.2 Post Event Understanding

Following the flood event of January 2003 there was a series of investigations, studies, reports and gathering of data to evaluate the full circumstances surrounding the apparent failure/underperformance of the Maidenhead, Windsor and Eton Flood Alleviation Scheme. A greater understanding of how the Jubilee River actually functions was gained through this work. The main conclusion was that the capacity of the Jubilee River was not as envisaged in the planning application. Details, of how understanding of the capacity changed, are provided in Section 6.

It is noted here that improvements in mathematical modelling techniques between the original LFP work and 2003 are significant and have a material influence on predicted water levels in the River Thames and Jubilee River. In addition the 2003 flood event itself provided us with a lot of data which enabled us to better calibrate the hydraulic models.

In addition to the modelling work there was a significant amount of topographical survey data obtained to assist in the revised assessment of capacity. This work highlighted areas where embankment levels were not as the original LFP design and hence where capacity was compromised.

5.3 Modelling of the Lower River Thames

At the same time as the various studies were being undertaken to investigate performance of the Jubilee River the Environment Agency was undertaking a separate study to model the Lower River Thames. Jacobs's re-calibration of the Lower River Thames model in July 2004 increased the predicted downstream water level for the Jubilee River under the original LFP 515m³/s design event from 19.35m AOD to 19.64m, effectively raising the estimated water level through the Jubilee River for the same return period. This finding had a significant impact on how the remedial works planned for the Jubilee River were to progress and the understanding of predicted water levels, capacity and return periods.

Subsequent analysis in June 2005 using a new two dimensional model of this reach of the Thames gave a revised downstream water level of the Jubilee River of 19.44m AOD. As a result, re-evaluation of the Jubilee River capacity was required.

5.4 Accuracy of Topographical Survey

As noted in Section 4.15 the several surveys undertaken after the 2003 event used a number of different techniques to provide the different types of data required at the time. During the course of data analysis it became apparent that there were differences between some of the data used.

One of the first surveys to be undertaken was using FLI-MAP, a remote sensing technique. Tolerance for the survey was set at plus or minus 100mm in the survey specification but onsite re-survey at known points indicated this error to be greater than 100mm. As a consequence of this apparent inaccuracy and a lack of confidence in the data set further detailed survey work was then procured at known critical reaches to provide greater confidence for bank raising works to progress.

5.5 Embankment Raising Principles

During the course of the post 2003 studies and with reference to the issues noted in Sections 5.1 to 5.4 above it became apparent that the Jubilee River could not be reconstructed / reinstated to its original design capacity especially given the planning permission granted. It was therefore agreed by the project team that the adoption of the LFP 1:65 design water level plus 300mm freeboard would be the criterion against which embankments would be evaluated.

The freeboard provides a margin of safety to allow for fluctuations in the bank levels due to settlement, higher than predicted water levels and for any surface waves breaking on the bank. Where embankments were identified as being more than 50mm below this evaluation level (i.e. in excess settlement tolerance) they have been raised.

The necessary bank raising is now complete (see Appendix B).

Following conclusion of the remaining items the MWEFAS will be deemed complete and passed to the Environment Agency as a maintainable asset. Any future requirement to review the functionality and capacity of the system will be undertaken as part of the regular review of assets undertaken from time to time by the Environment Agency.

6 Capacity Chronology

During the post event investigations, as noted in Section 5, knowledge of the combined hydraulic behaviours of the Jubilee River and the Thames local to the MWEFAS has increased significantly through additional survey and modelling work.

The increase in knowledge has led to improved predictions of flows, levels and capacity in the two watercourses. It should be noted that the level and flow in the River Thames reach has a significant bearing on the level and flow in the Jubilee River, therefore data should always be quoted either as a scheme capacity or as a pair of capacities. The MWEFAS return period assessments have been based on the combined scheme flow capacities of the two rivers. This process of knowledge change is detailed in the following table.

Date	Development	Jubilee River Modelled Flow	River Thames Modelled Flow	Combined Flow	Estimated Return Period
	Original design, LFP	215m ³ /s	300m ³ /s	515m ³ /s	1 in 65
Jan 03	Flood event	144m ³ /s (Estimated actual)	247m ³ /s	391m ³ /s Measured	1 in 12
July 04	Atkins Hydraulic Review, based on Jacobs River Thames model d/s conditions.			515m ³ /s 533m ³ /s	1 in 65 1 in 100
July 04	Atkins modelled Jubilee River flows assuming 180m ³ /s flow in the River Thames and the original design operation.	145m ³ /s. 300mm freeboard allowance.	180m ³ /s	325m ³ /s	Not reviewed at this time
July 04	Atkins modelled flows assuming Jubilee operates with 250m ³ /s as the suggested River Thames in bank capacity.	140m ³ /s. 330mm minimum freeboard.	250m ³ /s	390m ³ /s	Not reviewed at this time
March 05	Bank Raising Works at Chalvey.	150m ³ /s	250m ³ /s	400m ³ /s	Not reviewed at this time
Dec 05	Bank Raising Works at West Town Farm, results from the Taplow and Black Potts physical model tests and finalised downstream boundary model conditions.	170m ³ /s	250m ³ /s	420m ³ /s	Not reviewed at this time
Sept 05	The review of the River Thames capacity and completion of the final bank raising works.	180m ³ /s	270m ³ /s	450m ³ /s	1 in 25

It is important to note that the overall capacity of the Jubilee River is based on specific bank levels in critical reaches.

7 Conclusions

1. The original design capacity of the Jubilee River cannot be achieved by reinstating or reconstructing the channel as the original design drawings.
2. The actual capacity of the Jubilee River, post 2003 event, as determined by using the ISIS modelling software and post construction survey data is below the anticipated capacity as identified in the original planning application
3. Remedial works undertaken to date have endeavoured to reinstate the flood defence embankments to a level equivalent to the LFP 1 in 65 year water level plus 300mm freeboard as permitted in the original planning permission.
4. All recommendations regarding the structural integrity and capacity of the channel made in the post 2003 event reports are now complete.

8 Appendices

Appendix A: REPORT REFERENCES

The following reports have been considered during the closure investigation;

Ref No.	Title	Author	Date
1	Jubilee River Investigation, Condition Assessment Report	Atkins	April 2003
2	Jubilee River – Technical Review	Atkins	July 2004
3	Jubilee River – Hydraulic Review	Atkins	July 2004
4	Review of Atkins Jubilee River Modelling Work	Jacobs	August 2004
5	Modelling of Bank Improvements Downstream of Manor Farm Weir	Atkins	August 2005
6	Summary of Bank Raising based on Manor Farm Report	Jacobs	May 2005
7	Jubilee River: Final Remedial Works, Recommendations Report	Atkins	August 2005
8	Jubilee River: Bank Raising Works, Recommendations Report	Atkins	January 2006
9	Comments on Downstream Levels – Included at back of Hydraulic Review, (Extract)	Jacobs	
10	Preliminary Review of the Marsh Lane Topographic Survey Results, Technical Note – (Draft for discussion only),	Atkins	September 2005
11	Taplow Intake Structure, Jubilee River, Physical Model Study	HR Wallingford	January 2005
12	Black Potts Viaduct and Pockocks Lane Bridge, Jubilee River, Physical Model Study	HR Wallingford	September 2005
13	Marsh Lane Flow Control Structure, Jubilee River, Physical Model Study	HR Wallingford	March 2006

Appendix B: REPORT RECOMMENDATIONS

This appendix details the recommendations made in each of the reports highlighted in the brief. Where specific recommendations were not made actions or follow up requirements are noted. Where possible a table has been provided in each section to detail the specific recommendations and where these have been shown to have been undertaken that fact is also noted.

B.1 Atkins, Jubilee River Investigation, Condition Assessment Report – April 2003

The objective of this report was to identify locations that suffered deterioration and erosion due to the flows that passed down the Jubilee River channel since construction, including the flood events of winter 2002-3. The report is a baseline for future remedial works and further investigations.

Several locations of severe deterioration of assets within the Jubilee River were identified, particular recommendations were not made in this report, but conclusions were;

Where flow from a rectangular channel passes through a sluice structure and then under a 'hard' bridge into a 'naturalised' trapezoidal channel, extensive erosion and material loss has occurred adjacent to the end of the retaining walls. These locations are at:

1. Downstream of Mill Lane Bridge (Area 2)
2. Downstream of Marsh Lane Bridge (Area 4)
3. Downstream of Manor Farm Weir (Area 6)

Where flow passes over weirs and follows the weirs' downstream riverbanks erosion occurred. These locations are at

1. Manor Farm Weir (Area 6)
2. Slough Weir (Area 8)

The majority of locations where other deterioration had occurred only suffered from minor erosion and some bank slippage.

The report was a record of a visual assessment of the condition of the Jubilee River Channel. It was not within the scope of the report to state whether these incidents were the natural adjustment by the river in response to the higher flows or whether further assessment was required.

B.2 Atkins, Jubilee River – Technical Review – July 2004

The purpose of this report was to present, in outline, the technical issues relating to the Jubilee River as they were then understood.

The report highlighted a series of issues relating to the performance of the Jubilee River and its associated structures. Many of these issues were addressed during the summer 2003. However, analysis highlighted a series of potential shortcomings which needed to be investigated further. This led to a series of ongoing actions, summarised as follows:

Studies and Investigations:

Ref	Action	Follow Up	Status
2.1	Ongoing assessment of the Hydraulic Capacity and options to restore original capacity.	Various hydraulic and physical modelling works have been undertaken post this report.	Completed
2.2	A physical model is being developed to determine the revetment requirements downstream of Mill Lane Road Bridge.	HR Wallingford constructed and tested a physical model of the Taplow Intake Structure and the Mill Lane Bridge in January 2005, (final report), Ref.11. Works undertaken to repair the revetments were completed in January 2006	Completed
2.3	Design for works to Slough Road Weir.	Works undertaken at the Slough Weir summer 2005.	Completed
2.4	Options for protecting the golf course downstream of the Black Potts Viaduct and Strande Lane.	Works planned for summer 2006 to raise defences d/s of the viaduct and retain footpath. The Strande Lane project is separate from the Jubilee River and being progressed as such, PAR expected Sept 06 with construction mid 2007	Completed
2.5	Discussions are in hand with Thames Water to address the flood risk from the Roundmoor Ditch.	Discussions completed with Thames Water and agreed works (bund construction) completed by the Environment Agency's Operations Delivery team.	Completed

Works proposed for summer 2003:

Ref	Action	Follow Up	Status
2.6	Remedial Repairs to the Myrke Embankment.	Works completed September 2004, embankment rebuilt and crest raised 300mm.	Completed
2.7	Reinstatement of the footpaths damaged by the remedial works at Manor Farm.	Completed as part of the Myrke Embankment works.	Completed

B.3 Atkins, Jubilee River – Hydraulic Review – July 2004

The objectives of this hydraulic review were as follows:

1. To establish the existing capacity of the Jubilee River as compared to the design specification, the planning application and the published MWEFAS Operating Rules and Procedures.
2. To identify where the existing banks may be of insufficient height to contain the design flows.
3. To identify shortcomings in the current operating procedures and recommend modifications accordingly.
4. To develop and provide a hydrodynamic model for inclusion into the Jacobs Lower River Thames model for further investigation of flood risk management.

Based on the analysis and modelling undertaken as part of this study, the following recommendations regarding the way forward for the Jubilee River were suggested;

Ref.	Action	Follow Up	Status
3.1	Additional survey work should be carried out along critical lengths of bank, to improve the accuracy of the bank levels and to determine the extent of banks which fall below the levels stated on the original design drawings.	Extensive topographical surveys undertaken	Completed
3.2	An 'as built' survey should be carried out for all key structures (which have not already been surveyed) spanning the Jubilee River to validate the dimensions used in the modelling and to provide base line information for future use regarding structure settlement and deformation	Surveys carried out on all structures and planned for all bank raising works. All structures will be monitored for deformation.	Planned for February 2007
3.3	Sensitivity analysis has highlighted the need for more detailed information regarding the performance of critical structures. It is therefore recommended that physical modelling be undertaken to improve water level predictions through; Taplow Sluice, Marsh Lane Weir and Black Potts Viaduct.	Physical modelling was undertaken by HR Wallingford thus; <ul style="list-style-type: none"> • Taplow Intake Structure, EX5063, Jan 2005 • Black Potts Viaduct and Pockocks Lane Bridge, EX5213, Sept 2005. • Marsh Lane Flow Control Structure, EX 5289, Mar 2006. 	Complete
3.4	The programme of water level monitoring along the Jubilee River should be updated and maintained to ensure the reliability of records during future flood events. Upon the next operation of the Jubilee River the water levels recorded will provide valuable information to validate the model and the hydraulic performance of the key structures along the channel.	Telemetry has been installed at relevant locations and the alarm levels have been revised to reflect the expected new water levels. This information has been provided in updates to the Operations manual.	Complete

Ref.	Action	Follow Up	Status
3.5	<p>With the existing capacity study finalised, it is recommended that the ISIS model developed as part of this study be handed over to Jacobs Consultants for integration into their Lower River Thames Model. This will allow more detailed analysis to be undertaken regarding the operation of the MWEFAS and will better represent the out of bank flows surrounding the scheme during high flow events.</p>	<p>Jacobs Consultants are continuing to develop the Lower River Thames Model.</p>	Completed
3.6	<p>A programme of work to be undertaken to improve the capacity of the Jubilee River should the Environment Agency wish to return the channel to its original design specification. These should include the following elements:</p> <ul style="list-style-type: none"> • Resolve uncertainty as highlighted in the sensitivity tests. • Obtain further calibration data during the winter of 2004/05 if sufficient flows permit. • Review freeboard to account for EA guidance. • Investigate options for improving capacity at Black Potts and Marsh Lane. <p>Investigate bank raising as required.</p>	<p>Works have been undertaken to improve capacity from the as constructed situation. The focus has been to ensure levels and original freeboard allowances are brought up to that agreed in the planning consent.</p> <ul style="list-style-type: none"> • No further data available to date • It has been agreed to undertake all analysis and further works based on a 300mm freeboard allowance. • Physical models of Black Potts and Marsh Lane have concluded their capacity to be 215m³/sec. 	Complete
3.7	<p>A channel bed survey should be considered in order to confirm that there are no irregularities which may alter the hydraulic capacity of the channel. The information gained would provide a more accurate profile of the channel bed which can be used to update the model and in future used to monitor changes to the channel by way of deposition and scour.</p>	<p>Bathymetric survey to be commissioned.</p>	Planned for February 2007

B.4 Jacobs, Review of Atkins Jubilee River Modelling Work

The objective of this study was for Jacobs to provide an independent assessment of the findings of the Hydraulic Review (Ref 3). The Jacobs report supported the findings of the Hydraulic Review and the recommendations made by the report and follow up are summarised below.

Ref	Action	Follow Up	Status
4.1	Commission "top of bank" survey.	Extensive topographical surveys undertaken.	Complete
4.2	Survey of critical structures.	Deformation points installed for all major structures.	Complete
4.3	Swathe bathymetry or other means such that an accurate (DTM) Digital Elevation Model of the Jubilee River can be compiled.	Bathymetric survey to be commissioned.	Planned for February 2007
4.4	Physical modelling of Mill Lane bridge, Marsh Lane gated weir and Blackpotts viaduct.	Physical modelling was undertaken by HR Wallingford thus; <ul style="list-style-type: none"> • Taplow Intake Structure, EX5063, Jan 2005 • Black Potts Viaduct and Poccocks Lane Bridge, EX5213, Sept 2005. Marsh Lane Flow Control Structure, EX 5289, Mar 2006.	Complete
4.5	Installation and good maintenance of telemetry water level recorders.	Telemetry has been installed at relevant locations and the alarm levels have been revised to reflect the expected new water levels. This information has been provided in updates to the Operations manual.	Complete

B.5 Atkins, Modelling of Bank Improvements Downstream of Manor Farm Weir – August 2005 (Final Issue)

The purpose of this report was to present the findings from the additional modelling work undertaken to appraise the bank raising for the Jubilee River. It specifically required:

1. Update bank heights in the Hydraulic Model using either the recently surveyed topographic levels or levels achieved by the Agency's bank raising programme.
2. With all sections of bank now raised, determine the potential capacity of the Jubilee River with 300mm freeboard and with the channel at bank full.

The stand alone model used as part of this study is specifically for the purpose of appraising the programme of bank raising completed by the Agency. The analysis undertaken to determine the capacity of the Jubilee River, with completion of the Agency's programme of bank raising, has concluded the following;

1. The programme of bank raising completed by the Agency does not provide the original as designed capacity in the Jubilee River. However, the works do increase the capacity of the Jubilee River compared to the previous (as-constructed) condition.
2. With a flow of both 300m³/s and 250m³/s in the River Thames the Jubilee River would not convey the design flow of 215m³/s within bank.
3. If the River Thames conveys a flow of 250m³/s it is estimated that the capacity of the Jubilee River with 300mm freeboard would be 155m³/s.
4. If the River Thames conveys a flow of 250m³/s it is estimated that the capacity of the Jubilee River, at bank full, would be 180m³/s. This is an increase of 15m³/s compared to the existing capacity, which equates to 9%.
5. If the River Thames conveys a flow of 300m³/s it is estimated that the capacity of the Jubilee River, at bank full, would be 165m³/s.
6. If works are undertaken to address the LHB level downstream of the Chalvey Rail Bridge and along the RHB at Eton, then the capacity of the Jubilee River would increase.

Note

Originally this report was issued as draft in January 2005; the conclusions of that report were as above.

B.6 Jacobs, Summary of Bank Raising based on Manor Farm Report, April 2005.

This preliminary analysis was based on the January 2005 draft of the Manor Farm report referred to B5 above. The summary provided is a single page that gives a location and corresponding chainage of where bank raising should be undertaken, however it does not clearly indicate the extent of raising work either filling depth or length.

This preliminary analysis demonstrated that the following bank raising works would increase the Jubilee River capacity.

Ref	Action	Follow Up	Status
6.1	Raise LHB d/s of Chalvey Rail Bridge, ch. 9450.	Work identified not required as there exists a further embankment landward that provides adequate secure level.	Complete
6.2	Raise RHB at Eton Playing Fields, ch. 10757.	Works planned for August 2006 to strengthen the preferential spill way at Eton.	Complete
6.3	Raise LHB between Marsh Lane and the M4, ch 4046.	Part of the West Town Farm Service Bridge works completed in December 2006	Complete
6.4	Raise RHB, Glen Island, ch. 43.5 and 649.2	Decision made during meeting of 15 th December 2005 to not proceed with this work. Any overtopping of this embankment would only result in flow back into the River Thames.	Complete
6.5	Raise LHB, Between A4 and Dorney Railway Bridge, ch. 1900.	Works subsequently found to not be required as landward protection is already afforded by an existing flood wall.	Complete.
6.6	Raise LHB u/s of Marsh Lane, ch.2831.	Works subsequently found to not be required as landward protection is already afforded by the existing highway.	Complete
6.7	Raise RHB d/s of M4, ch.4345.	Resurvey work has indicated that this area does not require raising. Also it possibly falls outside the original planning consent levels.	Complete
6.8	Raise RHB u/s of Chalvey rail bridge, ch. 9234.	Works planned for September 2006 to raise an 18m section to a finished level of 20.50 m AOD.	Complete
6.9	Raise LHB d/s of A355 at Chalvey, ch. 8762	Resurvey work has indicated that this area does not require raising. Also it possibly falls outside the original planning consent levels.	Complete

B.7 Jubilee River: Final Remedial Works, Recommendations Report August 2005.

The purpose of this work was to produce a schedule of 'Final' remedial works after reconstruction of structures along the Jubilee River. These final remedial works were considered to be essential to deliver the Jubilee River scheme as originally specified, i.e. the levels provided in the original works information.

The following bank raising works were recommended;

Ref	Action	Follow Up	Status
7.1	Raise RHB 250mm at Glen Island Bund North, chainage 0 to 90.	Refer to 6.4, above.	Complete
7.2	Raise LHB 220mm between Taplow Lake and Marsh Lane, chainage 2350 to 2400.	Re-survey work revealed that the road behind the embankment offers a secondary defence that can accommodate the additional level requirement. No work to existing structure required, Sept 2006	Complete
7.3	Raise LHB 350mm between Taplow Lake and Marsh Lane, chainage 2750 to 3150.	Re-survey work revealed that the road behind the embankment offers a secondary defence that can accommodate the additional level requirement. No work to existing structure required.	Complete
7.4	Raise LHB 250mm 30m either side of the West Town Farm Service Bridge, chainage 3975 to 4100.	Works undertaken in December 2005 to raise the defence level.	Complete
7.5	Raise RHB 180mm at Eton Bank u/s of Myrke footbridge, chainage 10400 to 10600.	Re survey work confirms that no work required.	Complete
7.6	Raise LHB 200mm at Myrke embankment, d/s of Myrke footbridge, chainage 10900 (approx 20m length).	Raising works for a 16m length to be undertaken September 2006.	Complete
7.7	Raise RHB by 150mm and strengthen with geotextile at Eton Right Bank, Pockocks Lane to Myrke footbridge, chainage 10675 to 10925.	Works planned for September 2006 to strengthen the preferential spill way at Eton,	Complete
7.8	Replace temporary bund d/s of Black Potts Viaduct constructed to protect the Datchet Golf Course with a permanent brick wall.	Works planned for September 2006 to raise defences d/s of the viaduct and retain footpath.	Complete

Cost estimates for the proposed works were also included in this report.

B.8 Atkins, Jubilee River: Bank Raising Works, Recommendations Report January 2006.

The objective of this report was to identify where the river banks would not pass the LFP 1 in 65 HecRAS modelled water level, plus 300mm freeboard and confirm the recommendations for future bank raising works.

Recommendations were made in the form of bank raising required, thus:

Ref	Action	Follow Up	Status
8.1	Raise LHB 90mm, 100m d/s of Marsh Lane Bridge, chainage 3382.	Re survey of the existing works shows no further work is required here, based on the 50mm rule, i.e. bank raising of 50mm or less is not worthwhile	Complete
8.2	Raise LHB 180mm, 40m d/s of M4 Road Bridge, chainage 5347.	Re survey of the existing works shows no further work is required here, based on the 50mm rule.	Complete
8.3	Raise LHB 150mm, just d/s of the Myrke Footbridge, chainage 10721.	Works planned for September 2006 to raise an 18m section to a finished level of 20.18 m AOD. This work is actually at chainage 10600.	Complete
8.4	Raise RHB 80mm, 25m d/s of West Town Farm Service Bridge, chainage 4037.	Re survey of the existing works shows no further work is required here, based on the 50mm rule,	Complete
8.5	Raise RHB 60mm, 25m u/s of Chalvey Rail Bridge, chainage 9243.	Works planned for September 2006 to raise an 18m section to a finished level of 20.50 m AOD.	Complete
8.6	Raise RHB 240mm, Eton Right Bank and Spillway, chainage 10700 to 10906.	Works planned for September 2006	Complete
8.7	Raise RHB 70mm, between Pockocks Lane and Black Potts, chainage 11267.	Re survey of the existing works had shown no further work is required here, based on the 50mm rule,	Complete
8.8	Raise RHB 160mm, u/s of the A4, chainage 1582.	Works planned for September 2006	Complete
8.9	Replace temporary bund d/s of Black Potts Viaduct constructed to protect the Datchet Golf Course with a permanent brick wall.	Works planned for September 2006 to raise defences d/s of the viaduct and retain footpath.	Complete

The report concluded that completing the bank works recommended would provide an overall capacity in the Jubilee River of 190m³/s.

B.9 Jacobs Comments on Downstream Levels, Appended to Report 3

The document is a 2 page note setting out the derivation of water levels provided by Jacobs to Atkins on 16th April 2004 for Atkins summary of hydraulic capacity dated 30th April 2004. The note is specifically for the downstream boundary of the Jubilee River and investigates upper and lower bounds of predictions based on the hydraulic model and historical data. The bounds vary in line with flow.

The note does not make any particular recommendations.

B.10 Atkins, Preliminary Review of Marsh Lane Topographical Survey Results, Technical Note September 2005 (Discussion draft only)

The objectives of this technical note were;

1. To verify the Maltby survey work undertaken in August 2004
2. To provide suitable survey data with which to undertake the detailed design for the remedial works, i.e. bank improvements, as detailed in B5 above.

Analysis of the various survey data available and the original design drawings show that there were inconsistencies in available data such that the following recommendations/conclusions were made, albeit for discussion.

1. The works as previously recommended at the Taplow lake site are not required.
2. Proceeding with the bank restoration work at Marsh Lane would not provide value for money and the latest survey data means that the predicted 170m³/sec flow could be accommodated.
3. Condition monitoring could be provided for by improving the definition of embankment crest lines possibly through landscaping works within the Environment Agency owned areas.
4. Future use of plant and equipment in this site should be restricted to ensure no further degradation of local levels.

B.11 HR Wallingford – Taplow Intake Structure, Jubilee River, Physical Model Study – January 2005

The modelling investigation was commissioned specifically to investigate the scour problems observed at this structure during the 2002/03 event. Additionally the flow capacity and operation of the structure were investigated.

Modelling work found the rip rap limit of stability to be 120m³/s and that for flows above 160m³/s the gates should be operated in a non sequential manner. Recommendations were made for the preferred size of rip rap. The rip rap size has not been changed since the emergency works, however the gate opening sequence is now set automatically to ensure velocities do not de-stabilize the rock.

Additional testing was undertaken to investigate alternative scenarios for gate openings.

B.12 HR Wallingford – Black Potts Viaduct and Pockocks Lane Bridge, Jubilee River, Physical Model Study – September 2005.

The modelling work was commissioned specifically to investigate issues regarding flow capacity and performance of the two structures and to determine rating curves.

Key findings included that the rip rap will be stable under the depth averaged velocities likely under maximum flows predicted. The Viaduct is capable of freely discharging flows up to 250m³/s. Pockocks Lane Bridge starts to surcharge at a discharge in the order of 120m³/s as it is designed but is capable of freely discharging flows up to 250m³/s.

B.13 HR Wallingford – Marsh Lane Flow Control Structure, Jubilee River, Physical Model Study – March 2006.

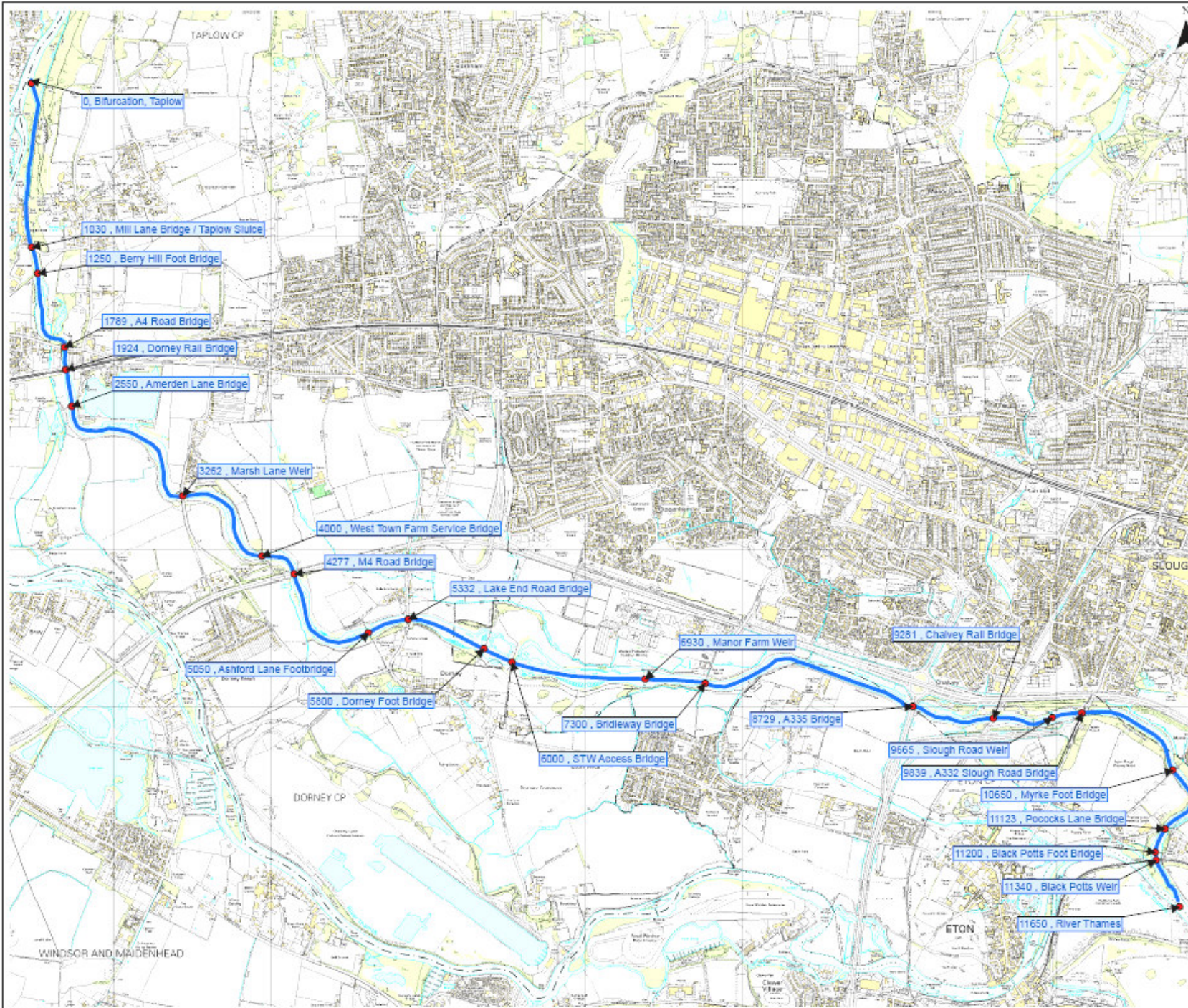
The modelling work was commissioned specifically to investigate issues regarding flow capacity and performance of the two structures and to determine rating curves.

Key findings include that the structure is capable of freely discharging flows of up to 250m³/s. The upstream banks would be stable under the maximum velocities measured and that the gabion mattresses on the bed and left and right banks downstream of the structure would be stable under depth averaged maximum flows predicted.

Appendix C: LOCATION PLAN

Key

- Chainage points
- Jubilee River



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CLIENT Environment Agency
Thames South East
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PROJECT TITLE Jubilee River Post 2003
Recommendations
Closure Report

DRAWING TITLE Key Locations and Chainages

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SCALE	DRAWN	CHECKED	AUTHORISED
NTS	JW	CC	TJS
REF NUMBER	DATE	DATE	DATE
5045275 App A Fig 1	5/09/06	5/09/06	5/09/06