Company Profile

The Port of London Authority (PLA) are the guardians of the tidal Thames with responsibilities for 95 miles of the tidal Thames. We work to keep commercial and leisure users safe, protect and enhance the environment and promote the use of the river for trade and travel. The Port of London oversees 230,000 vessel movements handling over 53m tonnes of cargo each year. Headquartered in Gravesend, with multiple offices in Gravesend and London, it was formed by an Act of Parliament in 1909 and employs around 400 people.

1. RFP Objectives

The purpose of this Request For Proposal (RFP) is to establish and award a long term contract for maintenance, superintendence and consultancy of works required at Richmond Lock and Weir.

The Supplier(s) submission shall be provided in accordance with the requirements of this RFP which, together with any associated annexure's issued by PLA, are together referred to as the RFP.

2. RFP Process

PLA shall issue this RFP under the timescales set out below. You will have the opportunity to propose more than one solution for the delivery of this service as long as it conforms to the brief provided.

The process steps are as follows;

1. RFP issued
2. Supplier(s) to submit clarification questions or site visits
3. Supplier(s) to submit proposal(s) in accordance with this RFP
4. RFP submission(s) evaluation by PLA
5. Contract Award

RFP Programme and Timetable

Task	Deadline
1. RFP Published	21/12/23
2. RFP close and supplier response submission(s)	16/02/24
3. RFP submission evaluation complete and shortlist of final 2	01/03/24
4. Assessment of shortlisted bidders – refinement of proposals, site visits etc.	22/03/24
5. Final bid submission	22/03/24
4. Business award communication	29/03/24
5. Contract start date	01/04/24

Any response received after this **RFP close date** shall only be included at the sole discretion of PLA.

During the RFP process suppliers should not contact or communicate with any person(s) other than the individual(s) listed below in reference to any aspect of this tendering exercise or the services sourced. Failure to comply may result in disqualification from this sourcing exercise.

Person 1 – Harriette Seymour, Harriette.seymour@pla.co.uk
Person 2 – Mark Collier, Mark.collier@pla.co.uk

Evaluation Criteria

An evaluation team will consider all submissions correctly submitted and will select one or more with a view to reaching a contractual agreement subject to any necessary clarification of the submission. An award will be made based on an assessment of total through life cost and Supplier competency in service delivery, support and account management.

Evaluation of the submissions provided shall be assessed under the following conditions:

- Quality of RFP Submission (innovations, options)
- Experience delivering services of this nature and with listed structures
- Ability to offer a range of services to meet complexities at site
- Total cost

3. Contractual Requirements

The services procured under this RFP shall be contracted under the NEC framework for Professional Services.

By taking part in this RFP, it is expected that the Supplier agrees to work under these conditions.

4. Suppliers Confirmation

Confidentiality

All information supplied and received between PLA and the Supplier(s) in connection with this RFP shall be regarded as confidential in nature and treated as such. Information supplied between PLA and the Supplier shall not be shared with any third party unless express consent to do so is given by the party from whom the information originated.

RFP Information

Information provided to Suppliers in connection with this RFP is provided in good faith. However, PLA accepts no responsibility for any loss or damage whatsoever that may occur arising from the use of such information.

It is incumbent on the Supplier(s) to ensure that they have all the information required for the accurate preparation of their RFP submissions, and that they satisfy themselves on the correct interpretation of terminology used in the RFP documentation.

Cost of Quotation

PLA will not, in any circumstances, be responsible for any costs or expenses incurred by the Supplier(s) in connection with the preparation and delivery of any RFP submission.

Independent Quotation

By submitting a response to this RFP, the Supplier warrants the following.

a) It is a *bona fide* submission intended to be competitive.

b) The prices in the submission have been arrived at independently, without consultation, communication, agreement or understanding for the purpose of restricting competition, as to any matter relating to such prices, with any other bidder or with any competitor.

c) Unless otherwise required by law, the prices which have been submitted in the RFP response have not knowingly been disclosed by you, directly or indirectly, to any other bidder or competitor, nor will they be so disclosed.

d) No attempt has been made nor will be made by you to induce any other person or firm to submit, not to submit or to withdraw a quotation for the purpose of restricting competition.

Notification of Outcome

When the successful Supplier(s) have been identified by PLA, all bidders will be informed in writing whether or not they have been successful; this communication will provide feedback on the bid submitted and the reasons for our decision. No information shall be given on the progress of the RFP until the successful Supplier(s) have been formally identified.

Treatment of RFP Submission(s)

PLA expressly reserves the rights to:

a) not award any contract as a result of this RFP exercise;

b) accept any part, or all, of any submission unless the Supplier expressly stipulates in their return that this is not acceptable;

c) not undertake to accept the lowest tender, or part, or all of any submission, and the acknowledgement of receipt of any submission shall not constitute any actual or implied agreement between PLA and the Supplier(s).

5. Specification

Background information

Situated between Teddington and Richmond, the weir comprises three vertical steel sluice gates suspended from a footbridge. Each gate weighs 32.6 tonnes and is 20 metres wide and 3.64 metres in depth. There is also a lock (RHS arch of below picture) and a boat slide on the LHS.

For around two hours each side of high tide, the sluice gates are raised into the footbridge structure above, allowing ships and boats to pass through. For the rest of the day the sluice gates are closed and passing river traffic must use the lock alongside the barrage.

This period of free navigation can be dramatically changed due to prevailing conditions. In drought conditions the gates will be closed for longer periods, whilst in periods of high fluvial flow they may remain open for much longer.

The sluice gates ensure that the water level between Richmond Lock and Teddington Lock is maintained at or above half-tide level and there is a legal requirement for the PLA to maintain this facility via an Act of Parliament. Lock keepers work shift patterns to ensure that it has a manned PLA presence 24/7/365.

The structure was officially opened by the Duke and Duchess of York in 1894 and is a Grade II* listed structure.

PLA completed a major, £4 million refurbishment of the lock and weir in the early 1990's. The lock and weir later underwent a £500,000 repaint that was completed in February 2020.

Current maintenance work is carried out by a contractor employed directly by PLA, following advice from a separately contracted consultant (naval architect). This covers most of the M&E work.

There are also civils works to be completed, though these tend to be less frequent and more involved.

Every year, there is a draw down period of approximately 4 weeks where the gates remain open. While this means the river runs somewhat dry upstream of it, this period provides a few weeks where more in-depth maintenance can take place as needed.

All works otherwise must allow the sluice gates to function as required according to the tide and the on duty lock keeper.

The maintenance operations described above have worked for a number of years and succeeded a period where the PLA used to complete both activities in house.

The incumbent consultant have, at the request of PLA, provided a 5 year report of activities required on the structure to maintain safe operations. This covers the M&E works which are seen as more pressing in terms of speed at which things could go wrong. The civils works are commonly completed following near misses or observations from PLA crews or other river users. These observations are then monitored and planned in for scheduled maintenance.

Within the PLA, the M&E maintenance is overseen by one department and the civils works by another.

The list of current maintenance requirements to the structure is included in attached document, ref 'Richmond Lock and Weir Survey Condition Report Breakdown'.

Specification

While this set-up has achieved its purpose, the PLA wishes to explore other options that may make it more efficient.

To this end, PLA is inviting tenderers to submit a proposal in line with the following:

Option A
A single contract for the consultancy, assessment and completion of all required works – M&E and civil.

It is assumed that this would be achieved through main sub-contractors, in which case these should be clearly stated (name of company) along with details of business relationship, years working together etc.

The mechanism for costing and approving works should be detailed within your proposal. I.e. fixed fee for the year based on an annual assessment or agreed rates.

Option B
A single contract for the consultancy, assessment and completion of all required works – M&E.

As per Option A but for M&E works only.

Option C
A single contract for the consultancy, assessment and completion of all required works – Civils.

As per Option A but for civils works only.

Option D
A contract for the consultancy and assessment of the works required – M&E and civils.

Option E
A contract for the physical completion of the works required – M&E and civils.

It is assumed that this would be achieved with support of consultants as required. In which case these should be clearly stated (name of company) along with details of business relationship, years working together etc.

In the interest of transparency, the PLA has a preference for Option A. However, we are aware that, along with Option's B and C, there are likely to be questions relating to an agreed way of working, i.e. whether it's costed as a lump sum for the year or on an agreed day rate for planned and unplanned work. Our expectation is that civils works in particular above £xk (TBD) per project would be quoted and costed as a lump sum prior to commencement.

Suppliers opting for either of A, B or C are required to provide an outline of this works approval/ payment methodology as part of their submission. PLA is open to suggestions in this respect.

Option D should be costed as a lump sum per annum as well as an agreed rate for unplanned works.

Option E should be costed as either a lump sum against a set number of days per month (no of days to be provided), with a day rate applicable for any additional time required for any additional jobs that may arise.

Rates provided shall assume normal working hours Monday to Friday.

Suppliers should detail their multiplier, if any, for any out of hours works required – evenings, weekends* and Bank Holidays. *Note that any Sunday working will be limited to review and assessments only, no physical works.

Parts and materials shall form part of the lump sum prices submitted for any physical works.

Prices for consultancy and assessment are expected to be fixed for the duration of the contract owing to the more consistent nature of the requirement. Physical works will be subject to a September CPI % increase from the previous year, depending on the final option taken.

Maintenance plan and history of works
Suppliers are encouraged to review the 5 year maintenance plan provided and the table of works completed on the structure for the last 3 years. This will give as good an indication as any of the size, variety and frequency of jobs.

Site visits
Site visits are encouraged and should be arranged via the named contacts above.

Quality of works
Owing to the listed status of the building, all works undertaken must be of the highest quality and in keeping with the existing structure and surrounding area.

All physical works on site must be completed by suitable trained, experienced and or qualified personnel.

Details of main personnel responsible for consultancy and assessment work is required within any relevant submissions, i.e. a CV summary of skills and experience.

Assessments and Reporting
The assessor of works shall be responsible for reviewing works undertaken, ensuring that they are in line with the expectations of PLA and the structure status. Further, formal quarterly reviews are required of the structure to ensure that the maintenance plan developed is still applicable, i.e. priorities have not changed and no additional works are required.

Availability
99% of works are expected to be completed with suitable notice and planning. The level of maintenance provided to the structure minimises the frequency of reactive works, however, this is still sometimes required. It will be expected that personnel engaged in assessing and completing these reactive works will be available to do so in line with PLA reasonable expectations (or a suitable work around employed to provide more time to complete works in the proper manner).

Insurances
The following insurances are required for the execution of these works, with suppliers confirmation that the insurance policies will specifically cover the works being undertaken.

Professional Indemnity cover of £10m
Public Liability - £5m
Employers liability - £5m

Length of contract
The PLA commissioned a 5 year plan 12 months ago and is looking to award a 4 year contract to execute the works defined and update as required as part of this RFP. There will be a requirement for the successful supplier, pending options taken above, to carry out another 5 year plan 6 months prior to expiry of the contract awarded under this tender.

Service Level Agreement

KPIs will be developed once the option(s) have been selected. These will of course focus on the timely completion of works and 'up-time' of the sluice gates.

Supplier Remuneration

Supplier should detail within their proposal the remuneration schedule required to complete the works.

Should the Supplier wish to submit multiple bids (i.e. for each option) then separate costs should be provided for each.

Governance and Compliance

As part of their proposal all Supplier(s) should clearly detail both the statutory and best practice bodies which govern, regulate and monitor standards applicable to the Services procured under this RFP. As part of this, the Supplier(s) should also confirm their accreditation to the bodies detailed.

Format of Response

Proposal submissions should be provided in Word or PDF format and comprise the following requirements in the sequence detailed:

1. Background and experience delivering services of this nature
2. Why supplier feels that the option(s) proposed are best suited to fulfil the needs of the PLA
3. Proposed fee structure(s), including a split for each section if options A, B or C are chosen.
4. PLA Support account structure, inc. summary CVs
5. Copies of current Public, Employers and Professional Liability and Indemnity insurance certificates or confirmation that this will be in place as part of award.
6. Confirmation of ISO9001 QMS accreditation (where it exists) and certifying body
    a. CSCS and SSSTS tickets for works on site.
7. Any other supporting information not detailed above

BECKETT RANKINE
Marine Consulting Engineers

HOULDER

Condition Survey Report 2021/2

Richmond Lock and Weir

Publish date: 01 April 2022

Our Reference: L/216/134257/11210 Rev 0

PORT OF LONDON AUTHORITY

BECKETT RANKINE
Marine Consulting Engineers

HOULDER

Condition Survey Report 2021/2

Richmond Lock and Weir

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Revision	Date	Reason for revision	Prepared by	Approved by
0	11/03/22	Client Comments	MPB / BR	MPB
1	01/04/22	Civils & Dive Surveys added	MPB / BR	MPB

Contents

The PLA has commissioned a condition survey of the mechanical and civil structures at Richmond Lock and Weir. The last full survey was undertaken in the late 1980s prior to the major refurbishments in the early 1990s.

Houlder Ltd provides Superintendent services for the mechanical operation of the Lock and Weirs. We have therefore undertaken the mechanical surveys and subcontracted the civils and dive surveys to Beckett Rankine.

This combined report presents the findings and recommendations for repair and maintenance in Part A Section 7 for the mechanical elements, Part B Section 6 for the sub and superstructure and Part C Section 4.7 for the dive survey.

BECKETT RANKINE
Marine Consulting Engineers

HOULDER

Part A - Mechanical & Structural Surveys

Contents

1. Introduction

The mechanical machinery at the Lock and Weir is inspected and maintained by ET Marine Ltd during the annual Draw Off. This survey is therefore focussed on aspects that are not part of these works. The surveys were conducted both during and just after the Draw Off.

2. Lock Gates

The gates were visually inspected at low tide and about 1 hr before high water from a small boat from both sides. Their condition is described in the following sections

2.1. General Condition of Gates

Timber of gates is eroded as shown below but the wood remains hard and resistant to penetration from a bradawl.

Photo 1: The steel straps have minimal wastage

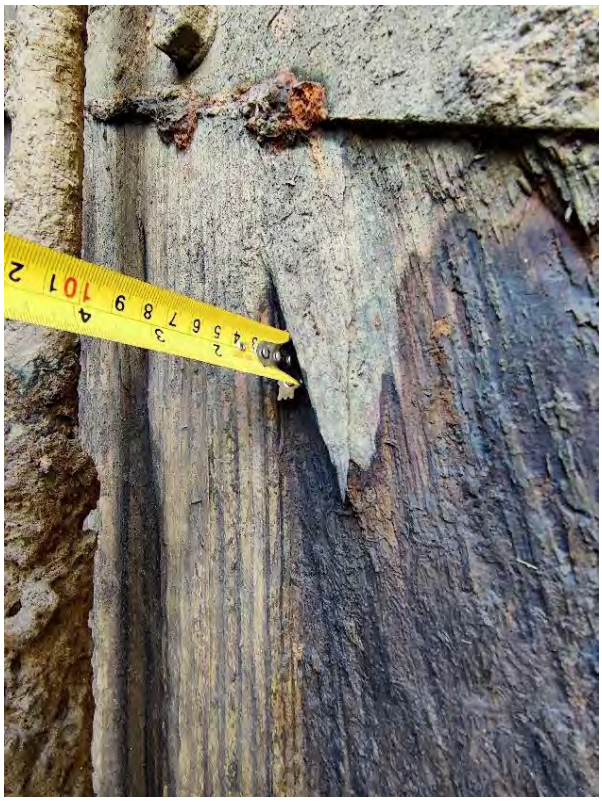
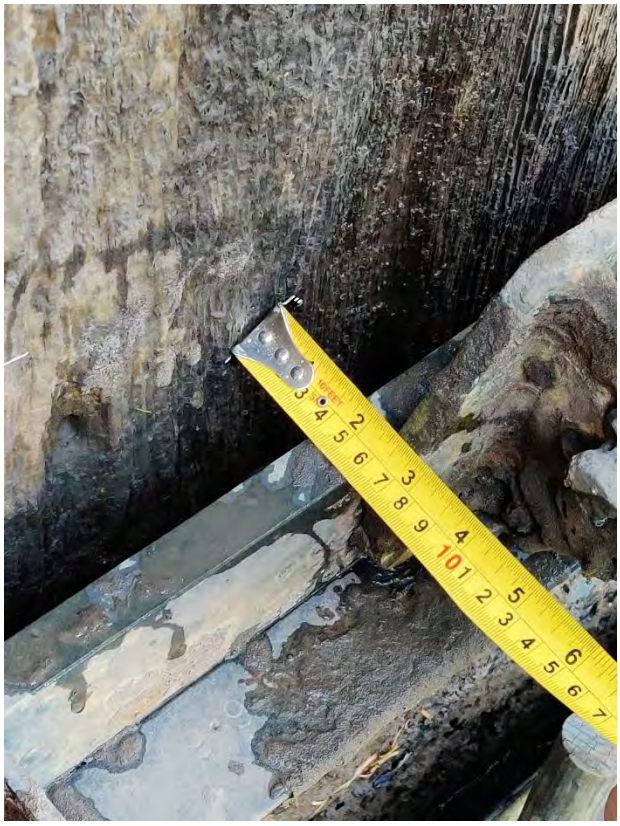


Photo 2: Typical 10-12mm of eroded timber

2.1.1. Penstocks leaking

There are large gaps behind the penstocks which allow water to pass through the gates. If the loss of water is of concern these could be blocked off.




Photos 3 & 4: Upstream gates 40 - 50mm gaps behind penstocks

2.1.2. Isolated Holes

There are some isolated holes going deep into the timer and in one case all the way through. These should be plugged to prevent further loss.

Photo 5: Downstream Gate holes

Photo 6: Upstream holes

2.1.3. Underside of walkway

Underside of walkway deck is rusty with minimal paint coating remaining.

Photos 7 & 8: Underside of Upstream Walkway

2.1.4. Vertical timbers

Vertical timbers on the downstream side of all gates are in good condition having recently been replaced

Photo 9: Upstream Gates

2.1.5. Lower gate bearings

No access to the lower gate bearings was possible as these remained underwater.

2.1.6. Silt in Lock

During the surveys the centre of the lock was sounded with a pole and there was over 1m of soft silt. The lock has had less use than normal in the last few years so the silt may reduce with more use. It should be sounded again and if necessary, flushed out by a vessel moored in the lock.

2.2. Upstream Gates

The tops of both main central verticals are badly rotten together with lapped packer pieces behind the steel plates as shown below.

Photo 10: Area of concern highlighted

Photo 11: Surrey gate

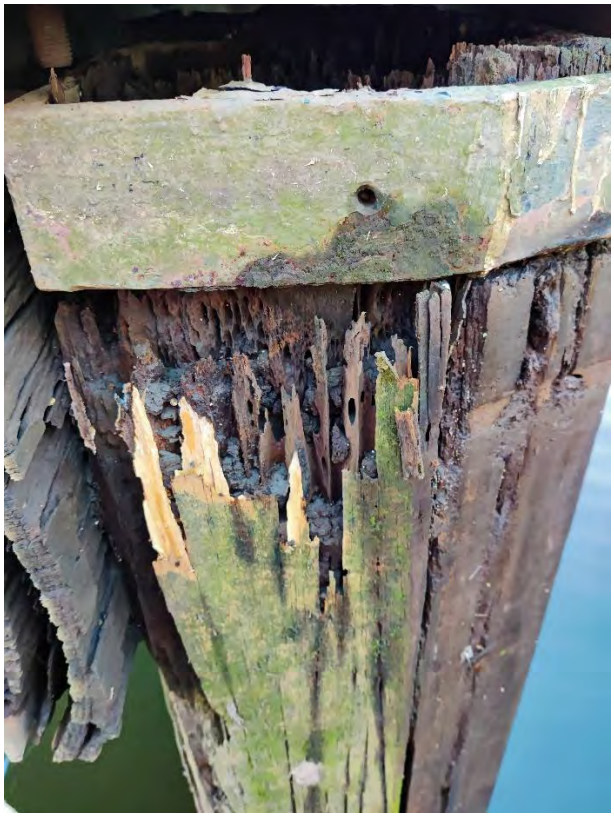


Photo 12: Middlesex gate

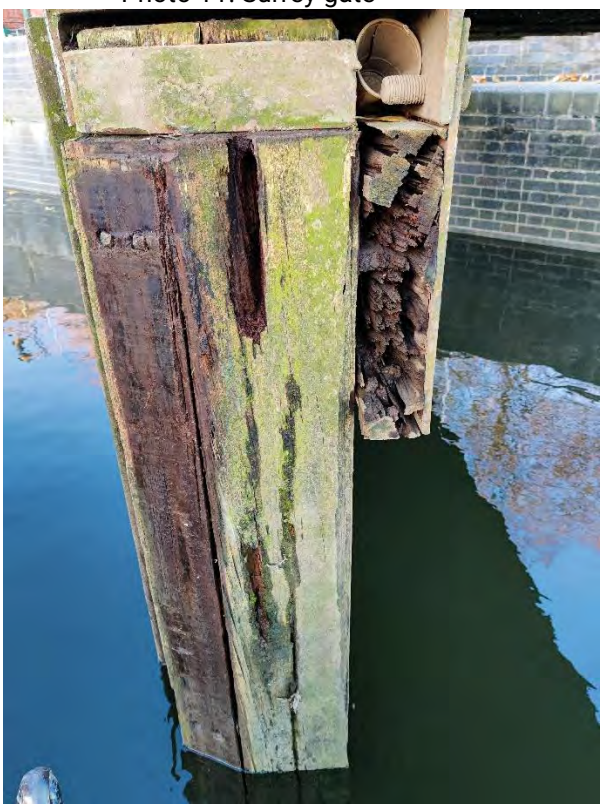


Photo 13: Surrey gate

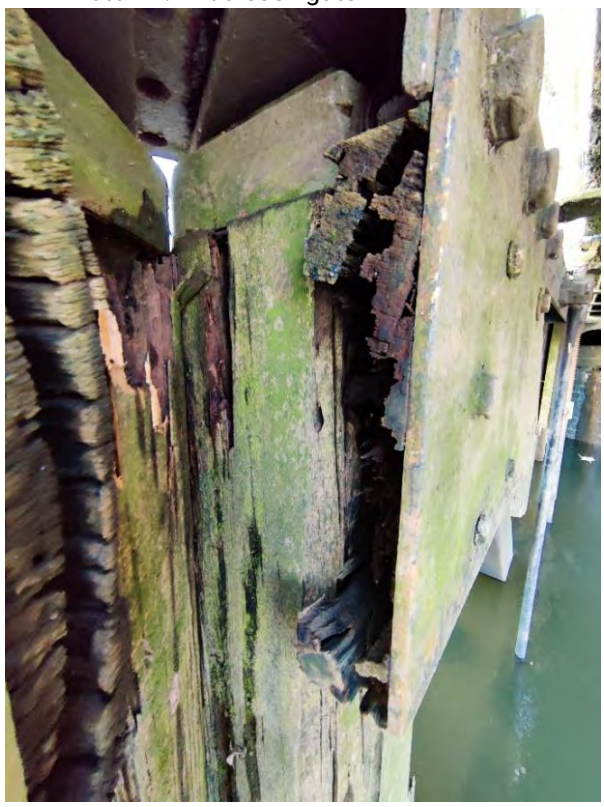


Photo 14: Both Gates at centre

Photo 15: Top of the vertical timber Upstream Middlesex Gate

3. Lock Gate Capstan Pits

The capstan pits had been pressure washed cleaned of mud so that the upper bearing retaining structure was visible. The condition of all four locations were very similar.

3.1. Typical Condition

3.1.1. Top Bearing Restraints

The bolts retaining the top bearing bands are not all galvanised and some not fitted with nylock nuts. Typical examples are shown below. These should be removed and replaced.

Photo 16: Upstream Middlesex Gate

3.1.2. Seating & Anchor Nuts

The nuts bolting the seating to the concrete foundation are heavily rusted in numerous locations. There are minimal remaining coatings on the seatings and nuts. The nuts need to be removed and replaced with galvanised ones and both upper and lower seatings recoated.

Photo 17: Downstream Middlesex

3.1.3. Restraint straps

The 3 restraint straps on each gate are heavily rusted together with the threaded ends and nuts. There is minimal coating remaining. It is proposed that these are removed and replaced with new galvanised straps.

The ground anchors are rusty but their thickness is substantial so these should just be recoated.

Photo 18: Typical Ground Anchor and top bearing restraint straps

3.1.4. Gate quadrants

There is heavy rust on all the gate quadrants as shown below. There is considerable thickness remaining, but recoating is required to prevent further loss.

Photo 19: Heavy pitting - Downstream Middlesex

3.1.5. Upper and lower seating connecting bolts

The bolts connecting the upper and lower seatings are very rusty. In some cases, the heads have disintegrated as shown below.

Photo 20: Typical example - Downstream Middlesex

3.1.6. Floor plating supports

The floor support beams are rusty, but the structure is substantial. However, the connection bolts are heavily rusted and in need of replacing with galvanised bolts. All the beams should also be repainted.

Photo 21 & 22: Typical example of bolts - Upstream Middlesex

3.2. Upstream Surrey

The shock absorber bracket retaining bolt nuts on the underside are badly rusted and need to be replaced.

Photo 23: Underside of brackets – nuts badly corroded

3.3. Upstream Middlesex

The upper seating is cracked and has been repaired with a bolted patch. However, the bolts and patch are badly rusting and needs replacing

Photo 24: Vertical Crack repaired with Doubler and 6 bolts

Photo 25: Close up showing the poor condition of the bolts

3.4. Downstream Middlesex

The shock absorber bracket and retaining bolt nuts have disintegrated and need to be replaced.

Photo 25: Nuts have disintegrated

4. Sluice Pits

Both sluice pits were inspected at low tide during the draw off. The table below summarises the condition of the items inspected.

	Upstream	Downstream
Sluice wires	New - replaced Nov. 2021	New - replaced Nov. 2021
Attachments to brickwork	Sound	Sound
Chains	Good condition	Good condition
Sluice gates	Covered is slit but in reasonable condition	Covered is slit but in reasonable condition
Roller Cradles		
Upstream clearance	15mm	5mm
Downstream Clearance	tight	10mm
Chain U bolt attachment to sluice	U bolts nuts are rusty	Threaded bolts heavily rusted
External grill	Intact	Underwater not visible

Table 1 Summary of findings

4.1. Upstream Sluice Pit

Photo 26: Wire attachment to gates and wall

Photo 27: Wear of gate from cradle rollers ~ 3mm

Photo 28: U bolt chain attachment to gate

Photo 29: Sluice pit viewed through the grating

Photo 30: Roller cradle

4.2. Downstream Sluice Pit

Photo 31: New Roller Cradle wires

Photo 32: Wear on gate structure

Photo 33: Chain sheave

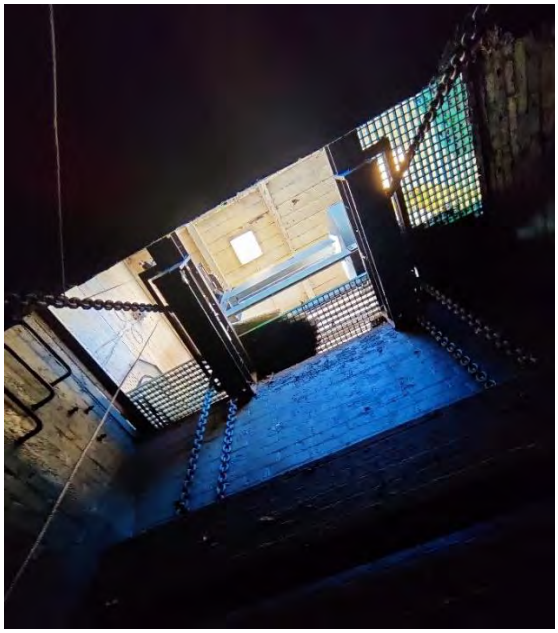


Photo 34: Chains and counter weights

Photo 35: Rusty threaded rod chain attachment to gates

5. Weir gates

5.1. General Condition

All three weir gates were surveyed and found to be in similar condition, as follows

5.1.1. End plate "voids"

The voids between the end plates are difficult to access and paint and consequently are suffering from corrosion. This is noticeably worse on the upper level than the lower which is more constantly submerged. Despite this, the thickness measurements taken on the end plats and more generally on the gates indicate that significant material remains as shown in the table below.

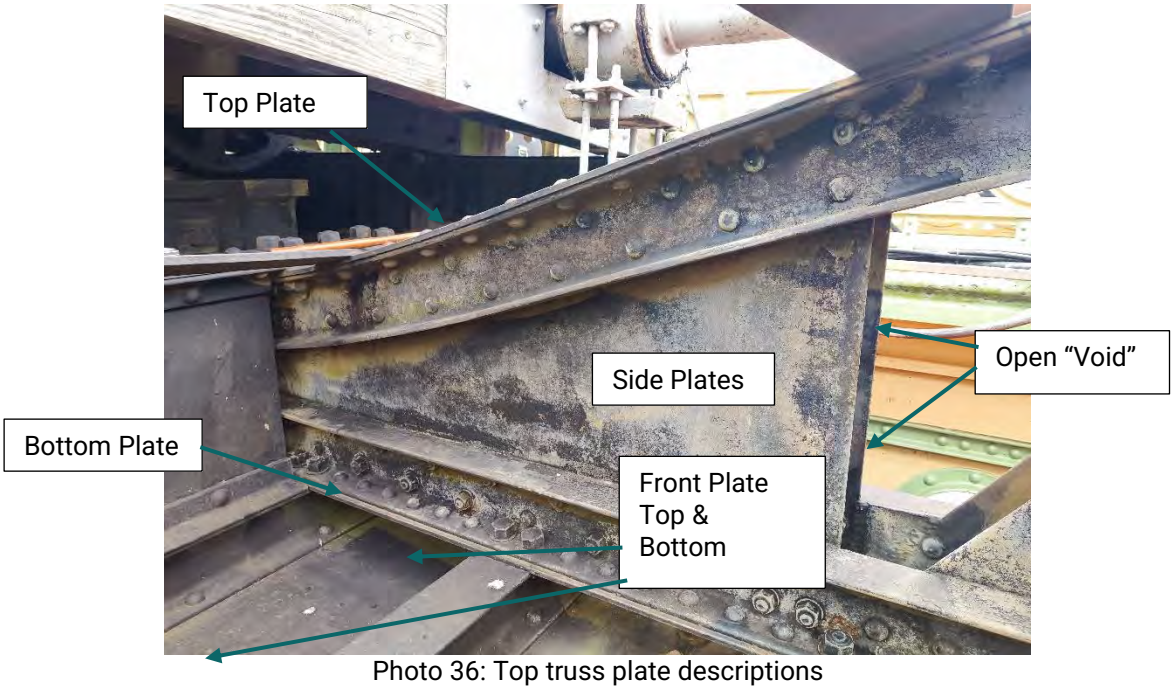


Photo 36: Top truss plate descriptions

Location		Original thickness	Surrey		Centre		Middlesex	
			Surrey	Middx	Surrey	Middx	Surrey	Middx
	Top Front Plate		10.7	10.4	10.3	10.5	10.2	9.6, 9.8
Top	Top Plate	3/8" (9.5)	7.2, 9.4	8.4, 9.5	9.4, 9.6	6.5	9.3, 8.7	6.1, 6.5
Top	Bottom Plate	3/8" (9.5)	7.1	8.2	8.3	7.7	7.8	7.7
Top	Side plates	½" (12.5)	11.2,12.4	12.6	11.3	10.1	12.7	12.6, 9.1
Bot	Top Plate	5/8" (16)	16, 16.1	15.6	16	16.1	15.2	15.1
Bot	Bottom Plate	5/8" (16)	13.8	14.2	13.2	14.6		13.9
Bot	Side plates	½" (12.5)	11.2	12	11.3	12.4	12.5	10.8
	Bot Front Plate		10.4, 9.8	9.9	9.6	9.9	10.1	9.9, 10
	Mid front plate		10.1, 9.5		10.3, 10.2, 9.7		9.3, 10.3, 9.9	

Table 2 Plate thickness measurements

Photo 37: Paint remaining on the end face

Photo 38: Heavy flaking rust on under side

Photos 39 & 40: Typical internal views

Photo 41: The spaces are about 1.5m deep

5.1.2. Corroded Rivets

There are numerous rivet heads that are rusty and appear to be “splitting” as shown in the picture below. However, when the rust is hammered off the remaining rivet heads are still effective, see photo 43.

Photo 42: Rusting Rivet Heads

Photo 43: The above rivet heads after removing the loose rust

There is evidence that eroded rivet heads in similar condition to those in the previous pictures have previously been painted as shown below.

Photo 44: Corroded rivet heads previously painted

5.1.3. Condition of coatings

Considering the weirs were last coated in the early 1990s the paint is in reasonable condition on the flat plate areas. However, there are numerous locations where the coatings have failed locally in inaccessible areas, water traps and around bolt and rivet heads. There is also evidence of local paint repairs which are now failing.

In summary all three weir gates need recoating.

Photo 45: Example of local paint failure

Photo 46: Large areas of the gates are covered in calcium, but the coating is intact beneath

Photo 47: Local paint repairs are failing

5.2. Centre Weir Collision damage

Many years ago, the centre weir gate was hit by a Class V passenger vessel. It rode up onto the gate folding over the top flange and buckling the diagonal below. This has never been repaired.

Photo 48: Impact damage from vessel riding up onto the Weir

Photo 49: Upper flange rolled over

6. Trunnion Bearings

6.1. Arrangement Drawing

To assist in understanding the problem with the Trunnion, an arrangement drawing has been made based on the original drawings. These are of varied quality so the drawing prepared is the best interpretation of these. The drawing is shown below.

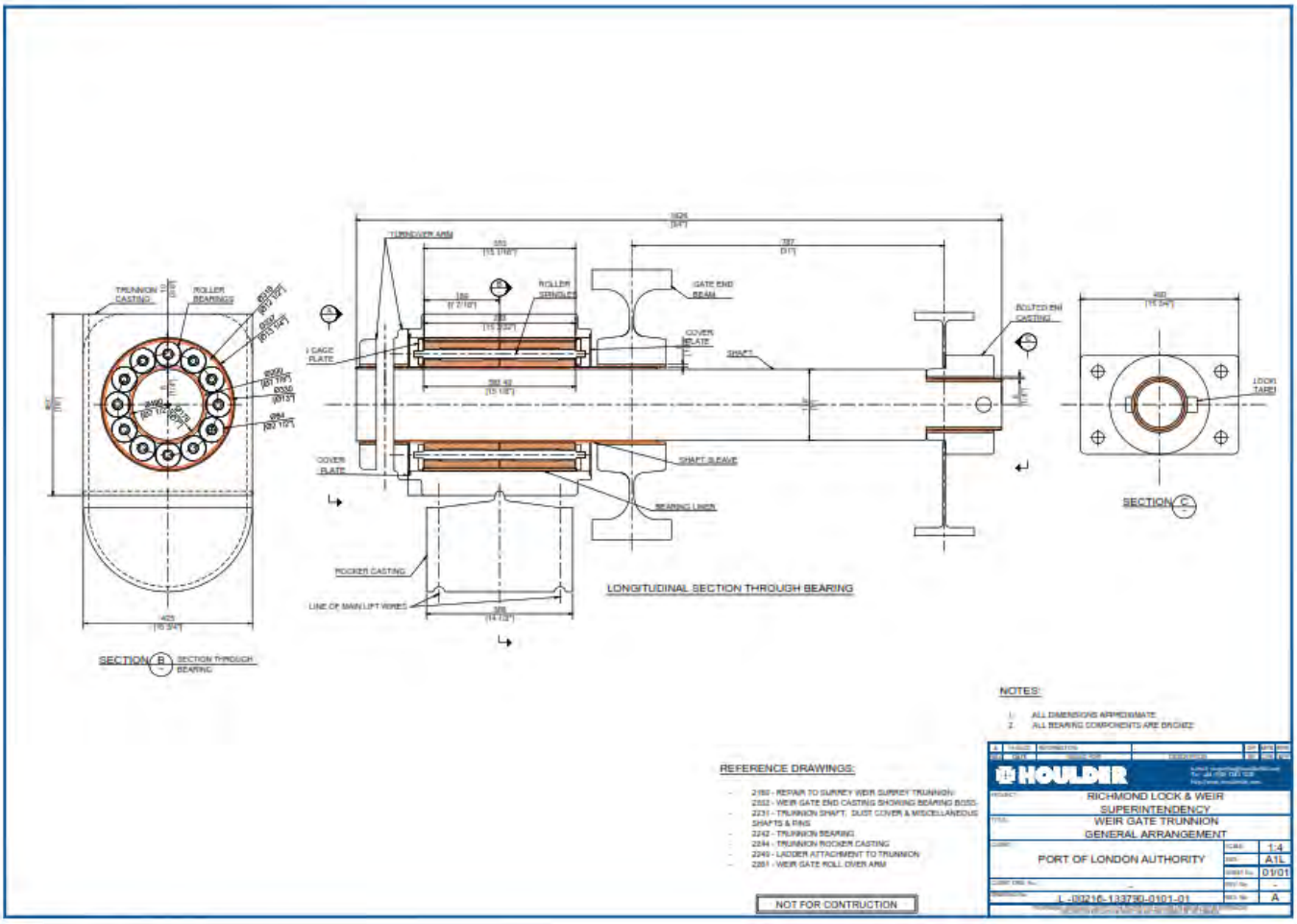


Figure 1 General Arrangement of Trunnion Bearing

6.2. Centre Weir

Shortly after the survey of the gates, the trunnion on the Middlesex end started to make noises during the 90˚ rotation whilst being lowered. Investigating this, the trunnion was found not to be hanging vertically. During the subsequent bagging operation, the trunnion failed to rotate and became more misaligned. The decision was made to lower the gate and leave it lowered until further notice. It is still able to be used for controlling the water level, ie vertical movement is permissible.

Following discussions with the PLA it was agreed to leave the gate lowered until the next draw off but to raise it monthly to ensure it could be raised if required.

It was therefore raised on Feb 10th and the opportunity taken to look inside the bearing with a borescope. The test raising and lowering was silent without the noises previously heard. Looking inside confirmed the bearing had not catastrophically failed and clearances around the bearing cage more even than indicated by previous photographs. The bearing was also observed to be rotating but metal on metal "crinkling" noises could be heard during the rotation. By comparison the surrey trunnion was silent during rotation. There was however a gap of about ½" between the trunnion and shaft end cap on the surrey end. This indicates that the gate has moved towards the surrey side. On the next raising we will try to close this gap by pushing the trunnion back against the end stop.

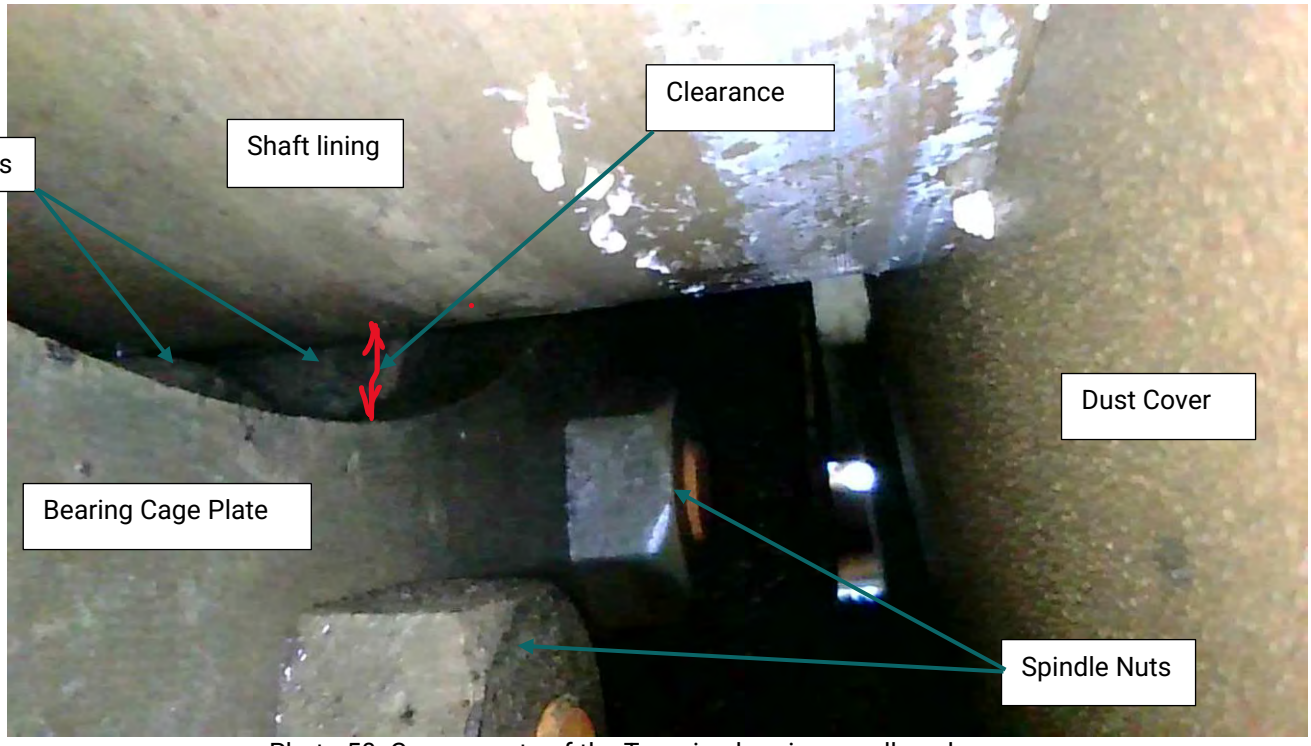


Photo 50: Components of the Trunnion bearings – all are bronze

Photo 51: Separation of the paint marks indicates the bearing is rotating

Photo 52: The clearance between the paint mark and shaft is small (top picture indicates otherwise)

Photo 53: Roller bearings visible inside the bearing cage

6.3. Surrey & Middlesex Weir

On Jan 21st a Borescope was used to look inside the trunnions as far as possible in the available space when the dust cover was removed. On the surrey end of the surrey gate the dust cover could not be retracted. Typical pictures taken are shown below of the three accessible trunnions. It is recommended that the trunnions should be listened to during their rotation (by riding on the gate as its lowered) to confirm they are silent and not making the same noise as the Centre Middlesex trunnion.

Photo 54: Small clearance between the bearing cage plate and shaft

Photo 55: Bronze Spindle Nuts

7. Well Boxes

The anodes bolted to the well boxes have totally dissolved leaving only the bolted flat bars, see below. These should all be replaced.

Photo 56 – Dissolved Anode

8. Recommendations

	Reference section	Issue	Proposal
Lock Gates	2.1.1	Leakage through penstocks	Fill in the gap along the top of the penstock housings to reduce the water flow if this is considered a problem
	2.2	Upstream top centre rotten timbers	Repair top section of both gates
	2.1.2	Local holes	Bore through and plug holes
	2.1.3	Paintwork	Repaint underside of gate top steelwork and walkways
Lock	2.1.6	Silt in Lock	Resound to see if silt has reduced, if not flush out using "Driftwood"
Capstan Pits	3.1.1	Coin band restraint nuts and bolts	Remove and replace with galvanised nuts and bolts
	3.1.2	Strap nut condition	Remove and replace with galvanised nuts
	3.1.3	Strap deterioration	Remove and replace with new galvanised straps or re-galvanise existing straps
	3.1.6	Deck support Beams	Repaint
	3.1.5	Deck support bolts	Replace bolts with new galvanised
	3.3	Doubler plate – Upstream Middlesex	Remove and replace with new plates and bolts
	3.1.2 3.1.4	No remaining paint coatings	Re paint seatings and gate quadrant structure
	3.2 3.4	Damper bracket attachments	Fit new brackets and bolts at two locations (this is in hand with ET Marine)
Sluice Pits	4	Upstream Upstream cradle clearance	Increase the diameter of the cradle rollers to reduce the play
	4.2	U bolt chain attachment to gate	Replace with galvanised U bolts (2 off)
Weir Gates	5.1.3	Deterioration of General paintwork	Repaint entire gates
	5.1.1	Inaccessible areas for painting	Devise a method of blasting and effective repainting in the "voids"
	5.2	Centre Weir damage	Repair impact damage and buckled diagonal

Trunnion Bearings	6.2	Unknown condition of trunnion bearings	Move centre gate surrey trunnion back against its end cap
			Test raise the centre weir monthly
			Remove and refurbish both Centre gate trunnions at next draw off
	6.3	Middlesex & Surrey	Check noise of trunnions by riding on the Middlesex and Surrey gates during rotation
			Depending on the findings when the centre weir trunnions are removed it may be necessary to refurbish other trunnions in the coming year's draw off works.

Well Boxes	7	No zinc remaining on the anodes	Replacement Anodes to be fitted to all 12 well boxes

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Marine Consulting Engineers

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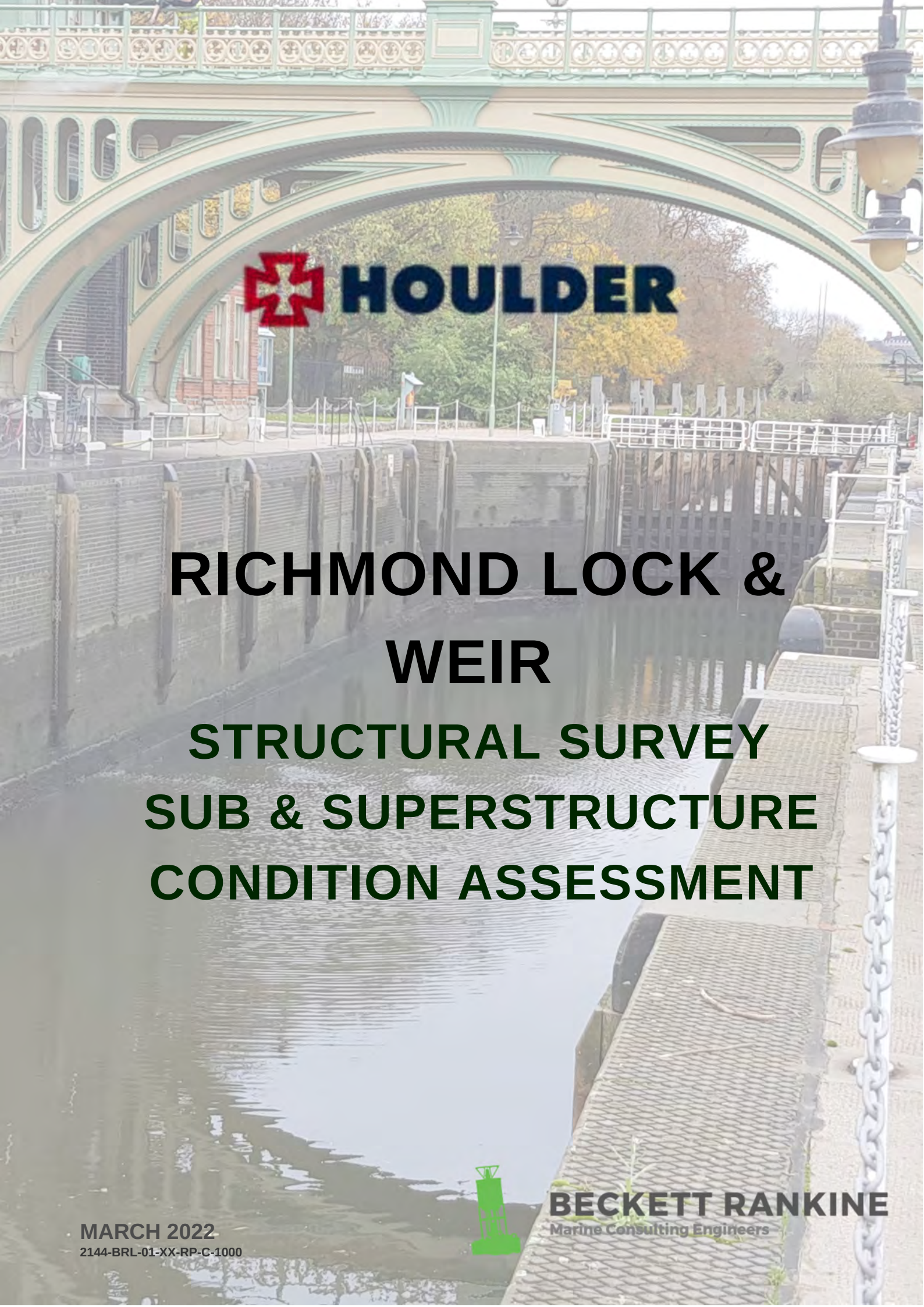
Part B - Civil Structural Surveys



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RICHMOND LOCK & WEIR

STRUCTURAL SURVEY
SUB & SUPERSTRUCTURE
CONDITION ASSESSMENT

BECKETT RANKINE
Marine Consulting Engineers

MARCH 2022
2144-BRL-01-XX-RP-C-1000

CONTROLLED DOCUMENT STATUS

CLIENT	Houlder Ltd
PROJECT TITLE	Richmond Lock & Weir
SUBJECT	Structural Survey
DOCUMENT TITLE	Sub & Superstructure Condition Assessment
DOCUMENT REF	2144-BRL-01-XX-RP-C-1000

REVISION RECORD

REV	STATUS	DATE	SUMMARY OF CHANGES	PREP	CHK	APP
P01	S2 – Suitable for Information	11/03/22		GG	-	TKHB
P02	S2 – Suitable for Information	25/03/22		GG	MB	TKHB

CONTENTS

1 INTRODUCTION

1.1 Purpose of Document

1.1.1 The Port of London Authority (PLA) has appointed Houlder Ltd and Beckett Rankine (BR) to carry out a full condition survey of the Richmond Lock and Weir arrangement.

1.1.2 This document summarises the extent of the site investigations undertaken, the result of these surveys, including any defects noted, and provides recommendations for any future works needed at the site.

1.2 Site Location

1.2.1 Richmond Lock and Weir is located in the river Thames between Richmond and Twickenham and can be seen in Figure 1.1.

Figure 1.1: Richmond Lock and Weir Location

1.3 Structure Overview

1.3.1 Construction drawings and written reports suggest that the Richmond Lock construction began in 1892. The structure is made up of a pair of foot bridges, each being ~106m in length which cross the river Thames between Richmond and Twickenham. The footbridges are of riveted iron construction.

1.3.2 Each footbridge is made up of 5 arches; the three central arches are ~20.1m in width and house steel weir gates. These weir gates and controlled using electric motors and can maintain a head of water of up to 3.6m above the level of the sluice sill.

1.3.3 The outer arches are ~15.25m in width. The full width of the arch is used by a lock on the north and by a boat slide on the south. The lock is approximately 76.2m long and has a clear opening width of ~7.9m. The interior of the lock widens to a maximum width of ~11.3m, which it maintains for 2/3 of its length. Approximately 32m of the lock island wall was rebuilt in 1944 following damage from a World War II bomb.

1.3.4 The abutments and piers of the bridge, and the walls of the lock, are comprised of mass concrete with a masonry face. This facing is either brickwork or granite blockwork.

1.3.5 A tollhouse is present on the landside at each end of the structure. The northern tollhouse is currently used by the PLA as a base for operations.

2 SURVEY METHODOLOGY

2.1 Access

2.1.1 A number of surveys have been carried out to inform this document and the conclusions contained within. These surveys are summarised within the table below:

Table 2-1: Schedule of Surveys

Date	Scope
19th November 2021	Sluice Pits
22nd November 2021	Sub-structure
12th January 2022	Super-Structure
27th January 2022	Level Survey
15th March 2022	Dive Survey*

***For information on the diver survey please see report ref: 2144-BRL-01-XX-RP-C-2000**

2.1.2 The sluice pit inspection was carried out at a low tide, during draw-off, such that as much of the interior structure could be inspected as possible. Access to each pit was via the access hatches within the sluice huts along the lock island. Inspection engineers were required to wear a suitable harness for access.

2.1.3 The sub-structure was carried out via vessel at low tide. The survey considered the area of the lock and abutment walls which were below the high tide mark. The abutments and the riverwall above the boat slide were assessed on foot. An underwater camera was used to inspect the weir sills.

2.1.4 The superstructure inspection was carried out entirely on foot from the topside of the structure.

2.2 Referencing

2.2.1 To facilitate comparison with previous condition surveys, this document adopts the reference system set out by Roughton and Fenton (1989). Following this approach, the wall is split into sections, where each section is generally bounded

by a pair of rubbing timbers. Where no rubbing timbers exist, a typical section width of 2m has been considered.

2.2.2 These wall sections are numbered based on their geographic location as per the below:

- LW Lock Wall
- LIM Lock Island Middlesex Side
- LIS Lock Island Surrey Side
- P1 Pier 1
- P2 Pier 2
- P3 Pier 3
- SW Slipway Wall

2.2.3 This reference system is fully set out in drawing ref: 2144-BRL-01-XX-DR-C-1000, included within Appendix A.

2.3 Defect Severity and Condition Ratings

2.3.1 Where the defects are discussed within this report, the condition assessment grades recommended by the Environment Agency's Condition Assessment Manual (2012) have been used. These are set out in the table below.

Table 2-2: EA Condition Assessment Ratings

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance
2	Good	Minor defects that will not reduce the overall performance of the asset.
3	Fair	Defects that could reduce the performance of the asset
4	Poor	Defects that would significantly reduce the performance of the asset
5	Very Poor	Severe defects resulting in complete performance failure

2.4 Defect Reporting

2.4.1 To improve clarity and readability of this report only severe defects and typically observed defects are discussed within each section. A full breakdown of defects is contained in the drawing package in Appendix A.

2.4.2 A photo appendix is also available in Appendix B to provide an overview of the structure and its condition.

2.5 Limitations of the Survey

2.5.1 The survey has been carried out across several visits to maximise the finding from the various elements of the structure. This has allowed the structure to be surveyed during water levels as low as could be reasonably expected and therefore capture as many defects as possible.

2.5.2 The survey was, however, subject to the following limitations:

- The survey is visual in nature and is complete as far as what could be seen across the visits; a borescope was used to assist in inspecting selected confined spaces where these could not be otherwise accessed. Any obscured defects will not have been identified as part of the survey. Defects may be obscured by water level, marine growth or additional parts of the structure for example.
- The sluice pit condition is considered as far as visible from the working platforms set out within each pit. Areas beneath the working platforms have been investigated as far as could be safely viewed.
- The survey was carried out by foot and by vessel. As such details with minimal visual impact may have been missed in higher areas of the structure.
- The pedestrian bridge structures are not accessible from on foot and can only be assessed fully via rope access or similar approach. Given they have been recently repainted it is concluded that there is unlikely to be any new defects on the structure. Therefore, the pedestrian bridges have been inspected visually from deck and ground level only.

2.5.3 This section of the report provides the output of the Beckett Rankine areas of the survey works and is limited to the Richmond Lock and Weir Structures. Houlder's inspection of the condition and ongoing maintenance of the mechanical elements of the facility are reported separately.

3 SURVEY RESULTS

3.1 Lock Wall (LW)

3.1.1 The LW forms the north face of the Richmond Lock. The wall is formed of brick masonry with larger blockwork incorporated in some areas, particularly around the lock gate installations. The wall is topped by a concrete capping beam. The wall curves towards to the shoreline at both its upstream and downstream extents. This survey does not consider the condition of the adjoining wall structures which make up the remainder of the river wall.

3.1.2 The wall is predominantly in a **good** condition across its length; however, several defects were noted which render local areas to be in a **fair** condition only.

Figure 3.1: LW19 Cracking. Full height (left), low level (right)

3.1.3 Cracking is present in numerous locations along the wall. Cracks range in size and orientation. One of the more severe cracks noted was at LW19 where a vertical crack can be seen which spans from the wall capping down to the water level

where it spans around the abutment toward LW18. The full extent of the crack, seen in Figure 3.1, was obscured by the water level even at low tide.

3.1.4 Across the wall there are numerous areas of water seepage identified. These locations correlate with crack locations and rubbing timber connections. While some areas of water seepage are very minor, a notable flow of water was observed from behind the rubbing timber at the LW7/8. During the survey, there was a significant flow of water at the interface between the lock wall, and the adjacent sheet pile wall at the upstream extent of LW1 (Figure 3.2).

Figure 3.2: LW1 - Interface Leak

3.1.5 Mortar loss is evident in multiple locations across the wall. While this mortar loss varies in location it is most often seen directly beneath the coping and around the rubbing timbers (see Figure 3.3).

Figure 3.3: Typical mortar loss around rubbing timbers

3.1.6 It was noted as part of the survey that the escape ladders are deformed at their lower extents (Figure 3.3) where they extend below the protecting fenders. This damage is assumed to be the result of vessel impact.

Figure 3.4: Ladder deformation (left), surfacing damage (right)

3.1.7 As a general comment the main surfacing of the Lock Wall is damaged where the rubbing timber at each stair location is connected to the wall via steel prop (Figure 3.4). Additionally, vegetation is growing in several places along the lock perimeter. This is true of the full lock perimeter and applies to Lock Island (Middlesex and Surrey sides) also.

3.2 Lock Island (LI)

3.2.1 The lock island comprises the south side of Richmond Lock and is integrated with the bridge pier in this location. The structure is believed to be of mass concrete construction although this cannot be confirmed visually due to its brickwork facing. The Surrey Side (LIS) of the lock island faces the lock internal and is faced with masonry brickwork with areas in blockwork in some locations around the lock gate installation. The Middlesex side (LIM) faces the main channel. The wall comprises a set of arches set against a mass concrete interior.

Surrey Side (LIS)

3.2.2 The structure is in a visually **good** condition. There are minor defects across its length although they are unlikely to impact the wall's structural stability. The wall is in much the same condition as the Lock Wall and exhibits the same defect types in terms of cracking, mortar loss, and water seepage.

3.2.3 Cracks on this wall section are often obscured by the rubbing timbers, a typical example of which is shown in Figure 3.5. As such the full extent of some cracks could not be confirmed.

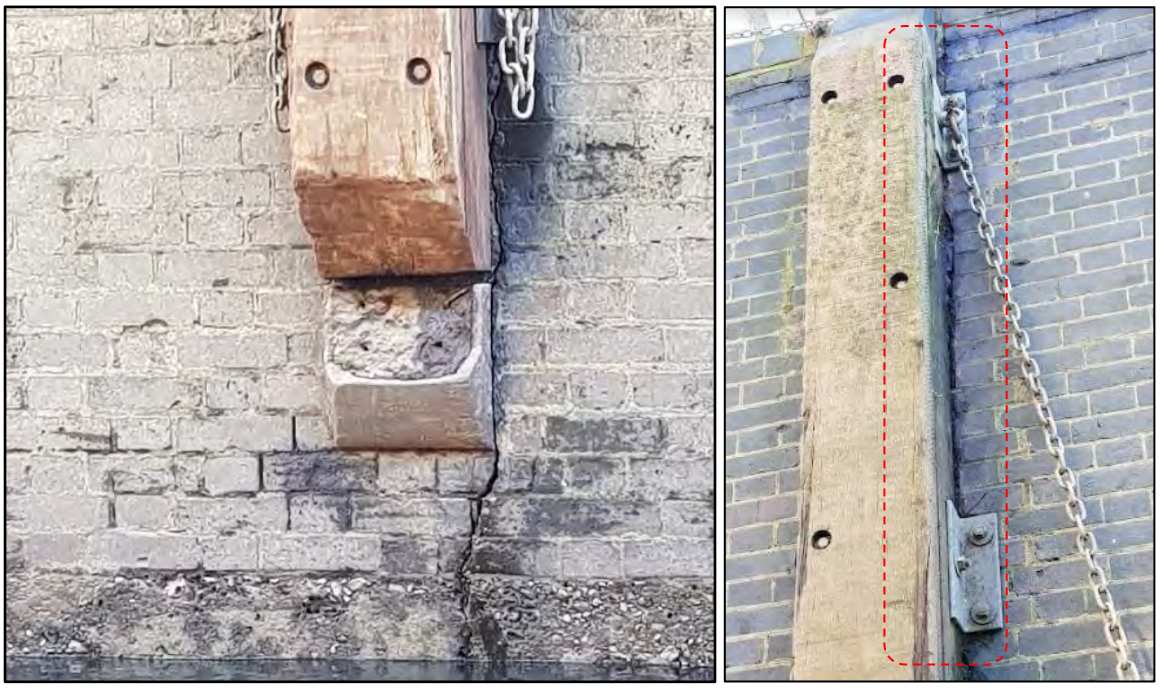


Figure 3.5: Crack alongside rubbing timber (LIS27/28)

3.2.4 There are several cases of damage to the brickwork capping. These are usually located adjacent to the rubbing timbers (Figure 3.6).

Figure 3.6: Brickwork mortar loss and damage

3.2.5 The steel plate which covers the lock gate mechanism at the upstream extent is cracked (Figure 3.7). This is covered in the Houlder Limit Report, refer to Section 3.3.

Figure 3.7: Cracked steel plate

3.2.6 The ladder in wall section LIS43 has a failed fixing such that it is not connected to the wall at its lower level. This would usually be obscured by the maintained water level.

Figure 3.8: Failed Ladder connection

Middlesex Side (LIM)

3.2.7 The structure is in a visually **good** condition and there are minor defects across its length. The wall is in a **poor** condition at LIM15 due to a long standing defect, where a crack spans the arch soffit and full-frontal height of the wall toward a handrail stanchion (see Figure 3.9). The handrail in this location is largely unsupported and is able to move laterally, representing a safety concern. At the time of the visit the handrail was braced with scaffold members but repair of the damaged brickwork is required.

Figure 3.9: LIM15 Cracking and handrail support

3.2.8 The downstream length of the wall demonstrates several areas of missing mortar. This is particularly true directly beneath the concrete capping and around areas

where there are existing irregularities in the wall (e.g., drainpipes, chain connections, rubbing timbers). In one instance, at LIM16, a hole is present just below the capping, it is assumed a drainpipe or similar was once installed here (Figure 3.10)

Figure 3.10: Hole in Capping

3.2.9 There are multiple areas of vegetation growth also located beneath the capping, examples are shown in Figure 3.11, which represent some of the more vegetated areas observed.

Figure 3.11: Typical vegetation growth

3.2.10 There are areas, such as that shown in Figure 3.12, where the brickwork is damaged. These areas are usually on the corner of the arch supports.

Figure 3.12: Arch Support Brickwork Damage

3.2.11 The upstream length is in much the same condition. A number of cracks are present toward the most upstream arches. The upstream arch (LIM02) is full of debris and could not be fully inspected.

3.2.12 The central area of this wall is the base of the integrated bridge pier. This pier is in **good** condition with no evident defects.

Sluice Pits

3.2.13 There are two sluice pits located within the Lock Island itself. These are referred to as the Upstream and Downstream Sluice respectively. These sluices allow for the water level within the lock to be controlled. While similar in function the two sluice pits have different internal structures as due to the differential head required to accommodate the addition height of retained water by the weir. The downstream sluice is circa 2m lower than the upstream sluice. The upstream sluice connects to the lock via multiple smaller outlets, while the downstream sluice has only a single larger outlet.

Downstream Sluice

3.2.14 The downstream sluice pit is in **good** condition.

3.2.15 The sluice pit has two platforms, once at a low level (directly above the sluice gate), and one beneath the counterweight. Both of these platforms were found to be secure and accessed as part of the survey.

Figure 3.13: Downstream sluice pit - minor grout loss

3.2.16 The brickwork is generally in a **very good** condition, although grimy in places. The soffit of the arch is obscured by marine growth and could not be closely inspected. There is very minor loss of grout in some localised locations (Figure 3.13) behind the upstream-most sluice chain and alongside the channels built into the brickwork on the riverside face. These channels are assumed to be used for a stoplog support during any sluice gate works.

3.2.17 The lowest rung of the access ladder is no longer perpendicular to the wall and is thus not fit for purpose. (Figure 3.14). The rung could not be moved by hand.

Figure 3.14: Access ladder rung

Upstream Sluice

3.2.18 The upstream sluice pit is in a **very good** condition. There were no identified defects in the brickwork or surroundings.

3.2.19 While two platforms are installed in the sluice pit the lower level is not accessible due to the upper platform obstructing the access ladder. The upper platform was found to be secure however and was accessed during the survey.

3.3 Timber Dolphins

3.3.1 Two timber dolphins form part of the structure, one at both the upstream and downstream extent of the Lock Island. It is assumed these dolphins are intended to act as navigational aids and provide a level of impact protection to the lock island.

3.3.2 Of these, the upstream dolphin is in **very poor** condition. The timber members are decaying and there is significant section loss within the intertidal range. The dolphin structure has lost its verticality and has developed a twist..

3.3.3 The downstream dolphin is in a **fair** condition, while the timber demonstrates similar decay and section loss, the structure retains its verticality and positioning.

3.3.4 Neither timber could be accessed for knife penetration testing as part of the survey.

3.3.5 It is noted these timber dolphins are independent from the main Richmond Lock structure and do not therefore contribute significantly to its operation, thus their condition is perhaps of lesser importance. However, the dolphins do provide impact protection as well as supporting PLA notice boards advising river uses of local conditions.

Figure 3.15: Timber Dolphins, Upstream (right), Downstream (left)

3.4 Bridge Piers (P0, P1, P2, P3)

3.4.1 There are four bridge piers within the channel which support the overhead pedestrian bridge and sluice gates. Pier 0 is built into the Lock Island, Pier 3 is built into the Concrete Slipway, while Pier 1 and Pier 2 are freestanding. These piers were assessed from a vessel as part of the substructure survey and, where safe to do so, from the water on foot in the channel or on the lock structure.

3.4.2 Historic drawings show that each pier has a mass concrete interior. The facing is brickwork on each side while each end is rounded and formed from larger stone blockwork. Large steel plates line the weir gate channels on each pier.

Pier 0

3.4.3 The brickwork of Pier 0 is in a **good** condition. The north face of the pier could be accessed from the lock island, as such the pier could be inspection more closely that the south face, and the following piers within this section.

3.4.4 The north face exhibits calcium staining in places, particularly on the soffits of the window arches built into the pier (Figure 3.16).

Figure 3.16: Pier 0, Mortar loss (left), arch soffit staining (right)

3.4.5 There is mortar loss and damage to the brickwork adjacent to the pedestrian bridge landings (Figure 3.16).

3.4.6 Elements of the older stone blockwork are weathered.

Pier 1

3.4.7 The brickwork of Pier 1 is in **good** condition. Marine growth is evident around the high-water line. Further staining is present on the upstream side of the pier, at heights which would usually be covered were the survey not carried out during draw off (see Figure 3.17).

Figure 3.17 Pier 1. Water seepage (left), vegetation staining (right)

3.4.8 Water seepage was observed between the blockwork at the downstream end of the pier (Figure 3.17). While not a key defect, it suggests there may be a void or similar failing of the mortar in this location.

Figure 3.18: Pier 1. Upper level vegetation

3.4.9 Vegetation growth is present in several mortar joints at the upper levels of the abutment (Figure 3.18).

Pier 2

3.4.10 Pier 2 is in good condition as per Pier 1 and shares the same typical defects as identified previously. Marine growth obscures the brickwork around the high-water level. A larger patch of marine growth is present on the upstream blockwork which would usually be below water level (Figure 3.19).

Figure 3.19: Pier 2 - Marine Growth

3.4.11 Water seepage is noted in several locations, particularly between the weir channel steel plate and the adjoining brickwork.

Figure 3.20: Pier 2 - previous repair

3.4.12 There are signs of a previous repair on the downstream extent, this bond between this repair and the wall is **poor** (Figure 3.20).

Pier 3

3.4.13 Pier 3 is not isolated within the channel like Pier 1 and 2 but acts as the outer extent of the concrete apron which houses the boat ramp. As such the low-level elements are obscured by the slipway structure.

Figure 3.21: Pier 3 - Water seepage

3.4.14 From what can be seen Pier 3 is in **good** condition as per Pier 1 and Pier 2. Marine growth obscures areas of the wall toward the high-water mark, and there is a degree of greening of lower levels. Water seepage is present is several locations. No vegetation growth was noted on this pier.

3.5 Boat Ramp & Concrete Apron

3.5.1 The south side of the river features an elevated concrete apron with a set of tracked rollers incorporated. This acts as a ramp to allow river uses to move canoes/kayaks across the weir. The edge of this concrete apron is a raised wall which is in line with Pier 3.

Boat Ramp & Concrete Apron

3.5.2 The concrete apron looks to be formed from a concrete slab cast immediately above an older concrete slab.

3.5.3 The concrete apron upper slab is in a **good** condition. There is a construction joint between the two concrete pours where the gradient of the ramp changes. Several cracks are present across the surface of the concrete but they do not compromise its function.

Figure 3.22: Concrete Apron

3.5.4 The lower concrete slab can only be seen beneath the tracked rollers, and at the end of the structure on the upstream side, where the ramp does not extend down to the foreshore level. The slab is in a **fair** condition, although the top surface is aged and abraded.

Figure 3.23: Concrete Slipway - Low Level Concrete

Concrete Apron – Retaining Wall

3.5.5 The retaining wall is formed from brickwork masonry and in a varied condition across its length.

3.5.6 Downstream of Pier 3, the wall is in a **fair** condition. The wall is cracked in numerous places; these cracks are often the full height of the wall. Water seepage is also noted along several of the mortar joints. The walkway along the top of the wall can be felt to be settling towards one side suggesting some movement, but this was not observed on the front face of the wall.

Figure 3.24: Pier 3 - Downstream retaining wall

3.5.7 The section of wall upstream of Pier 3 is fully obscured by marine growth such that little can be seen from the river side. A large horizontal mortar gap with missing bricks is visible toward the top of the wall. This section of the wall is in **poor** condition.

Figure 3.25: Upstream Slipway wall - missing mortar and brick

3.6 Slipway Wall (SW)

3.6.1 The slipway wall acts as the river wall on the south side of the site. The wall is brickwork masonry in nature. Unlike the Lock Wall on the other side of the river, this wall does not feature the incorporation of any larger stone blockwork at either of the returns and does not include the rubbing timbers seen elsewhere in the arrangement. The wall is in a **good** condition, but several localised defects reduce the assessed condition to **fair** only.

3.6.2 There are cracks in the curved return walls at both the upstream and downstream extents. These cracks span the full height of wall. The crack of the upstream return wall has a broken crack gauge installed, indicating a previous attempt to monitor the defect.

Figure 3.26: Slipway Wall - Typical Cracks

3.6.3 The central section of the wall is mainly obscured by marine growth but there are minor cracks visible in places.

3.7 Toll Houses

3.7.1 There are buildings at both the North and South side of Richmond Lock, used as offices by the PLA. The external facing of these buildings was looked at as part of

the superstructure survey. The structures are primarily brickwork masonry; however, the lower courses are larger stone blockwork. Each building is in **good** condition with no significant structural defects noted, however minor cracking of brickwork and decorative stonework is noted in places.

3.7.2 The lower area of blockwork is more eroded than the remainder of the structure, assumed to be due to the water level at high tides (see Figure 3.27).

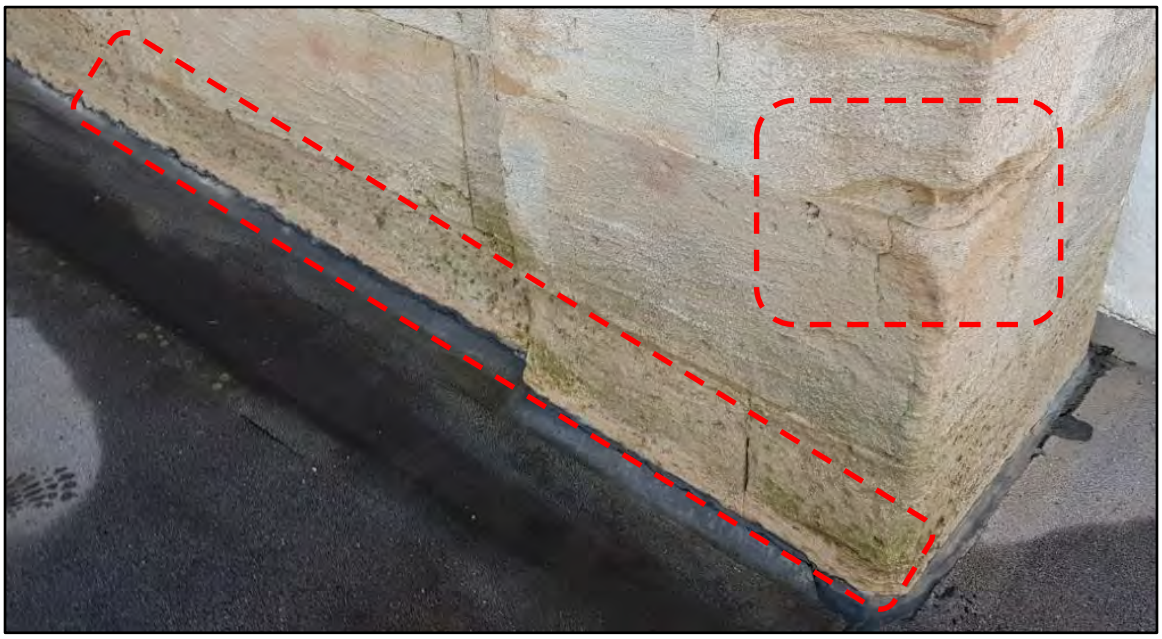


Figure 3.27: Tollhouse - low level erosion, and blockwork damage (red)

3.7.3 There is minor damage to the brickwork/blockwork around the corners in some locations (Figure 3.27).

3.7.4 Brickwork and stonework in localised areas across the buildings are weathered and some locations are missing mortar. This is also true of several window/door lintels.

Figure 3.28: Pedestrian bridge - foundation cracks

3.7.5 There is cracking within the foundation which supports the Pedestrian Bridge at the North Tollhouse (Figure 3.27). There are signs this has been repaired previously, but the underlying cause does not seem to have been resolved. A similar defect is present at the south building but to a more minor extent.

3.8 Pedestrian Bridges

3.8.1 There are two pedestrian bridges across the structure. The upstream bridge is for staff only, while the downstream bridge is open to the public.

3.8.2 The main bridge structure is assessed visually only from ground level. The structure has been recently repainted, and no deterioration of this paint system was observed. The exception to this is around the walkway landing connection detail with the masonry piers, where corrosion is evident. This defect was highlighted by the PLA at the onset of the survey as an area of concern because the back of the flanges were not able to be painted due to lack of access. This same landing connection detail is present in multiple locations across the site including the Tollhouse, the Lock Island Bridge Pier and Piers 1, 2 & 3.

3.8.3 The steelwork of the bridges at a low level is noted to be corroded where the flange meets the blockwork. Typical examples of corrosion in these areas are shown in Figure 3.29.

Figure 3.29: Corrosion at base of pedestrian support flange (typical)

3.8.4 Through a combination of UT measurements and observations behind the steelwork using a borescope, it has been established that the areas in which the section is lacking thickness are isolated to very local areas. The flange is completely corroded in some areas; however, this returns to typical section thickness within 300mm. A breakdown of the UT readings obtained can be found in Appendix C

3.8.5 An additional location of corrosion identified is at a higher point in the landing structure, where a flange backplate is corroded right through. This area can be seen to be corroding at the corresponding locations on Pier 1, Pier 2, and Pier 3. Close access to these locations was not possible during the survey so further UT measurements were not possible, however the defects could be identified from a distance, see Figure 3.30

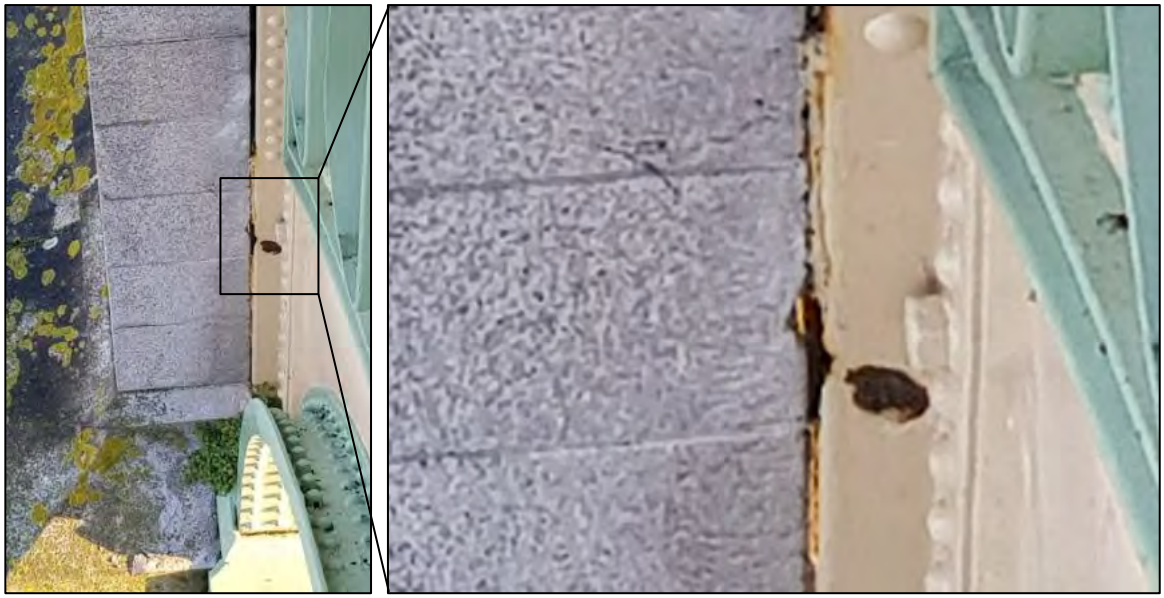


Figure 3.30: Pier Landing - Typical corrosion locations - Pier 1, 2, 3

4 LEVEL SURVEY

4.1 Overview

4.1.1 A level survey was carried out by Roughton and Fenton to establish where the formation of any cracks was due to foundation movement. This survey has been repeated by BR as part of the current works. The BR survey was carried out using a GPS survey stick such that accurate information could be obtained as to the elevation of the wall at regular intervals along its length.

4.1.2 Measurements were taken from centre points of each wall section, midway between the rubbing timbers (identified within drawing ref: 2144-BRL-01-XX-DR-C-1000 – see Appendix A). All measurements were taken ~100mm back from the front face of the wall. On the slipway wall, where no rubbing timbers are present, readings were taken every 2m. Additional measurements have been taken for the Slipway Wall, which previous covered only the main wall element. BR took further readings for each of the two curved return walls to understand any potential wall movement more fully.

4.1.3 The results of the Level Survey can be found within Appendix D, where the readings are presented graphically against the results of the Roughton and Fenton survey. As the Roughton and Fenton survey datum is unknown, all levels have been reduced based on the initial reading to allow useful comparison between the information. Given the potential tolerances within this approach, minor variances in levels are assumed to be insignificant, not least because the precise location of the measurement points is unlikely to be the same, and only significant variations are focused on.

4.1.4 As the GPS survey relies on a good connection to satellites, the accuracy of readings drops in some locations where the signal is weaker. This occurred in locations beneath the pedestrian bridges. Where data points were inaccurate, they have been replaced with linear interpolation and marked in red.

4.2 Lock Wall

4.2.1 The lock wall demonstrates a relatively consistent relationship between the new levels results and the historic with less than 10mm discrepancy between points along the majority of the wall, this is easily within the combined tolerances of the two surveys.

4.2.2 The exception to this is at LW19 which has risen circa 35mm since the previous survey. This location coincides with the crack spanning the full height of wall, discussed in Section 3.1.3.

4.2.3 There is a significant difference in level between LW8 and LW12, on opposing sides of the pedestrian bridge foundations (~35mm) which may represent ongoing settlement of the wall around the bridge structures.

4.3 Lock Island - Middlesex Side

4.3.1 There is a close correlation between the levels obtained during the current survey, when compared to the historic, suggesting little movement has occurred. The majority of the wall demonstrate a differential of less than 10mm.

4.3.2 The downstream extent of the wall, from LIM16 onwards, has continued to settle since the previous survey, and is approximately 20mm lower that previously. This location aligns with the scour pocket in front of the wall. The increased settlement at this location was also noted by Roughton and Fenton and attributed to the ~3m surcharge of water on the downstream base of the lock which occurs during operation condition in the lock with the downstream water at a low tidal level.

4.4 Lock Island – Surrey Side

4.4.1 Levels tend to be within 10mm of the previous survey across the length of the wall. The largest discrepancies are at LIS25 which has increased in level by 25mm since the previous survey, this is adjacent to the lock gate opening location.

4.4.2 A 15mm discrepancy between LIS 30/31 could suggest settlement which would tie in with the crack observed in this location, however due to the respective predicted survey tolerances, this cannot be confirmed. A crack is also present at LIS39, where the other largest discrepancy between survey can be observed, suggesting a settlement of circa 15mm.

4.5 Slipway Wall

4.5.1 The GPS signal was less strong along the slipway wall and less useful data was able to be obtained. Based on the received measurements, the wall appears to be approximately 50mm higher at its maximum 28m from its upstream extent.

4.5.2 The data for chainage 0 through 12m appears to be relatively in keeping with the previous data with a ~20mm maximum discrepancy in places. However, at this location, the pedestrian bridge foundations are located, and the overhead bridge renders any measurements inaccurate. The signal could not be accurately taken to inform the study. The signal does not recover to a suitable strength until chainage 26m, where the new measurements suggest the wall has risen by ~45mm.

5 ANALYSIS

5.1 Overview

5.1.1 As part of the survey of the Richmond Lock and Weir, any elements which were identified as of potential structural concern have been subject to a structural analysis to ascertain their continued suitability for purpose.

5.1.2 There were two elements raised throughout the survey which were considered to require analysis works.

5.1.3 The first is the steelwork of the pedestrian bridges which are corroded in some places. Noting however, that this is limited to the localised area of the flanges, which are not load bearing; all load being carried by the webs, no further assessment has been carried out.

5.1.4 The second element meriting assessment is that the downstream lock island wall. This is due to the scour hole in front of the structure potentially having an impact.

Note that this assessment and its output are to be updated following the dive survey, and confirmation of the scour hole size, location, and depth.

5.1.5 The following assessment has been carried out using previous geotechnical data based on the Roughton & Fenton report and its appended Oakley Soils Survey. Wall dimensions have been based on the Roughton & Fenton drawings.

5.2 Assessment Scope

5.2.1 The downstream lock island wall as assessed with regards to its stability. The assessment has been based on Coulomb's Theory of earth pressures on retaining walls.

5.2.2 Due to the age of the structure and the various unknowns surrounding it structure, geotechnical information has been considered as the most extreme values suggested by Oakley Soils Survey, as below:

- Saturated Soil Density 21 kN/m³
- Angle of Shear Resistance 26°
- Angle of Friction (with wall) 23°
- Cohesion 35 kN/m²

5.2.3 We have considered the worst case loading as when the lock is full during a low tide, resulting in a net overturning force riverward.

5.2.4 The assessment has considered:

- Gravity resistance of the structure against overturning due to water pressure
- Gravity resistance of the structure against sliding due to water pressure
- Bearing pressure impacted on the soil beneath the wall foundation as a result of its loading.

5.2.5 For all calculations, a high-water level of 4.89m OD has been considered (PLA Chart 304, 2016), this is conservative when compared to the retained water level. The average height of the wall has been considered to be 4.45m OD based on result of the level survey (see Section 4). The riverbed level has been taken to be -1.0m OD at the foot of the wall, and the sill of the lock is taken at -2.7m OD (PLA Chart 304, 2016).

5.2.6 The cross section of the wall at the centre span of the southside arches has been considered, such that the bearing area, stability, and stiffness provided by the arch supports are not considered.

5.3 Assessment Output

5.3.1 The output of the assessment is expressed in terms of utilisation where a utilisation of 1 would suggest the wall is on the edge of failure. A utilisation below 1 is required.

5.3.2 The output of the assessment is tabulated within Table 5-1 below for each sliding, overturning and bearing pressure. The data set included within brackets,

illustrates the utilisation which would be achieved when using the (less conservative) soil parameters adopted by Roughton and Fenton.

Table 5-1: Lock Wall Assessment - Utilisations

River Low, Lock High	
Check	**Utilisation**
Sliding	0.28 (0.22)
Overturning	0.14 (0.14)
Bearing	0.54 (0.50)

6 INSPECTION AND MAINTENANCE REGIME

6.1 Recommended Future Inspections

6.1.1 An inspection schedule is currently understood to be in place for the sluice gates and weir which constitutes of a yearly survey, however limited information is known as to the inspection plan in place for the masonry and civils elements.

6.1.2 An inspection schedule is suggested below to allow suitable tracking of the structure and its condition.

Item	Scope	Frequency
Inspection of the Lock and Weir Structure	Inspection of the complete arrangement from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off by a suitably qualified engineer.	Every 5 years (from 2022)
Inspection of the Lock and Weir Structure	Landside walkover inspection of complete arrangement to ensure deterioration is progressing and expected rate and highlight any areas of potential concern. To be carried out by PLA staff or similar.	Quarterly
Steel thickness measurements	Measure steel thicknesses of pedestrian access bridge – areas accessible on foot only	Every 5 years (from 2022)
Steel thickness measurements	Inspection of pedestrian bridges from roped / scaffold access. Measure steel thicknesses of pedestrian access bridge	Every 10 years (from date of last painting)
Sluice pit survey	Visual inspection of sluice pits to identify any defects and general condition.	Every 3 years (from 2022)
Dive inspection	Visual / tactile inspection of area below water including concrete sills, and low-level wall areas.	Every 10 years (from 2022)

6.1.3 This schedule should be reviewed after each inspection of the full arrangement. Additionally, the schedule should be reviewed should the rate of deterioration be noted to change, or if there is any significant worsening of any specific defect.

6.2 Recommended Maintenance

6.2.1 Works recommended across the pier arrangement are listed below. The repair activities have been split dependent on their perceived urgency. The repair periods are:

- Immediate – any repairs which are safety focused
- Short term – to be carried out within 2/3 years
- Medium term – to be carried out within 4/5 years

6.2.2 These timescales, particularly those currently considered with lesser urgency should be reviewed alongside the regular inspections.

6.2.3 Typical repair methodologies have been provided within Section 6.3

Immediate / Safety Critical

6.2.4 Work should be carried out to reattach the lowest connection on the upstream lock island ladder.

6.2.5 The lowest rung of the downstream sluice pit access should be repaired. It is noted that this rung is not required for safe access and egress, however.

6.2.6 The crack at LIM15 should be repaired and the associated handrail refixed in accordance with the typical repair methodologies.

6.2.7 Monitoring systems should be put in place for the crack at LW19 as the level survey suggests movement at the crack location. Strain gauges should be installed and monitored quarterly for 1 year to better the root cause of cracking and if they are movement generated. Wall movement over time will indicate whether they have been formed due to differential settlement (linear wall movement) or as a result of

thermal activity (cyclic movement). This will then allow the correct repair method to be specified.

6.2.8 Given the number of cracks noted in close proximity to the rubbing timbers, these members should be temporarily removed, the condition of the underlying wall, and the full extent of these cracks identified. Crack due to the rubbing timber fixings should be repaired as per this document, while those at location of identified movement should be monitored as per LW19.

Short Term (within 2/3 years)

6.2.9 The upstream timber dolphin should be repaired. The type of repair is dependent on the condition of the midlevel timbers which are the most degraded but were unable to be accessed for testing. The dolphin should either be:

- Replaced in its entirety
- Degraded timber removed and good timber be installed via splice joint. New timber should be a marine grade hardwood such as Ekki.

6.2.10 The corrosion of the steel pedestrian bridge landings should be addressed. While the exact nature of the repair should be dictated by the available access between the wall and the corroded flange, it is anticipated that corroded material would be blasted to good steel, the recesses filled by a hard setting grout such as Chemical Metal, and the remaining metal painted to match the existing structure. The same methodology should be used for the areas of the steel pedestrian bridge supports identified which have corroded at a higher level where the flange back plate ceases.

6.2.11 The crack at LW19 should be repaired as dictated by the recommended crack monitoring. Any further exposed cracks should be repaired in line with the guidance in this document.

6.2.12 Marine growth across the structure should be cleaned to verify the condition of the underlying structure.

6.2.13 The slipway retaining wall which forms the upstream and downstream extents of Pier 3 should be repaired. This will require repointing of spalled and damaged brickwork, and the repair to the identified cracks.

6.2.14 The damaged brickwork, and areas of more severe mortar loss around the Lock Wall and Lock Island capping beams should be repaired. There should be a focus on the elements adjacent to the rubbing timbers.

6.2.15 The cracked steel plate at the upstream lock gate mechanism should be replaced.

Medium Term (within 4/5 years)

6.2.16 All defects to the tollhouse were aesthetic only and their repair is not considered urgent. While any identified crack should be noted and monitoring moving forward, they are not considered to be structural in nature. Any cracks at a low level such that they are exposed to the tide should be sealed with a suitable cementitious render to prevent further damage.

6.2.17 Any outstanding areas of masonry brickwork within the lock and the lock island walls should be repaired. All areas of lost mortar should be regrouted.

6.2.18 Seepage was noted in multiple locations across the site. While this may be due to voids within in the wall filling and draining with the tide, it is likely part of these is due to water ingress from the retained water on the other side of the Thames path. To avoid ongoing erosion to the wall structure the areas of seepage at LW1 should be sealed. To avoid water build-up a drain may be required in the adjacent sheet piling.

6.3 Repair Methodologies

6.3.1 Typical repair methodologies are provided within this section. These do not represent the only method of repairing the structure and further methods could be explored if required.

Crack Repair

6.3.2 The following is a table of the key materials sectioned for the proposed crack repair works. Alternative methodologies and products may be proposed by the Contractor in place of the specified approach, though equivalent or better performance criteria should be achieved.

Table 6-1: Proposed material for crack repair works

Crack Size	Material	Description	Purpose
<10mm	NITOKID LV low-viscosity expoxy resin	Marine Concrete Resin	Crack Repair
10 – 25mm	NITOKID TH thixotropic expoxy resin	Marine Concrete Resin	
>25mm	CONBEXTRA UW cementitious grout	Marine Grout	

6.3.3 The existing horizontal and vertical crack will be repaired with the following methodology:

1. Crack is to be broken back to solid concrete / brickwork so as not to induce excess vibrations in the structure.

2. Pressure wash surface then clear area to remove debris, vegetation, and other loose particles

3. Apply the relevant product for the crack width (see Table 6-1), in accordance with the manufacturer's recommendations.

4. The finish of the mortar is to be flush with the surrounding material.

Removal of Vegetation

6.3.4 Any vegetation and roots are to be removed by hand using hand operated tools to minimise the damage to the structure. All debris is to be disposed of to a suitable facility and particular care shall be taken to ensure no debris falls into the river.

Repointing of worn masonry and joints

6.3.5 The joints surrounding worn masonry should be cleaned out with a jet of water with sufficient pressure to remove loose or defective material but without damaging sound mortar. Where the original mortar is weak, hand raking, or mechanical removal of loose material is preferable to avoid unnecessary damage.

6.3.6 Worn masonry should be removed of and recycled in an appropriate waste facility. The masonry should then be replaced with an engineering brick colour matched to the surrounding brickwork.

6.3.7 Joints surrounding any new bricks should be pointed using a masonry mortar suitable for use within the marine environment, such as Flexcrete Marine Mortar S (or similar approved) and should have a curing time such that the mortar is able to set before being dampened by the tide.

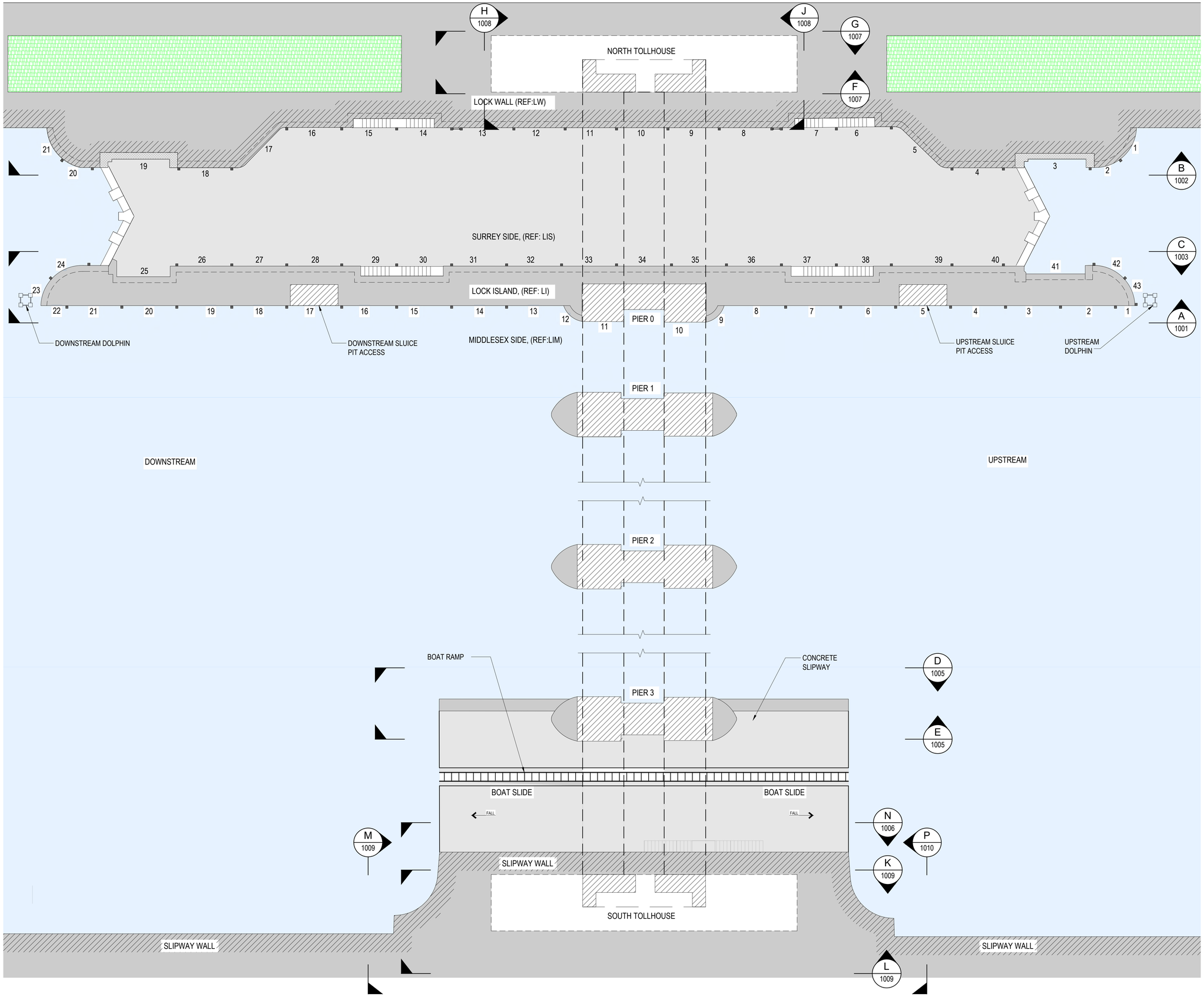
6.3.8 Narrow joins up to 100mm deep, or wider joints up to 300mm deep should be filled with pressure pointing. Injection pointing should be used for joints deeper than 300mm with a nozzle size appropriate for the width of the joint.

Replacement of missing masonry

6.3.9 Missing masonry should be replaced following the same methodology as that for the repointing of worn masonry. Any replacement bricks or stone blocks should match the surrounding materials.

APPENDICES

APPENDIX A REFERENCE DRAWINGS



RICHMOND LOCK & WEIR - GENERAL ARRANGEMENT

(SCALE 1:150)

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RICHMOND LOCK & WEIR
EXISTING PLAN

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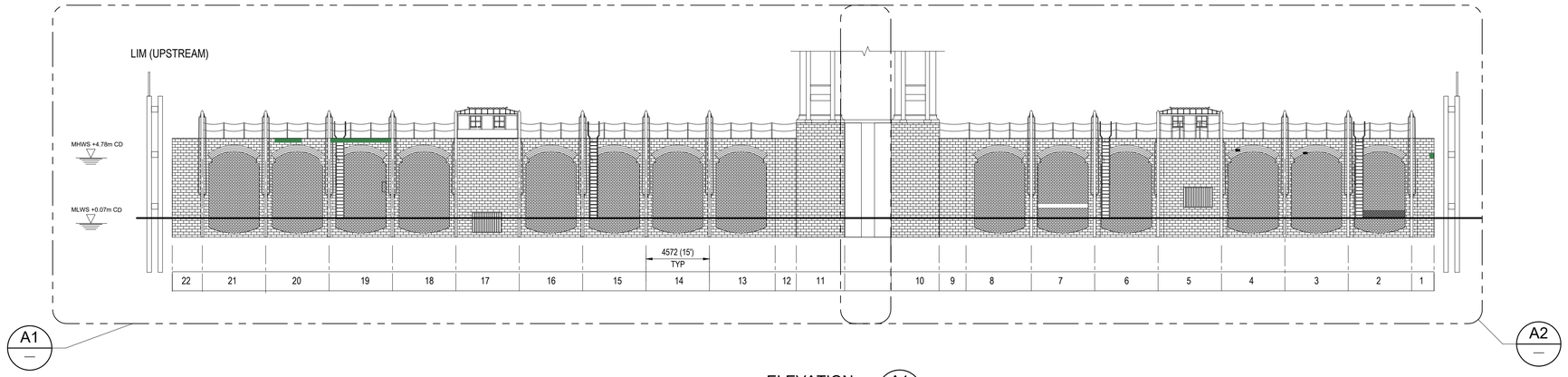

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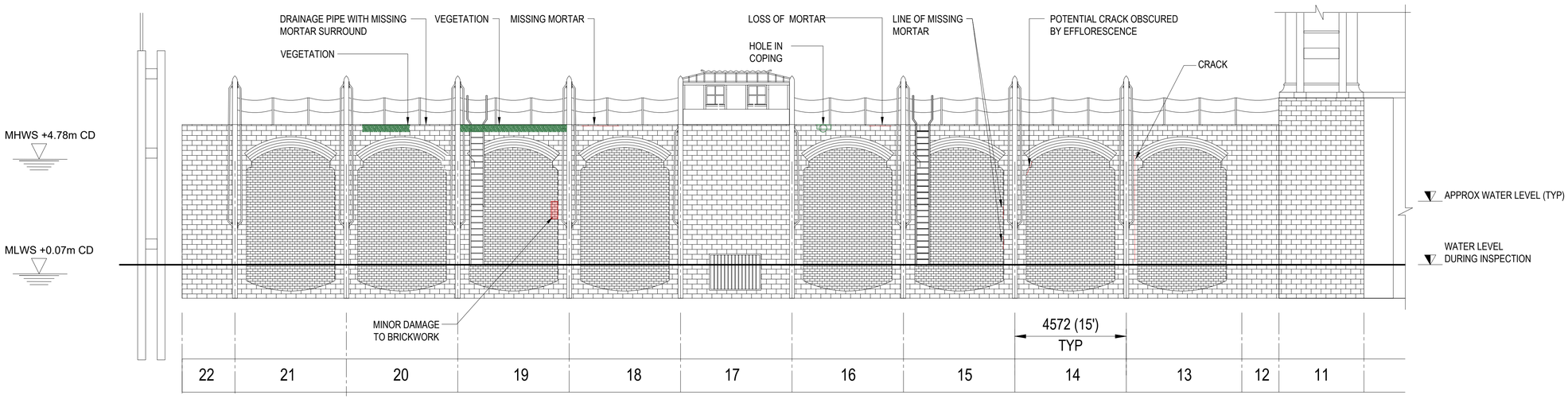

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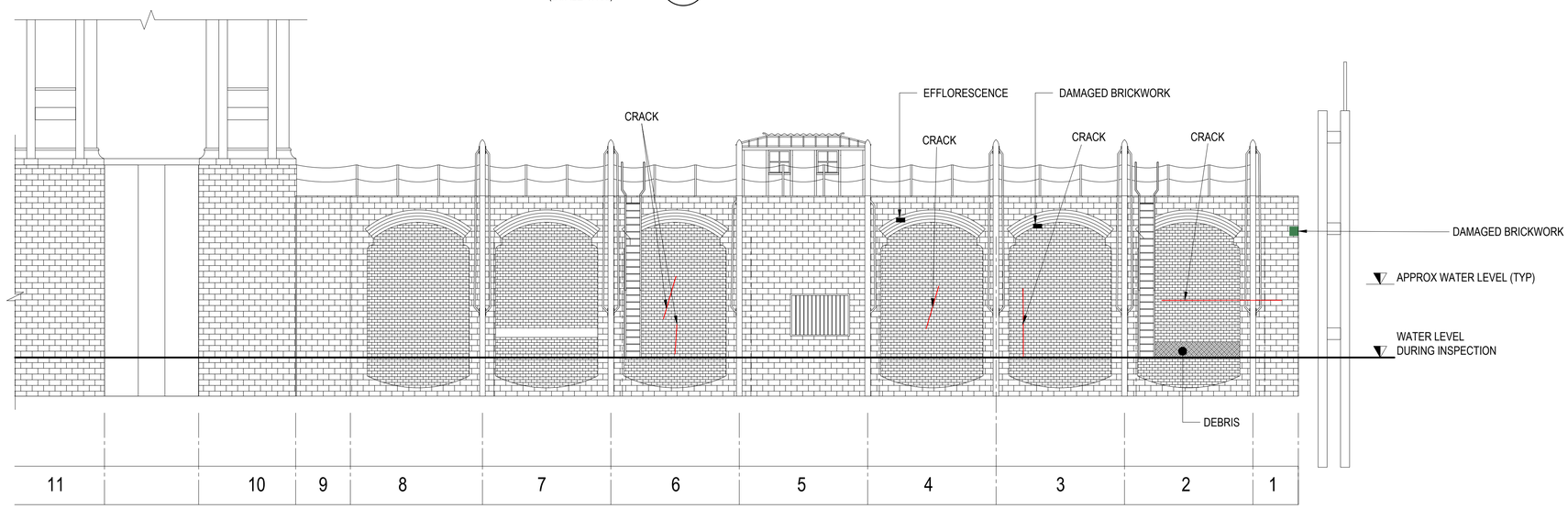

PART ELEVATION A2
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RICHMOND LOCK & WEIR
LOCK ISLAND (MIDDLESEX SIDE) ELEVATION

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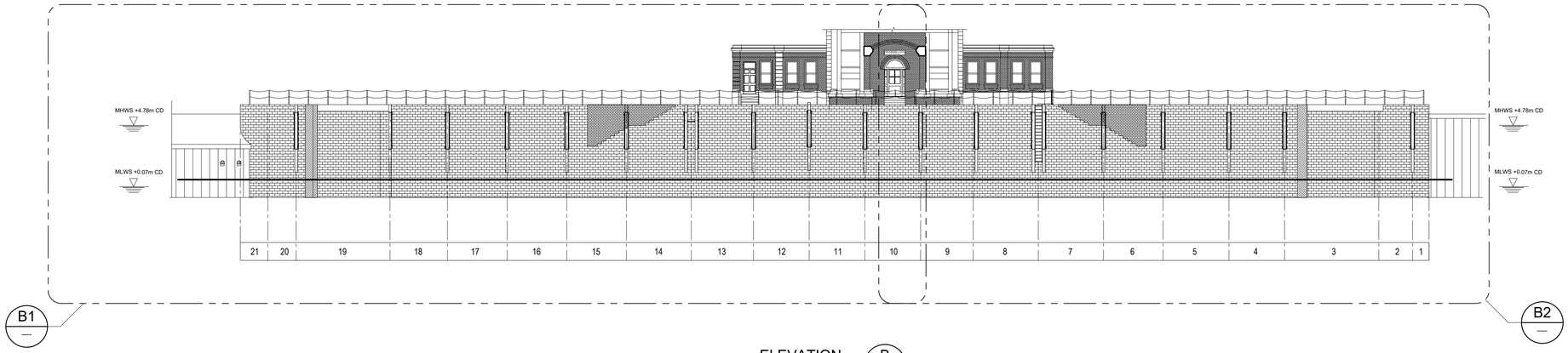

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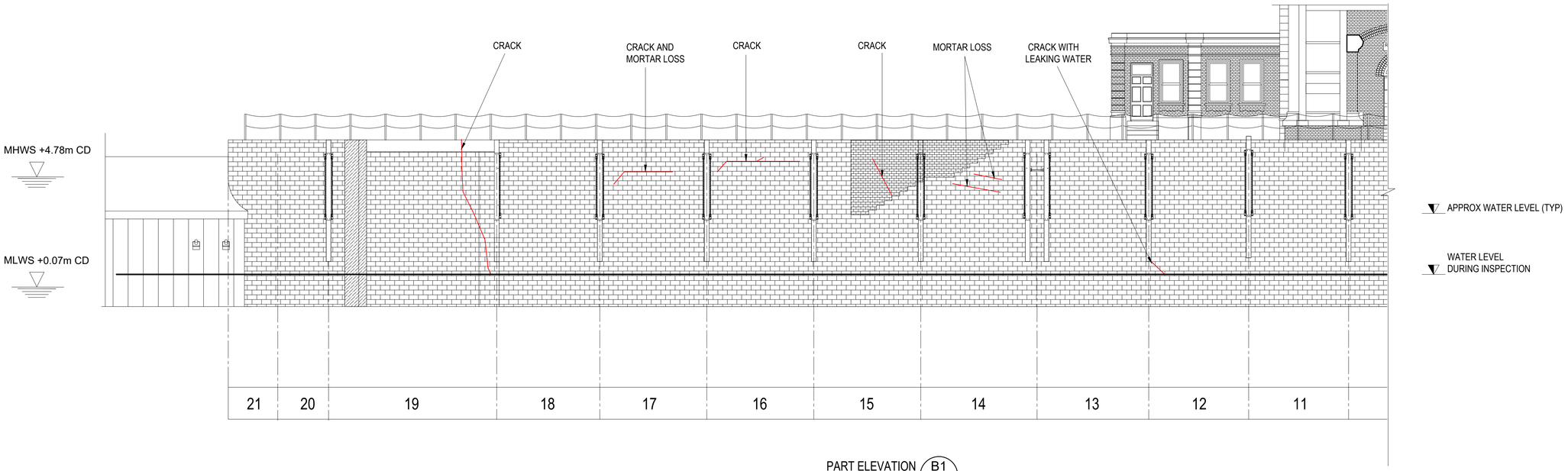

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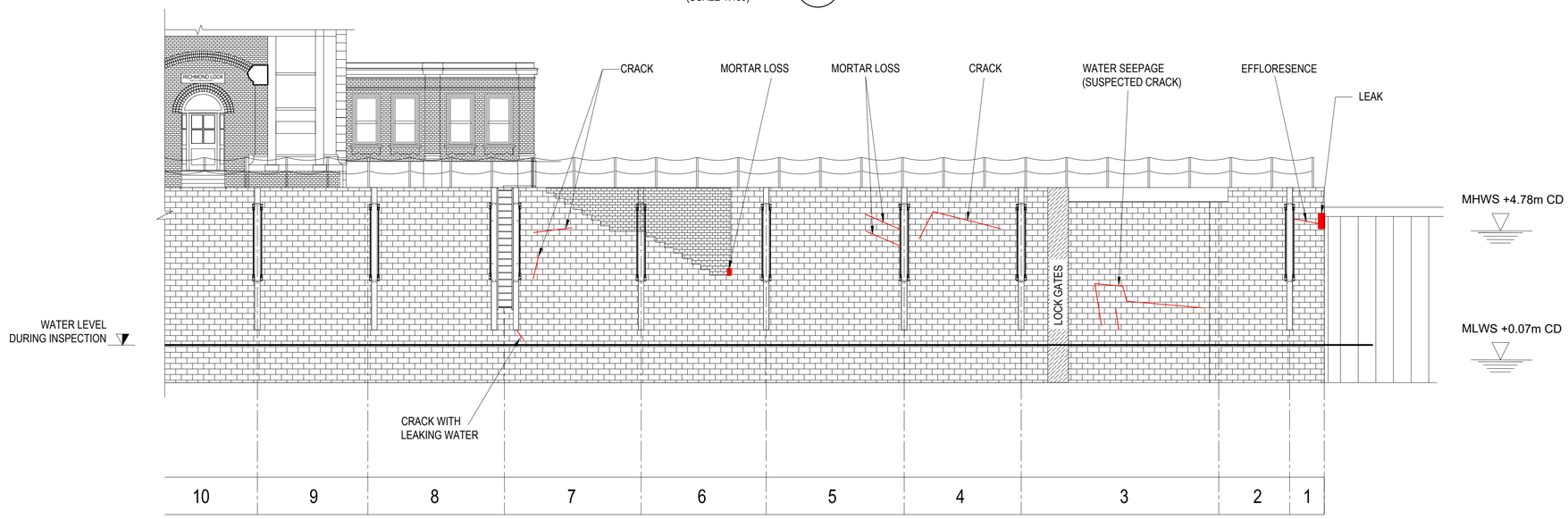

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RICHMOND LOCK & WEIR
LOCK WALL ELEVATION

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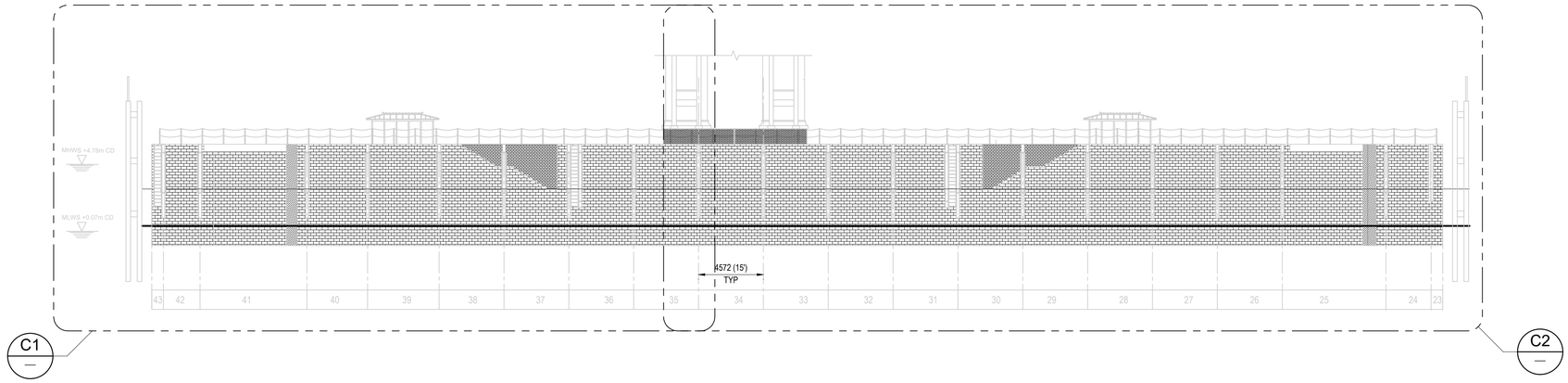

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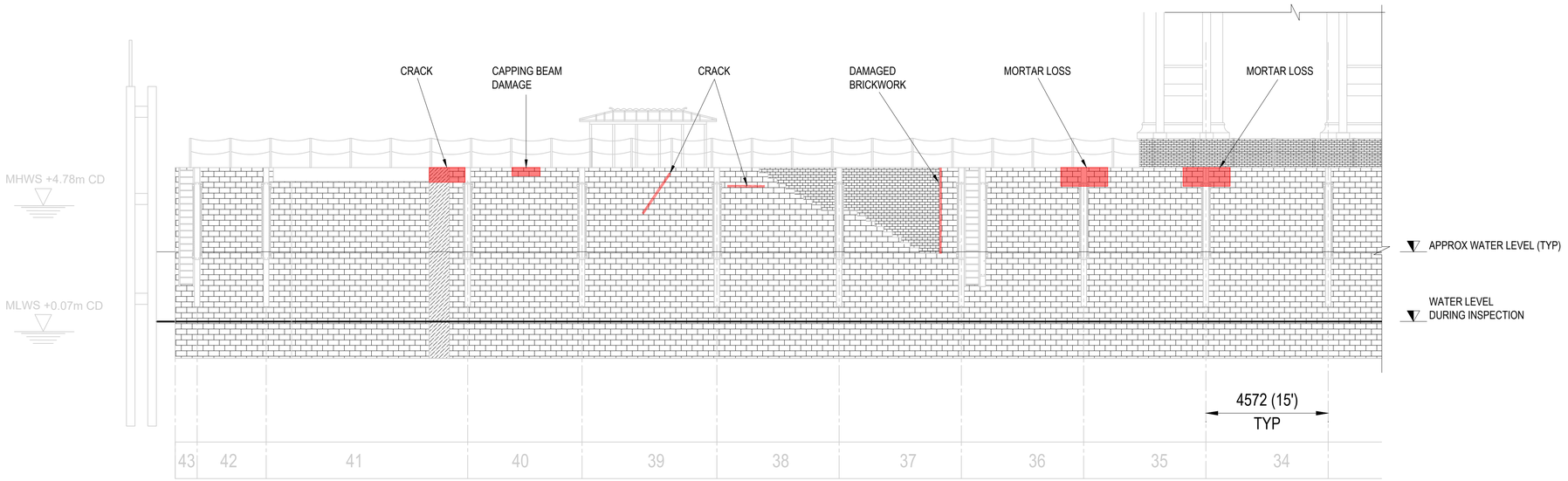

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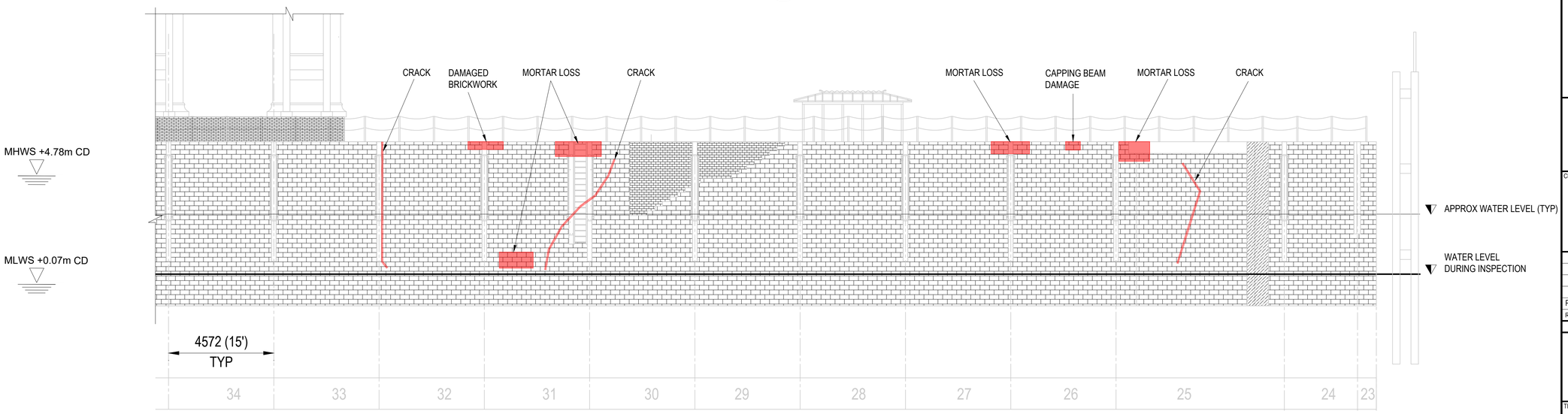

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RICHMOND LOCK & WEIR
LOCK ISLAND (SURREY SIDE)
ELEVATION

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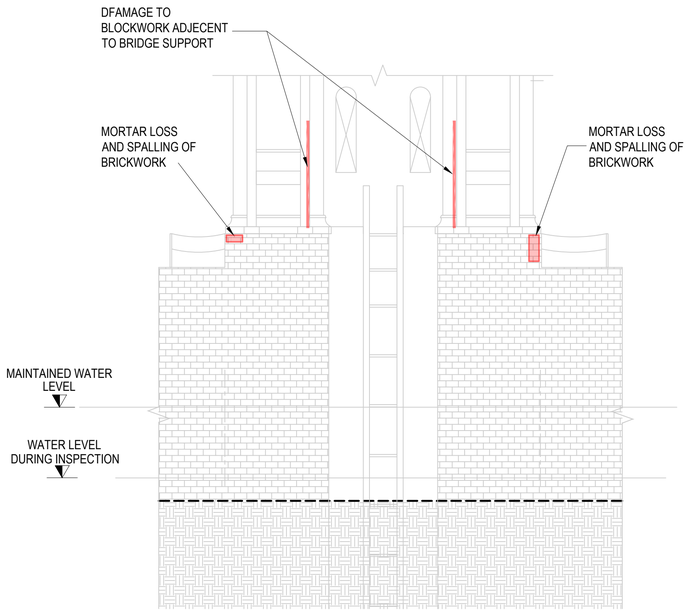

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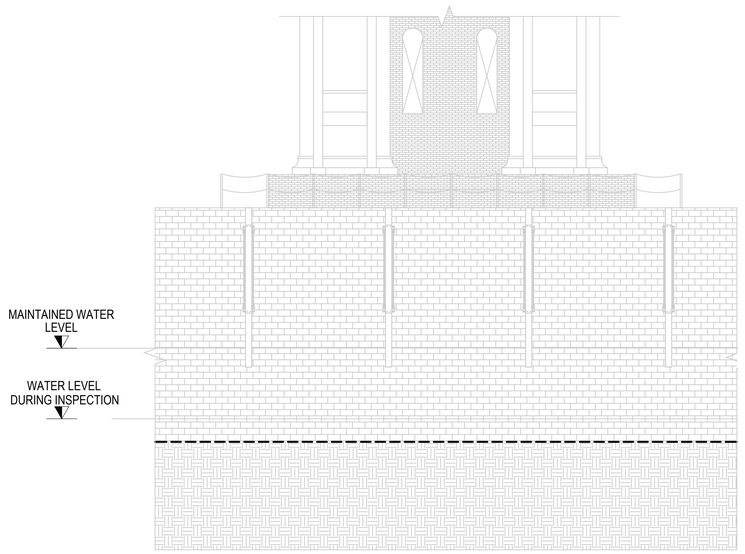

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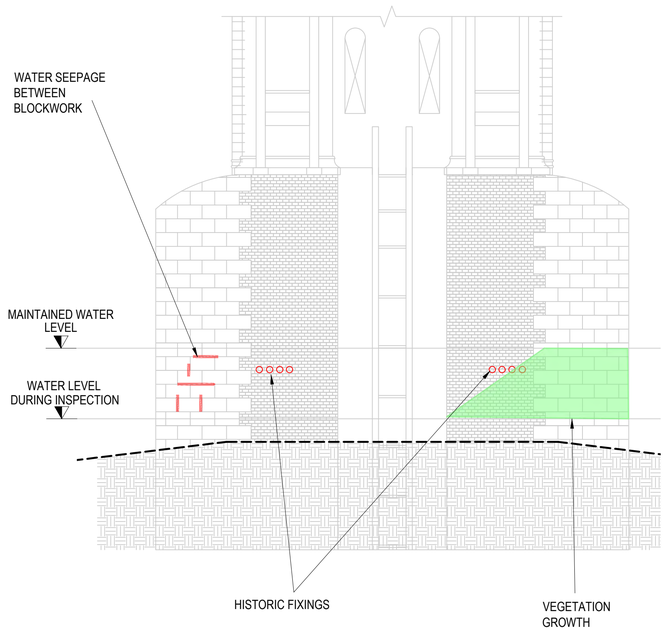

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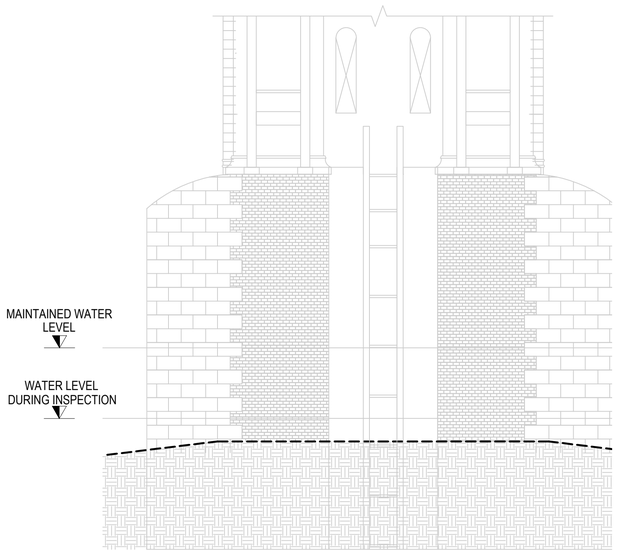
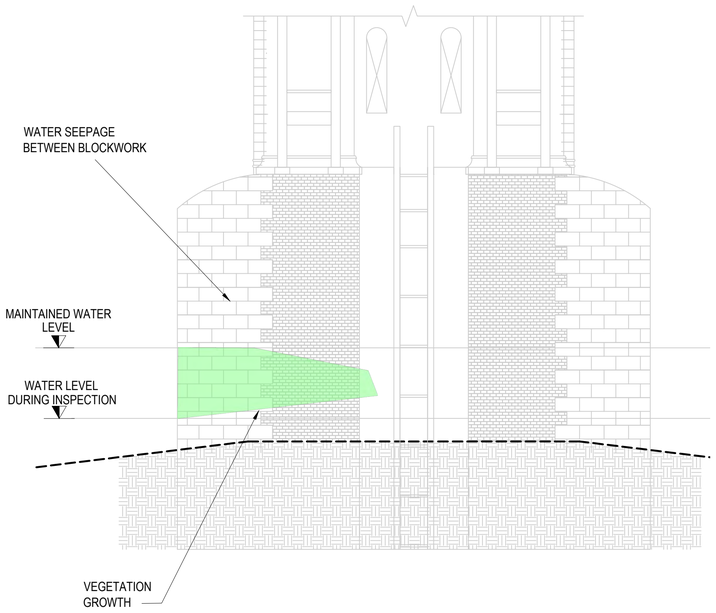


PIER 1 SOUTH 4 / 1004
(SCALE 1:100)



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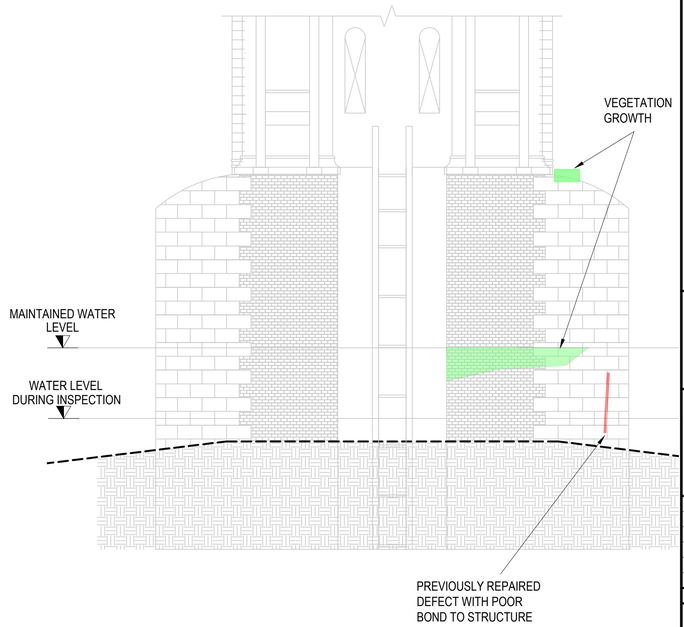

PIER 2 SOUTH 6 / 1004
(SCALE 1:100)

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6. TIDE LEVELS IN CHART DATUM WHICH IS +0.61m BELOW ORDNANCE DATUM.
7. TIDE DATA TAKEN FROM PLA CHART No. 304, DECEMBER 2018.
8. DRAWINGS SHOULD BE READ IN CONJUNCTION WITH SURVEY REPORT REF 2144-BRL-01-XX-RP-C-1000.

DRAWINGS

1000	REFERENCE PLAN
1001	LOCK ISLAND (MIDDLESEX SIDE) ELEVATION
1002	LOCK WALL ELEVATION
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1006	SLIPWAY WALL ELEVATION
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1008	NORTH TOLL HOUSE ELEVATIONS (2 OF 2)
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1010	SOUTH TOLL HOUSE ELEVATIONS (2 OF 2)

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PORT OF LONDON AUTHORITY

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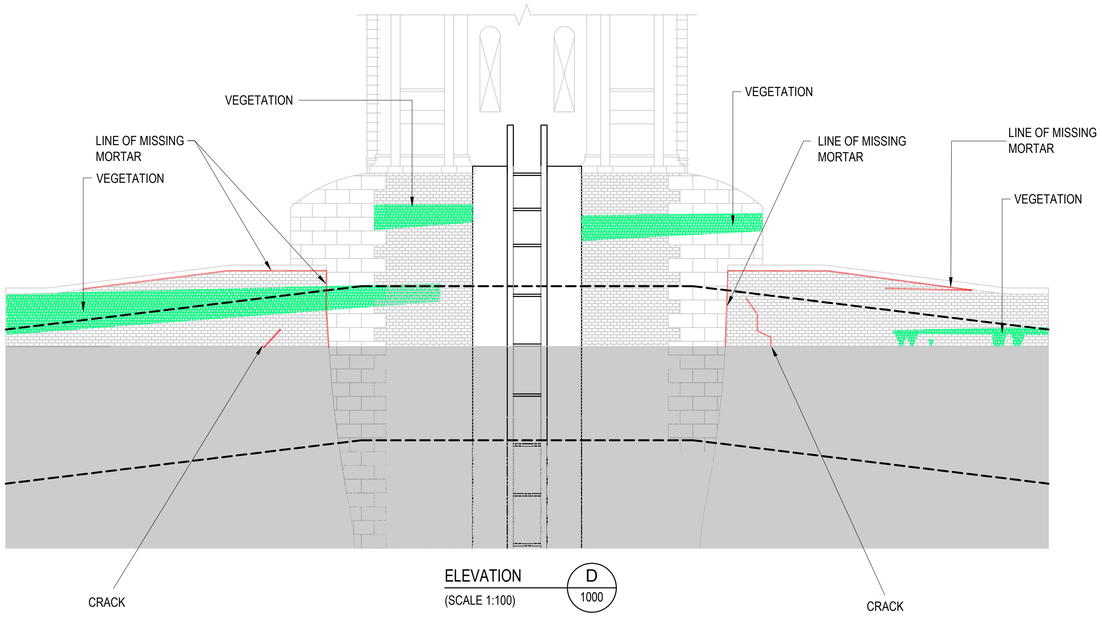
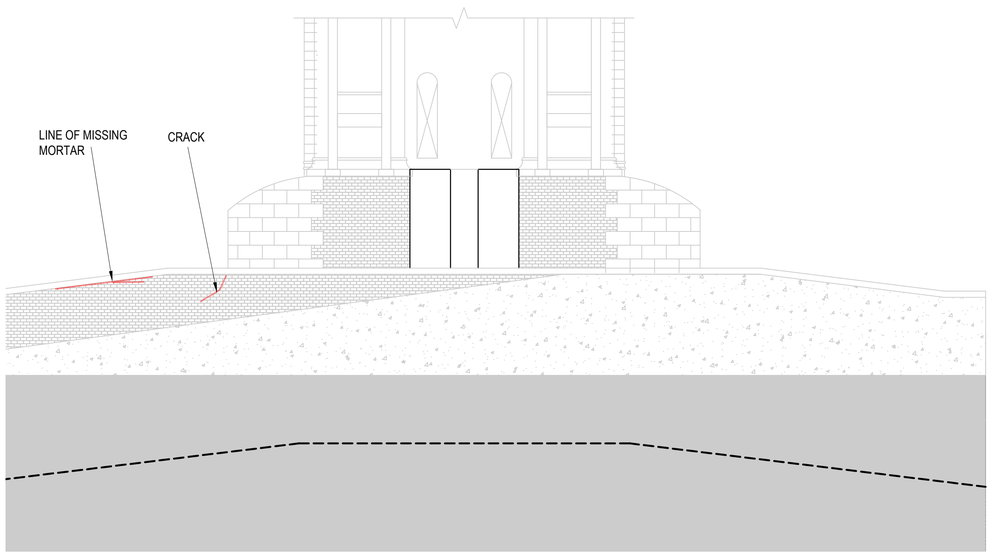
TITLE

RICHMOND LOCK & WEIR
PIER 0, 1 AND PIER 2 ELEVATIONS

PROJECT DRAWING No.	SCALE	S. CODE	REV
2144-BRL-01-XX-DR-C-1004	AS NOTED	S2	P01



ELEVATION D / 1000
(SCALE 1:100)



PART ELEVATION E / 1000
(SCALE 1:100)

PART PLAN OF SLIPWAY E / 1000
(SCALE 1:100)

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7. TIDE DATA TAKEN FROM PLA CHART No. 304, DECEMBER 2018.
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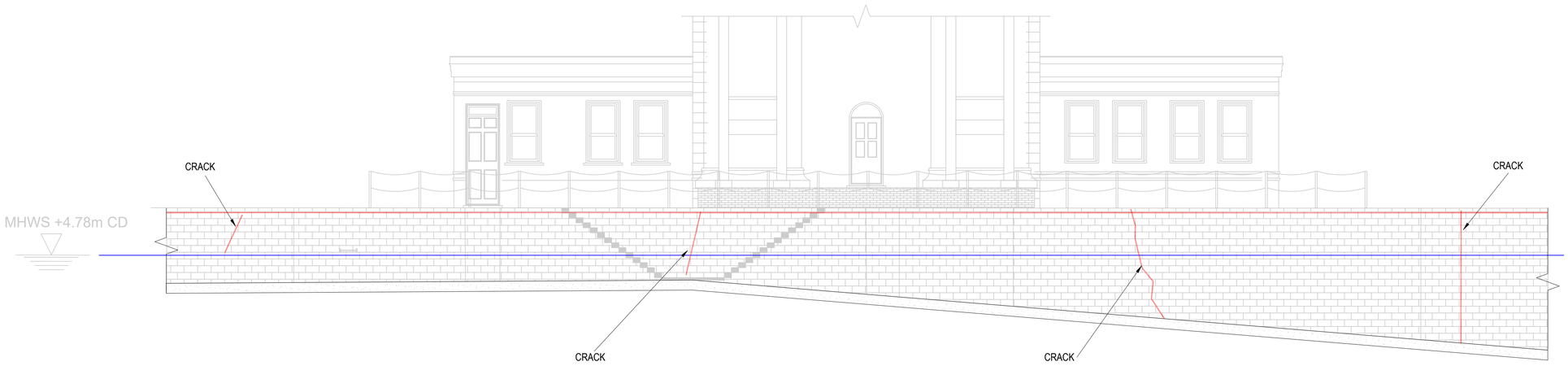
TITLE

RICHMOND LOCK & WEIR PEIR 3 ELEVATIONS AND CONCRETE SLIPWAY PLAN

PROJECT DRAWING No.	SCALE	S. CODE	REV
2144-BRL-01-XX-DR-C-1005	AS NOTED	S2	P01



ELEVATION (SCALE 1:75)

N 1000

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6. TIDE LEVELS IN CHART DATUM WHICH IS +0.61m BELOW ORDNANCE DATUM.
7. TIDE DATA TAKEN FROM PLA CHART No. 304, DECEMBER 2018.
8. ALL INFORMATION PRESENTED IS INTENDED AS FOR CONCEPT ONLY AND IS SUBJECT TO CHANGES FOLLOWING DETAILED DESIGN.

DRAWINGS

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1001	LOCK ISLAND (MIDDLESEX SIDE) ELEVATION
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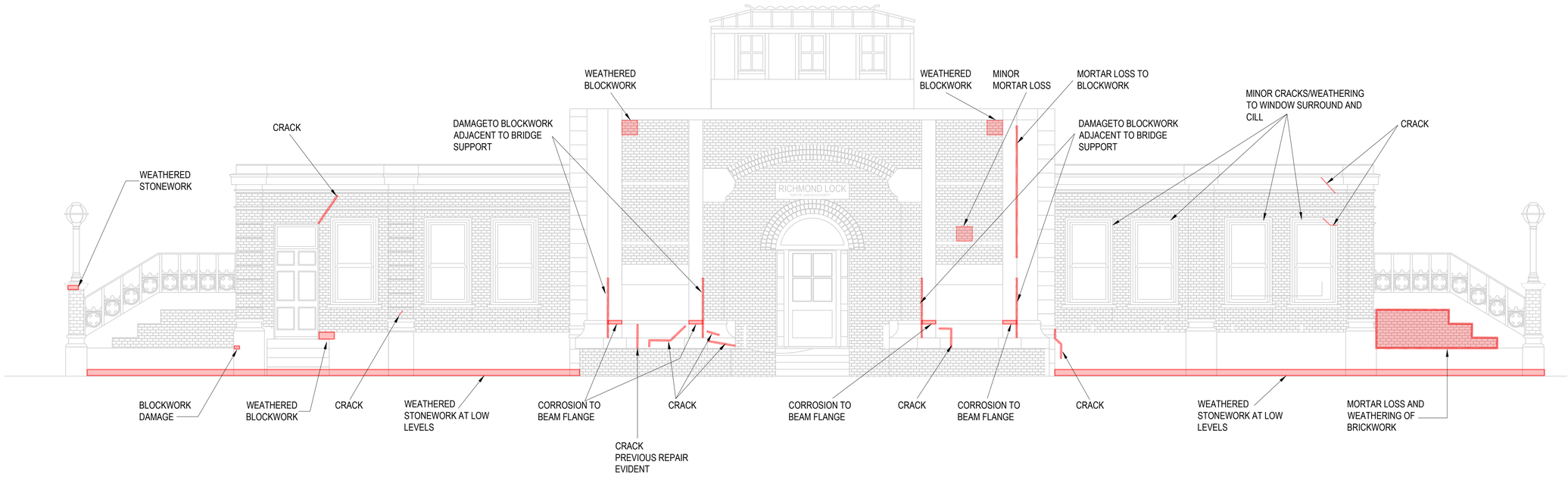
TITLE

RICHMOND LOCK & WEIR
EXISTING PLAN ELEVATIONS
SHEET 6

PROJECT DRAWING No.	SCALE	S. CODE	REV
2144-BRL-01-XX-DR-C-1006	AS NOTED	S2	P01



ELEVATION (SCALE 1:50) — F / 1000 — NORTH TOLL HOUSE ELEVATION

ELEVATION (SCALE 1:50) — G / 1000 — NORTH TOLL HOUSE ELEVATION

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7. TIDE DATA TAKEN FROM PLA CHART No. 304, DECEMBER 2018.
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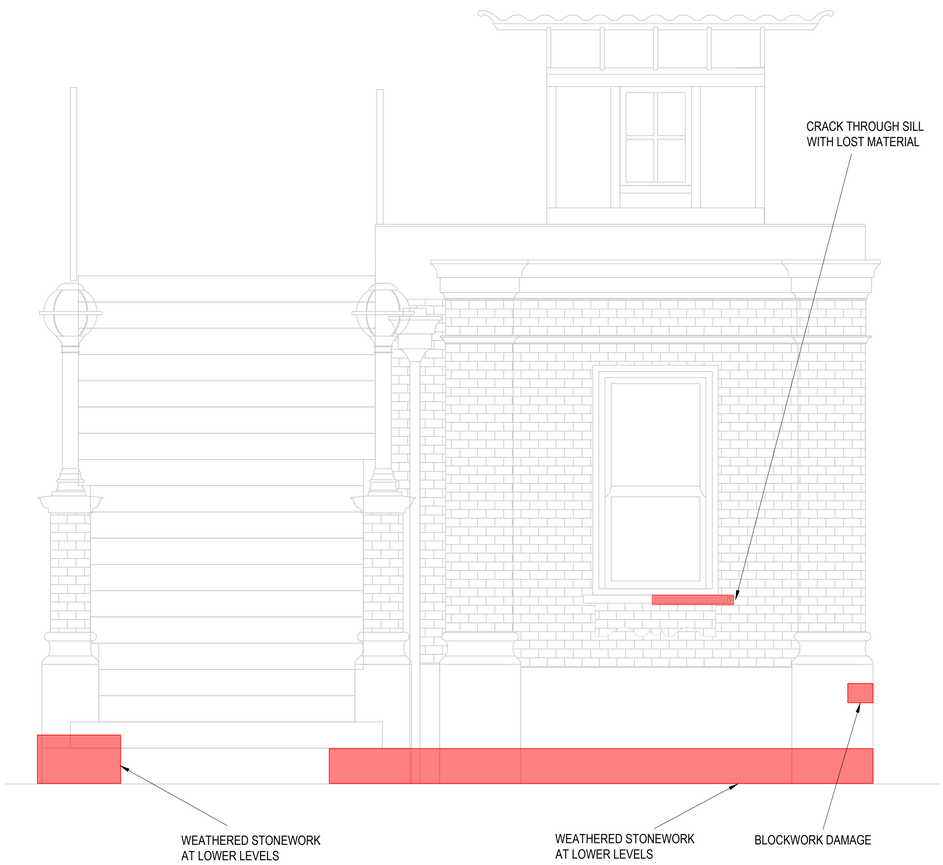
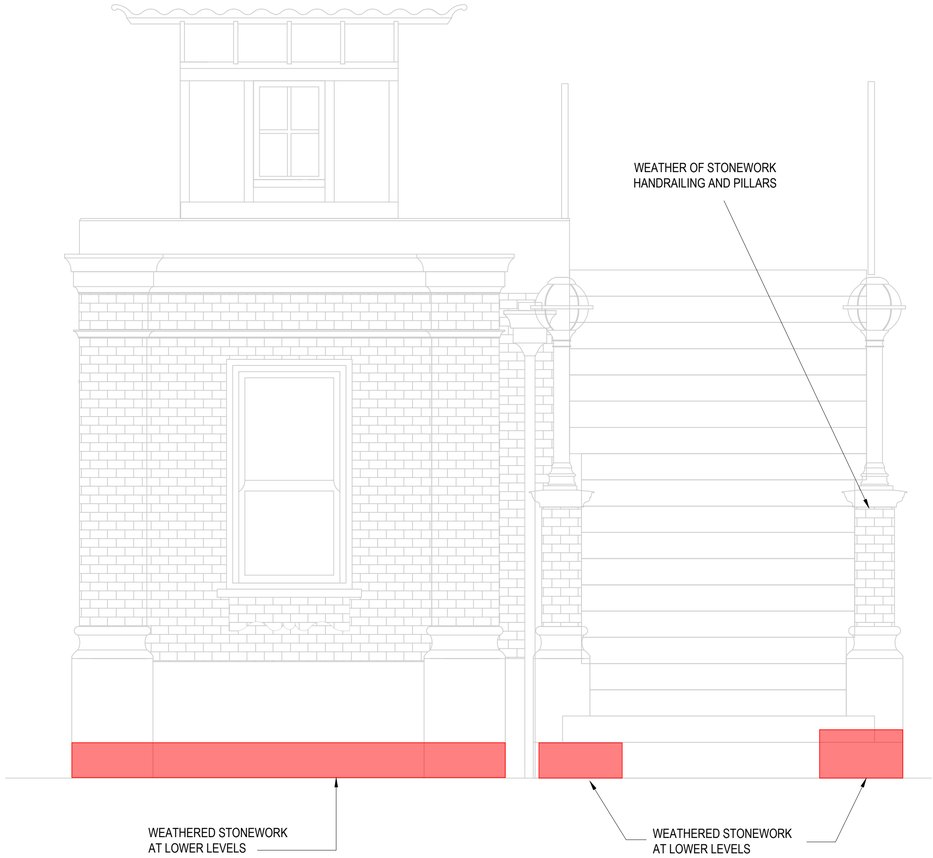
RICHMOND LOCK & WEIR
NORTH TOLL HOUSE ELEVATIONS
SHEET 1 OF 2

PROJECT DRAWING No.	SCALE	S. CODE	REV
2144-BRL-01-XX-DR-C-1007	AS NOTED	S2	P01



ELEVATION H
(SCALE 1:50)
1000



ELEVATION J
(SCALE 1:50)
1000

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RICHMOND LOCK & WEIR
NORTH TOLL HOUSE ELEVATIONS
SHEET 2 OF 2

PROJECT DRAWING No.	SCALE	S. CODE	REV
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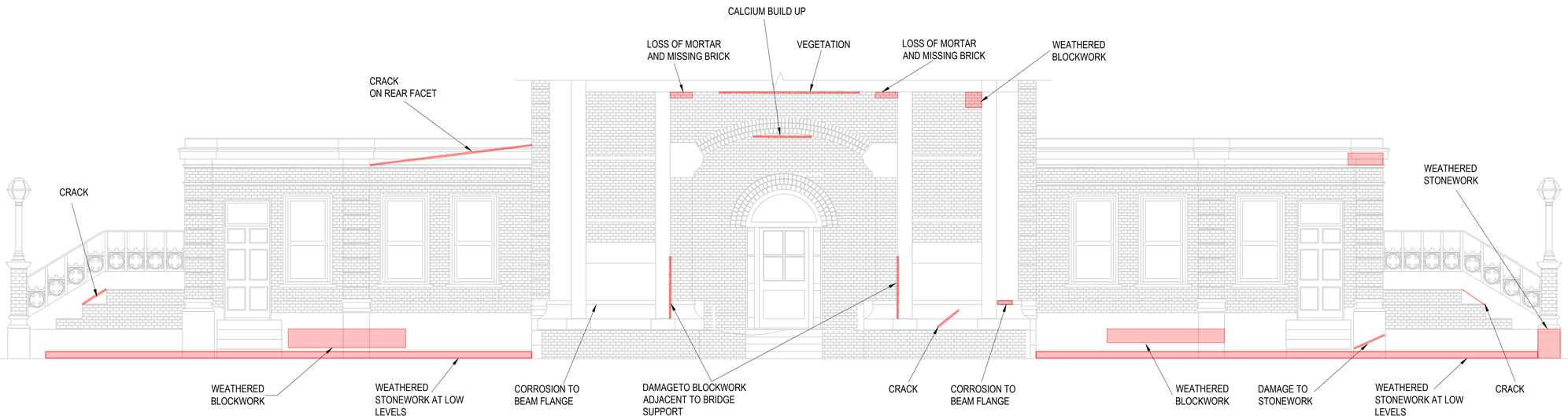
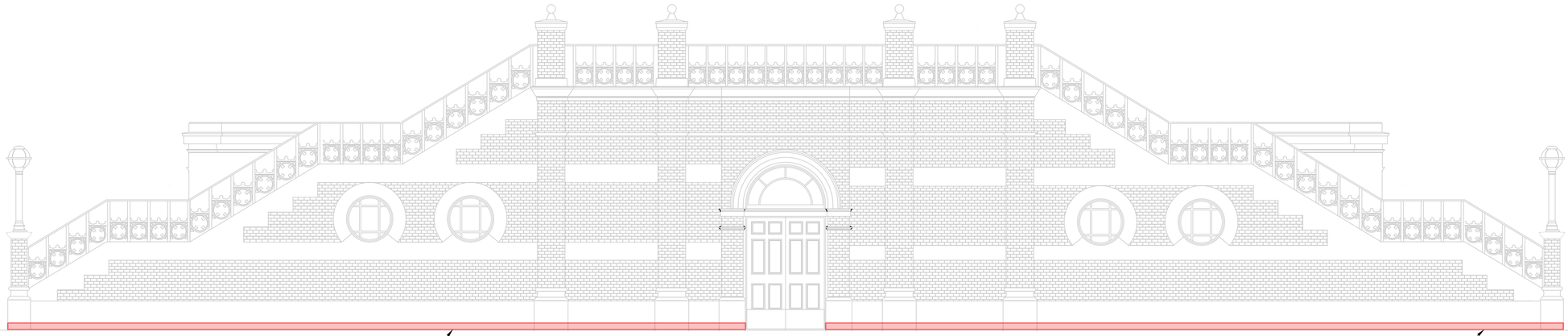


ELEVATION (SCALE 1:50) — K / 1000 — BOAT HOUSE ELEVATION



ELEVATION (SCALE 1:50) — L / 1000 — BOAT HOUSE ELEVATION

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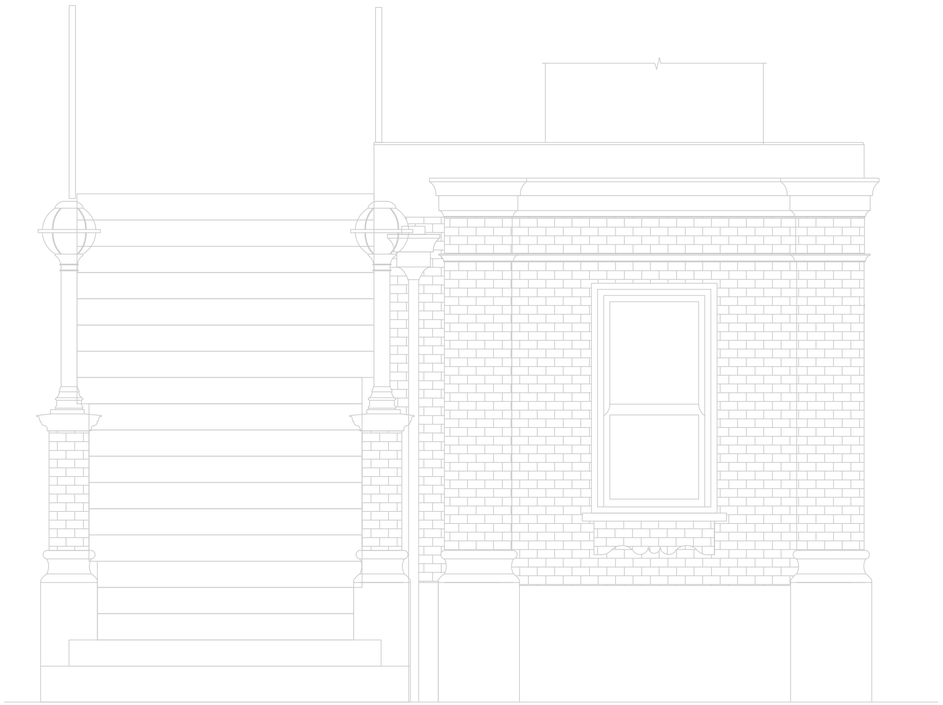
TITLE

RICHMOND LOCK & WEIR
SOUTH TOLL HOUSE ELEVATIONS
SHEET 1 OF 2

PROJECT DRAWING No.	SCALE	S. CODE	REV
2144-BRL-01-XX-DR-C-1009	AS NOTED	S2	P01



ELEVATION M 1000
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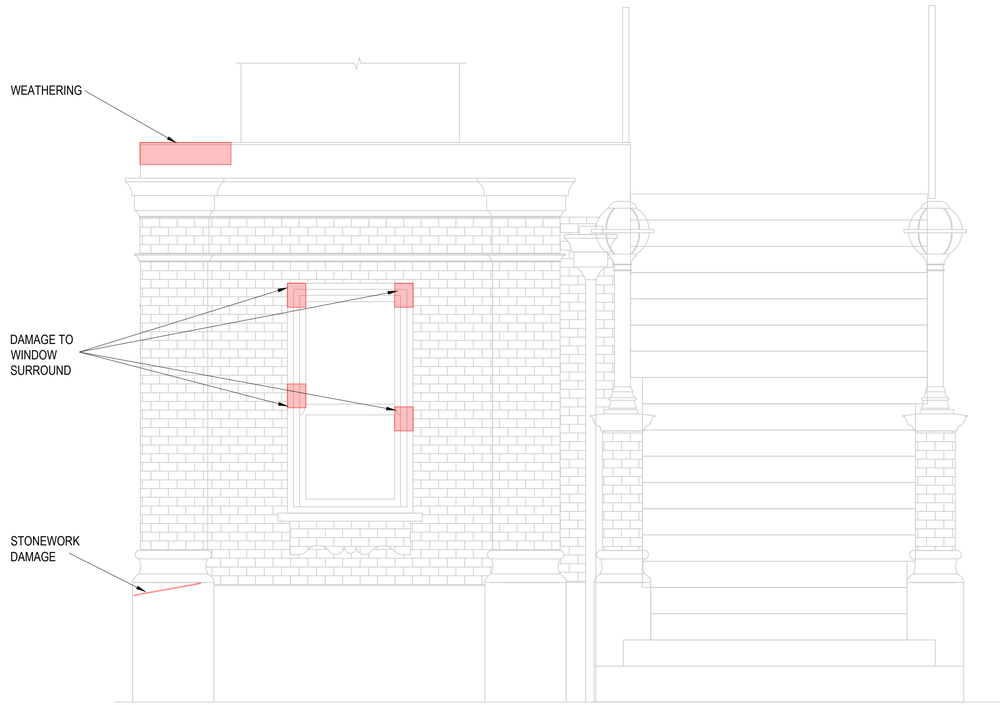

ELEVATION P 1000
(SCALE 1:50)

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TITLE

RICHMOND LOCK & WEIR
SOUTH TOLL HOUSE ELEVATIONS
SHEET 2 OF 2

PROJECT DRAWING No.	SCALE	S. CODE	REV
2144-BRL-01-XX-DR-C-1010	AS NOTED	S2	P01

APPENDIX B PHOTO APPENDIX

Photo 1:

Photo 2:

Photo 3:

Photo 4:

Photo 5:

Photo 6:

Photo 7:

Photo 8:

Photo 9:

Photo 10:

Photo 11:

Photo 12:

Photo 13:

Photo 14:

Photo 15:

Photo 16:

Photo 17:

Photo 18:

Photo 19:

Photo 20:

Photo 21:

Photo 22:

Photo 23:

Photo 24:

Photo 25:

Photo 26:

Photo 27:

Photo 28:

Photo 29:

Photo 30:

APPENDIX C UT MEASUREMENTS

Table 6-2: UT Measurement of Pedestrian Bridge Landing Flanges

LW1 - Downstream Support			
	US Flange	DS Flange	Web
Corroded	10.4	7.3	-
Uncorroded	11	10.8	9.6
LW1 - Upstream Support			
	US Flange	DS Flange	Web
Corroded	7.4	7.8	8.9
Uncorroded	11.3	11.3	9

LW2 - Downstream Support			
	US Flange	DS Flange	Web
Corroded	8.5	9.7	9
Uncorroded	12.3	11.8	10.5
LW2 - Upstream Support			
	US Flange	DS Flange	Web
Corroded	-	8.6	9.3
Uncorroded	11.5	11.7	9.4

LIS1 - Downstream Support			
	US Flange	DS Flange	Web
Corroded	11.2	9.9	9.1
Uncorroded	11.9	11.8	10.4
LIS1 - Upstream Support			
	US Flange	DS Flange	Web
Corroded	10.8	9.5	-
Uncorroded	11.6	11.1	9.5

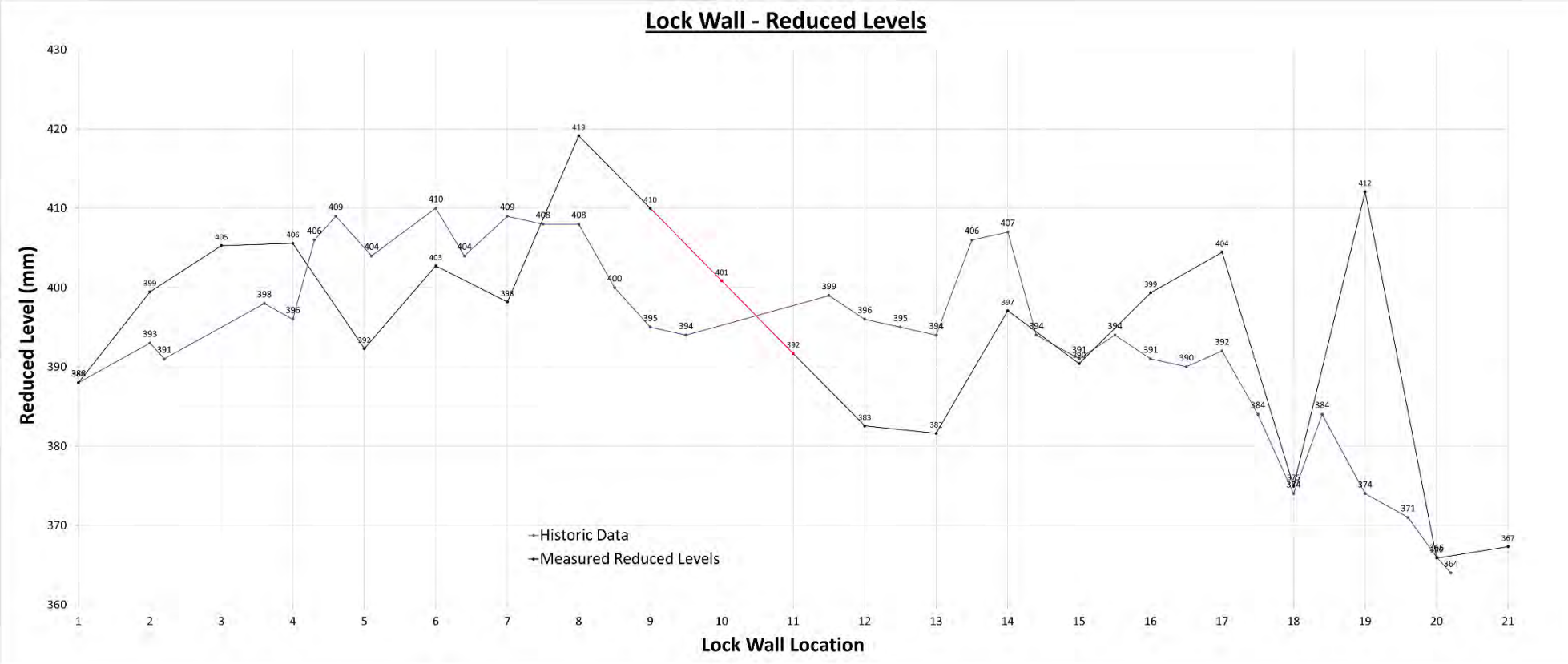
LIS2 - Downstream Support			
	US Flange	DS Flange	Web
Corroded	7.8	10.7	-
Uncorroded	11.6	11.7	9.1
LIS2 - Upstream Support			
	US Flange	DS Flange	Web
Corroded	7.1	7.5	-
Uncorroded	11.6	11.4	9

SW1 - Downstream Support			
	US Flange	DS Flange	Web
Corroded	5.4	8.2	-
Uncorroded	11	11.3	9.7
SW1 - Upstream Support			
	US Flange	DS Flange	Web
Corroded	8.2	5.4	-
Uncorroded	11.3	11	9.3

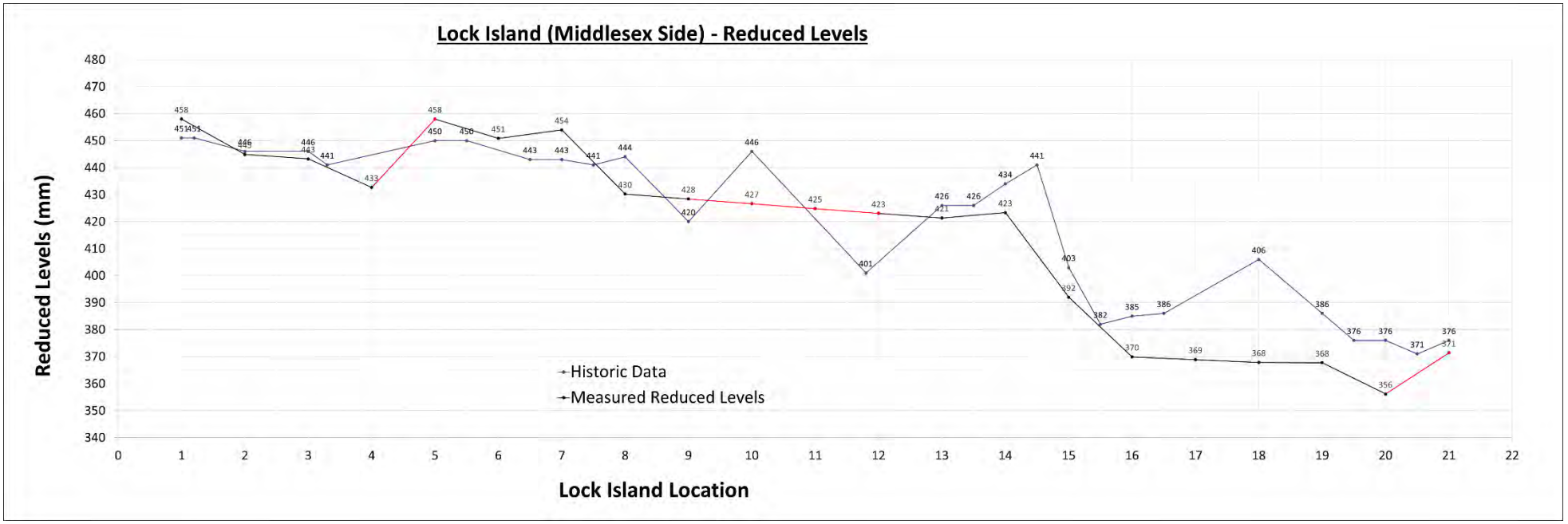
SW2 - Downstream Support			
	US Flange	DS Flange	Web
Corroded	6.4	0	8.9
Uncorroded	11.1	10.8	10.2
SW2 - Upstream Support			
	US Flange	DS Flange	Web
Corroded	5.9	7.6	-
Uncorroded	11.2	11	9.5

All dimensions are in mm

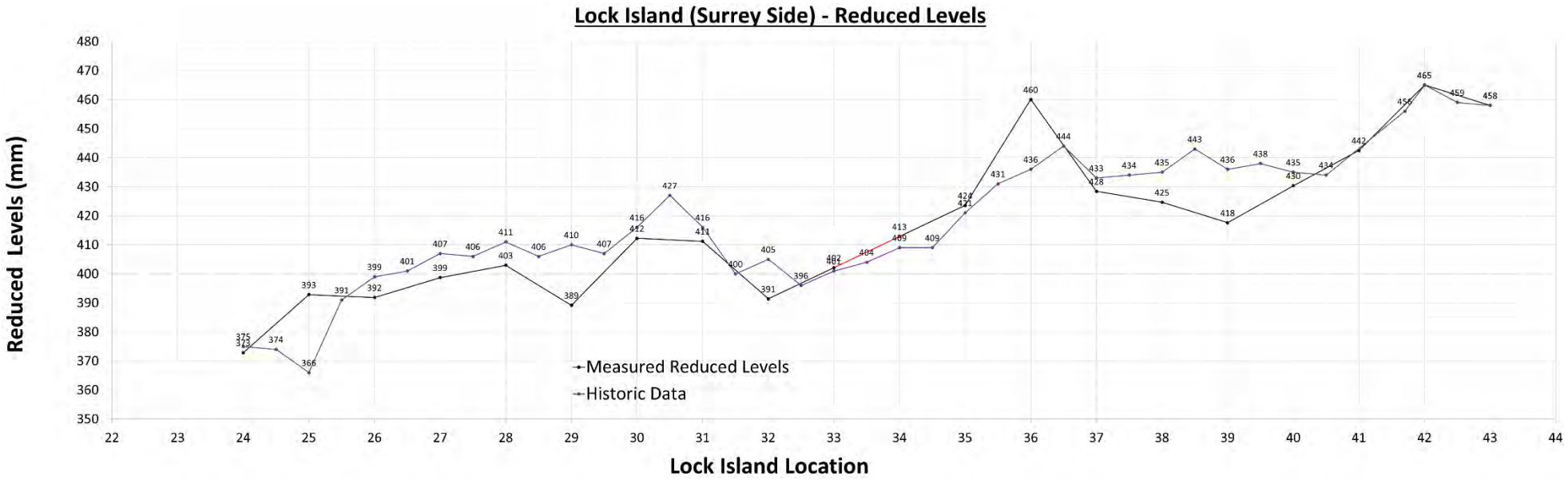
APPENDIX D LEVEL SURVEY



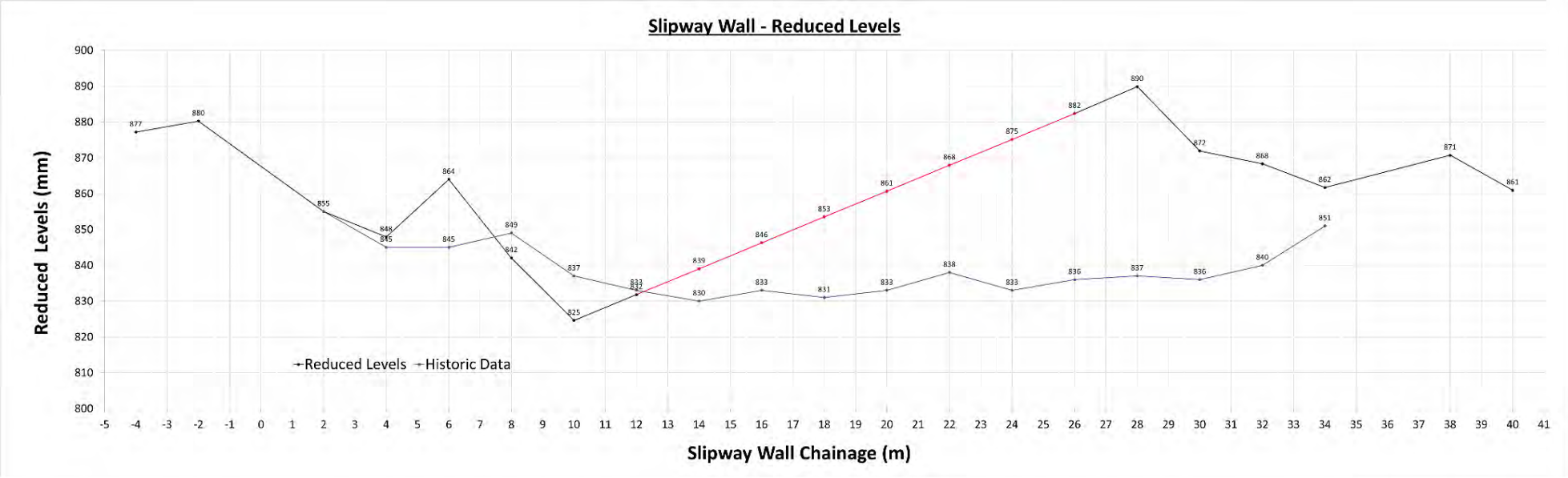
Lock Wall - Level Comparison



Lock Island (Middlesex Side) - Level Comparison



Lock Island (Surrey Side) - Level Comparison



Slipway Wall - Level Comparison

Note that Locations -4m, -2m, 38m and 40m are not linear chainages and demonstrate the levels along the Slipway Wall return wall

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HOULDER

Part C – Dive Survey

HOULDER

RICHMOND LOCK & WEIR

STRUCTURAL SURVEY
DIVE SURVEY

BECKETT RANKINE
Marine Consulting Engineers

MARCH 2022

2144-BRL-01-XX-RP-C-2000

CONTROLLED DOCUMENT STATUS

CLIENT	Houlder Ltd
PROJECT TITLE	Richmond Lock & Wier
SUBJECT	Structural Survey
DOCUMENT TITLE	Dive Survey
DOCUMENT REF	2411-BRL-01-XX-RP-C-2000

REVISION RECORD

REV	STATUS	DATE	SUMMARY OF CHANGES	PREP	CHK	APP
P01	S2 – Suitable for Information	25/03/22		DT	GG	TKHB

CONTENTS

1 INTRODUCTION

1.1 Purpose of Document

1.1.1 The Port of London Authority (PLA) has appointed Houlder Ltd and Beckett Rankine (BR) to carry out a full condition survey of the Richmond Lock and Weir arrangement.

1.1.2 This document discusses the diver survey that has been carried out and summarises the results of this survey and its conclusion. The document also provides recommendations for any future works needed at the site.

1.2 Site Location

1.2.1 Richmond Lock and Weir is located in the river Thames between Richmond and Twickenham and can be seen in Figure 1.1.

Figure 1.1: Richmond Lock and Weir Location

1.3 Structure Overview

1.3.1 A circa 5m deep scour hole (relative to adjacent bed levels) exists downstream of the central arch to Richmond Weir, see Figure 1.1. A concrete apron is present downstream of the cill bounded by a line of cut off steel sheet piles prior to a scour protection mattress.

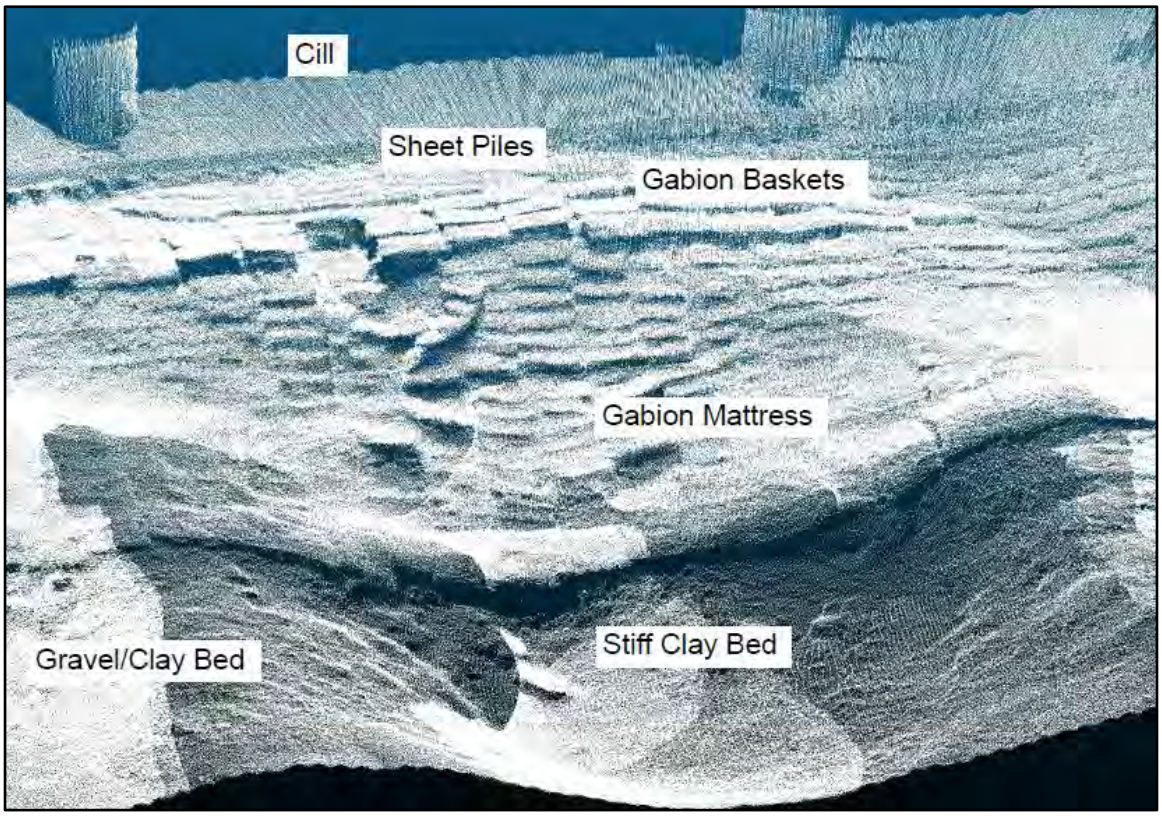

Figure 1.2: Structural Overview

1.3.2 The mattress extends approximately 22m beyond the sheet piles, the scour hole deepens downstream of the scour protection.

1.4 Dive Survey Aims

1.4.1 The scour hole downstream of the central weir has deepened over time raising concerns regarding the possibility of it undermining the adjacent structures. Recent multibeam sonar surveys have identified defects in the scour protection and potential ongoing scour activity.

1.4.2 The aims of the dive inspection were to:

- Investigate the defects identified in the scour protection.
- Inform the condition assessment of the scour protection.
- Inform consideration of the potential for the scour to undermine the adjacent structures.
- Inform the consideration of options for the ongoing maintenance and/or repair of the scour protection or further options to address the scour.

1.5 Review of Historical Information

Scope of Desk Study

1.5.1 A desk top review of the available historical drawings, reports and bathymetric surveys has been completed. This review has allowed BR to gain a better understanding of the site and its behaviour over time such that areas of concern could be identified and focused on within the site visit. The information provided and reviewed includes:

- Roughton & Fenton Structural Condition Survey (1989) Volumes 1 & 2
- PLA Report on Hydrographic Survey of Richmond Shoal, PLA 304 (drawing ref: 113-304-099)
- PLA Archive Drawings
    - 192-2074 Steel Sheet Spiling – Upstream End of Lock
    - 192-2081 Richmond Lock Repairs – Survey of Site
    - 192-2082 Richmond Lock Reconstruction Drawing 2
    - 192-2083 Richmond Lock Reconstruction Drawing 1
    - 192-2173 Toe Piling and Toe Beam – Downriver and Outside Lock Island
    - 192-2269 Middlesex and Boat Slide Arches (excerpt provided only)
- Richmond Lock and Weir Study of Scour due to temporary works (HR Wallingford 1991, ref: EX 2474)
- Scour Downstream of Richmond Weir - PLA Data Summary from Alex Mortley (05/07/2021)
- May 2021 XYZ data of site
- March 2022 refined XYZ data of site

Desk Study Conclusions

1.5.2 Following the completion of the desk study the following conclusions are obtained:

- The weir and lock were built in the 1890's.
- The riverbed is stiff London Clay, the riverbanks are gravel.
- Granite blocks formed the scour protection prior to the mid 1990 when some were moved to enable cofferdams to be installed to facilitate structural maintenance.
- Scour protection options of rip rap, gabion and concrete mattresses were considered in an HR Wallingford report in 1991.
- Gabion basket and mattress scour protection was installed in the mid 1990's during the cofferdam works and extended to the full width of the river (excluding the lock) and circa 28m from the gate line.
- The HR Wallingford scour protection assessment identified that scour of stiff clay if very difficult to predict with limited case studies.
- The deepest scour depth recorded suggests that the scour hole was deepening at an average rate of 40mm/year prior to the cofferdam works (-4.3mOD in 1921 compared to -6.7mOD in 1986). Post cofferdam works, the scour hole deepened at a rate of circa 150mm a year (-5.9mCD in 1998 compared to -8.3mCD in 2015), CD is 0.6m below OD.
- Since 2015 the charted depth of the scour hole has oscillated between -8.3mCD and -7.3mCD in 2021. The latest survey (March 2022) suggests the maximum depth in the scour hole is circa -8.9mCD suggesting the hole is currently as deep as it has ever been.
- Review of the May 2021 and March 2022 point cloud surveys of the scour hole and scour protection show, as visualised in Figure 1.3, show that:
    - The scour hole has deepened by circa 0.4m over the last 10 months.
    - There are large lumps/blocks in the bottom of the scour hole.
    - Limited change in the scour mattress condition between the two surveys appears to have occurred, although there is an absolute position difference between the two surveys making the comparison difficult.
    - A hard flat surface (slab) exists in front of the cill line.

- A line of sheet piles (assumed to be the cut down remains of the cofferdams) is evident downstream of the slab.
- Large blocks consistent with gabion baskets circa 2m by 1m in plan are present downstream of the sheet piles. Up to 4 blocks can be identified in front of the sheet piles but a circa 1m wide slab is directly in front (downstream) of the sheet piles. This is consistent with the historical section showing 5 gabions with concrete tops placed downstream of the cofferdam with the gabion mattresses downstream of this. Gaps up to 400mm wide are noted between the gabion baskets.
- The deepest part of the scour hole is circa 23m downstream of the sheet pile line central to the centre weir.
- Shadowing in the point cloud data suggesting possible voids exists at the leading edge of the gabion mattress.
- Two gabion baskets appear to be missing towards the Surrey side of the central weir.
- Defects (level step changes) in the gabion mattress are noted downstream of this area.

1.5.3 Figure 1.3 is an image of the March 2022 point cloud data.

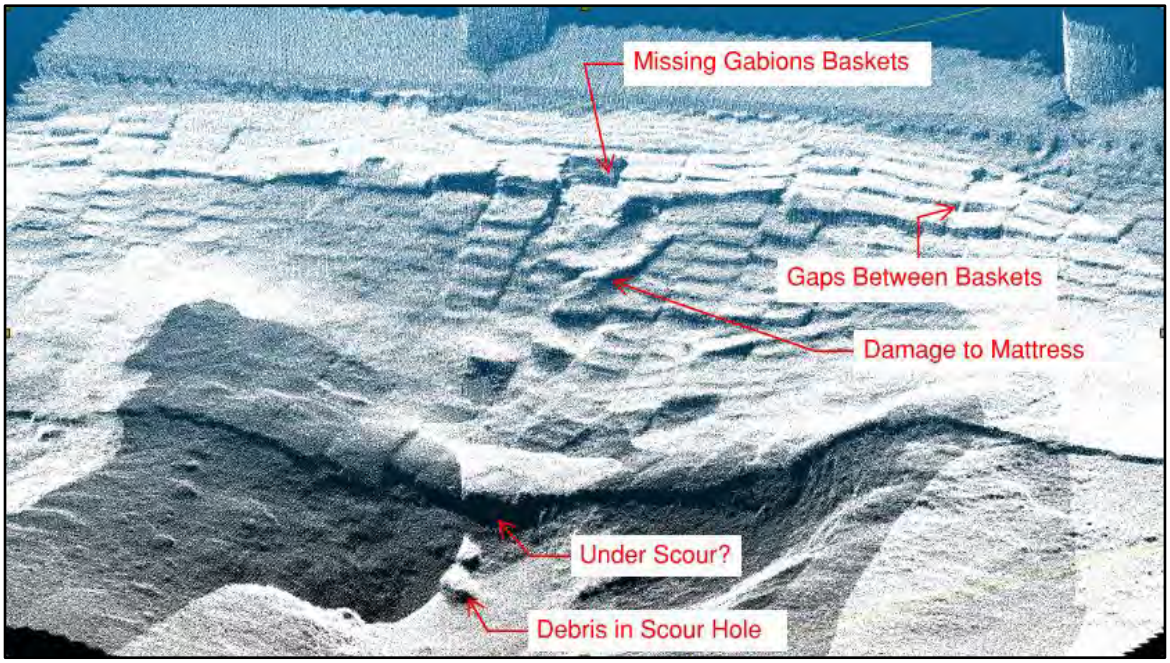

Figure 1.3: March 2022 Point Cloud Observations

2 METHDOLOGY

2.1 Approach

2.1.1 The dives were undertaken on a rising tide on 15th March 2022 with the gates lifted to limit the turbulence and water velocity. It was possible for the diver to maintain position with the water velocities encountered.

2.1.2 Underwater visibility was limited to 0.5m with natural light very limited below 5m water depth. Survey of the scour hole was limited to tactile only with some visual survey possible at shallower depths.

2.1.3 An extendable survey staff was used to probe voids and obtain approximate measurements.

2.1.4 David Tresidder, a chartered engineer from Beckett Rankine with 26 years of experience inspecting marine structures, who is also a qualified commercial diver undertook all of the in-water inspections.

2.1.5 Dive equipment and support was provided by the Port of London Authority (PLA) dive team using Driftwood 3 as the dive platform with the assistance of a small tender. The PLA were the Dive Contractor in accordance with the Diving at Work Regulations.

2.1.6 Inspection notes were made by the PLA Dive Supervisor. The dive was not videoed, or sound recorded due to the limitations of available PLA equipment.

2.1.7 Due to the limited visibility and lack of natural or artificial light it is possible that some defects were not identified during the inspection. A representative sample of the areas identified in Figure 2.1 were inspected and the significant defects identified on the point cloud data were specifically investigated. Further defects may not have been identified and the findings of the inspection should be considered to be representative and not exhaustive.

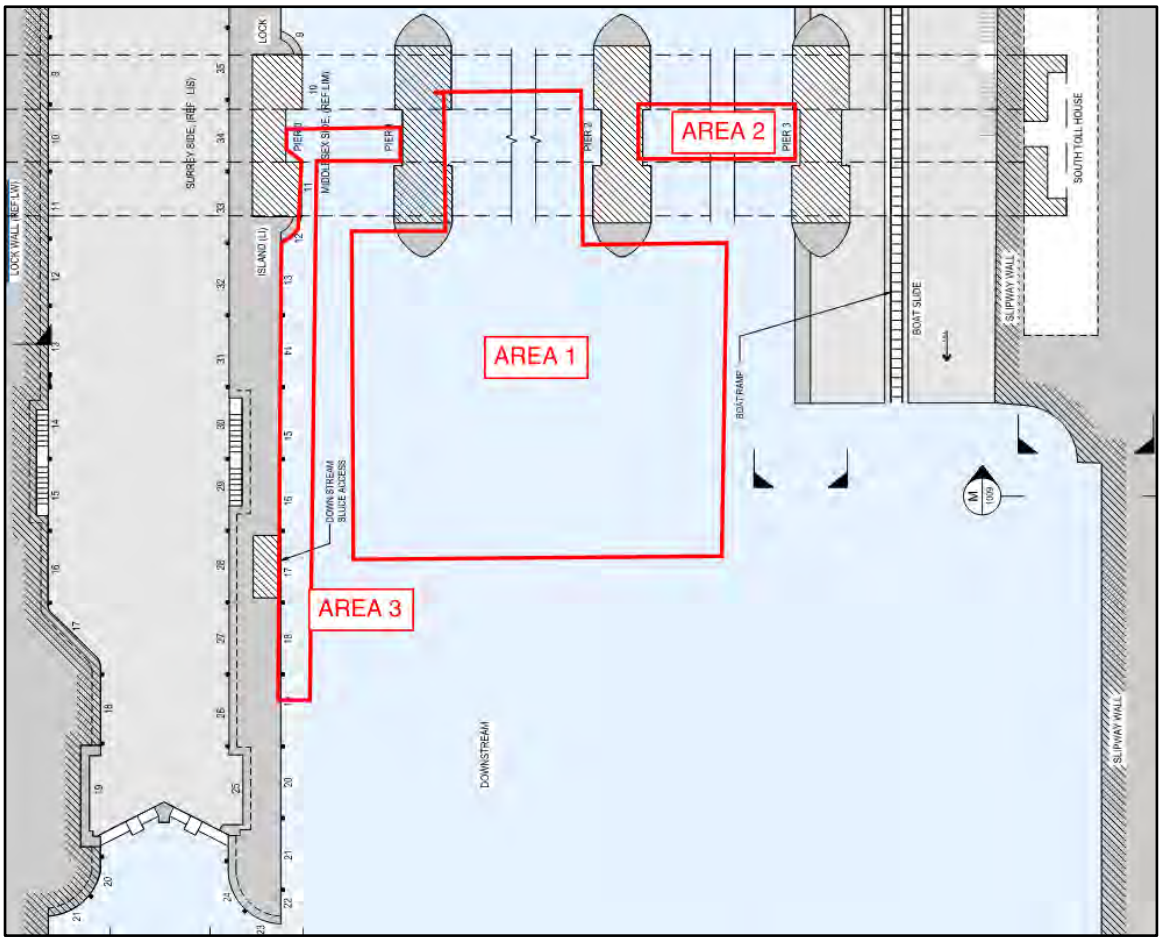

Figure 2.1 - Dive Inspection Areas

2.2 Areas and Process

2.2.1 The dive inspection surveyed three separate areas as shown in Figure 2.1.

2.2.2 Area 1 includes the scour hole and the mattress/baskets in front of the central weir which formed the main part of this dive. The base of the scour hole was initially inspected followed by the leading edge of the scour protection mattress from the centreline of the Surrey weir to the centreline of the Middlesex weir. A general swim over survey of the mattress and baskets was then completed within the same limits. Time was spent focusing on the areas of previously identified defects. The cut down sheet pile line was also followed to the centre of the side weirs. Finally, the cill line of the central weir was inspected.

2.2.3 Area 2 was dived to inspect the cill line of the Middlesex weir.

2.2.4 Area 3 included an inspection of the slab to the outside of the lock island wall and the bed in front of it. The dive progressed towards the pier and included a swim survey of the cill of the Surrey weir.

2.2.5 Dive records are provided in Appendix A.

3 FINDINGS

3.1 Scour Hole and Bed

3.1.1 The sides and base of the scour hole are a stiff clay. The large blocks within the scour hole are clay boulders. There is a small amount of 10 to 20mm diameter pea gravel within the base of the scour in sporadic pockets up to 50mm thick.

3.1.2 The slopes of the scour hole match those on the point cloud data and vary between 30 and 45 degrees.

3.1.3 As the bed levels out to the sides of the scour hole, a consistent bed covering of 10 to 20mm diameter pea gravel is present with patches of the stiff clay exposed.

3.1.4 The leading edge of the gabion mattress is undercut within the scour hole by 400 to 600mm. The height of the undercut bellow the mattress varied between 600 and 1000mm. As the sides of the scour hole rise up, the undercut void beneath the mattress decreases in height and penetration depth, and the mattress is in good contact with the bed to either side of the scour hole.

Figure 3.1 - Second scour to the riverbank side of the scour protection

3.1.5 A secondary scour hole up to 1.7m deep at the riverbank edge of the scour protection in front of the Middlesex weir was also identified. This was not dived due to tidal constraints.

3.2 Mattress

3.2.1 The mattress is 250mm thick and well packed with stones along its leading edge within the scour hole. The mattress is a plastic-coated wire wound type. Individual units are laced together with plastic coated wire.

3.2.2 Where it was possible to determine, the mattresses sit directly on the stiff clay and there are no signs of any erosion to the clay below the mattress away from the scour hole itself.

3.2.3 Where the mattress is on a level bed, a space within the mesh of up to 100mm exists suggesting some loss of stone fill, poor filling or damage to the intermediate ties allowing the top to lift.

3.2.4 At occasional locations the joints between the mattress units have widened and the tying wire has failed exposing the clay below. There was no evidence of any geotextile beneath the mattress. At Location A on Figure 3.2, a mattress top has failed and the loose stone within is unconfined.

3.2.5 The top of the mattresses upstream of the scour hole (Location B on Figure 3.2) is undulated significantly and there are a number of steps and misshapen mattresses where the mesh is stretched and deformed.

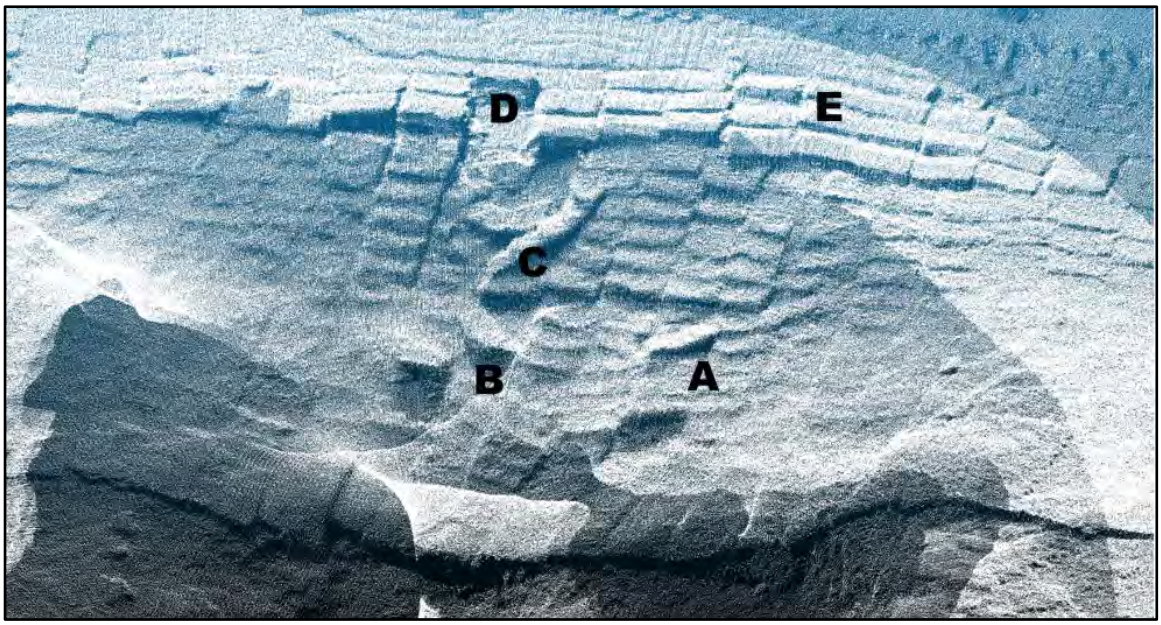

Figure 3.2 - Mattress and Basket Defect Locations

3.2.6 At location C on Figure 3.2 the top layer of the mattress has turned over, exposing the second layer of mattress beneath.

3.3 Gabion Baskets

3.3.1 The baskets were found to have the top 100 to 200mm encased in concrete with the wire mesh not visible other than at the sides.

3.3.2 Two baskets were found to be missing at location D on Figure 3.2 with what appears to be the remains of the baskets on top of the mattress downstream, close to location C on Figure 3.2. Voids up to 300mm deep and 300mm high exist under the baskets around the edges of the void at location D which is formed by the missing baskets. The base of the void is solid and appears to be the top of the old granite block scour protection. No clay was present within the void, hard refusal of the staff occurred when probed in all locations.

3.3.3 Downstream of the central weir (location E on Figure 3.2) the majority of the baskets had moved downstream opening up at the joints with the tying wire having failed. The gaps between baskets varied between 200 and 400mm. The gaps extended the full height of the basket (1000mm) to a hard surface assume to be the top of the original granite block scour protection below. There were no signs of bed scour in the voids between the baskets.

3.3.4 Close to the line of the sheet piles (1m to 2m downstream of the piles) the baskets have not moved, and the concrete topping forms a continuous slab with the baskets indistinguishable below. The concrete continues up to the sheet piles and fills the in pans of the Frodingham piles as well. There is no gap between the piles and the concrete.

3.4 Sheet piles and slab

3.4.1 The sheet piles extend 200mm to 300mm above the level of the concrete either side of them. The tops of the piles are rough cut, most likely by thermic lance.

3.4.2 The concrete cill slab upstream of the piles is smooth with no obvious defects, damage, cracks, deformations or similar. The surface is weathered but not pitted, there was no evidence of spalling or corroding reinforcement.

3.4.3 The concrete slab continues to the edge of the granite cill blocks.

3.5 Cills

3.5.1 The cills are formed of 900mm wide granite blocks with sloping top surfaces (circa 5 degrees) in both the upstream and downstream direction from a 150mm flat top that mates with the weir gate.

3.5.2 The Middlesex weir is in good condition with block joint varying between 5mm and 10mm in width and rounded bullnose edges to the joints with a 10mm radius either side. Grout in the joint was firm and flush with the base of the bullnose on either side. Either side of the cill, isolated raised lumps in the block surfaces were noted up to 150mm in diameter and 30mm high. The nature of the solid, fixed lumps could not be identified, possibly a hard marine growth. The cill surface was lightly pitted.

3.5.3 The central cill is in the best condition of all three with tight 5mm joints and 5mm radius bullnoses to either side. No deviation to the line or level are present and the granite slopes to the sides of the cill are clean. The cill surface is smooth.

3.5.4 The Surrey cill is in a similar to the central cill other than the last block adjacent to the central pier has dropped creating a step of 10 to 12mm between the blocks. The joint was tight, and loss of grout is not evident.

3.6 Lock Island Slab

3.6.1 A concrete bed slab extends for circa 1m in front of the outside of the lock island. Riverwards of this is a cut off sheet piled wall assumed to also date back to the cofferdam structural repair works in the mid 1990's. Riverside of the sheet piles is an undulating bed consisting of clay, gravel and large boulders up to 600mm diameter.

3.6.2 A set of grouted/concrete bags have been placed around the mid length of the island. These are smooth and any geotextile is not present suggesting they have been in place for some time. The rounded concrete units were up to 1500mm in diameter.

4 CONCLUSIONS AND RECOMMENDATION

4.1 Inspection

4.1.1 The dives undertaken achieved good coverage of the areas within Figure 2.1. The diver identified and investigated the defects on the point cloud, as well as the cills, part of the lock island bed slab, the main scour hole, and the leading edge of the scour protection. The inspection provides a representative sample investigation; however, some defects may not have been identified due to the constraints of the water current and poor underwater visibility.

4.2 Scour Hole and Bed

4.2.1 The scour hole has formed within stiff London Clay. Where the clay is covered with gravel or gabions (baskets or mattresses) the erosion of the clay surface appears to have been halted and the protection is reducing the water velocity sufficiently.

4.2.2 The concrete grouting of the tops of the gabion baskets has created a smooth surface and will have resulted in higher water velocities reaching the leading edge of the mattress than would otherwise have occurred had they not been concreted.

4.2.3 The main scour hole has formed at the tail edge of the scour protection indicating that the gabions are performing as intended but do not extend far enough to prevent edge scour. Clay exposed to the water will soften over time and this in turn increases the propensity for scour to occur. This would normally be a slow process but could be accelerated by turbulence .

4.2.4 The water turbulence at the edge of the gabion mattress has resulted in the clay both in front and under/behind the edge being eroded. Uneven erosion has formed clay boulders which have fallen into the bottom of the scour hole. This ongoing process has resulted in the formation of the scour hole and the undermining of the mattress causing it to drop into the hole at its edge. There is no evidence to suggest the majority of the mattress has significantly dropped in level since its installation; a comparison of the point cloud surveys back to 2008 would be useful to confirm this. The further scour that has occurred since the installation of the scour protection has formed predominantly downstream of the scour protection. A

secondary scour hole exists at the riverbank side of the protection in front of the Middlesex weir.

4.2.5 The increased water depth at the scour hole will result in reduced water velocities and is likely to lead to an eventual equilibrium and cessation to the ongoing scour. The gravels within the area are likely to refill the scour hole during times of lower water flow explaining the reduction in water depth at times. The gravel offers a degree of scour protection, but its small size means that it is easily removed to expose the clay and permit ongoing erosion to occur. This can be seen in the varying depths of the scour hole since 2015. At the time of this inspection, the scour hole was empty of gravel and at its deepest on record. It is uncertain therefore if the last few years have been a period of lower flow and this is why scour has not occurred of if the lack of deepening is a result of an equilibrium being formed.

4.2.6 The steep (45 degree) sides to the main scour hole are unnaturally steep and without protection will naturally regrade to a shallower slope over time. Without intervention this will result in a gradual widening of the scour hole.

4.2.7 The limited extent of the scour hole downstream of the central weir at present, presents no risk to the stability of the adjacent structures. Its growth would be slow due to the cohesive nature of the London Clay limiting the rate at which the scour can occur.

4.2.8 If the gabion mattress were to fail, the scour hole would likely progress upriver towards the weir. The sheet piles offer a robust protection to the cill slab but could become undermined and failed in a matter of years.

4.2.9 The secondary scour hole to the riverbank side of the scour protection in front of the Middlesex weir was not inspected. This has the potential to undermine the adjacent structure and should be monitored for change on an annual basis. The data for this hole was cut out of the May 2021 survey and no comparison is therefore possible from the data provided to Beckett Rankine. It is recommended that the development of the hole should be assessed using historical point cloud data to help form a view on the need for further inspection and remedial action.

Increased Scour Protection

4.2.10 Given the depth to which the scour hole has formed it can be assumed that a significantly longer mattress would be required to prevent such a hole from forming again. Back analysis of the likely velocities at the leading edge could be undertaken and the extent of the hole used to determine a velocity at which the bed does not tend to sour. This could then be used to determine the extent of a mattress that would prevent bed scour. The hole would need to be filled with a suitably sized stone to enable a level mattress to be laid.

Ongoing Monitoring

4.2.11 As there is uncertainty regarding the equilibrium or otherwise of the water depth in the hole versus the scour potential, ongoing monitoring of the main scour hole is necessary. The hole can be expected to widen and progress backwards towards the weir slightly in order to reach a more stable state, but this could be the extent of ongoing change and monitoring on an annual basis would enable confirmation of this or otherwise. This option is only feasible if the scour protection remains effective, see below.

4.3 Gabion Mattress and Baskets

4.3.1 Other than at its leading edge, as detailed above, the gabion mattress has performed well and has prevented significant scour from occurring over its area. The mattress thickness and stone size appears to be correct and is effectively preventing scour.

4.3.2 The wire mesh and tying wire is performing well from a durability perspective but has failed where excessive loads have occurred as a result of unit movement.

4.3.3 Gabion mattresses are not normally intended to protect slopes as steep as 45 degrees or to span over voids. They are therefore working beyond their design intent at the mattress edge although they remain in a fair condition and continue to provide protection.

4.3.4 There are areas of local damage resulting in exposed bed clay. Where exposed the clay has not eroded. This may be due to the recent nature of the exposure or as a result of the clay being 250mm below the top of the mattress void and therefore still protected from fast-flowing water.

4.3.5 The first 1 or 2 gabion baskets downstream of the sheet piles have not moved and remain encased in concrete. The baskets downstream of these have all moved toward the scour hole. This movement could result from the mattress falling into the hole and pulling the baskets downstream with them, gravity and the baskets being sat on top of the smooth granite blocks, or water forces pushing the blocks apart. A combination of all three mechanisms is possible; loss of material from beneath is considered unlikely as the baskets are sat on granite blocks and with a concrete top in place there is no apparent mechanism to initiate the movement through scour. The thin concrete topping has cracked and the tying wire between the baskets has failed although some remains in place.

4.3.6 The voids up to 400mm wide between the baskets expose a hard stratum beneath which is assumed to be the old granite scour protection. The inspection found no evidence of scour between the 1m high baskets.

4.3.7 Three options are considered for the existing scour protection:

Monitor

4.3.8 There are no immediate concerns that the scour hole will increase in size rapidly and risk undermining the adjacent structures.

4.3.9 The existing scour protection, whilst damaged is offering ongoing protection to the clay bed other than at its trailing edge. Assuming, as above, that the main scour hole has reached a natural equilibrium, there would be limited ongoing movement of the gabion mattress and basket units.

4.3.10 Annual high resolution multibeam surveys of the scour protection should be undertakenen with point cloud comparison software utilised to monitor movement and deterioration.

4.3.11 If deterioration continues, then a relatively rapid (within 12 months) repair may be required.

4.3.12 The secondary scour hole should be monitored in the same way following the retrospective analysis of its formation as detailed above.

4.3.13 The cost of the alternative options below could therefore be delayed and the value of the existing scour protection utilised if it is accepted that a rapid future repair may be required.

Repair Voids and Damage

4.3.14 The voids between the baskets and the damage to the mattresses could be locally repaired. This would reduce the risk of scour occurring in these voids and prolong the life of the scour protection. This would not address the trailing edge scour, options for which are detailed above.

4.3.15 Options to repair the voids include:

- Stone and mesh – the voids could be filed with stone and gabion mesh could be tied over the top. This is a relatively labour/diver intensive activity but would provide a permeable and flexible solution that would adapt and likely accommodate small ongoing movements.
- Concrete fill – filling the voids with concrete offers a cost-effective solution that minimises diver time. This could be through the use of grout injected geotextile bags to reduce the risk of loss of wet concrete into the gabions. The solution is brittle, and any ongoing gabion movement would likely result in voids reopening. The impermeable concrete does not slow the water in the way stone filled gabions do and, if used extensively, has the potential to increase downstream water velocities.
- Bituminous fill – similar to the concrete fill above but using a bituminous impregnated stone fill that would retain some flexibility and offer some ongoing protection if movement continued. This is a common repair technique used for gabions, but the correct product needs to be established for a permanently submerged environment.

- The large void where two baskets are missing should be repaired with the installation of new stone filled gabion baskets tied into the adjacent baskets. As the tops of the adjacent baskets have been concreted, tying of the new units to the existing will require some consideration and the tops of the baskets may need to be filled and tied in situ in order to achieve this.

Replace

4.3.16 The above repair options will involve significant diver time and require ongoing monitoring and maintenance. Removal and replacement of the scour mattress is therefore an option in combination with filling of the scour hole and extension of the scour protection downstream.

4.3.17 A long-term low maintenance solution could be designed and installed; options could include:

- Replacement gabion mattress and basket solution similar to the existing.
- Pre-cast concrete mattress.
- In-situ grouted concrete mattress.
- Rip rap stone protection.

4.4 Sheet piles and slab

4.4.1 The sheet piles are corroding but not aggressively, they provide a vertical barrier that offers a tertiary level of protection to the structures although their toe levels are unknown.

4.4.2 The presence of the sheet piles and the concrete either side of them will present a constraint to the installation of any future maintenance cofferdams.

4.4.3 The sheet piles and concrete slabs are stable and defect free. Ongoing monitoring via multibeam or diver survey is recommended on a 5 yearly basis. Monitoring can however be incorporated into the more frequent scour protection monitoring.

4.5 Cills

4.5.1 It is understood that leakage control under the weir gates is not a critical consideration. As such the small defects in the cill block joints are not a concern.

4.5.2 The defects that were present in the Middlesex weir span were away from the cill line and would not affect the operation of the gates or performance of the weir.

4.5.3 It is recommended that the cills are monitored on a 3 to 5 yearly basis with the end cill block to the Surrey weir closest to the central pier included within future annual point cloud surveys in order to monitor for any ongoing settlement or movement. This can be relaxed if no movement has been established over a 3-year period.

4.6 Lock Island Slab and Adjacent Bed

4.6.1 This area was partially inspected and did not form a primary objective of the dive survey. Limited point cloud data for this area has been available.

4.6.2 The sheet piles and concrete slab riverwards of the lock island wall were found to be in a good stable condition with no obvious defects.

4.6.3 The riverbed riverwards of the sheet piles has been scour protected in the past at the locations where the lock sluices exist. The protection appears to be retrospective and would suggest historical scour issues may have existed at these locations. Whilst adjacent bed and scour protection appears to be stable at present, it is recommended that this area is included within annual multibeam surveys and compared year on year similar to that proposed for the central scour hole.

4.7 Overall

4.7.1 The central scour hole presents no immediate concern to the adjacent structure but ongoing failure of the scour protection could result in the scour hole progressing towards the weir. Damage to the gabion mattress and baskets could be repaired in combination with partial filling of the scour hole and extension of the protection downstream.

4.7.2 The scour hole to the side of the protection downstream of the Middlesex weir should be investigated further and monitored in a similar way to the main scour hole.

4.7.3 Options to repair and replace the scour protection are presented above but represent considerable expenditure. Ongoing annual monitoring of the depth and size of the scour holes in combination with year-on-year comparison of the degradation of the scour protection is considered to be a feasible solution for delaying capital expenditure. Ongoing monitoring should be considered in the context of the possible need to act relatively quickly if rapid deterioration starts to occur. It is considered likely that without intervention, progressive deterioration of the scour protection will require action within the next 5 to 10 years. Action to prevent further deterioration now could be cost effective depending on the long-term solution adopted.

APPENDICES

APPENDIX A DIVE RECORDS

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Document Control:

PLA Marine Services	Form No:	DOR-511.1

Issue Date:	Revision:	Originator:	Approved by:
8/2017	1	KL	JD

Diving Operations Record

PORT OF LONDON AUTHORITY

Date:	15.03.2022	**Diving Supervisor:**	K LEADBETTER
Site Location:	RICHMOND LOCK.		
Vessel Details:	DRIFTWOOD II		
Task: (Purpose)	INSPECTION of SCOUR HOLE & SILL'S ACROSS THE WEIR.		

Dive Team Names	
	D TRESIDDER
	J DUNKIN
	R BRAND
	R PEARCE

		Cylinder Pressures:	
Helmet:	KMB 37 B		
Gas:	AIR		
Supply: LP or HP:	L.P. COMP & H.P.	1	210
		2	210
Decom. Tables:	USN REV 7.	3	200
		4	200

Record of Dives:

(PDC = Pre Dive Check. LS = Left Surface. AB = At Bottom. LB = Left Bottom. AS = At Surface. TDT = Total Dive Time)

	Name	BO Cyl	PDC	LS	AB	LB	AS	Depth(m)	TDT
D1	D TRESIDDER	230	JP	1137	1138	1219	1220	10	43
SB	R PEARCE	230	RB						
D2	D TRESIDDER	190	JP	1234	1235	1304	1305	5	31
SB	R PEARCE	230	KD						
D3									
SB									

Emergency / Incident Record:

Decompression Record

Table:	USN
Depth:	10
Stop 1:	—
Stop 2:	—
Duration:	74 MINS
Notes:	ALL GOOD

Equipment Check Notes:	ALL GOOD	**Any Defects ?**	NO DEFECTS
Weather Notes:	DRY BRIGHT		
Safety Issues:	NO	Signed by Supervisor:	KD Whitt

Richmond Report Summary Civils

Key

Masonry Package	Steel Package	Requires Detailed Investigation	Not Urgent

Rpt Ref	Title		Priority	Rpt Location	Location Description	Category	Sub Cat	Details	Actioned	Price to Repair	RN
3.1.3	Severe Crack LW19	1	H	Lock Wall Landside	LW19	Masonry	Severe Cracks	Vertical crack from capping to water level at low tide, possible continuation of crack below this level	No		1
3.2.7	Arch and full height crack	1	H	~~Lock Island MDS~~	~~LIM15~~	~~Masonry~~	~~Severe Cracks~~	~~Long standing crack extends from arch up full face to handrail stanchion, which is loose as a result and present safety hazard~~	~~Completed~~	~~DONE~~	1
3.8.2	Flange connection corrosion	1	H	Pedestrian Bridges	Walkway landing connections	Metal Work	Heavy Corrosion	Walkway landing connection at Masonry piers heavily corroded. In accessible, therefore not painted. See UT readings for details	No		1
3.3.2	Decaying timber dolphins	1	H	~~Timber Dolphins~~	~~Upstream Dolphins~~	~~Timber~~	~~Rotten/degraded~~	~~Timber dolphins are heavily decaying, especially between tidal ranges. Structure is also out of plumb and has twisted~~	~~Completed~~	~~DONE~~	1
3.3.3	Decaying timber dolphins	1	H	~~Timber Dolphins~~	~~Downstream Dolphins~~	~~Timber~~	~~Rotten/degraded~~	~~Timber dolphins are in slightly better condition but still significant decay between tidal ranges. Structure however still vertical and positioned correctly~~	~~Completed~~	~~DONE~~	1
3.2.11	Debris blocking archway	2	M	~~Lock Island MDS~~	~~LIM02~~	~~General/Other~~		~~Archway LIM02 unable to be inspected due to debris~~	~~No~~		2
3.1.4	Water Seepage Lock Wall/Sheet Pile	2	M	Lock Wall Landside	Lock Wall LW1/Sheet Pile	Masonry	Breakage/Gap	Significant water seepage between upstream LW1 and sheet pile wall	No		2
3.2.8	Hole just below capping	2	M	Lock Island MDS	LIM16	Masonry	Breakage/Gap	Large hole present just below capping, appears to be from a previous installation which has since been removed	No		2
3.4.12	Failing repair	2	M	Bridge Pier 2	Downstream extent	Masonry	Breakage/Gap	Previous repair to blockwork failing, bond very poor	No		2
3.2.4	Damaged capping brickwork	2	M	Lock Island Surry	Adjacent rubbing timbers	Masonry	Loose Masonry	Capping brickwork damaged in several places, mainly around rubbing timbers	No		2
3.5.7	Missing bricks and mortar	2	M	Boat Ramp & Apron	Upstream from pier 3	Masonry	Loose Masonry	Large horizontal gap visible at top of the wall including missing bricks	No		2
3.5.6	Retaining wall cracks and movement	2	M	Boat Ramp & Apron	Retaining wall downstrm	Masonry	Severe Cracks	Numerous cracks, some full height. Walk way appears to be settling towards one side, however no visible from face of wall	No		2
3.6.2	Full height cracks in curved wall	2	M	Slipway Wall	Curved rtn walls up&dwn	Masonry	Severe Cracks	Full height cracks on both upstream and down stream return walls. Upstream previous movement gauge installed has broken.	No		2
3.7.5	Foundation cracking	2	M	Toll Houses	North pedestrian supports	Masonry	Severe Cracks	Cracking of the foundation support for pedestrian bridge at the North Toll House. Previous attempts to repair present but don't appear to have addressed the root cause.	No		2
3.1.6	Deformed escape ladders	2	M	Lock Wall Landside	Lock Walls Gen	Metal Work	Access/Egress	Escape ladders deformed below fenders, possible damage from vessels	No		2
3.2.17	Broken ladder rung	2	M	Dwn Sluice	Bottom ladder rung	Metal Work	Access/Egress	Bottom ladder rung is broken and hangs down, can be moved by hand	No		2
3.2.6	Failed Ladder Fixing	2	M	Lock Island Surry	LIS43 - below water lvl	Metal Work	Access/Egress	Fixing below normal water line on ladder has failed	No		2
3.1.4	Water Seepage Rubbing Timber	2	M	Lock Wall Landside	LW7/8	Timber	Hiding other issue	Flow of water behind rubbing timber at LW7/LW8	No		2
3.2.3	Cracks behind rubbing timbers	2	M	Lock Island Surry	Rubbing Timbers	Timber	Hiding other issue	Small cracks visible around rubbing timbers, but extent of issue hidden by the timbers	No		2
3.2.19	Inaccessible lower platform	3	L	Up Sluice	Lower lever platform	General/Other		Unable to access as blocked by upper platform, so not inspected	No		3
3.1.7	Surface damage at stairs	3	L	Lock Wall Landside	All access stairs	Masonry	Breakage/Gap	Capping surface face damaged by steel props from rubbing timbers	No		3
3.2.10	Arch brick damage	3	L	Lock Island MDS	Archways	Masonry	Breakage/Gap	Damage to face/edges of archway corner bricks	No		3
3.4.11	Seepage around blockwork	3	L	Bridge Pier 2	Downstream pier end	Masonry	Breakage/Gap	Seepage around blockwork, concern around weir channel steel plate and blockwork	No		3
3.4.14	Seepage around blockwork	3	L	Bridge Pier 3	Downstream pier end	Masonry	Breakage/Gap	Seepage around blockwork at several locations	No		3
3.4.6	Blockwork weathering	3	L	Bridge Pier 0	Pedestrian bridge landing	Masonry	Breakage/Gap	Older stone blockwork are weathered	No		3
3.4.8	Seepage around blockwork	3	L	Bridge Pier 1	Downstream pier end	Masonry	Breakage/Gap	Seepage around blockwork at downstream end of pier, not significant but may suggest a void or similar behind which may worsen	No		3
3.1.3	General Cracks Lock Wall	3	L	Lock Wall Landside	Lock Walls Gen	Masonry	Minor Cracks	Cracking present at numerous locations	No		3
3.1.4	Water Seepage	3	L	Lock Wall Landside	Lock Walls Gen	Masonry	Minor Cracks	Water seepage around cracks and rubbing timber connections	No		3
3.2.2	General Cracks Lock Wall	3	L	Lock Island Surry	Lock Walls Gen	Masonry	Minor Cracks	Cracking present at numerous locations	No		3

3.2.8	General Cracks Lock Wall	3	L	Lock Island MDS	Lock Walls Gen	Masonry	Minor Cracks	Cracking present at numerous locations	No		3
3.6.3	Minor cracks to centre wall	3	L	Slipway Wall	Centre section	Masonry	Minor Cracks	Minor cracks to wall, where visible between growth	No		3
3.7.5	Foundation cracking	3	L	Toll Houses	South pedestrian supports	Masonry	Minor Cracks	Cracking of the foundation support for pedestrian bridgeless severe than North Toll House.	No		3
3.1.5	Mortar Loss	3	L	Lock Wall Landside	Lock Walls Gen	Masonry	Missing Pointing	Multiple location, mainly at copings and rubbing timbers	No		3
3.2.2	Mortar Loss	3	L	Lock Island Surry	Lock Walls Gen	Masonry	Missing Pointing	Multiple location, mainly at copings and rubbing timbers	No		3
3.2.8	Mortar Loss	3	L	Lock Island MDS	Lock Walls Gen	Masonry	Missing Pointing	Multiple location, mainly at copings and wall irregularities, drain pipes, chains, rubbing timbers)	No		3
3.4.5	Mortar loss and brickwork damage	3	L	Bridge Pier 0	Pedestrian bridge landing	Masonry	Missing Pointing	Mortar loss and some damage to brickwork around pedestrian bridge landings	No		3
3.7.4	Missing mortar	3	L	Toll Houses	Window/door lintels	Masonry	Missing Pointing	Missing mortar across brickwork, especially around window and door lintels	No		3
3.4.4	Calcium staining to brickwork	3	L	Bridge Pier 0	Northern arch soffits	Masonry	Other/minor issue	Calcium staining in places, focused on soffits of the window arches	No		3
3.5.4	Lower slab degraded	3	L	Boat Ramp & Apron	Lower slab below ramp	Masonry	Other/minor issue	Top surface of concrete aged and abraded	No		3
3.7.1	Minor damage to blockwork	3	L	Toll Houses	Lower blockwork areas	Masonry	Other/minor issue	Minor erosion to lower sections of blockwork that go under at very high tides, especially corners	No		3
3.2.5	Lock mechanism cover cracked	3	L	Lock Island Surry	Lock gate mech upstream	Metal Work	Other	Cracked steel plate covering upstream lock mechanism, see Mech Sum/Houlders report section 3.3	No		3
3.1.7	Vegetation lock perimeter	3	L	Lock Wall Landside	Lock Walls Gen	Vegetation	General Growth	Vegetation across Lock perimeter and Lock Island all sides	No	Jet wash and remove inside the lock only	3
3.2.9	Vegetation Lock Wall	3	L	Lock Island MDS	Lock Walls Gen	Vegetation	General Growth	Vegetation across walls, mainly under copings	No		3
3.4.9	Vegetation growth on abutments	3	L	Bridge Pier 1	Abutment	Vegetation	General Growth	Vegetation grown around mortar joints on upper levels of the abutment	No		3
3.2.16	Downstream Sluice Vegetation/Grime	3	L	Dwn Sluice	Arch soffit	Vegetation	Marine Growth	Area generally grimy and arch soffit obscured by heavy marine growth	No		3
3.4.10	Marine growth	3	L	Bridge Pier 2	High water line	Vegetation	Marine Growth	Marine growth around highwater line, large patch upstream usually below water level	No		3
3.4.14	Marine growth	3	L	Bridge Pier 3	High water line	Vegetation	Marine Growth	Marine growth around highwater line, plus some greening at lower levels	No		3
3.4.7	Marine growth	3	L	Bridge Pier 1	High water line	Vegetation	Marine Growth	Marine growth around highwater line	No		3
3.5.7	Marine growth, heavy	3	L	Boat Ramp & Apron	Upstream from pier 3	Vegetation	Severe Growth	Little visibility of the wall from riverside due to heavy marine growth	No		3
3.6.3	Marine growth centre section	3	L	Slipway Wall	Centre section	Vegetation	Severe Growth	Heavy marine growth obscures wall from being surveyed	No		3

TECHNICAL NOTE

To	**Mark Collier - Port of London Authority**	**Our reference**	**L/216/150204/51132**
CC		**Your reference**	
From	**Mark Beck**	**Date**	**15th June 2023**
Subject	**Richmond Lock and Weir – Asset Management Strategy**		

Purpose

This document provides an Asset Management Strategy for Richmond Lock and Weir. It is divided into two sections reflecting the different requirements of the mechanical components and the civil structures. The current condition and future inspection regimes are proposed. In addition, the regular maintenance and replacement periods of the mechanical components is included.

Contents

Revision	Date	Reason for Revision	Prepared by	Notes
0	15/06/23	Information	MPB	

1. Introduction

The PLA are considering establishing a framework contract to support the infrastructure of Richmond Lock and Weir. This would include the following:

1. Repair works for known defects – these will require design, specification and procurement of the works.

2. Additional surveys or inspections of known areas which require further investigation.

3. Ongoing inspections of the assets which would confirm the condition and identify any additional items to be added to 1 & 2 above.

This Asset Management Strategy will inform the ongoing requirements for 3 above.

2. Methodology and Assumptions

2.1. Mechanical Assets

All the components of the mechanical workings of the weir and lock have been itemised and the following information recorded:

- Last major refurbishment
- Current Condition
- Inspection Regime
- Routine Maintenance
- Replacement Frequency
- Any planned works

The information is presented in Appendix 1 and is based on the current maintenance regime and annual draw off works.

No assessment of the electrical system has been considered.

2.2. Civil Structures

Beckett Rankine assisted Houlder Ltd with a condition survey of the Lock and Weir in 2022 and are therefore familiar with the facility. They were contracted to prepare a management strategy for the civil structures. This is presented in Appendix 2.

The following periodical surveys have been recommended. For some items more than one inspection regime is recommended. For example, regular 3 monthly visual inspection followed by a more detailed survey each 5 or 10years. The frequency of surveys may change depending on the findings of the previous survey.

Period (Years)	Inspection
0.25A	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.
0.25B to 0.5B	Install crack gauges within 6 months. Inspect crack gauges every quarter for the first year including once in mid-winter and once in mid-summer to give a range due to expansion and contraction of the structure. Twice per year after that. Results after 2 years to inform future frequency.
1.0A	To monitor all marine structures and bed levels and formations where scour is known to be occurring, high resolution multibeam surveys should be undertaken with point cloud comparison software utilised to monitor movement and deterioration. BR to interpret the results and advise on future monitoring frequency or if relatively rapid (within 12 months) repair may be required. Ref report 2411-BRL-01-XX-RP-C-2000
1.0B	Landside walkover inspection to ensure remain stable and not deteriorating significantly. To be carried out by briefed PLA staff or similar.
1.0C	Riverside inspection from a small vessel. Use photographs and notes from previous inspections to compare the condition/deterioration since the last inspection. This should be carried out by a briefed PLA staff or similar.
<1.0D	Jet wash and reinspect the wall within 12 months
<3A	As part of crack repair works remove the timber fenders and inspect behind
3.0B	Inspection of the asset to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000
5.0A	Ongoing monitoring via multibeam and diver survey where they are visible above bed level.
5.0B	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by an chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000
5.0C	Representative measurements of steel thicknesses of pedestrian bridge - areas accessible on foot only
5.0D	Monitored on a 5 yearly basis. 4.5.3 of 2411-BRL-01-XX-RP-C-2000. This can be completed by being included in the annual multi beam survey every 5 years. Diver survey every 5 years.
10.0A	Inspection of pedestrian bridges from roped / scaffold access. Measure the steel thicknesses of the pedestrian access bridge. Inspection frequency starting from the last painting

Table 1: Inspection Table for Civil Structures

3. Conclusions

The current condition and future survey recommendations have been made for all components of the Lock and Weir. It had been hoped to use an identical format for both the mechanical and civils structures, but this was found not to be practicable due to the routine and annual maintenance of the mechanical components.

The mechanical register in Appendix 1 indicates work required to maintain the mechanical workings of the Lock and Weir except for the electrical systems. This is what has been undertaken over the past few years but is now summarised in a single table.

The summary tables presented in Appendices 1 & 2 should enable the PLA to input this information into their asset management software to define their required maintenance and inspection commitments. It will also be useful in defining the requirements of a Framework contract to undertake the inspections and specifying contractor work scopes for maintenance/repair works.

Appendix 1 **Mechanical Asset Management**

Richmond L&W Asset Management Strategy
(Mechanical)

	Last major refurbishment	Current Condition	Inspection Regime	Routine Maintenance	Replacement Frequency	Planned works
Middlesex Weir						
Gate Structure	1992/4	Good	5 year survey	None	-	-
Gate Coating	1992/4	Poor	5 year survey	Touch up repairs	-	
Middlx Trunnion	1992/4	unknown	Not possible	Not possible	-	Possible refurbish in 2024
Surrey Trunnion	1992/4	unknown	Not possible	Not possible	-	Possible refurbish in 2024
Main wires (4 off)	2012	Fair	Annual at Drawoff	3 monthly Greasing	15years	Possible replacement in 2024
Middlx Cradle	2022	Refurbished in 2022	Annual at Drawoff	6 month Auto greasers	-	-
Surrey Cradle	2022	Refurbished in 2022	Annual at Drawoff	6 month Auto greasers	-	-
Cradle Wires	2022	New in 2022	Annual inspection, Replaced 3 yearly	None	3 years	-
Ladders (4 off)	2022	New in 2022	Annual inspection, Replaced 3 yearly	3 monthly lubrication of links	3 years	-
Middlx Rocker Bar Upstream	1992/4	Tight	Should be annual at drawoff	None	-	Draw off 2023
Middlx Rocker Bar Downstream	1992/4	Tight	Should be annual at drawoff	None	-	Draw off 2023
Surrey Rocker Bar Upstream	1992/4	Tight	Should be annual at drawoff	None	-	Draw off 2023
Surrey Rocker Bar Downstream	1992/4	Tight	Should be annual at drawoff	None	-	Draw off 2023
Guide Arm and roller	1992/4	Good	Annual at Drawoff	Annual Greasing	-	-
Drive End Machinery Middlx	1992/4	Good	Annual at Drawoff	3 monthly greasing	-	-
Drive shaft and plumber bearings	1992/4	Good	Annual at Drawoff	Lock foreman Greasing	-	-
Surrey Machinery	1992/4	Good	Annual at Drawoff	3 monthly greasing	-	-
Electric Actuator	1992/4	Poor	TBC - from Rotork manual	None	10 years?	To be replaced with Rotork
Well Boxes (4off)	1992/5	Good	Annual at Drawoff	Pump out as required, monthly	-	
No entry Sign		Good	Annual at Drawoff	Monthly check	-	
Centre Weir						
Gate Structure	1992/4	Good	5 year survey	None	-	-
Gate Coating	1992/4	Poor	5 year survey	Touch up repairs	-	Re paint in 2023?
Middlx Trunnion	2022	New	Not possible	Not possible	-	-
Surrey Trunnion	2022	New	Not possible	Not possible	-	-
Main wires (4 off)	2022	New	Annual at Drawoff	3 monthly Greasing	15years	-
Middlx Cradle	2021	Refurbished in 2021	Annual at Drawoff	6 month Auto greasers	-	-
Surrey Cradle	2021	Refurbished in 2021	Annual at Drawoff	6 month Auto greasers	-	-
Cradle Wires	2022	New	Annual inspection, Replaced 3 yearly	None	3 years	-
Ladders (4 off)	2021	Good - 1yr old	Annual inspection, Replaced 3 yearly	3 monthly lubrication of links	3 years	-
Middlx Rocker Bar Upstream	1992/4	Tight	Should be annual at drawoff	None	-	Draw off 2023
Middlx Rocker Bar Downstream	1992/4	Tight and section worn	Should be annual at drawoff	None	-	Draw off 2023
Surrey Rocker Bar Upstream	1992/4	moves freely	Should be annual at drawoff	None	-	Draw off 2023
Surrey Rocker Bar Downstream	1992/4	Tight	Should be annual at drawoff	None	-	Draw off 2023
Guide Arm and roller	2022	New	Annual at Drawoff	Annual Greasing	-	-
Drive End Machinery Middlx	1992/4	Good	Annual at Drawoff	3 monthly greasing	-	-
Drive shaft and plumber bearings	1992/4	Good	Annual at Drawoff	Lock foreman Greasing	-	-
Surrey Machinery	1992/4	Good	Annual at Drawoff	3 monthly greasing	-	-
Electric Actuator	1992/4	Failing	TBC - from Rotork manual	None	10 years?	New Rotork unit on order
Well Boxes (4off)	1992/4	Good	Annual at Drawoff	Pump out as required, monthly	-	-
No entry Sign		Good	Annual at Drawoff	Monthly check		

Surrey Weir						
Gate Structure	1992/4	Good	5 year survey	None	-	-
Gate Coating	1992/4	Poor	5 year survey	Touch up repairs	-	Repaint in 2023?
Middlx Trunnion	1992/4	unknown	Not possible	Not possible	-	Possible refurbish in 2025
Surrey Trunnion	1992/4	unknown	Not possible	Not possible	-	Possible refurbish in 2025
Main wires (4 off)	2011	Good	Annual at Drawoff	3 monthly Greasing	15years	Possible refurbish in 2025
Middlx Cradle	2021	Fair	Annual at Drawoff	6 month Auto greasers	-	To be refurbished in 2023
Surrey Cradle	2021	Fair	Annual at Drawoff	6 month Auto greasers	-	To be refurbished in 2023
Cradle Wires	2022	New in 2022	Annual inspection, Replaced 3 yearly	None	3 years	-
Ladders (4 off)	2022	New in 2022	Annual inspection, Replaced 3 yearly	3 monthly lubrication of links	3 years	-
Middlx Rocker Bar Upstream	1992/4	Tight	Should be annual at drawoff	None	-	Draw off 2023
Middlx Rocker Bar Downstream	1992/4	Tight	Should be annual at drawoff	None	-	Draw off 2023
Surrey Rocker Bar Upstream	1992/4	Tight	Should be annual at drawoff	None	-	Draw off 2023
Surrey Rocker Bar Downstream	1992/4	Tight	Should be annual at drawoff	None	-	Draw off 2023
Guide Arm and roller	1992/4	Good	Annual at Drawoff	Annual Greasing	-	-
Drive End Machinery Middlx	1992/4	Good	Annual at Drawoff	3 monthly greasing	-	-
Drive shaft and plumber bearings	1992/4	Good	Annual at Drawoff	Lock foreman Greasing	-	-
Surrey Machinery	1992/4	Good	Annual at Drawoff	3 monthly greasing	-	-
Electric Actuator		Poor	TBC - from Rotork manual	None	10 years?	New Rotork to be fitted May 23
Well Boxes (4off)	1992/4	Good	Annual at Drawoff	Pump out as required, monthly	-	-
No entry Sign		Good	Annual at Drawoff	Monthly check	-	-

Upstream Look Gates						
Surrey gate	1992	Poor	5 year survey	None	30years +	Repair top centre section
Middlesex Gate	1992	Poor	5 year survey	None	30years +	Repair top centre section
Sluice Paddle screws and linkages		Good	Annual at Drawoff	2 weekly check	-	-
Surrey Capstan	1992	Good	Annual at Drawoff	2 weekly check	-	-
Surrey Capstan wire		Good	Annual at Drawoff	2 weekly check	-	-
Middlesex Capstan	1992	Good	Annual at Drawoff	2 weekly check	-	-
Middlesex Capstan wire		Good	Annual at Drawoff	2 weekly check	-	-
Surrey Quoin bearing and straps	1992	Heavy corrosion	5 year survey	2 weekly greasing	-	-
Middlesex Quoin bearing and straps	1992	Heavy corrosion	5 year survey	3 weekly greasing	-	-
Surrey Capstan Pit deck supports	1992	Bolts in poor condition	5 year survey	None	-	Replace all bolts
Middlesex Capstan Pit deck supports	1992	Bolts in poor condition - crack in casting to be repaired	5 year survey	None	-	Replace all bolts and plate repair
Surrey Actuator	?	Good	3 monthly check of oil level	-	-	Replace with Rotork in future
Middlesex Actuator	?	Good	3 monthly check of oil level	-	-	Replace with Rotork in future

Upstream Sluice						
Sluice Gate structure	1992	Fair	5 year survey		30yr +	-
Gate contact faces	1992	Worn	Annual at Drawoff		-	-
Upstream Roller Cradle	2022	Good	Annual at Drawoff		-	-
Downstream Roller Cradle	2022	Good	Annual at Drawoff		-	-
Cradle wires	2022	Good	Replaced annually at draw off		1 year	-
Chains and counter weights	1992	Good	5 year survey	6 month Auto greaser change	-	-
Winch mechanism	1992	Good	Annual at Drawoff	2 weekly grease and lubricate	-	-
Actuator	?	Good	3 monthly check of oil level		-	Replace with Rotork in future

Downstream Look Gates						
Surrey gate	1992	Poor	5 year survey	None	30years +	Repair top centre section
Middlesex Gate	1992	Poor	5 year survey	None	30years +	Repair top centre section
Sluice Paddle screws and linkages		Good	Annual at Drawoff	2 weekly check	-	-
Surrey Capstan	1992	Good	Annual at Drawoff	2 weekly check	-	-
Surrey Capstan wire		Good	Annual at Drawoff	2 weekly check	-	-
Middlesex Capstan	1992	Good	Annual at Drawoff	2 weekly check	-	-
Middlesex Capstan wire		Good	Annual at Drawoff	2 weekly check	-	-
Surrey Quoin bearing and straps	1992	Heavy corrosion	5 year survey	2 weekly greasing	-	-
Middlesex Quoin bearing and straps	1992	Heavy corrosion	5 year survey	2 weekly greasing	-	-
Surrey Capstan Pit deck supports	1992	Bolts in poor condition	5 year survey	None	-	Replace all bolts
Middlesex Capstan Pit deck supports	1992	Bolts in poor condition	5 year survey	None	-	Replace all bolts
Surrey Actuator	?	Good	3 monthly check of oil level	-	-	Replace with Rotork in future
Middlesex Actuator	?	Good	3 monthly check of oil level	-	-	Replace with Rotork in future

Downstream Sluice						
Sluice Gate structure	1992	Fair	5 year survey		30yr +	-
Gate contact faces	1992	Worn	Annual at Drawoff		-	-
Upstream Roller Cradle	2021	Good	Annual at Drawoff		-	-
Downstream Roller Cradle	2021		Annual at Drawoff		-	-
Cradle wires	2022	Good	Replaced annually at draw off		1 year	-
Chains and counter weights	1992	Good	5 year survey	6 month Auto greaser change	-	-
Winch mechanism	1992	Good	Annual at Drawoff	2 weekly grease and lubricate	-	-
Actuator	?	Good	3 monthly check of oil level		-	Replace with Rotork in future

Lock						
Silting of lock	2023	Good	Lock Foreman	Annual Flush		

Richmond Lock and Weir **Rev 2.0**
Civil Infrastrucutre Assesst Management Inspection Plan **05/06/2023**

	Asset (2144-BRL-01-XX-DR-C-1000)	Current Condition Grade (2022)	2022 Condition Ref (2144-BRL-01-XX-RP-C-1000)	Inspection 1 Regime	Inspection Frequency and Type	Inspection 2 Regime	Inspection Frequency and Type	Inspection 3 Regime	Inspection Frequency and Type
River Beds (excluding scour protection)	Upstream Riverbed	Unknown	Unknown	Initial high resolution multibeam survey recommended or review of existing if available to determine ongoing maintenance regime.	TBC				
	Downstream Riverbed	Poor	The water turbulence at the edge of the gabion mattress has resulted in the clay both in front and under/behind the edge being eroded. Uneven erosion has formed clay boulders which have fallen into the bottom of the scour hole. This ongoing process has resulted in the formation of the scour hole and the undermining of the mattress causing it to drop into the hole at its edge (from section 4.2.4). There is also a scour hole at the downstream end of the lock island and one at the edge of the gabion matters adjacent to the downstream boat ramp. The existing scour protection, whilst damaged is offering ongoing protection to the clay bed other than at its trailing edge and as detailed above. ref 2411-BRL-01-XX-RP-C-2000	Monitoring both primary and secondary scour holes, high resolution multibeam surveys of the scour protection should be undertaken with point cloud comparison software utilised to monitor changes and deterioration. Chartered engineer with at least 5 years relevant experience to interpret the results and advise on future monitoring frequency or if relatively rapid (within 12 months) repair may be required. Ref report 2411-BRL-01-XX-RP-C-2000	1.0A	Ongoing monitoring via diver survey.	5.0A		
Upstream Masonry Walls and Structures	Upstream River Banks	Unknown but appears Good from passing photographs		Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection to ensure remain stable and not deteriorating significantly. To be carried out by briefed PLA staff or similar.	1.0B		
	Upstream Submerged Sheet Pile Walls	Fair	The sheet piles are corroding but not aggressively, they provide a vertical barrier that offers a tertiary level of protection to the structures although their toe levels are unknown. Ref 4.4.3 2411-BRL-01-XX-RP-C-2000	Ongoing monitoring via multibeam and diver survey where they are visible above bed level.	5.0A				
	Upstream Submerged Slabs	Fair	Concrete slabs are stable and defect free. 4.4.2 2411-BRL-01-XX-RP-C-2000	Ongoing monitoring via multibeam and diver survey where they are visible above bed level.	5.0A				
	Upstream Lock Island Surrey Side Wall (LIS)	Good	There are minor defects across its length although they are unlikely to impact the wall's structural stability.	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A	Install crack gauges within 6 months @ LIS39. Inspect crack gauges every quarter for the first year including once in mid-winter and once in mid-summer to give a range due to expansion and contraction of the structure. Twice per year after that. Results after 2 years to inform future frequency.	0.25B to 0.5B
	Upstream Lock Island Middlesex Side Wall (LIM)	Good	The structure is in visually good condition and there are minor defects across its length. The wall is in a locally poor condition at LIM15 due to a long-standing crack defect	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A	Install crack gauges within 6 months @ LIM15. Inspect crack gauges every quarter for the first year including once in mid-winter and once in mid-summer to give a range due to expansion and contraction of the structure. Twice per year after that. Results after 2 years to inform future frequency.	0.25B to 0.5B
	Upstream Lock Wall (LW)	Good	Wall is predominantly in good condition with local defects that mean some areas are in a fair condition.	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A		
	Upstream Apron Wall	Poor	A large mortar gap with missing bricks is visible towards the top of the wall. Marine growth obscures much of the wall	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A	Jet wash and reinspect the wall within 12 months	<1.0D
	Upstream Slipway wall	Fair	The wall is cracked in numerous places; these cracks are often the full height of the wall. Water seepage is also noted along several of the mortar joints. The walkway along the top of the wall can be felt to be settling towards one side suggesting some movement, but this was not observed on the front face of the wall.	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A		

	Asset (2144-BRL-01-XX-DR-C-1000)	Current Condition Grade (2022)	2022 Condition Ref (2144-BRL-01-XX-RP-C-1000)	Inspection 1 Regime	Inspection Frequency and Type	Inspection 2 Regime	Inspection Frequency and Type	Inspection 3 Regime	Inspection Frequency and Type
Downstream Masonry Walls and Structures	Downstream River Banks?	Unknown but appears Good form passing photographs		Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection to ensure remain stable and not deteriorating significantly. To be carried out by briefed PLA staff or similar.	1B		
	Downstream Submerged Sheet Pile Walls	Fair	The sheet piles are corroding but not aggressively, they provide a vertical barrier that offers a tertiary level of protection to the structures although their toe levels are unknown. Ref 4.4.3 2411-BRL-01-XX-RP-C-2000	Ongoing monitoring via multibeam and diver survey where they are visible above bed level.	5.0A				
	Downstream Submerged Slabs	Fair	Concrete slabs are stable and defect free. 4.4.2 2411-BRL-01-XX-RP-C-2000	Ongoing monitoring via multibeam and diver survey where they are visible above bed level.	5.0A				
	Downstream Lock Island Surrey Side Wall (LIS)	Good	There are minor defects across its length although they are unlikely to impact the wall's structural stability.	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A		
	Downstream Lock Island Middlesex Side Wall (LIM)	Poor	The downstream length of the wall demonstrates several areas of missing mortar. This is particularly true directly beneath the concrete capping and around areas where there are existing irregularities in the wall (drainpipes, chain connections, rubbing timbers).	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A		
	Downstream Lock Wall (LW)	Good	Wall is predominantly in good condition with local defects that mean some areas are in a fair condition.	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A	Install crack gauges within 6 months @ LW19. Inspect crack gauges every quarter for the first year including once in mid-winter and once in mid-summer to give a range due to expansion and contraction of the structure. Twice per year after that. Results after 2 years to inform future frequency.	0.25B
	Downstream Apron Wall	Fair	Wall is cracked in numerous places, often full height with evidence of some movement.	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A		
	Downstream Slipway wall	Fair	The wall is cracked in numerous places; these cracks are often the full height of the wall. Water seepage is also noted along several of the mortar joints. The walkway along the top of the wall can be felt to be settling towards one side suggesting some movement, but this was not observed on the front face of the wall. 3.2.8 of 2144-BRL-01-XX-RP-C-1000	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A	Install crack gauges within 6 months. Inspect crack gauges every quarter for the first year including once in mid-winter and once in mid-summer to give a range due to expansion and contraction of the structure. Twice per year after that. Results after 2 years to inform future frequency.	0.25B

	Asset (2144-BRL-01-XX-DR-C-1000)	Current Condition Grade (2022)	2022 Condition Ref (2144-BRL-01-XX-RP-C-1000)	Inspection 1 Regime	Inspection Frequency and Type	Inspection 2 Regime	Inspection Frequency and Type	Inspection 3 Regime	Inspection Frequency and Type
General Masonry and Surfaces	Pier 0	Good	The north face exhibits calcium staining in places, particularly on the soffits of the window arches built into the pier. There is mortar loss and damage to the brickwork adjacent to the pedestrian bridge landings	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A		
	Pier 1	Good	Marine growth is evident around the high-water line. Further staining is present on the upstream side of the pier. Water seepage was observed between the blockwork at the downstream end of the pier	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A		
	Pier 2	Good	As per Pier 1 and shares the same typical defects as identified previously.	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A		
	Pier 3	Good	As per Pier 1 and shares the same typical defects as identified previously.	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A		
	Timber Fender Locations	Poor	Vertical masonry cracking adjacent to the timber fenders was frequently encountered, this may extend behind the fenders in places and the extend could not therefore be fully determined	As part of crack repair works remove the timber fenders and inspect behind	<3.0A	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by an chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A
	Surfacing/Pavements	Unknown but appears Good from passing photographs	Unknown. Local Damage around timber fender locations.	Inspection of the asset from land. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by aa chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B				
	South Toll House Exterior	Good	No significant structural defects noted, however minor cracking of brickwork and decorative stonework is noted in places.	Inspection of the asset from land. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by a chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B				
	North Toll House Exterior	Good	No significant structural defects noted, however minor cracking of brickwork and decorative stonework is noted in places.	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by n chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B				
Super structure	Downstream Pedestrian Bridge Structure	Good	Recently Painted. Areas of corrosion where flange meets blockwork.	Representative measurements of steel thicknesses of pedestrian bridge - areas accessible on foot only	5.0C	Inspection of pedestrian bridges from roped / scaffold access. Measure the steel thicknesses of the pedestrian access bridge. Inspection frequency starting from the last painting	10.0A	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A
	Upstream Pedestrian Bridge Structure	Good	Recently Painted. Areas of corrosion where flange meets blockwork.	Representative measurements of steel thicknesses of pedestrian bridge - areas accessible on foot only	5.0C	Inspection of pedestrian bridges from roped / scaffold access. Measure the steel thicknesses of the pedestrian access bridge. Inspection frequency starting from the last painting	10.0A	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A
	Upstream Pedestrian Bridge Surfacing and parapet	Unknown but appears Good from passing photographs	Unknown	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A				
	Downstream Pedestrian Bridge Surfacing and parapet	Unknown but appears Good from passing photographs	Unknown	Landside walkover inspection of asset to ensure deterioration is as expected and highlight any areas of potential concern. To be carried out by briefed PLA staff or similar.	0.25A				
Sluice Pits	Upstream Sluice Pit	Very Good	There were no identified defects in the brickwork or surroundings. Also failed ladder connection	Inspection of the asset to identify defects and classify assets. To be carried out during draw-off and overseen by an chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	3.0B				
	Downstream Sluice Pit	Good	The brickwork is generally in a very good condition, although grimy in places.	Inspection of the asset to identify defects and classify assets. To be carried out during draw-off and overseen by an chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	3.0B				

	Asset (2144-BRL-01-XX-DR-C-1000)	Current Condition Grade (2022)	2022 Condition Ref (2144-BRL-01-XX-RP-C-1000)	Inspection 1 Regime	Inspection Frequency and Type	Inspection 2 Regime	Inspection Frequency and Type	Inspection 3 Regime	Inspection Frequency and Type
Various	Gabion Mattress	Fair	Variable condition with undermined edges, evidence of movement, separation of joints between baskets and local loss of gabion fill material. There is no evidence to suggest the mattress has significantly dropped in level since its installation; a comparison of the point cloud surveys back to 2008 would be useful to confirm this (4.2.4).	Ongoing monitoring via diver survey.	5.0A	High resolution multibeam surveys of the scour protection should be undertaken with point cloud comparison software utilised to monitor movement and deterioration. If deterioration continues, then a relatively rapid (within 12 months) repair may be required. 2411-BRL-01-XX-RP-C-2000	1.0A		
	Cills	Good	The central cill is in the best condition of all three with tight 5mm joints and 5mm radius bullnoses to either side. No deviation to the line or level are present and the granite slopes to the sides of the cill are clean. The cill surface is smooth.3.5.3 of 2411-BRL-01-XX-RP-C-2000	Monitored on a 5 yearly basis. 4.5.3 of 2411-BRL-01-XX-RP-C-2000. This can be completed by being included in the annual multi beam survey every 5 years. Diver survey every 5 years.	5.0D	The end cill block to the Surrey weir closest to the central pier should be included within future annual multi beam surveys in order to monitor for any ongoing settlement or movement. This can be relaxed if no movement has been established over a 3-year period.	1.0A		
	Boat Ramp and Apron	Good	Several cracks are present across the surface of the concrete, but they do not compromise its function.	Landside walkover inspection of complete arrangement to ensure deterioration is progressing and expected rate and highlight any areas of potential concern. To be carried out by PLA staff or similar.	1.0B				
	LI Upstream Dolphin	Very Good	New timber dolphin installed in 2022	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by an chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Riverside inspection from a small vessel. Use photographs and notes from previous inspections to compare the condiiton/deterioration since the last inspection. This should be carried out by a briefed PLA staff or simular.	1.0C		
	LI Downstream Dolphin	Very Good	New timber dolphin installed in 2022	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by an chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Riverside inspection from a small vessel. Use photographs and notes from previous inspections to compare the condiiton/deterioration since the last inspection. This should be carried out by a briefed PLA staff or simular.	1.0C		
	Ladders	Fair	Deformation in ladders assumed to be from vessel impact	Inspection of the asset from land and boat. Inspections to identify defects and classify assets. To be carried out during draw-off and overseen by an chartered engineer with at least 5 years relevant experience. 2144-BRL-01-XX-RP-C-1000	5.0B	Use photographs and notes from previous inspections to compare the decay/deterioration since the last inspection. This should be completed by PLA staff or similar.	1.0B		

Notes:

Repair recommendations are not included.

Inspection frequency to be amended following each inspection as required, this remains a live document.

Inspection frequency assumed that the repair recommendations as detailed within report 2144-BRL-01-XX-RP-C-1000 are undertaken within the timescales indicated with the report. Failure to do so would result in the recommended inspection type and frequency needing to be reviewed.

Mechanical and electrical equipment and associated channels, runners and supports are excluded, the structures that support the M&E are included.

The extent to which crack gauges are recommended is informed by the known history of the cracks and evidence of age i.e. lack of signs of ongoing deterioration, additional gauges could be installed and it would be cost effective to do so at the time of installing others.