Jacobs

CSO Discharge Designers Risk Assessment Permanent Case – Putney Embankment Foreshore

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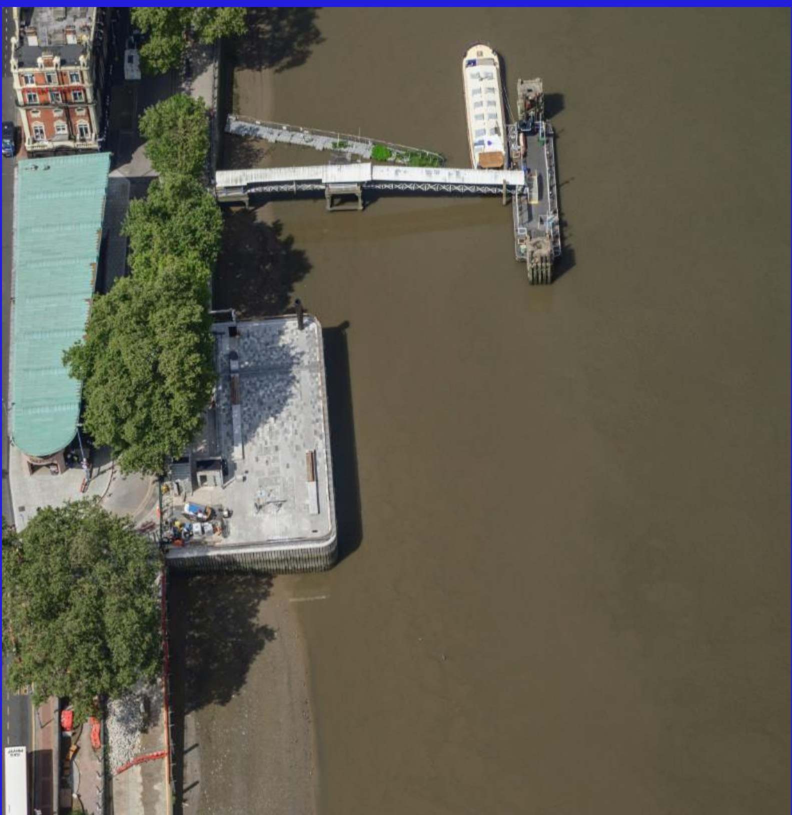
Version: 03

Bazalgette Tunnel Limited

Tideway
14 December 2024



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Version:	03	**Prepared by:**	James Spikesley, Paul Hallas, Phil Reed & Russell Guest
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Document history and status

Revision	Date	Description	Revised by
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1	10/01/2024	Updated to Waves comments CW1757-IDR009	JS
2	07/03/2024	Updated to PLA review comments 20240223 PUTEF CSO DRA perm case Rev1 PLA response	JS/PH/PR/RG
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4 (3)	14/12/2024	1.17 removed from the executive summary.	PR

Required Approvals

	Name	Role	Signature	Date
Checked by	Phil Reed	Lead Marine Civil Engineer	PR	01/05/24
Reviewed by	Ed Davies	CDM Advisor (Ports and Maritime)	ED	01/05/24
Reviewed by	Simon Fricker	Head of Design Authority	SF	01/05/24
Approved by	James Smith	Jacobs Project Manager	JS	01/05/24

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Executive summary

1.1 This designers risk assessment has been produced to assess the hazards of swamping, capsizing, grounding and collision created by the physical impact of the PUTEF CSO discharge flows to vessels on the Thames at the Putney Embankment Foreshore site (PUTEF).

1.2 It has been undertaken for the permanent phase when the existing CSO is diverted into the new CSO that is situated further into the river Thames in the new PUTEF structure and the tunnel is in operation.

1.3 This designers risk assessment has assessed the risk of a CSO discharge to all types of vessels that passage past the location for the impact of changing the vessels course and the consequential harm that could be caused with a further check to vessel simulations.

1.4 A worst-case scenario discharge rate of a 1:15-year event at mean low water springs (MLWS) has been analysed to assess the impacts to vessels within zones of impact and vessel accessibility.

1.5 All discharges should be considered as the most probable worst case where it is not possible to establish the magnitude of the discharge at the time of discharge. Consideration should be made to the magnitude of the discharge rate and the minimum period of 30 minutes from the start of the discharge to a significant rate of discharge.

1.6 With the tunnel in permanent operation the discharges are likely to occur once a year reducing from the current predictions of 93 times per year when the tunnel is not in operation.

1.7 It has been concluded that the impact of the discharge occurs for 60 minutes, starting 40 minutes before MLWS and concluding 20 minutes after in the fairway, this period of impact should be applied for all low tides.

1.8 It has been concluded that the impact of the discharge 3 hours before low water slack to 3 hours after in the inshore zone.

1.9 The assessment has concluded that the discharges cannot be predicted within 30m of the CSO outfall and all vessels should avoid that close proximity to the discharge at any state of the tide.

1.10 It is assumed that the same effects from the CSO discharges would be present when a Thames barrier closure is in operation and the river is in a permanent state of slack water.

1.11 It has been concluded that the risk to powered vessels is very low, the risk to unpowered vessels is low when the mitigations of an effective warning system is adopted.

1.12 The main works contractor BMB will undertake a navigational risk assessment to consider the residual risks and confirm their mitigations from the operational plan, in consultation with the Port of London Authority, required to be in place during the phase that is covered by this DRA.

1.13 To analyse the risk in greater detail for the permanent DRA the following studies have been undertaken:

a. Simulations of the discharge flows on vessels to assess the actual impact caused by the drift angle have been completed. The simulations were a clear demonstration of the impact to the passing vessels.

b. Closed circuit television (CCTV) recording of actual vessel traffic. The survey proved to be inconclusive but their conclusions had no bearing on the risk assessment due to the low frequency and magnitude of the discharge being the dominating parameters of the assessment.

1.14 The permanent mitigations are currently being planned and produced by Tideway in conjunction the Main Works Contractor BMB and will be issued for agreement to the PLA and the operational suitability confirmed in line with Tideway's "Technical Memorandum on CSO warning performance specification and strategy".

1.15 The permanent case has been risk assessed incorporating the findings of the ship simulations and will be subject to a navigational risk assessment by the Main Works Contractor to determine, in agreement with the Port of London Authority, any permanent mitigations that may be required. The Technical Memorandum on CSO warning performance specification and strategy should be considered to confirm the mitigations.

1.16 The permanent navigational risk assessment undertaken by the Main Works Contractor BMB will need to determine, in agreement with the Port of London Authority, that the permanent mitigations provide an acceptable warning system for the established risks.

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Acronyms and abbreviations

Abbreviation	Abbreviation Description
ALARP	As Low As is Reasonably Practicable
BMB	Balfour Morgan Bam Joint Venture Main Works Contractors
CCTV	Closed Circuit Television
CDM	Construction Design and Management Regulations 2015
CFD	Computational Fluid Dynamics
CSO	Combined Sewer Overflow
DRA	Designers Risk Assessment
EDM	Discharge Monitor
ERIC	Eliminate, Reduce, Inform and Control
ICM	Integrated Catchment Model
LTT	London Tideway Tunnel
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
NRA	Navigational Risk Assessment
PLA	Port of London Authority
PUTEF	Putney Embankment Foreshore
SCADA	Supervisory Control and Data Acquisition
TWUL	Thames Water Utilities Limited
UWWTD	Urban Waste Water Treatment Directive
VTS	Vessel Traffic Service

2. Introduction

2.1 Introduction

2.1.1 As part of the Thames Tideway Tunnel project a new foreshore structure to intercept the existing Putney Bridge CSO has been constructed at Putney Embankment Foreshore (PUTEF).

2.1.2 At the PUTEF site the new combined sewer overflow (CSO) outfall will be relocated from its original location of Putney bridge abutment within Arch 4 to discharge from the new permanent structure.

2.1.3 Jacobs as the designer for the reference design has the duty under the CDM regulations to eliminate risks as far as reasonably practicable, where the risks cannot be eliminated the risks need to be reduced as far as reasonably practicable and information provided on residual risk.

2.1.4 Under the CDM regulations the Principal Designer "Jacobs" has a responsibility to plan, manage, monitor and coordinate the health and safety in the pre-construction phase of the project.

2.1.5 During the development of the design a designer's risk assessment was undertaken to identify risks through design whilst also identifying any residual risks that would need to be considered.

2.1.6 As part of Designers Risk Assessment PP05X/TA the impact of a CSO discharge on boats moored to the front of the new structure was considered under risk reference CDM-PUTEF-016, as presented below in Table 2-1.

Table 2-1 Extract from Designers Risk Assessment PP05X/TA

Risk ref.	Title / description	Phase	Activity	Potential hazards	Effect summary inc person at risk.	Severity	Probability	First Risk Rating	Design measures to eliminate hazards	Design measures to reduce risk and/or design assumptions	Severity	Probability	Risk Rating after E & R	Residual risk (if significant, etc.)	How is it communicated and / or documented?
CDM-PUTEF-016	Boats mooring in front of new CSO.	Operation and Maintenance	On completion there is the possibility of boats mooring along foreshore structure and directly in front of CSO.	CSO discharging onto boats moored in front causing capsize.	Damage to boat, Damage to foreshore structure, risk of injury or possible fatality to boat user.	5	3	High	Not possible to eliminate.	Architects have arranged seating to discourage boats from mooring in front of the CSO. Works Information includes requirement for signage warning against mooring at this location. Design provides enlarged of outfall which reduces flow velocity. Detailed design to detail any residual risk within the O&M Manual and H&S File.	5	1	Medium	Serious injury or possible fatality to construction personnel, possibility of inundating Cofferdam. Possibility of workers within sewer (e.g. installing flume / removing flap valves) to be inundated / swept away / ill from exposure to sewage.	'Dealing with Flows' report included in Section 0.

2.1.7 Whilst CDM-PUTEF-16 recognises that there is a risk to moored boats from a CSO discharge it does not consider any direct risk to vessels operating in the river away from the site or that mitigations may be required. It should be noted that during the development of the design the risk to moored vessels was mitigated with the removal of mooring equipment from the permanent structure thus eliminating this risk and the requirement for the sign.

2.1.8 To ensure that all the relevant risks and mitigations are covered through a Designers Risk Assessment this document will be an addendum which will consider a detailed risk assessment of the new PUTEF CSO discharges impacting vessels on the river.

2.1.9 This designer's risk assessment (DRA) will consider:

(a) The permanent case with the new foreshore structure in place and the flows able to be intercepted and diverted to the main tunnel

(b) When the tunnel is out of operation for maintenance and inspection works.

2.1.10 The DRA will make the assessment based on the information that has been produced by the contractor, document 3120-BMBJV-PUTEF-240-CW-RG-000001 P02, Tideway West PUTEF Traffic Survey Report 11I01 and the updated rainfall information produced by Tideway. Albeit for a period of seven weeks that did not fall during the busiest period across the summer months.

2.1.11 The DRA should be read in conjunction with HR Wallingford document 3120-BMBJV-PUTEF-240-CW-RG-000001 P02. Within the HR Wallingford report the discharges are modelled with a mean absolute error of 6% for neaps and 7% for springs when compared to the peak flow.

2.1.12 In addition, it will include information provided within document LL1658-R-01 Navigational Risk Assessment Review Port of London Authority, which was undertaken by Rendel Limited with Waves Group and the latest discharge modelling data.

2.1.13 To support the development of this DRA vessel passages past the new PUTEF CSO outfall were simulated at H.R.Wallingford ship simulator and CCTV survey was carried out to record the time, position and direction of vessels transiting past the site.

2.2 Report Structure

2.2.1 The Structure of this report is as follows:

a. Section 3 – Outline methodology for producing the risk assessment

b. Section 4 – Site discharge activity

c. Section 5 – Impact on vessels on the river

d. Section 6 – Risk assessment

e. Section 7 – Mitigations

f. Section 8 – Summary and Conclusions

g. Section 9 – References

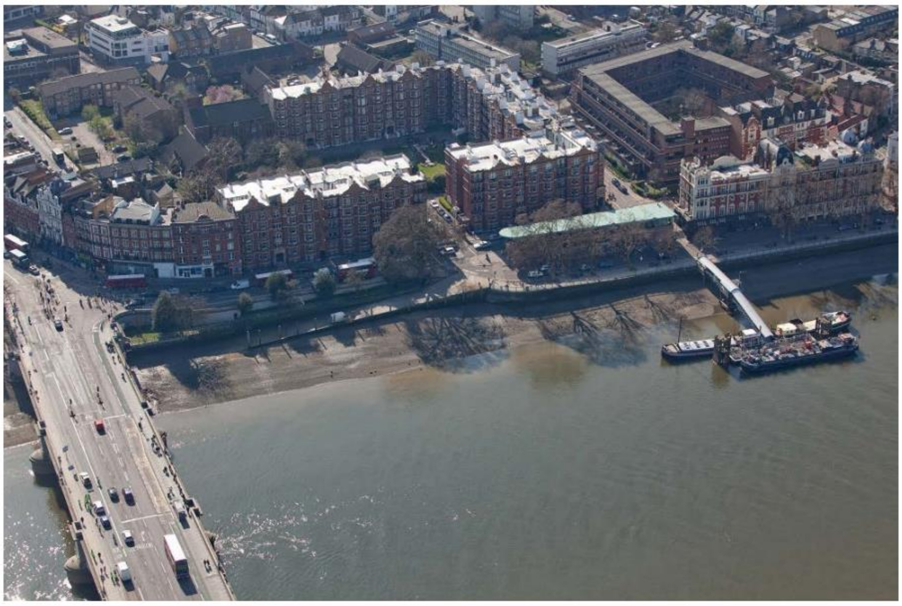
2.3 The site and CSO discharge location

2.3.1 The PUTEF site is located on South bank of the river Thames just upstream of Putney Bridge in the London Borough of Wandsworth. The site consists of a new foreshore structure which houses the interception chamber, drop shaft and air treatment chamber which will receive the CSO discharges from under the Putney bridge via a connecting culvert.

2.3.2 Prior to the construction of the site the Putney bridge CSO outfall was at the downstream end of the site and discharges through the eastern Putney Bridge abutment into the Thames as shown in Figure 2-2.

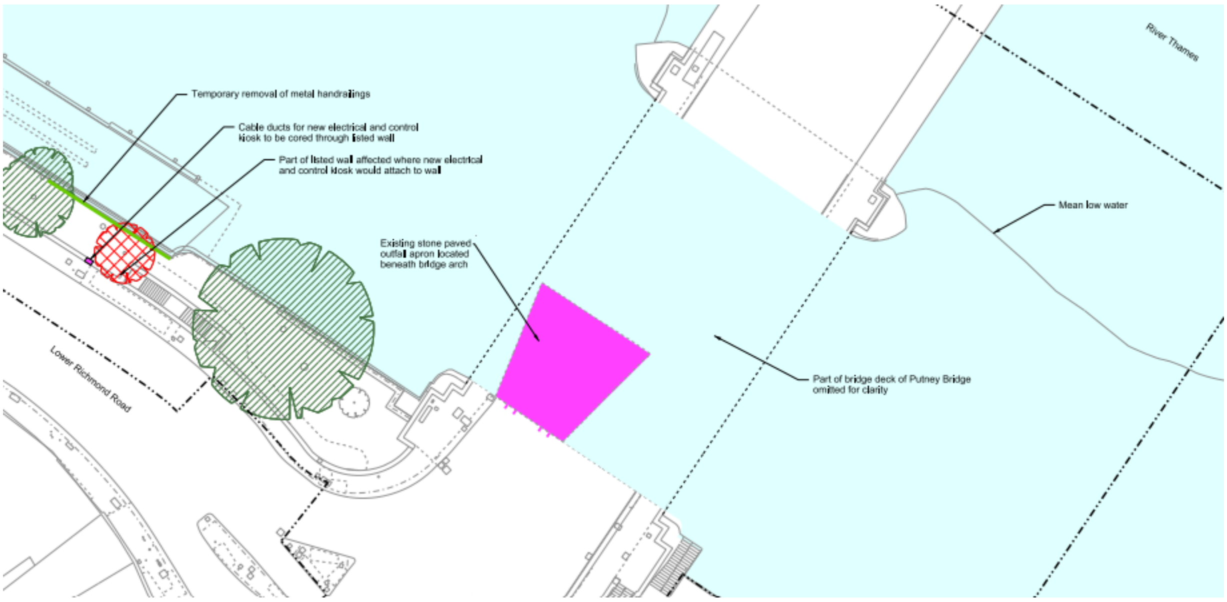
Figure 2-1 Putney Bridge CSO outfall

Figure 2-2 Aerial photograph of Putney Embankment Foreshore Pre-Tideway



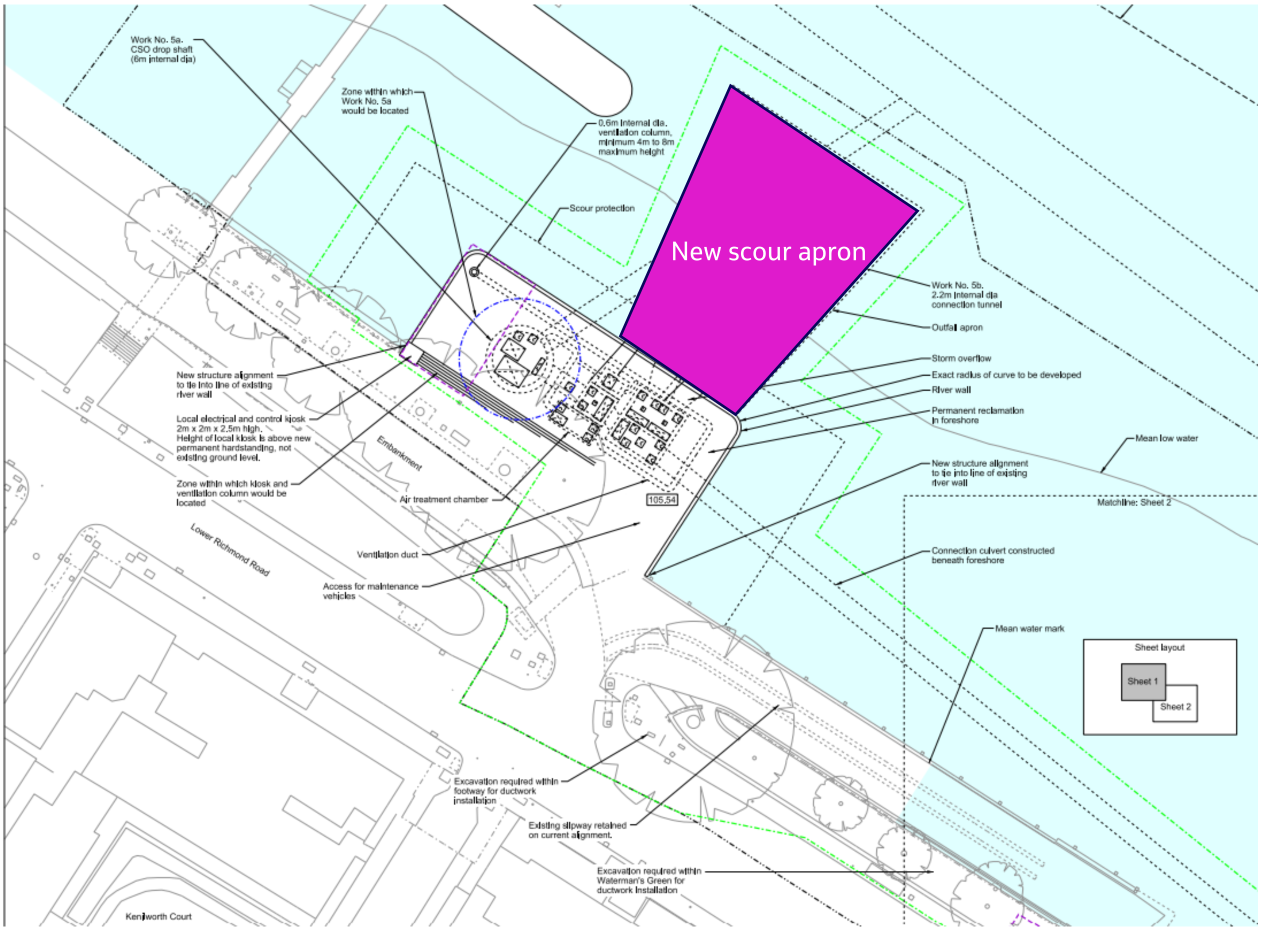
2.3.3 Figure 2-3 present the historical outfall located the bridge arch with its scour apron. In the figure the historic scour apron is shaded in purple.

Figure 2-3 Extract of DCO-PP-05X-PUTEF-080006 showing the original Putney Bridge CSO discharge point.



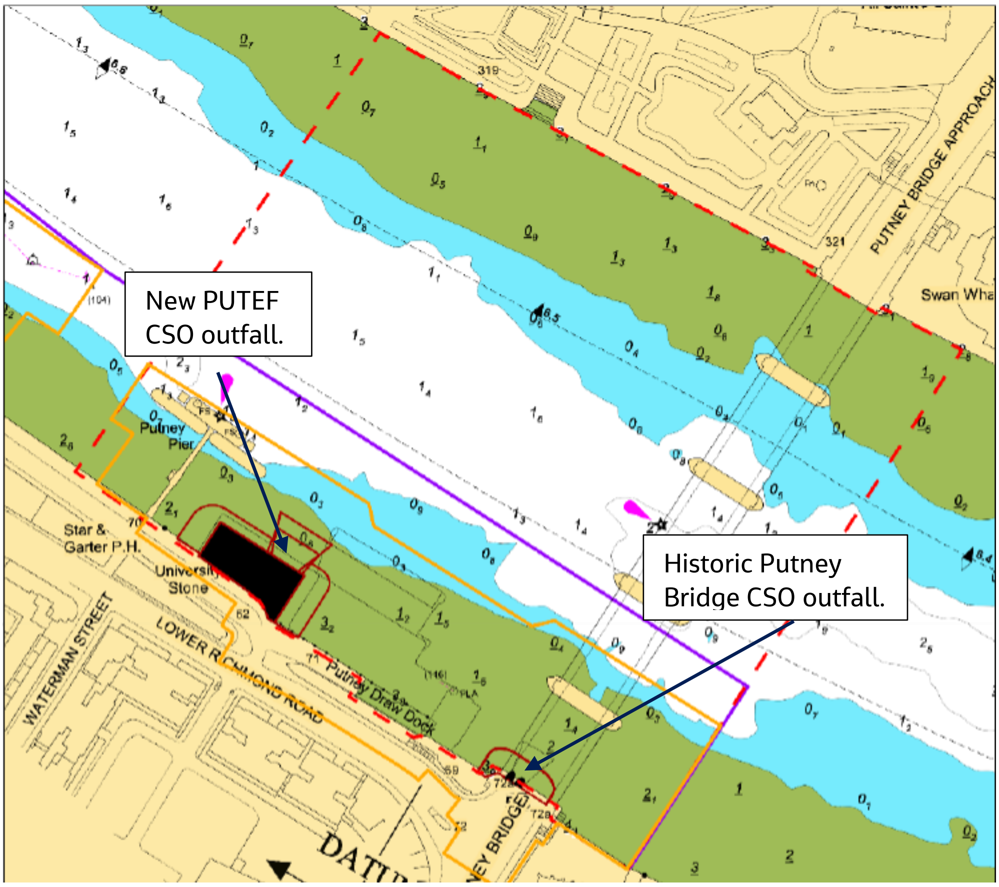
2.3.4 The new foreshore structure projects into the river and moves the PUTEF CSO outfall approximately 110m upstream and 15m further into the river. Figure 2-4 presents the permanent works arrangement with the new outfall location and scour apron.

Figure 2-4 Extract of DCO-PP-05X-PUTEF-080010 showing the permanent works arrangement.



2.3.5 Figure 2-5 shows the new PUTEF CSO outfall relative to the historic Putney Bride CSO outfall.

Figure 2-5 New CSO outfall location relative to the historic CSO outfall.



2.3.6 In conjunction with the change of outfall location there is also a change in the size and layout of the new outfall.

2.3.7 The new PUTEF CSO outfall will discharge through two sets of flaps which discharge onto the new scour apron and have approximately 2.2 times larger area than the original Putney Bridge CSO outfall.

3. Outline Methodology

3.1 To analyse the impact of a CSO discharges from the site to the river, identify the risks to vessels on the river, identify the impacted vessels, propose mitigations and present the residual risks the following has been undertaken:

3.1.1 Confirm site discharge activity by:

i) Reviewing historical rain and discharge data

ii) Reviewing resilience to climate change

iii) Analyse tidal windows to confirm worst case

iv) Review and analyse the impact of discharges on the river from 3120-BMBJV-PUTEF-240-CW-RG-000001 P02.

3.1.2 Review impact of worst-case discharge on vessels on the river by:

i) Confirm areas of the river

ii) Confirming vessels that use the river in this area

iii) Confirming predicted drift angle of vessels caused by a PUTEF CSO discharge

iv) Summarise impacted vessels on the river

3.1.3 Risk assessment

i) Hazards

ii) Receptors – incorporating the CCTV survey data outputs.

iii) Severity of harm

iv) Likelihood of harm

3.1.4 ERIC approach to review mitigation

i) Eliminate

ii) Reduce

iii) Inform

iv) Control

3.1.5 Summary

4. Site discharge activity

4.1 Consideration of rainfall events

4.1.1 CSO discharges were produced for a range of return period storms using an InfoWorks network model of the upstream sewer catchment.

4.1.2 Synthetic storms were generated by the software based on the Flood Estimation Handbook (FEH).

4.1.3 The critical storm duration for the system (i.e., that which produces the highest flows at the outfall) was found to be 120 minutes.

4.1.4 Normally, when generating synthetic storm events, rainfall intensities are reduced as the footprint of a storm increases. However, in this instance, the storm event was applied over the entire catchment without applying an areal reduction factor.

4.1.5 With an approximate catchment area of 550km^2, the corresponding reduction factor for the Tideway catchment would have been 0.76 – the rainfall intensities are therefore overestimated by approximately 32%.

4.1.6 In addition, the model assumes that all rainfall landing on a catchment freely enters the sewer system. In practise, for higher rainfall intensities, this cannot happen as the gullies and upstream collection pipework act as a restriction, resulting in flooding and ponding on the surface. For this reason, the modelled high return period storm flows are considered theoretical and unlikely to ever be realised. It is the upstream sewer system that limits the peak CSO discharge rate, not the size of the CSO opening itself.

4.1.7 The InfoWorks model of the existing sewer network, without the London Tideway Tunnel, was run with free discharge as a worst-case scenario (i.e., low tide) and the peak flow rates included in the project's works information (WI 7706). These WI flows are shown in Table 4-1. The peak flow from the PUTEF CSO was found to be approximately 5m^3/s for a 15-year storm.

4.1.8 Periodic updates are made to the model depending on the results of surveys/inspections. These updates had very little impact on peak flows at Putney.

Table 4-1 Instantaneous peak discharge rates from WI 7706

Source		LT 1 – Year Storm	LT 2-year storm	LT 5-year storm	LT 10-year storm	LT 15-year storm	LT 30-year storm
WI 7706	Instantaneous Peak Flow	3.7	3	4.2	4.5	5	6

4.1.9 It should be noted that occasionally TWUL can make minor diversions to the sewer network upstream to facilitate maintenance access. However, these are generally local in nature and don't have a significant impact on CSO discharges.

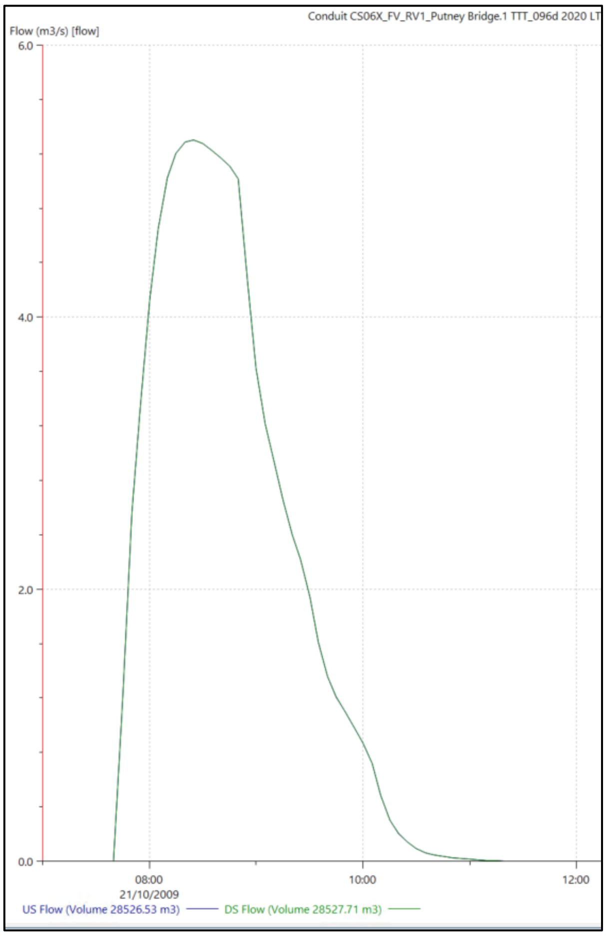
4.1.10 The developed nature of the upstream catchment means it is not possible to make substantial changes to the network connectivity that could significantly affect peak CSO discharges. Ultimately there is a fixed amount of rainfall falling on a fixed area, served by a sewer system of fixed and limited capacity.

4.1.11 Every 10 years it is planned to close the tunnel for inspections – under these conditions all flow is diverted to the CSO. Whilst the exact duration of the closure is yet to be finalised, it is expected to be of the order of two weeks.

4.1.12 Given the conservative nature of the rainfall generation, the theoretical nature of the network modelling, the limited scope to significantly alter the upstream sewer network and the range of possible tide levels, $5m^3/s$ is considered a maximum realistic CSO discharge rate.

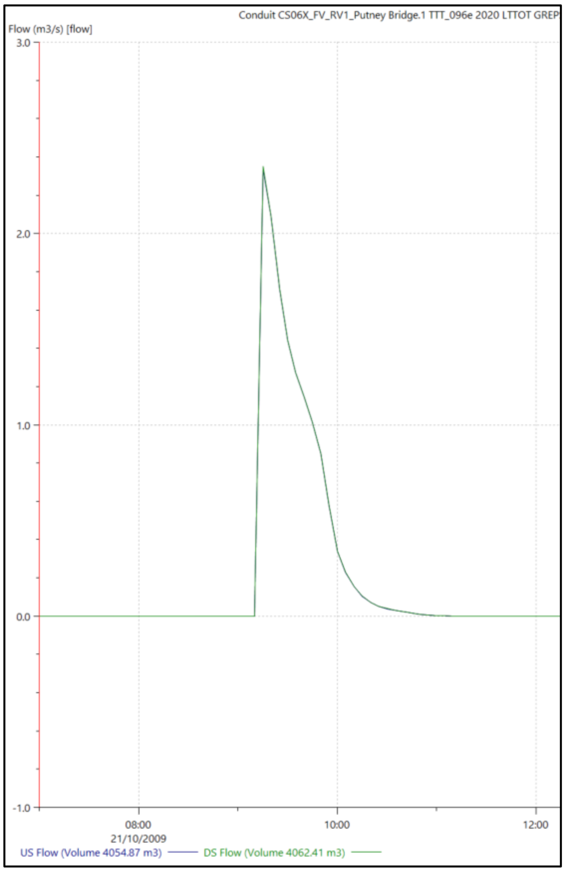
4.1.13 Figure 4-1 shows the discharge hydrograph for the 15-year storm at low tide, using the latest Design Authority model. The hydrograph represents the 'Tunnel Closed' scenario. In this instance the storm started at 07:00 - it took approximately 45 minutes for the CSO to start discharging and approximately another 30 minutes for the peak discharge (approximately 5 m3/s) to be realised.

Figure 4-1 CSO Discharge Hydrograph for the 15-year storm, tunnel closed



4.1.14 Figure 4-2 shows the 15-year discharge hydrograph representing the 'Tunnel Operational' scenario. The onset of the CSO discharge is delayed by approximately 90 minutes. Discharge occurs due to the penstocks closing as the tunnel fills. When it is discharging the peak flow will be approximately 2.4m3/s due to most of the discharge being captured by the tunnel.

Figure 4-2 CSO Discharge Hydrograph for the 15-year storm, Tunnel Operational



4.1.15 At the design phase of the project, 40 years of recorded rainfall data was available, spanning 1970–2010. Following inspection of this data set it was determined that the most representative (typical) year was October 1979 to September 1980. A further review of the data up to 2020 has confirmed that this remains the case.

4.1.16 Table 4-2 summarises the peak CSO discharges at PUTEF during the typical year (1979/80).

Table 4-2 Peak CSO discharges during typical year (1979/80)

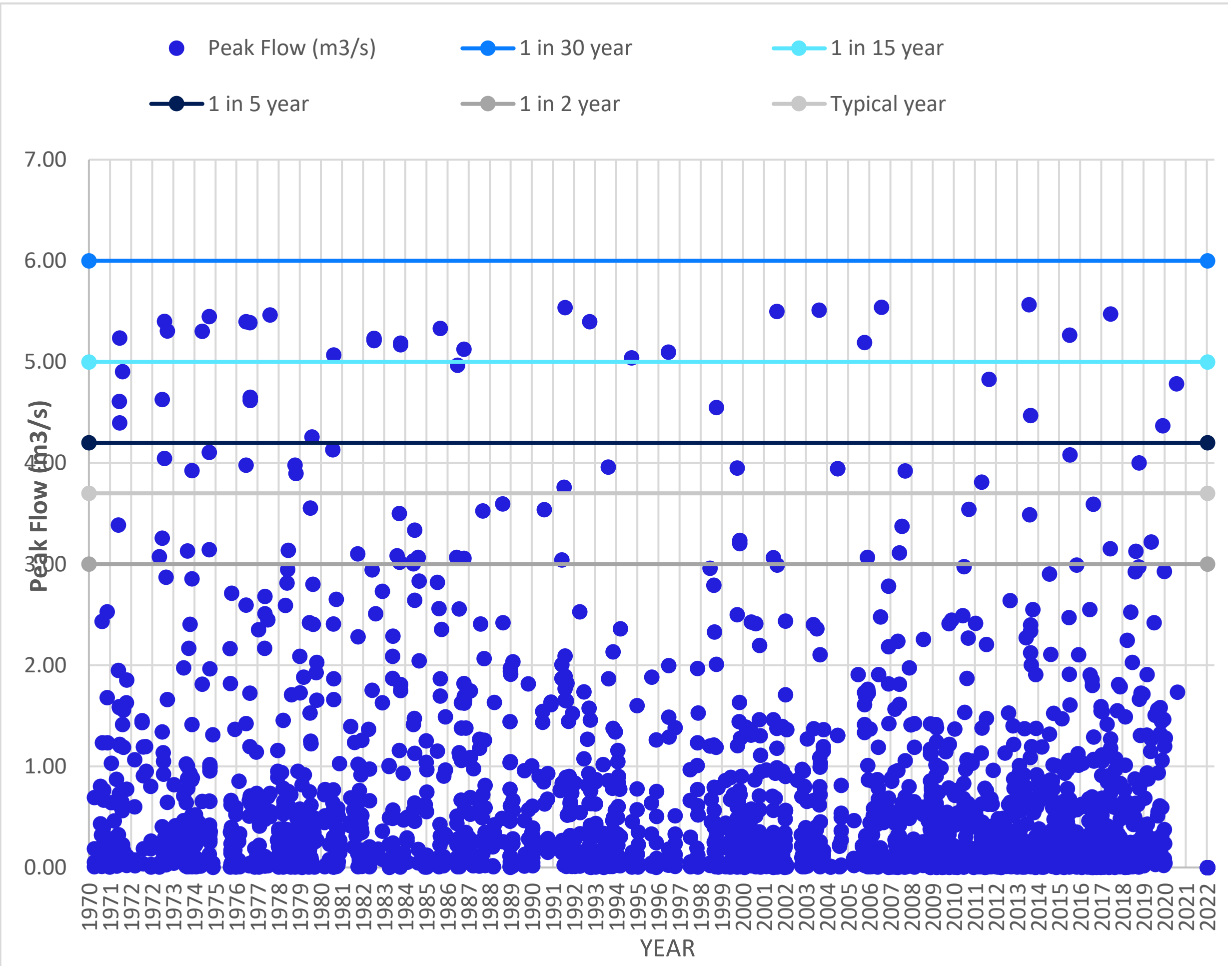
Start of Spill	Spill Duration (mins)	Peak Flow (m3/s)	Spill Volume (m3)
06/10/1979 12:05	12	0.01	2
09/10/1979 05:50	209	3.98	8958
10/10/1979 01:55	30	0.25	192
25/10/1979 13:45	414	3.90	9291
30/10/1979 16:15	29	0.07	52
01/11/1979 23:45	38	0.21	182
06/11/1979 00:10	49	0.52	624
07/11/1979 21:55	68	0.48	607
11/11/1979 13:00	19	0.01	8
11/11/1979 20:55	35	0.25	203
26/11/1979 13:10	238	0.95	3918

05/12/1979 11:35	21	0.01	7
08/12/1979 23:50	120	0.04	57
09/12/1979 03:35	43	0.27	261
11/12/1979 01:00	38	0.24	208
13/12/1979 03:00	159	0.16	463
14/12/1979 19:05	19	0.01	8
27/12/1979 01:00	359	0.58	3332
28/12/1979 17:20	19	2.09	671
03/01/1980 21:50	119	1.73	3112
20/01/1980 16:30	136	0.41	765
21/01/1980 12:46	21	0.01	8
30/01/1980 01:05	21	0.03	15
31/01/1980 04:00	40	0.31	271
03/02/1980 14:05	140	0.82	1470
04/02/1980 12:51	13	0.00	2
04/02/1980 14:05	33	0.08	71
06/02/1980 14:10	28	0.07	41
22/02/1980 10:59	34	0.06	53
06/03/1980 09:53	116	1.88	3043
07/03/1980 09:56	47	0.05	60
12/03/1980 15:45	154	0.03	32
17/03/1980 06:45	295	0.92	2999
24/03/1980 21:50	113	0.20	299
28/03/1980 08:35	39	0.03	37
31/03/1980 09:50	99	0.50	729
31/03/1980 15:55	34	0.08	75
01/04/1980 09:50	186	0.35	420
01/04/1980 17:16	33	0.01	14
30/05/1980 09:40	52	0.23	296
31/05/1980 07:35	30	0.19	124
31/05/1980 09:10	18	0.01	4
31/05/1980 12:55	111	0.34	573
31/05/1980 18:10	86	0.39	582
12/06/1980 13:57	102	0.17	161
13/06/1980 01:30	113	0.75	1163
13/06/1980 15:25	87	2.42	3894
17/06/1980 16:45	107	0.28	317
22/06/1980 09:45	141	1.53	3900
26/06/1980 05:10	27	0.10	53
26/06/1980 10:40	22	0.03	22
26/06/1980 23:45	28	0.08	50
27/06/1980 10:50	13	0.01	3
27/06/1980 13:30	39	0.21	184
30/06/1980 19:06	217	3.56	5497
03/07/1980 22:50	53	1.25	1181
06/07/1980 23:00	27	0.10	72
07/07/1980 14:05	69	1.22	1342
08/07/1980 09:55	55	0.62	733

13/07/1980 15:00	38	0.25	199
13/07/1980 16:55	28	0.05	36
18/07/1980 05:40	29	0.06	50
18/07/1980 08:40	41	0.32	261
25/07/1980 23:20	164	4.26	8237
29/07/1980 04:05	19	0.03	13
12/08/1980 21:05	96	2.80	5067
14/08/1980 18:45	133	2.41	3495
29/08/1980 04:25	50	0.43	530
29/08/1980 12:05	84	0.34	336
05/09/1980 18:03	16	0.01	3
16/09/1980 07:20	40	0.26	224
16/09/1980 17:35	135	0.49	559

4.1.17 Figure 4-3 below shows the simulated peak flows from the PUTEF CSO outfall, assuming the tunnel is not available, using the full set of actual rainfall data for 1970-2020.

Figure 4-3 Simulated peak flows from PUTEF CSO outfall using actual weather data from 1970-2020 against the WI 7706 return periods (assuming tunnel unavailable).



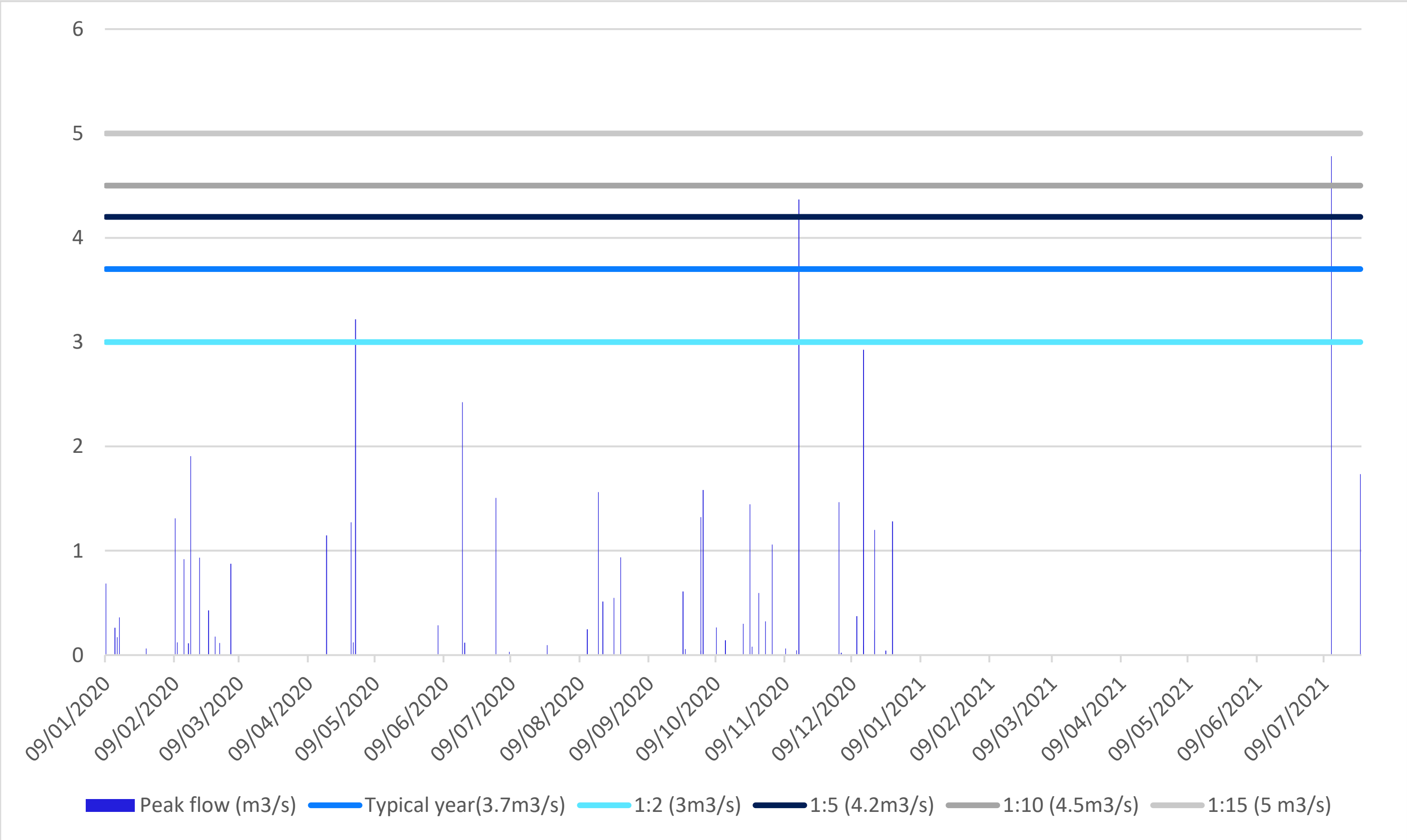
4.2 Discharge frequency and magnitude

4.2.1 The PUTEF structure will be intercepting the Putney Bridge CSO discharges to the main tunnel however there will be periods when the tunnel will be taken out of operation for inspection and maintenance. During these periods the tunnel will be isolated, and the intercepted flows will discharge through the new CSO. Whilst these works will be planned to be undertaken during periods of low flow there may be storms and there the magnitude of these discharges and the potential frequency needs to be understood.

Magnitude

4.2.2 The 2020 CSO peak discharge flows have been analysed and presented in Figure 4-4, this includes the two storms from July 2021 which were noted for their intensity.

Figure 4-4 Modelled PUTEF CSO discharge peak rates with actual rain data for 2020, including storms from July 2021



4.2.3 From the information presented in Figure 4-4 the average instantaneous peak discharge rate during 2020, including the 2021 July storms was 0.86m^3/s with a maximum instantaneous peak of 4.78m^3/s which occurred during the summer storm on the 12th July 2021.

Frequency

4.2.4 In 2019 an event duration monitor (EDM) was installed in the Putney Bridge CSO to enable TWUL to deliver against the regulatory requirement to report CSO discharges capturing the number of discharges and their duration. The records from the Putney Bridge EDM started being reported from 2020 and since installation the EDM has recorded between 35 and 158 discharges per year with a long-term average of 92.7 discharges per year.

Climate change

4.2.5 During the development of the scheme and in support of the application for Development Consent, Tideway produced document 7.23 Resilience to Change. This document was developed to assess whether the scheme would continue to meet the Urban Waste Water Treatment Directive (UWWTD) requirements in the future whilst taking into consideration climate change and population increase.

4.2.6 The baseline data for the frequency and volume of CSO discharges was developed from the 1979/80 typical year of 588mm of rainfall depth which when modelled indicated a discharge of circa 39 million m^3 of sewage into the Thames.

4.2.7 Table 6.3 from document 7.23 presents the typical year CSO spill volumes and event count comparisons for the current climate and medium emission modelled scenarios from the UKCP09 government data on climate change. Table 4-3 below is the extract from that table for the modelled CSO discharges at PUTEF.

Table 4-3 Extract of table 6.3 from document 7.23 - typical year CSO spill volumes and event count comparisons for the current climate and medium emission modelled scenarios

LTT ID	EA Category	CSO Name	Typical Year – 2020 population and current climate			Typical year – 2080 population and medium emission scenario, 10 percentile			Typical year – 2080 population and medium emission scenario, 50 percentile			Typical year – 2080 population and medium emission scenario, 90 percentile		
			Total Volume (m^3)	No. of Spills	Spill Duration (Hrs)	Total Volume (m^3)	No. of Spills	Spill Duration (Hrs)	Total Volume (m^3)	No. of Spills	Spill Duration (Hrs)	Total Volume (m^3)	No. of Spills	Spill Duration (Hrs)
CS06X	Cat 1	Ranelagh	1,600	1	3	3,300	1	6	4,400	1	6	6,600	1	8

4.2.8 Table 4-3 demonstrates that the predicted CSO discharge frequency from PUTEF, once the tunnel is in operation, is not expected to increase.

4.2.9 The UK government updated the climate scenarios and presented them as UKCP18. Tideway reviewed the information to confirm that the scheme would still meet its UWWTD requirements in the future. The review confirmed there had not been significant change in the outcomes and the resilience of the scheme as described in document 7.23 still held true.

4.2.10 Table 4-4 summarises the peak rainfall climate change allowances in England up to 2125, extracted from the DEFRA website.

Table 4-4 Peak rainfall climate change allowances up to 2125

	Storm Return Period	
	30 year	100 year
Central Range (50th %ile)	20%	25%
Upper Range (95th %ile)	35%	40%

4.2.11 These allowances are of the same order of magnitude as the overestimation of the synthetic rainfall intensities explained in paragraph 4.1.5 (32%). It can therefore be considered that climate change has been adequately allowed for.

4.2.12 Notwithstanding the above, any future increase in rainfall intensities will not have a significant impact on the peak PUTEF CSO discharge rates for the reasons set out in paragraph 4.1.6.

4.2.13 Another impact of climate change could be the increased use of the Thames Barrier. Currently the barrier is used to protect against fluvial flooding upstream of Teddington as well as storm surges. However, to protect the Thames barrier from excessive wear the procedures will change by 2035 and it only operate when high trigger levels are reached but not to manage smaller fluvial flooding. This will reduce the overall number of times the barrier will be closed.

4.3 Tidal Considerations

4.3.1 This section is to consider the HR Wallingford report 3120-BMBJV-PUTEF-240-CW-RG-000001 P02 titled "Putney Foreshore Embankment CSO Discharge Modelling" to confirm the worst-case scenario and the impact of a CSO discharge across the tidal range.

4.3.2 The1:15-year return HR Wallingford plumes will be used to assess the zone of impact of the lateral flow on the river with its associated tidal window and is the most probable worst-case return period event that could occur without warning during a maintenance period.

4.3.3 The HR Wallingford document 3120-BMBJV-PUTEF-240-CW-RG-000001 P02 Putney Foreshore Embankment CSO Discharge Modelling was commissioned to provide 2-d depth averaged velocity discharge plumes using the instantaneous peak velocities for a typical year (1:1) and 1:15 -year events at the following tide states shown in Table 4-5. Depth average velocity is the average velocity at any location within the stream and typically occurs at 60% of the depth, measured from the top

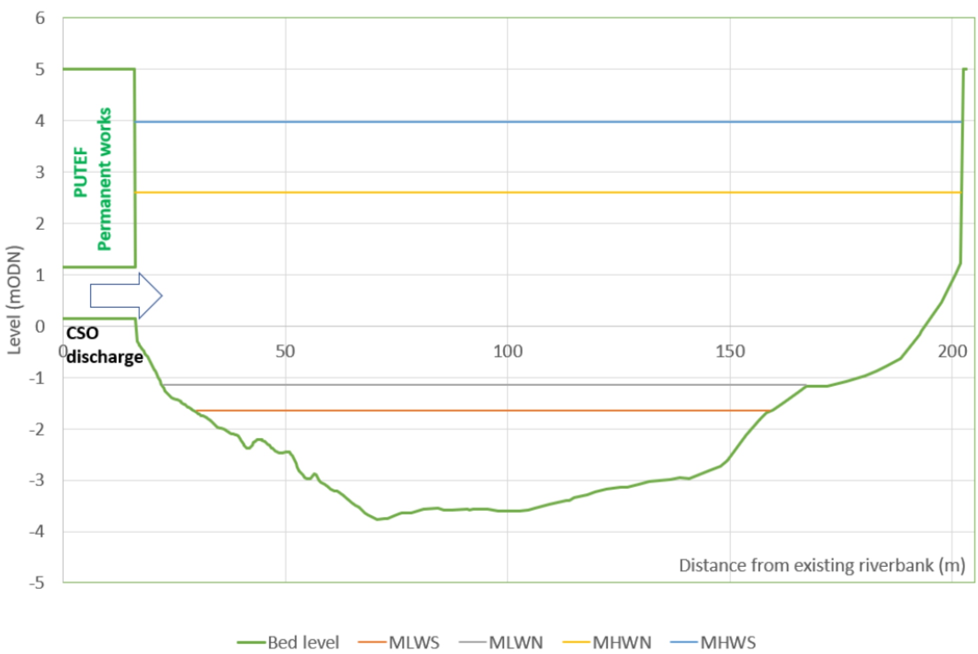
4.3.4 The report states that in considering the results it should be remembered that the model is 2D depth-averaged and hence will not model the detail of 3D aspects of the jet, especially within the distance taken for the expanding jet to mix fully with the receiving waters. Therefore, care should be taken in assessing the results close to the discharge point. Beyond 20 to 30 m of the discharge point the jet would be expected to be mixed with the receiving waters and the general modelled flow patterns are reliable. It has therefore been concluded that any effects within that zone are unpredictable and therefore the impacts within that zone cannot be established and will be considered as worst case.

Table 4-5 HR Wallingford modelling tidal discharge cases.

Tidal condition	Tidal States			
Spring tide	Low water slack	Mid-ebb flow	Mid-flood flow	High water slack
Neap tide	Low water slack	Mid-ebb flow	Mid-flood flow	High water slack

4.3.5 The height of the new CSO, relative to the riverbed and river level, is presented in Figure 4-5.

Figure 4-5 River section showing the new CSO outfall position relative to the riverbed.



4.3.6 The analysis of the tidal cases undertaken by HR Wallingford identified that during the periods of rising or falling tide there was minimal lateral flow entering the navigational channel due to the dominance of the main river flow and rapid dispersion of momentum of the discharge. Figure 4-6 presents an example of this for a mid-flood tide. The resulting impact of the lateral flow on the navigational channel for mid-ebb tide is presented in Figure 4-7.

Figure 4-6 Depth average currents at peak 1:15-year return period discharge at mid-flood tide.

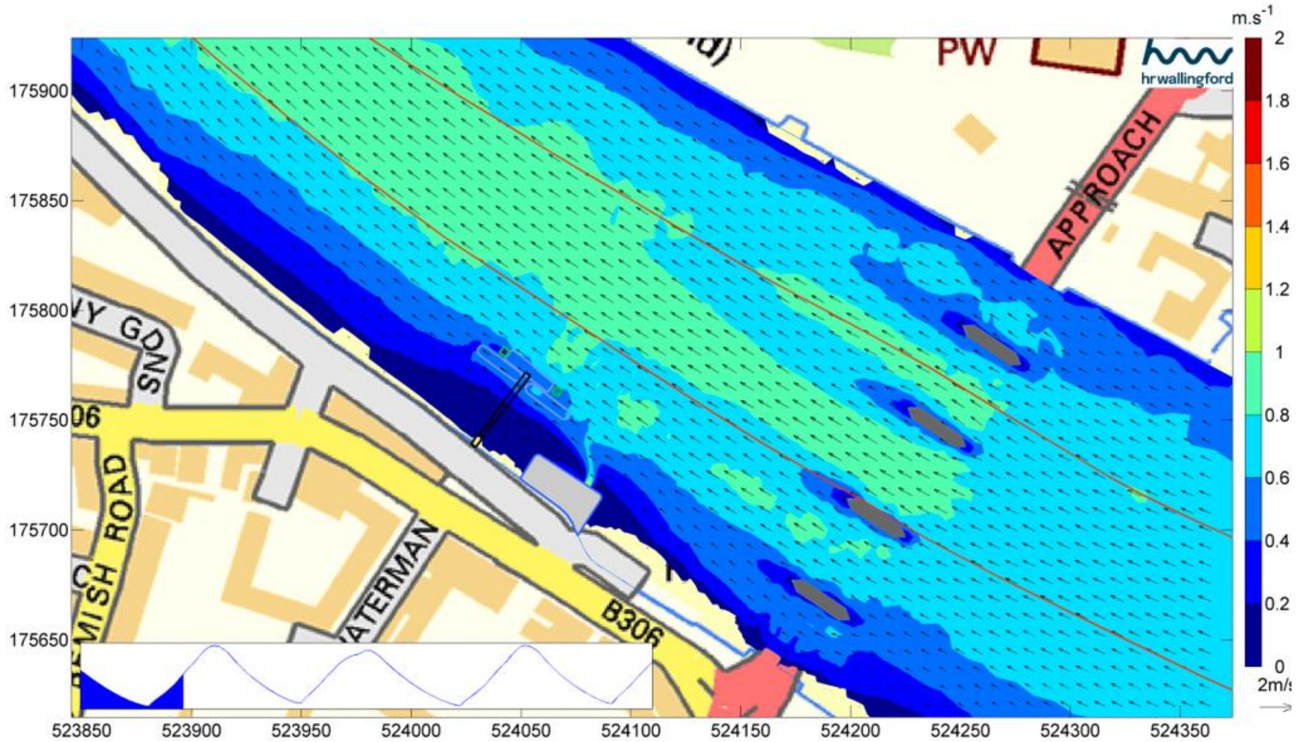
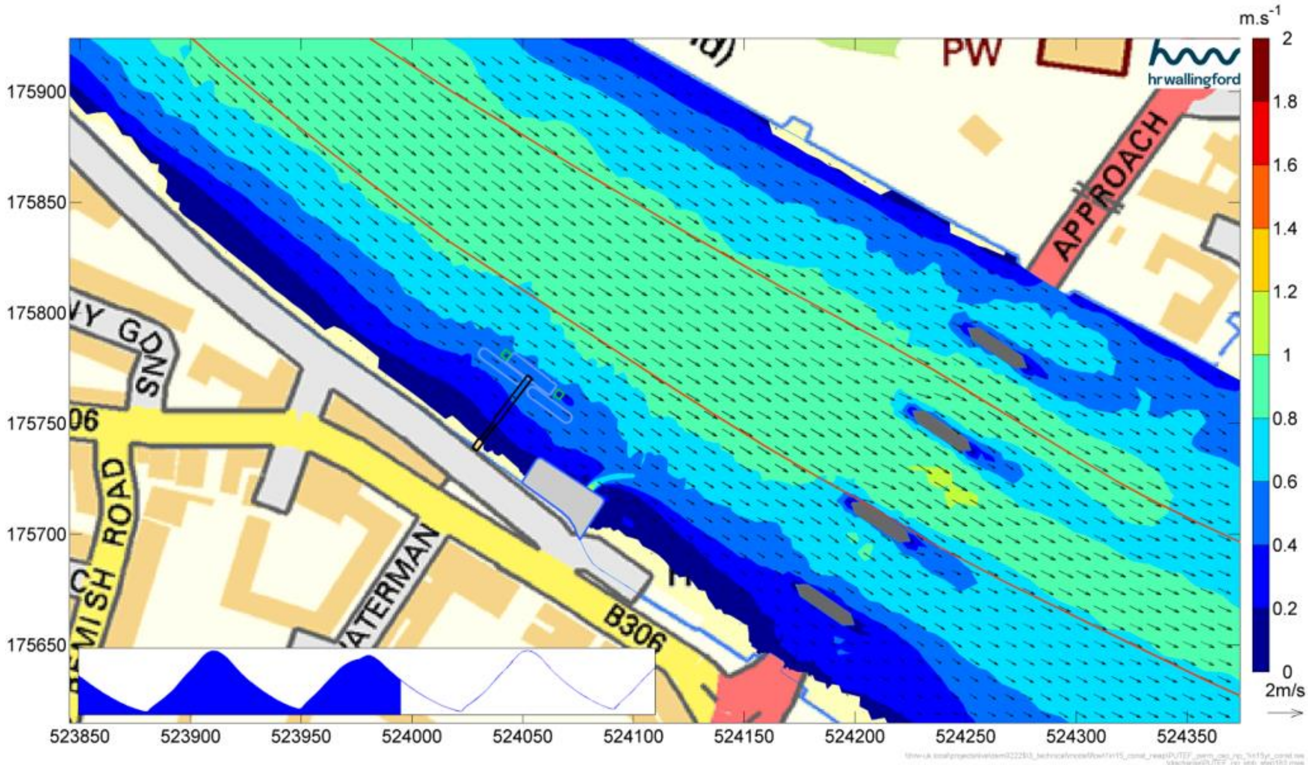
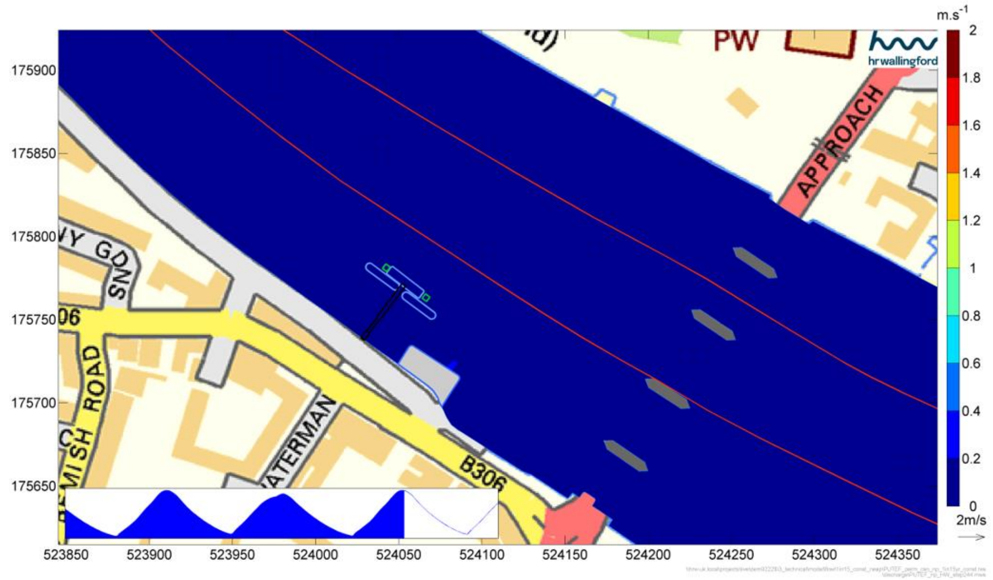


Figure 4-7 Depth average currents at peak 1:15-year return period discharge at mid-ebb tide.



4.3.7 During Neap high water slacks with a 1:15 return period discharge the lateral flow extends minimal distance from the structure, less than 5 metres, although the difference between the main river flow and the lateral flow is up to 0.2m/s more than the main river. This is presented in Figure 4-8.

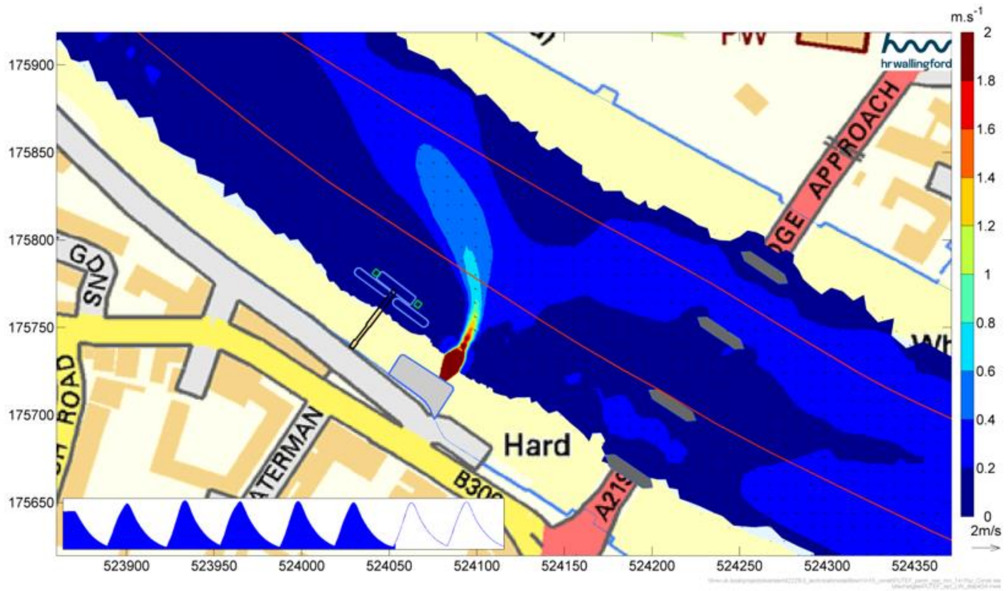
Figure 4-8 Depth average currents associated with a 1:15 return period discharge at neap high water slacks.



4.3.8 From analysing the above information, it can be determined that for any discharge event from mid-flood across high water to mid ebb there is minimal lateral flow that would makes it into the inshore zone and none of the flow makes it to the main fairway.

4.3.9 The HR Wallingford report states that the worst case for PUTEF CSO is at low water springs which has a greater footprint of the 0.4m/s increase into the main fairway than at low water neaps. This can be seen in Figure 4-9 that presents the depth average currents for a 1:15-year return period discharge and spring low water.

Figure 4-9 1:15-year return period depth average currents at spring low water slacks



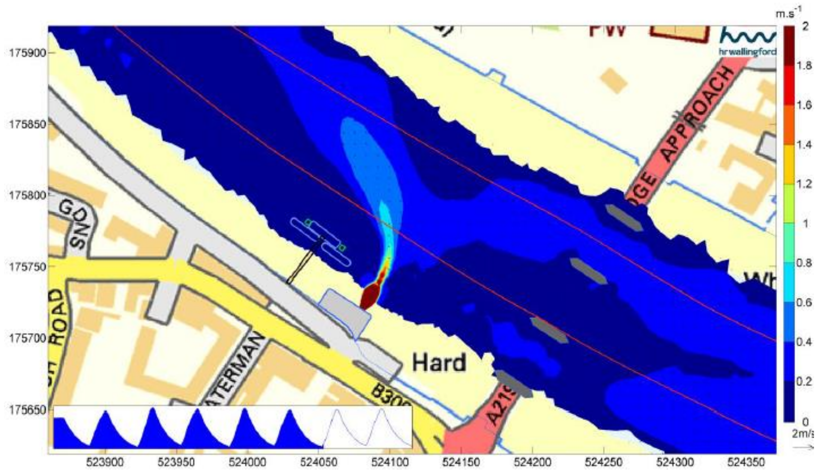
4.3.10 From the analysis of the 1:15-year return period discharge of the HR Wallingford information, it can be determined that there is minimal flow entering the navigation channel. The inshore zone, between the main fairway edge and the river wall, will be affected by a CSO discharge over the low water period, from 50 minutes before low water to 50 minutes after low water.

4.4 Zone of PUTEF CSO Discharge impact

4.4.1 For determining the zone of discharge impact the most probable worst-case is a1:15-year return period event, with a discharge rate of 5 m^3/s, will be used. Further to section 4.2.1 the zone of impact for a typical year will also be analysed using the typical year return period discharge rate of 3.7 m^3/s.

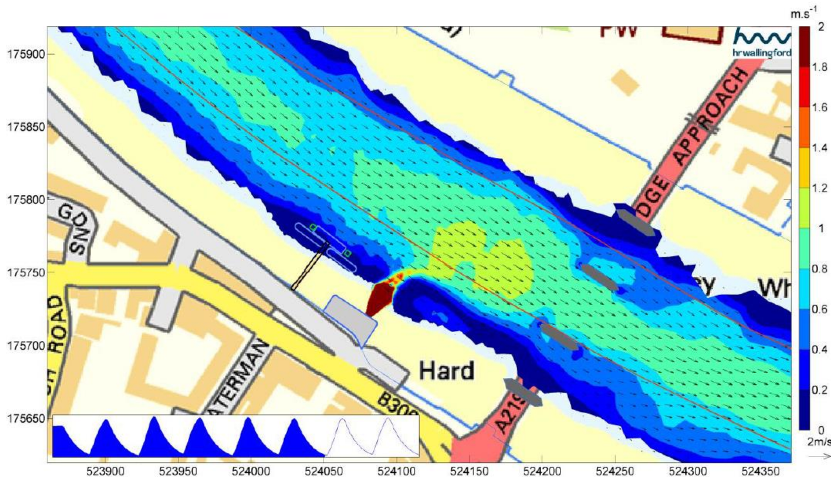
4.4.2 Figure 4-10 presents the 1:15 year return period depth average currents at spring low water slacks. The CSO discharge velocity starts at over 3.5m/s from the outfall maintain most of its velocity across the scour apron until it contacts the river. The flow slowly deteriorates down to 1.2-1.4m/s by approximately 45m out from the outfall and is starts to veer upstream. The flow reduces to 0.6-0.8m/s as it enters the main fairway and quickly deteriorates to 0.4-0.6m/s, which is only 0.2m/s greater than the background flow.

Figure 4-10 1:15 year return period depth average currents at spring low water slacks



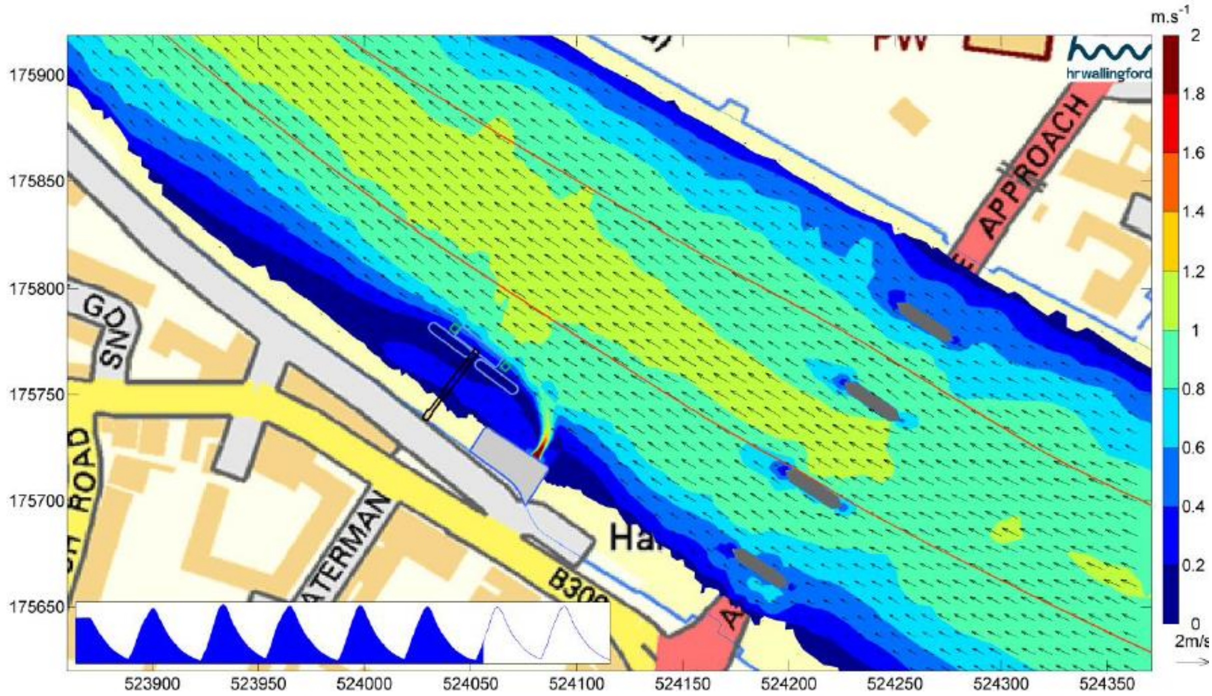
4.4.3 Figure 4-10 presents the worst-case scenario for the navigational channel from a 1:15-year event at the point of still water and spring low water. Figure 4-11 shows the depth average currents for a 1:15 year return period event 60 minutes before spring low water and appears to have a minimal effect on the navigational channel but the inshore zone is affected out to around 30m.

Figure 4-11 1:15 year return depth average currents at 60 minutes before spring low water slacks



4.4.4 Figure 4-12 Shows the 1:15 year return depth average at 60 minutes after spring low water. It is clear that by this stage there is no lateral flow getting to the main fairway whilst its impact on the inshore zone is limited to approximately 20m until it veers quickly due to the dominant main river flow.

Figure 4-12 1:15 year return depth average currents at 60 minutes after spring low water



4.4.5 Following analysis of the plumes it can be determined that the tidal window when flows could impact the main fairway is from 40 minutes before spring low water slack and 20 minutes after spring low water. However, the tidal window for the inshore zone is from mid ebb to mid flood therefore 3 hours either side of low water, outside of this period it is apparent that the main river flow is dominant.

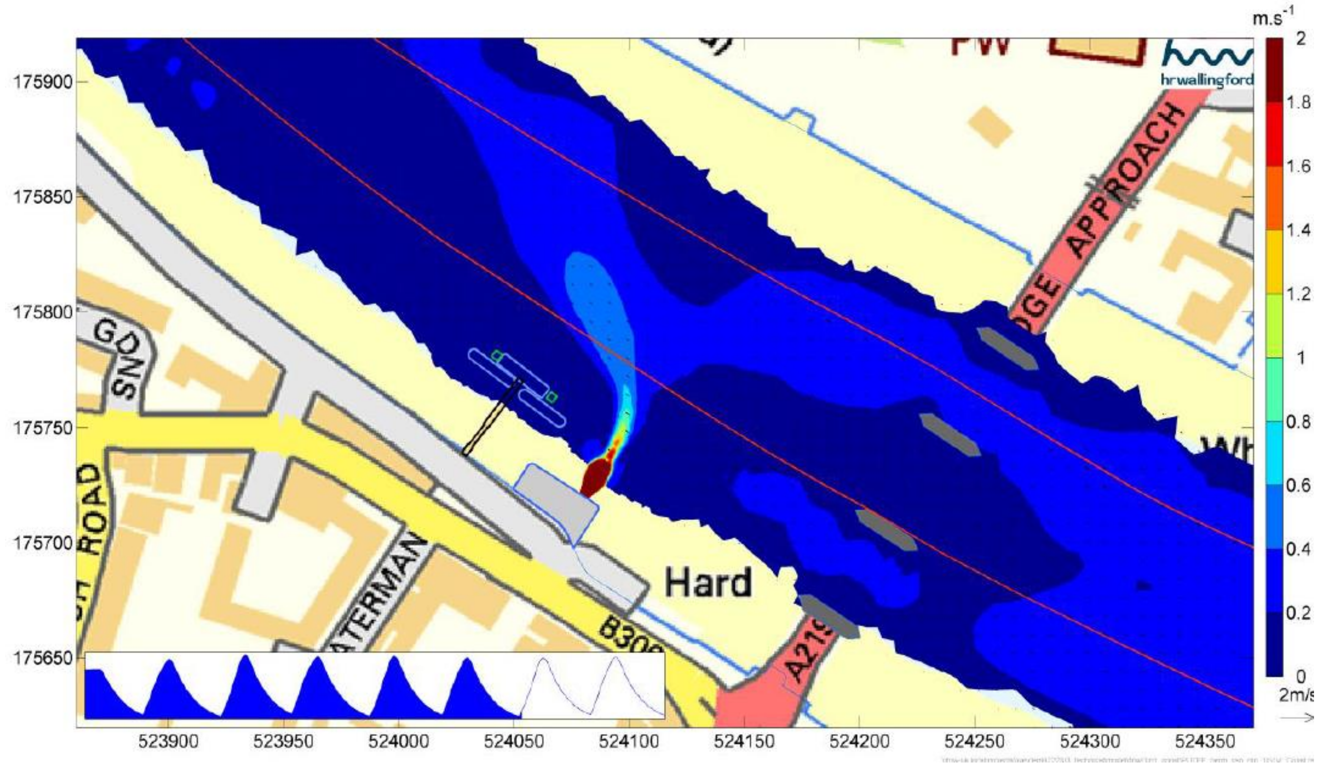
Table 4-6 Summary of tidal windows for inshore zone and main fairway

Inshore Zone (beyond 30m)		Main Fairway	
Start	Finish	Start	Finish
LW -3 hours	LWS+3 hours	LW -40 minutes	LW +20 minutes

4.4.6 Having determined the zone of impact for the 1:15-year probable worst case, the zone of impact for a typical year, using the typical year discharge plumes will be assessed.

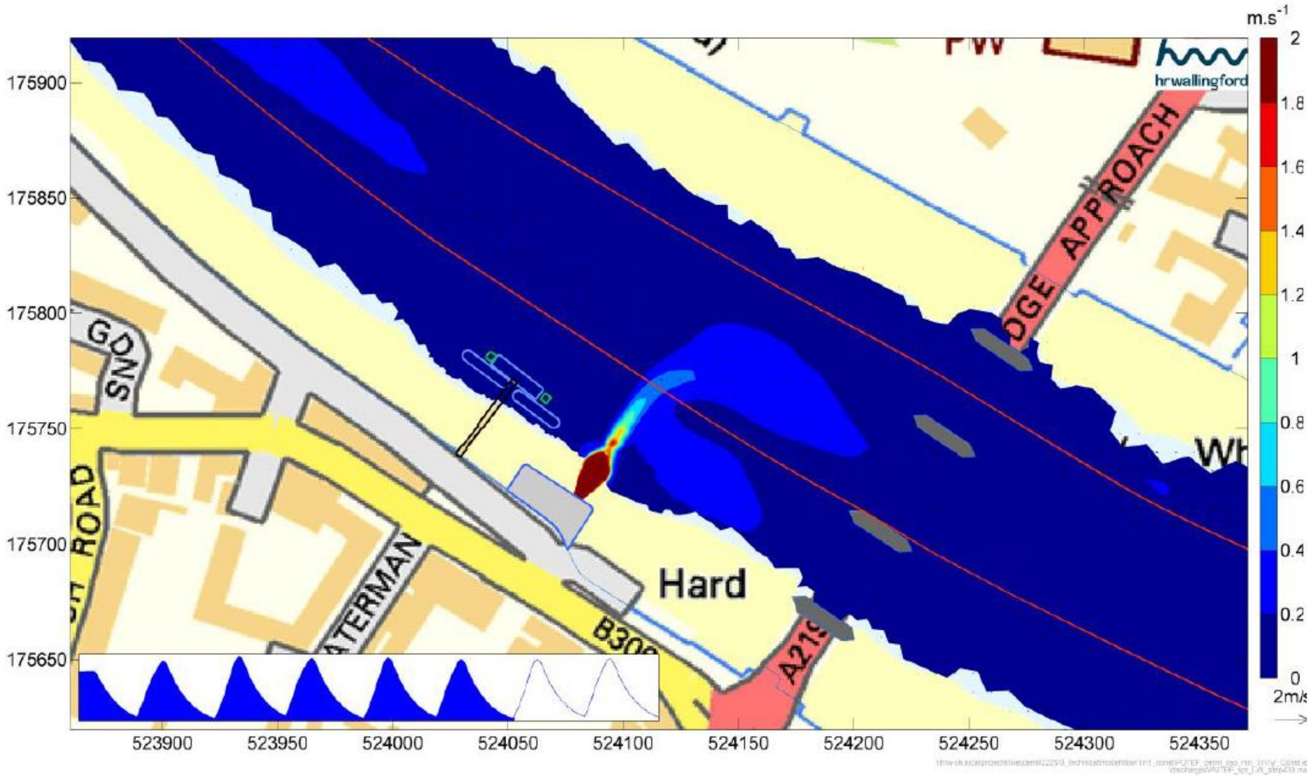
4.4.7 Figure 4-13 shows the CSO discharge for a typical year return period event at spring low water slacks. The lateral flow discharges through the flaps at more than 3.5m/s. The flow slowly deteriorates down to 0.8-1m/s by approximately 45m out from the outfall and is starting to veer upstream. The flow reduces to 0.4-0.6m/s as it enters the main fairway and quickly deteriorates to 0.2-0.4m/s, which is only 0.2m/s greater than the background flow.

Figure 4-13 Typical year discharge event at spring low water slack



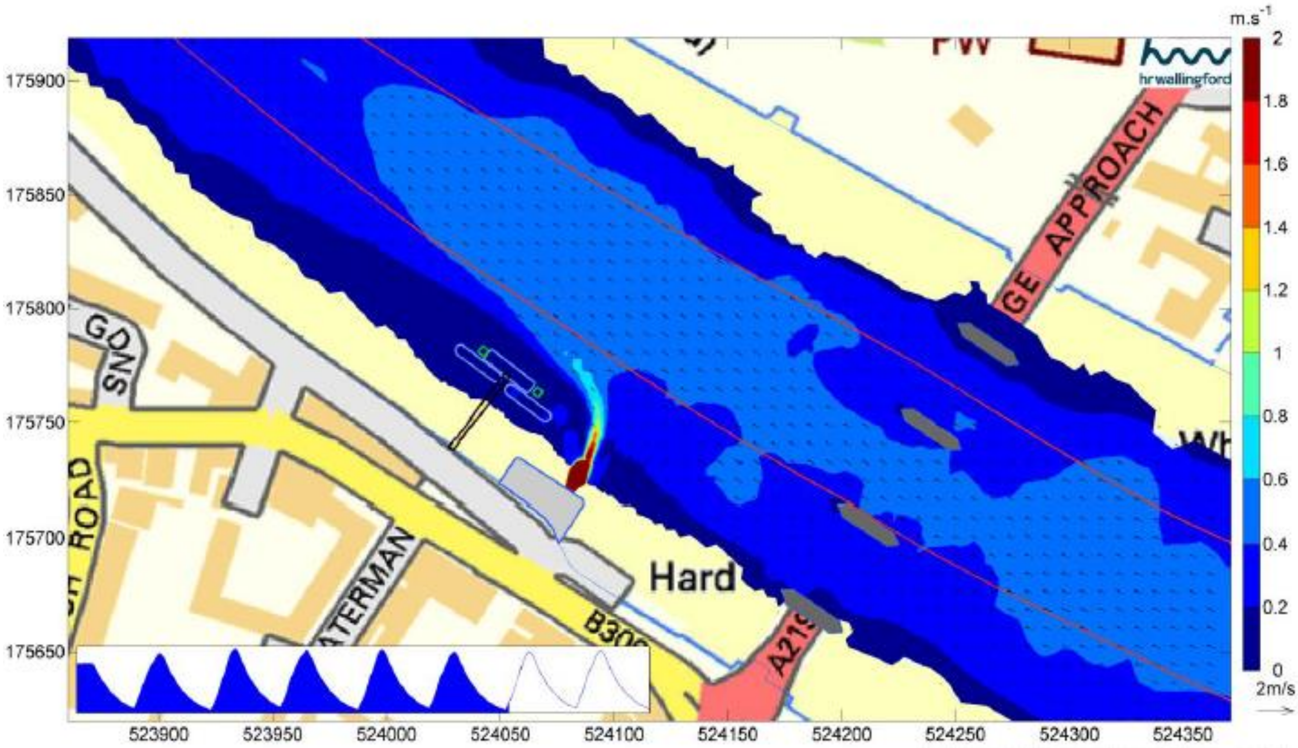
4.4.8 Figure 4-14 shows the typical year return period discharge 10 minutes before spring low water slacks. This is when the lateral flow from the discharges first enters the main fairway with a difference greater than 0.2m/s.

Figure 4-14 Typical year return period discharge 10 minutes before spring low water slacks.



4.4.9 Figure 4-15 shows the typical year return period discharge at 10 minutes after spring low water slack. At this point there is no lateral flow entering the main fairway.

Figure 4-15 Typical year return period discharge 10 minutes after low water slacks



5. Impact on vessels on the river

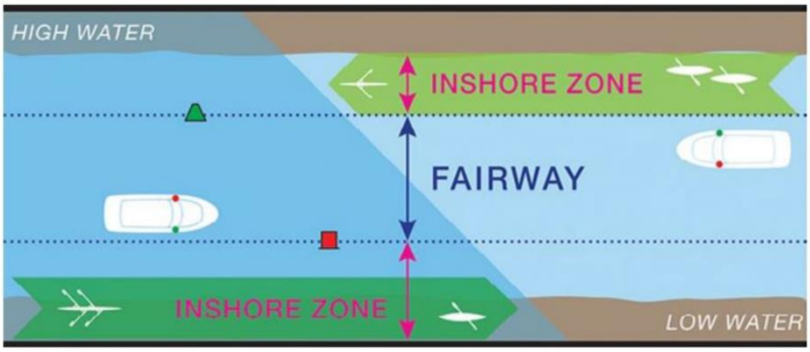
5.1 Assessment of the discharges

5.1.1 The 1:15 year event discharge plumes and sections are taken from 3120-BMBJV-PUTEF-240-CW-RG-000001 P01 Putney Foreshore Embankment CSO Discharge Modelling.

5.1.2 As stated in 4.4.2 the assessment for the impact on vessels on the river will be conducted using a 1:15 return period PUTEF CSO discharge of 5 m^3/s at low water springs which produces the most probable worst case discharge plume for the site.

5.1.3 The assessment will consider the impact on vessels on the river in both the inshore zone, which is the area of the river between the main fairway edge and riverbank, and the main fairway, which is the area of the river between main fairway edges. As presented in Figure 5-1. The assessment will also consider collision with other vessels due to course change.

Figure 5-1 Diagram showing Fairway and Inshore Zones, (P58, The Tideway Code, PLA, 2019)



5.2 Outline which vessels have been assessed for and why.

5.2.1 Table 5-1 presents the vessels, and their characteristics, that have been chosen to represent the different types of vessels on the river that could be affected by a CSO discharge at Putney Embankment Foreshore (PUTEF)

Table 5-1 Vessels and their characteristics that could be affected by a CSO Discharge

	Vessel Classification	Vessel Type	Min Speed (knots)(SOG)	Max Speed (knots)(SOG)	Power	Manoeuvrability	VHF
1	Commercial Powered Vessels	Uber Boat	6	25	High	High	Yes
2		RIB/Emergency services	3	12 (40+ Emergency only)	High	High	Yes
3		Sightseeing/Pax	3	12	Medium	Medium	Yes
4		Restaurant/Pax	3	10	Medium	Medium	Yes
5		Tug vessel engaged in pushing	3	6	High	Low	Yes
6		Tug vessel engaged in towing	3	6	High	Low	Yes
7		Workboats	3	6	Low	Medium	Yes
8	Recreational Powered Vessels	Narrow Boat/cabin cruisers	3	4	Low	Low	No
9	Un-Powered Vessels	Dinghy	1	3	V. Low	Low	No
10		Kayak/Rowers/SUP	1	2	V. Low	Low	No

5.3 Impacts of discharge on the different classes of vessel.

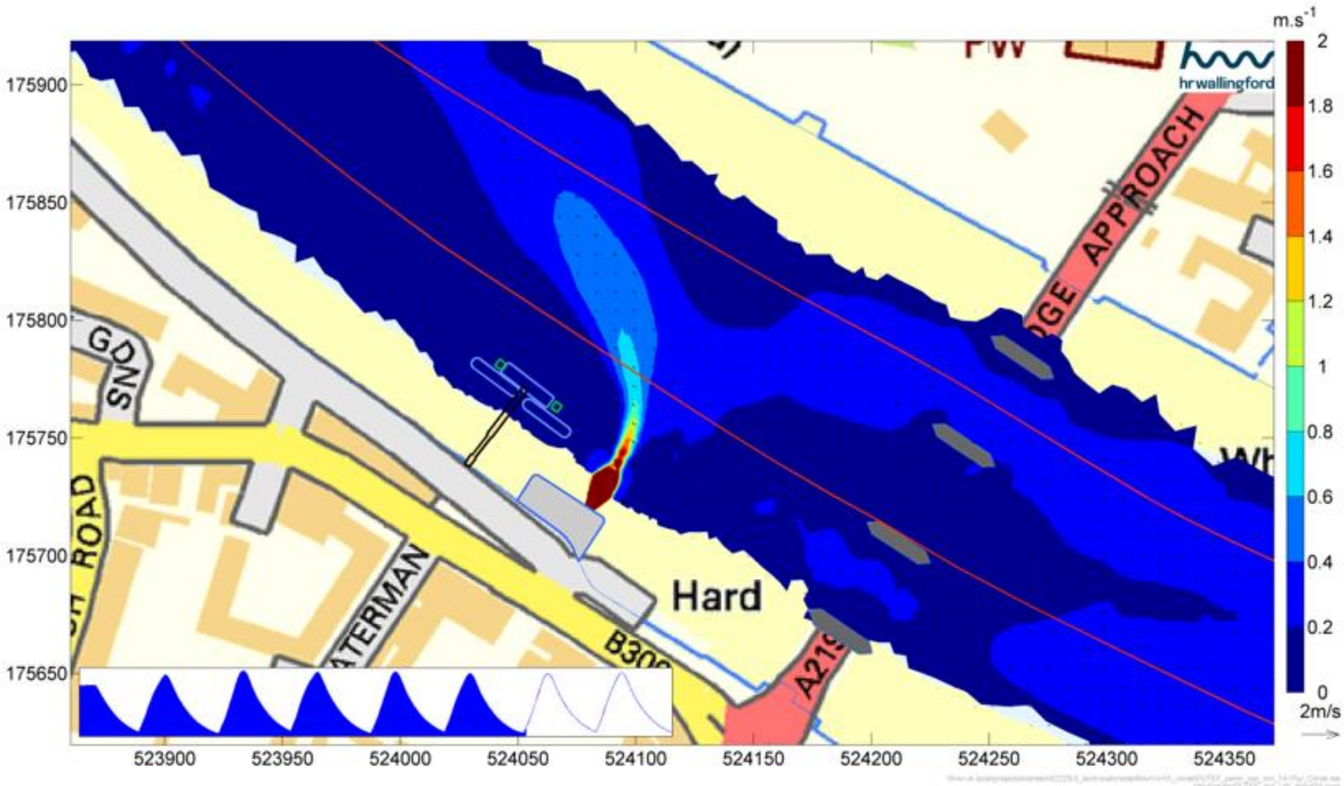
5.3.1 This section sets out the vessels that could be impacted by the CSO discharge, where the vessels are in relationship to the discharge and the corresponding drift angle that impact the vessels from the magnitude of the discharge flow.

5.3.2 Section 4.4 establishes the PUTEF CSO discharge impact and displays the plan of the zone in Figure 4-10.

5.3.3 For the purposes of identifying where the impacts, and the magnitude of those impacts, occur Figure 5-2 has been utilised as it provides charted positions of the same discharge flow information as the figures from section 4.4.

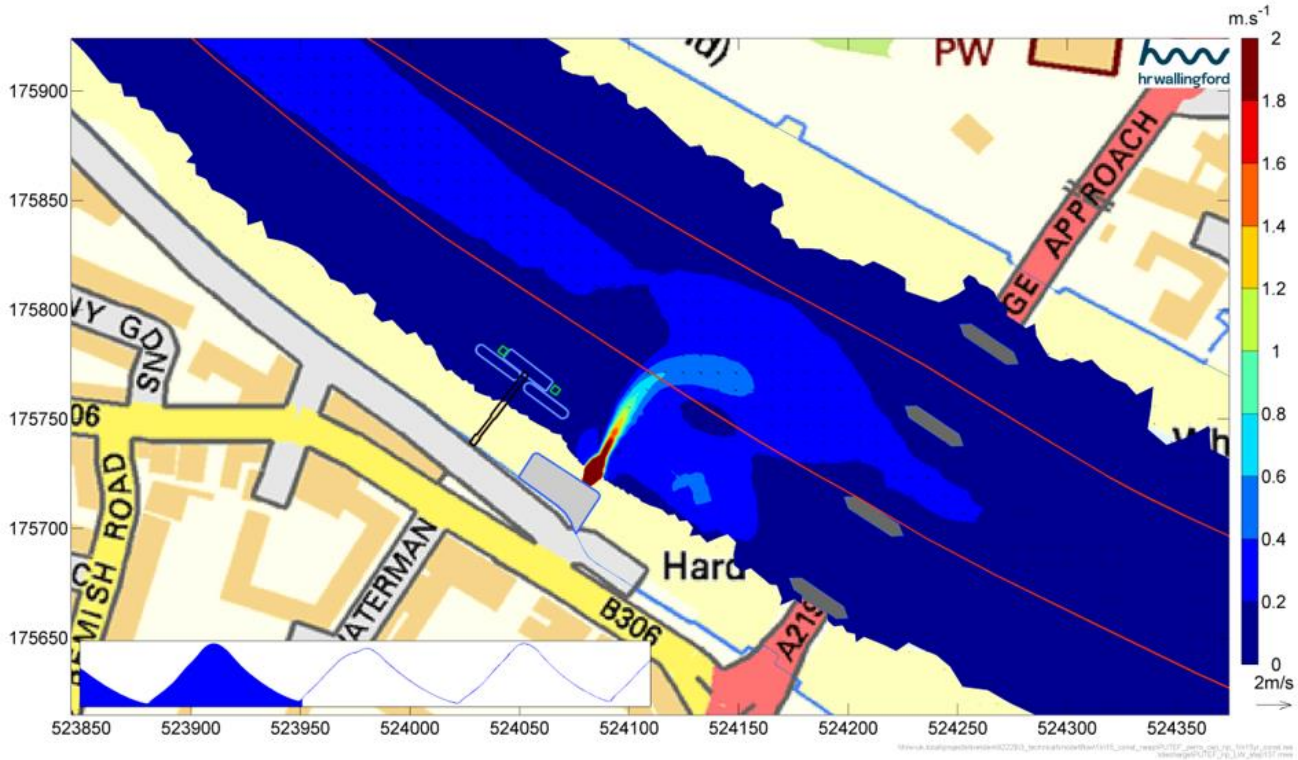
5.3.4 Figure 5-2 shows the modelled flow velocities for a 1:15 discharge at slack low water springs. The CSO discharge velocity starting in excess of 3.5m/s from the outfall and the velocity being maintained across the scour apron until it meets the river. The velocity is maintained for approximately 30m before it starts to deteriorate. The velocity of the lateral flow reduces to 0.4-0.6m/s more than the background flow from 30m from the outfall to the main fairway edge, and about 10m into the main fairway. The plume continues to deteriorate to 0.2-0.4m/s more than the background as it also veers to be more in alignment with the main river flow.

Figure 5-2 Modelled flow velocities for a 1:15-year discharge at slack low water springs



5.3.5 Figure 5-3 shows the modelled flow velocities for a 1:15 discharge at slack low water neaps. It can be seen that the CSO discharge velocity starts in excess of 3.5m/s from the outfall, the same as the low water springs case. The deterioration of the velocity is in line with the low water spring case, although the projection of the plume was smaller than of the low water spring case.

Figure 5-3 Modelled flow velocities for a 1:15-year discharge at slack low water neaps



5.3.6 The governing parameter of the draft of a vessel determines the minimum depth of water that the vessel needs to safely operate without grounding. This parameter is therefore listed in Table 5-1.

5.3.7 In this area at low tide powered vessels will mainly operate in the fairway due to the drying heights, the lack of traffic and the position of Putney Pier relative to the channel. The closest a powered vessel can safely transit past the CSO outfall at low water would be approximately 40m from CSO outfall, therefore the vessels have been assessed passing at this distance.

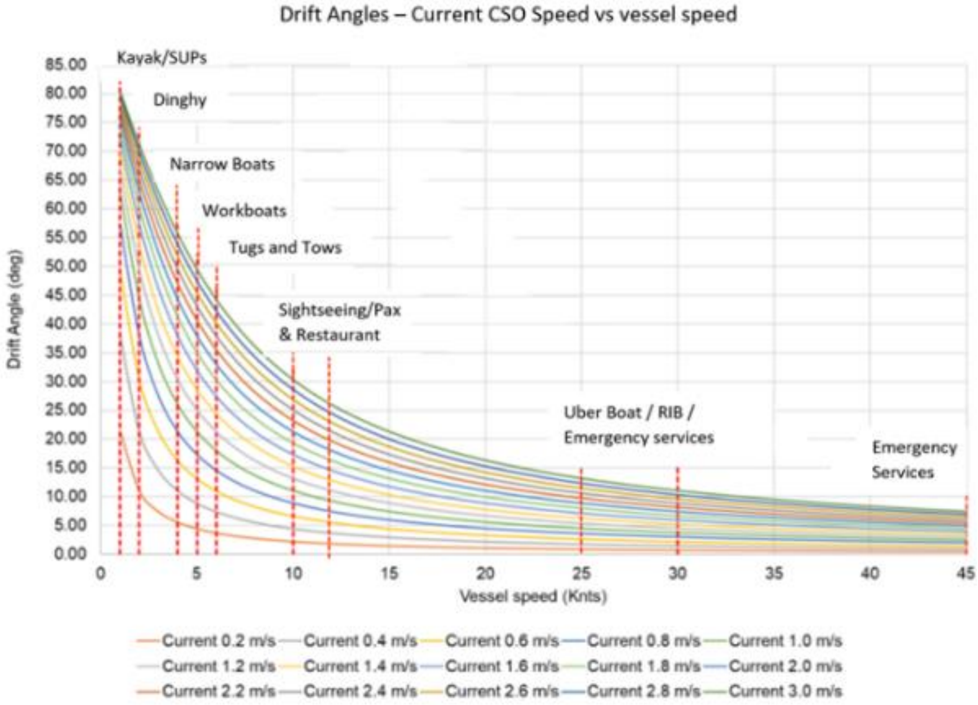
5.3.8 In this area at low tide non-powered vessels will mainly operate in the area of the inshore zone between the main fairway and the outside face of Putney Pier due to the drying heights. The closest most non-powered vessels can safely transit past the CSO outfall at low water would be approximately 40m from CSO outfall, therefore the vessels have been assessed passing at this distance.

5.3.9 Kayakers could transit the site within 30m of the outfall by passing underneath Putney Pier, once there was sufficient water to do so, and this would expose them to stronger flows, although a Kayaker would have full visibility of a discharge as they approached the area.

5.3.10 The drift angle will be determined in relation to the lowest operating speed at the relevant distance from the CSO (Table 5-1) where the lowest speed will incur the highest magnitude impact.

5.3.11 The drift angles of the vessels are a function of the vessel speed while impacted by the PUTEF CSO discharge current speed without any course correction, this will be taken as the worst-case scenario. The results are presented below in Table 5-2 noting that drift angles are related to the speed of vessel and not category of vessel.

Figure 5-4 Drift angle – Current CSO vs vessel speed



5.3.12 This approach allows a direct evaluation of the CSO discharge as a potential hazard to the vessels passing the area.

5.3.13 Table 5-2 presents the assessed impact of a 1:15-year PUTEF CSO discharge on the different vessel types, using the drift angle curves when the vessels are operating at the different distances within the main fairway and from the CSO. It is considered that this worst-case impact, recorded within the table, will be applied over the tidal window as defined in Table 4-6**.**

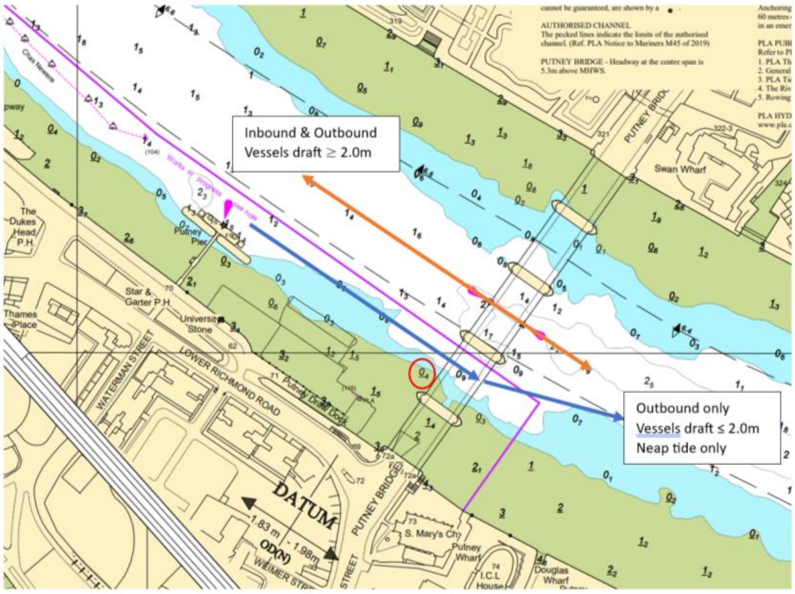
5.3.14 The estimated speed over ground for vessels passing the CSO, as stated in the Table 5-2, is recorded as an estimate of the slowest probable speed whilst still maintaining steerage.

Table 5-2 Approximated drift angle when passing the CSO in the inshore zone, during a 1:15-year CSO discharge at MLWS and MLWN

Vessel Type	Vessels Speed passing CSO. (SOG)	Minimum Vessels Draft (metres)	Water depth allowing for Under Keel Clearance (Add 0.5m)	Approximation of drift angle when passing the CSO MLWS	Approximate Distance from CSO to allow safe draft clearance at chart datum plus 1.7m (MLWN)	Approximation of drift angle when passing the CSO MLWN
Uber Boat (i.e., Hunt Class)	6 knots	1.2	1.7	3°	50m	17°
RIB/Emergency Services	3 knots	0.5	1.0	7°	50m	32°
Sightseeing/Pax	3 knots	1.5	2.0	7°	100m	0°
Restaurant/Pax (i.e., Symphony)	3 knots	1.8	2.3	7°	100m	0°
Tug vessel pushing	3 knots	3	3.5	7°	100m	0°
Tug vessel towing	3 knots	3	3.5	7°	100m	0°
Workboats	3 knots	0.5	1.0	7°	50m	32°
Narrowboats/Motor cruisers	3 knots	1.0	1.5	7°	50m	32°
Dinghy	1 knot	0.8	1.3	21°	50m	64°
Kayak/Rower	1 knot	0.2	0.2m	64°	25m	76°

5.3.15 Figure 5-5 is an extract of PLA chart 312, which covers the Barn Elms Reach (Lower) and highlights the passage of vessels transiting through the area. The Blue arrowed line shows the closest running position for shallow draft vessels transiting downstream at low water. The orange arrowed line presents the normal running position for reporting vessels transiting upstream and downstream

Figure 5-5 Extract of PLA chart 312 Vessel Operating zones governed by draft



5.3.16 For vessels transiting downstream on the edge of the fairway the CSO discharge impact could be 0.6-0.8m/s on the side. For vessels transiting upstream or downstream in the normal running position in the fairway the impact could be 0.4-0.6m/s but will be more aligned with the main river flow.

5.3.17 Whilst considering the passage of a vessel past the CSO, the hydrograph in figure 4-1, without the tunnel in operation, indicate that there are 45 minutes from the start of discharge before it reaches its 1:15 year peak discharge of 5m^3/s, whilst the hydrograph in figure 4-2, with the tunnel in operation, indicates that there is a delay in the start of the discharge the duration to reach its peak discharge is reduced to 10 minutes. It should be noted that the peak discharge following interception from the tunnel is reduced to approximately 2.4 m^3/s.

5.3.18 The assessment of the discharge impact on passing vessels, recorded in Table 5-2, has determined that there are impacts on all vessels transiting downstream past the PUTEF CSO. Vessels are similarly impacted by speed group although the non-powered vessels are the most significantly impacted.

5.4 Summary of impacted vessels and outcomes.

5.4.1 The summary of the 1:15-year CSO discharge impacts on the different vessel types for any low water period is presented in Table 5-3 below. Whilst these impacts are appropriate at low water they are considered as applicable over the impact tidal window, as stated in section 4.

Table 5-3 Impact of 1:15-year CSO discharge on vessels at low water.

Vessel Type	Fairway / Inshore	Impact on vessel	
		Normal Running Position at MLWS	Minimum achievable distance from CSO at MLWN
Uber Boat	Fairway	Minimal impact	Negligible
	Inshore		Minimal Impact
RIB/Emergency services	Fairway	Minimal impact	Negligible
	Inshore		Minor/Moderate impact Course and/or speed adjustment required
Sightseeing/Pax	Fairway	Minimal impact	Negligible
	Inshore		
Restaurant/Pax	Fairway	Minimal impact	Negligible
	Inshore		
Tug vessel engaged in pushing/Towing	Fairway	Minimal impact	Negligible
	Inshore		
Workboats	Fairway	Minimal impact	Negligible
	Inshore		Moderate impact Course and/or speed adjustment required.
Narrow boat/Motor cruisers	Fairway	Minimal impact	Negligible
	Inshore		Moderate impact Course and/or speed adjustment required.
Dinghy/Kayak/SUP/Rower	Fairway	Minimal impact	Negligible
	Inshore	High impact Potential risk of collision with other vessels due to inability to maintain course.	High impact Potential risk of collision with other vessels due to inability to maintain course.

5.4.2 The assessment of 1:15 year return period event impact indicates: -

- There is minimal impact on all vessels transiting downstream in the fairway past the CSO when it is discharging at low water springs.
- There is a high impact on the Dinghy/Kayak/SUP/Rowers when passing the CSO in the inshore zone.
- When passing at the CSO outfall during a 1:15 year event discharge during low water neaps at minimum achievable distance the impact on the majority of vessels is negligible. There is however a minor/moderate impact on Ribs, workboats and Narrowboats and there continues to be a high impact for dinghy's, Kayaks, Rowers and SUPs.

6. Ship Simulation comparison

6.1.1 As part of the works to identify the impact of a CSO discharge on the safe navigation of vessels passing the area Tideway engaged HR Wallingford to undertake a real time navigation simulation to assist in the assessment of this impacts.

6.1.2 The outputs of the simulations would be used to corroborate the desktop analysis undertaken in sections 4.3 and 4.4, which identify the period and zones of impact, and section 5 which used predicted drift angles as a function of the lateral flow velocities and the vessel velocities to determine the level of impact on passing vessels or indicate if additional considerations needed to be made.

6.1.3 Simulations for Putney were undertaken at the HR Wallingford Ship Simulation Centre during the 8th, 9th and 10th of November 2023 with representatives from HR Wallingford, Tideway, Waves, the Port of London Authority and a number of river operators. Additional simulations were carried out at HR Wallingford Ship Simulation Centre on the 5th ofMarch 2024 with representatives from HR Wallingford, Tideway, Waves and the Port of London Authority.

6.1.4 It was agreed during the first round of simulations that the focus at Putney should be on vessels that could be in and around the area at low tide, except for one run with a tug and tow. The additional runs on the 5th of March 2024 were to determine the impact on a kayaker transiting downstream past the site inside Putney Pier.

6.1.5 The full table of simulations undertaken are presented in Table 6-1 which include the comments on the run, which were agreed by the attendees following each simulation.

Table 6-1 Simulated cases for PUTEF on the 8th, 9th and 10th of November 2023.

Run ID	Ship	Manoeuvre	Bridge arch	Tidal condition	Comments
53	28m tug pulling unladen 50m barge	Outbound 28m tug through no. 3 arch at 3 knots	No. 3	Low water slack	No noticeable effect from the outflow.
54	Clipper	Outbound at 7 knots.	No. 3	Low water slack	No noticeable effect from the outflow.
55	21m Narrowboat	Outbound at 4 knots	No. 3	Low water slack	No significant effect from the outflow.
56	Kayak	Inbound behind Putney pier at 1 knot	None	Low water slack	Significant effect from the outflow. The effect diminished before the vessel reached 50m adjacent to the outflow.
57	Kayak	Outbound at 1 knot	No. 4	Low water slack	Significant effect from the outflow. The effect diminished at approximately 60m from the outflow.
58	Kayak	Outbound at 3 knots	No. 4	Low water slack	Moderate effect from the outflow.
59	Kayak	Outbound at 3 knots	No. 4	Low water slack	The start position was just past the 50m parallel distance from the outflow (previous run was on the inside of the 50m parallel line). No significant effect from the outflow.
60	Kayak	Outbound at 1 knot	No. 4	20 minutes before low water slack	Moderate effect from the outflow. Vessel was then manoeuvred towards the shoreline after the effect diminished.
61	Kayak	Outbound at 1 knot	No. 4	20 minutes after low water slack	Moderate effect from the outflow.
62	Rowing eight	Inbound at 6 knots.	No. 4	Low water slack	No significant effect from the outflow.

6.1.6 The full table of simulations undertaken on the 5th March, focusing on the transit of kayaks past the CSO outfall are presented in Table 6-2 which include the comments on the run, which were agreed by the attendees following each simulation.

Table 6-2 Simulated cases for PUTEF on the 5th of March 2024

Run ID	Ship	Manoeuvre	Bridge Arch	Tidal Condition	Comments
9	Kayak Running under Livett Pier	Outbound 3 Knots	N/A	40 Minutes after low water slack	The vessel was deflected rapidly 40 m towards the centre of the river
10	Kayak running 10m off Livett Pier	Outbound 3 Knots	N/A	40 Minutes after low water slack	The vessel experienced a marginal deviation (3-4m(but was able to safely recover.
11	Kayak running 10m off Livett Pier	Outbound 3 Knots	N/A	40 Minutes after low water slack	The vessel experienced a marginal deviation (3-4m(but was able to safely recover.

6.1.7 During the simulations the vessels were operated by a master who established the course and speed of the vessel to align with the case. Once the simulation started the master made the necessary corrections to allow the vessel to maintain course and then feedback to the group.

6.1.8 It was recognised that for the simulation of the kayak, whilst the response of the vessel to the flows is correct, the steering mechanism is simplistic and a kayakers corrective actions would probably have an effect earlier reducing the level of course deviation, so the tracks produced for kayak transits can be considered conservative.

6.1.9 The track of each simulated run was recorded so that it could be reviewed, Figure 6-1 shows the recorded track for run 55, which is a Narrowboat going outbound at 4 knots. The track of the narrow boat from the entire passage is in grey and was determined to not be significantly affected by the discharge.

Figure 6-1 Extract of run 55

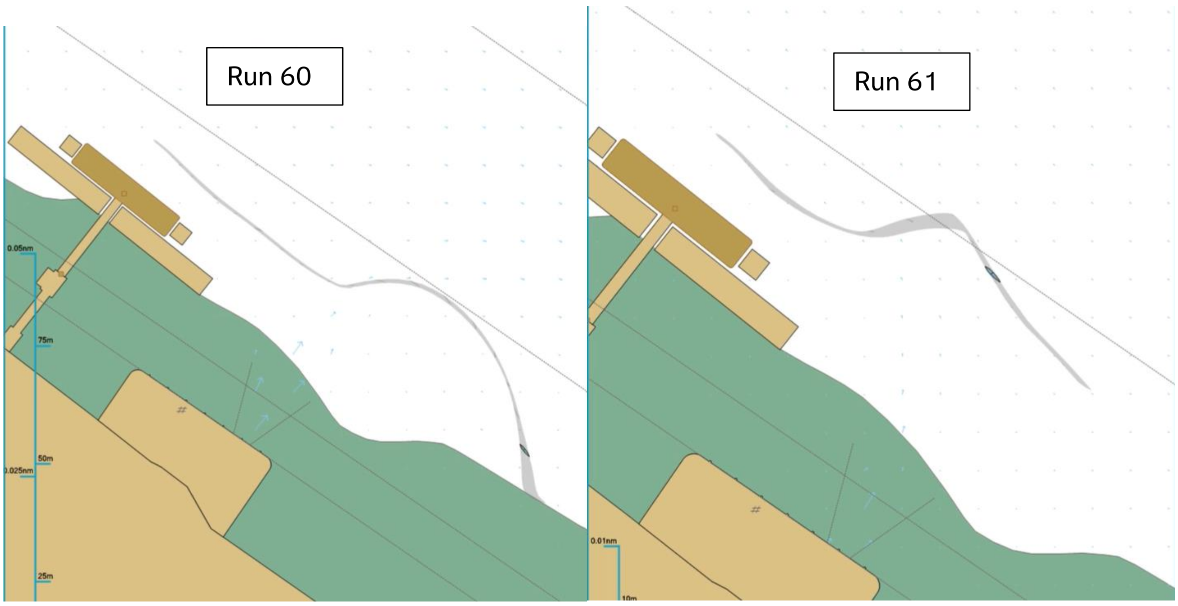
6.1.10 Figure 6-2 shows a comparison of runs identified as 57 and 58 in Table 6-1. The runs show the transit of a Kayak at 1 and 3 knots. This shows the difference that the speed of a vessel can have on the track the vessel will take.

Figure 6-2 Comparison of runs 57 and 58

6.1.11 There was good correlation of impacts between the simulations and the desk top studies, Table 5-3 which identified that the only vessels that would be significantly affected would be the Kayak/SUP, therefore there are no amendments required to the impacts as presented in Table 5-3.

6.1.12 Figure 6-3 show the Kayak tracks for 20 minutes before and 20 minutes after low water slacks. These runs were conducted to demonstrate how quickly the impact of the CSO lateral flow diminished when there was some tidal/fluvial effect in the river. There is a significant reduction in the impact on the kayak as it passes the CSO in both cases, although there is a larger reduction during the ebb period.

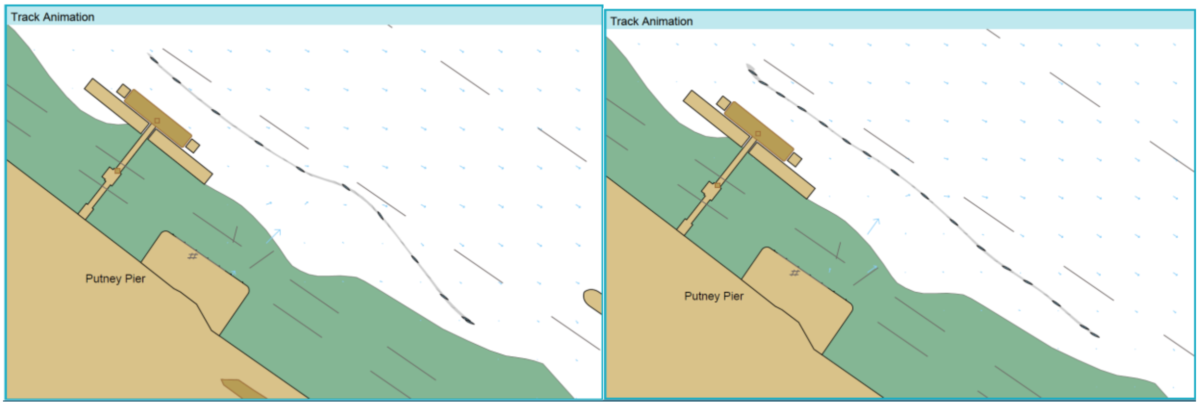
Figure 6-3 Runs 60 and 61



6.1.13 Due to the significance in the reduction of the impact of the CSO discharge on the kayak 20 minutes either side it can be determined that the tidal window of impact on the inshore zone identified in 4.4.5 is too conservative and that the tidal window for impacts could be reduced.

6.1.14 On the 5th March two runs were carried out at 40 minutes after low water slack to determine the level of impact on a kayak transiting past the CSO outfall 10 outside of Putney Pier.

Figure 6-4 Runs 10 and 11 from 5th March 2024

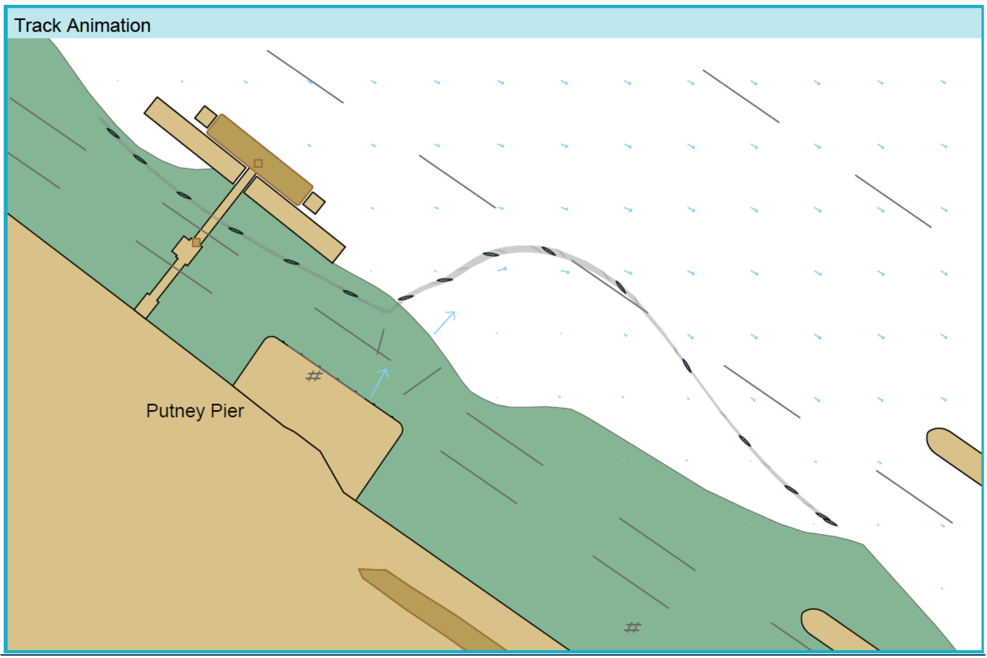


6.1.15 The two runs, 10 and 11, demonstrate that there is a very much reduced impact on a kayaker compared to runs at 20 minutes after low water.

6.1.16 During the 5th of March cases a run was undertaken to understand the impact of a kayaker transiting downstream and passing under Putney Pier and then past the outfall. This is the worst case by placing the kayaker closest to the CSO.

6.1.17 To allow the simulation of a kayaker transiting past the outfall whilst passing underneath Putney pier at MLWS with a maximum discharge, the river height had to be raised by 1m to prevent grounding. The track of the kayaker is presented in Figure 6-5 .

Figure 6-5 Run 9 from 5th of March 2024.



6.1.18 The simulation produced a significant impact on the kayak which deviated to just inside the main fairway and struggled to regain control of steerage, however once steerage was regained the kayak was able to head back towards its original course.

7. Risk Assessment

7.1 Risk Assessment

7.1.1 The Risk Assessment is undertaken using the Jacobs design hazard elimination and risk reduction register and can be found in Appendix A.

7.1.2 The following sections of this document present the risk associated with the hazard linked to a 1:15 year return period PUTEF CSO discharge impacting on vessels operating on the Thames.

7.1.3 The risk assessment has been undertaken to eliminate or reduce risk to vessels on the Thames and provide mitigations for the risk so far as reasonably practicable by assessing the design and operation risks for the permanent case of the PUTEF CSO outfall.

7.1.4 The residual design / operational risks identified in this will be used to inform an NRA. The NRA will be produced by navigational experts for consideration by the PLA and any further mitigations established if required.

7.2 Hazards

7.2.1 The Risk Assessment considers the impact of the flows from the PUTEF CSO discharge to Vessels on the river with consideration to the change in drift angle incurred by contact with the flow. The hazards associated with the impact are:

i) Swamping

ii) Capsizing

iii) Grounding

iv) Collision

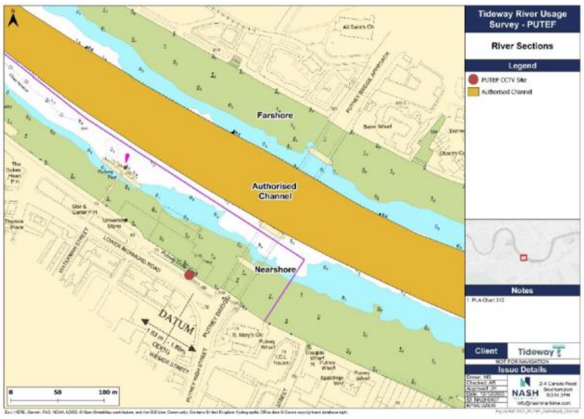
7.3 Receptors

7.3.1 CCTV surveys of the river were undertaken at PUTEF from the 23rd September to the 31st December 2023, but data has been processed from the period 23rd September 2023 to 10th of November 2023 giving a 7 week data set and the analysis of the data is presented in document "Tideway West PUTEF Traffic Survey Report 11I02".

7.3.2 The period of recorded data from September to November is unlikely to give a thorough representation of either peak (through the summer months) or annual vessel passages past the CSO outfall.

7.3.3 The analysis was carried out to determine the class of vessel and which area of the river the vessel was operating from nearshore, authorised channel and farshore, as indicated in Figure 7-1.

Figure 7-1 Nearshore, Authorised Channel and Farshore sections of the River Thames at PUTEF



7.3.4 Table 7-1presents the data received from the CCTV surveys, which were also correlated with AIS information.

Table 7-1 Number of recorded vessels transiting nearshore, through the Authorised Channel and farshore

PLA Vessel Class	Nearshore	Authorised Channel	Farshore	Total
Uber Boat	26	1,740	0	1,766
RIB/Emergency Services	39	291	15	345
Class 5 Passenger	2	283	10	295
Tug	1	39	1	41
Tug (Pushing)	0	6	0	6
Tug (Towing)	0	10	0	10
Workboat	54	130	8	192
Recreational Cruiser	6	98	3	107
Narrowboat	0	18	1	19
Sailing Dinghy	1	136	2	139
Kayak	59	59	30	148
Rowing Boat	262	548	75	885
SUP	0	3	1	4
Coach / Safety Boat	26	210	19	255
Total	476	3,571	165	4,212

7.3.5 For the impacts of a discharge from the PUTEF CSO outfall the primary interest is in vessels that undertake transits within the nearshore zone past the outfall. Over the analysed period there were 476 vessel transits within the nearshore zone, which is 11.2% of all transits in the area.

7.3.6 Of the 476 there were only 59 transits by kayaks which have been demonstrated to be the most impacted craft due to a CSO discharge. Most of the these are small groups on a Wednesday or the weekend, with just one event of a single kayaker on their own. This would indicate that these kayakers are members of the Putney Bridge Canoe Club based at Barn Elms.

7.3.7 Table 5-3 lists the vessels that are subject to the impact of the PUTEF CSO discharge flow and will continue to be used as the worst case, despite the recognition that vessels such as narrow boats and sups did not enter the nearshore zone, but they could do at some point in the future.

7.3.8 Figure 5-5 is an extract of PLA chart 312, which covers the Barn Elms Reach (Lower) and highlights the passage of vessels transiting through the area. The Blue arrowed line shows the closest running position for shallow draft vessels transiting downstream at low water. The orange arrowed line presents the normal running position for reporting vessels transiting upstream and downstream

7.3.9 Figure 5-5 provide zones of impact and safe draft access respectively. It has been determined that due to the lack of power/manoeuvrability it will only be man-powered vessels, Narrowboats, workboats and emergency vessels that are likely to be able access closer to PUTEF CSO at low water neaps.

7.3.10 Of the other vessel types which may be impacted such as the SUP and Sailing Dinghies only a single sailing dinghy entered the nearshore channel but this again appears to be during an organised event with a safety boat nearby.

7.3.11 Further analysis has been undertaken to understand the number of non-powered vessels transiting and direction of travel past the site in the period 1 hour before low water to 1 hour after low water. The results of this analysis are presented in Table 7-2 which covers vessels transiting past the outfall between 1 hour either side of low water. The table refers to vessels traveling eastbound only as no vessels were recorded transiting westbound in the nearshore zone during this period.

Table 7-2 Analysis of vessels passing PUTEF outfall Eastbound at low water ±1 hour

Eastbound	Authorised Channel				Nearshore	
Tidal period	Kayak	Rowing Boat	Sailing Dinghy	SUP	Kayak	Rowing Boat
L+1		21	1	1		11
L+0.5	7	43	2		11	6
L		10	13	1	5	
L-0.5	9	12	49			3
L-1	7	12	6		3	1
Grand Total	23	98	71	2	19	21

7.4 Severity of Harm

7.4.1 Jacobs rate the hazard on worst potential severity:

i) 1: Nil or slight injury / illness, property damage or environmental issue.

ii) 2: Minor injury / illness, property damage or environmental issue.

iii) 3: Moderate injury or illness, property damage or environmental issue.

iv) 4: Major injury or illness, property damage or environmental issue.

v) 5: Fatal or long-term disabling injury or illness. Significant property damage or environmental issue.

vi) 10. Multiple fatalities and catastrophic event

7.4.2 The hazard identified above has potential to cause harm to the vessel users:

i) Swamping leading to a major injury or drowning.

ii) Capsizing leading to a major injury or drowning.

iii) Grounding leading to major Injury or illness due to exposure to sewage.

iv) Collision with another vessel due to a CSO discharge event forcing non-powered vessel to drift from previous course leading to major injury or drowning.

v) Collision between third party vessels caused by one of the vessels changing course to avoid collision with a non-powered vessel leading to major injury or drowning.

7.5 Likelihood of Harm

7.5.1 Jacobs risk assessment rates the likelihood of harm with the following probabilities:

1: Highly Unlikely
2: Unlikely
3: Possible
4: Likely
5: Highly Likely

7.5.2 The assessment has been undertaken by analysing the data presented in document 3120-BMBJV-PUTEF-240-CW-RG-000001 P01 Putney Foreshore Embankment CSO Discharge Modelling and the corroboration of the information from the HR Wallingford Ship simulation tracks. The risk assessment has also established the $5m^3$/sec to be the most probable worst-case scenario.

7.5.3 From analysis of the peak flow velocity plumes, it has been determined that the tidal window of impacts for the inshore zone is 3 hours either side of low water. The ship simulation tracks indicate that the tidal window could be reduced, but further runs did not clarify the situation and therefore any mitigations would necessary for the 3 hours either side of low water.

7.5.4 A barrier closure could create still water and increase the impact of a discharge at any state of the tide, however this impact will still not be greater than the worst case of low water springs.

7.5.5 In 2019 an event duration monitor (EDM) was installed in the Putney Bridge CSO to enable TWUL to deliver against the regulatory requirement to report CSO discharges capturing the number of discharges and their duration. The records from the Putney Bridge EDM started being reported from 2020 and since installation the EDM has recorded between 35 and 158 discharges per year with a long-term average of 92.7 discharges per year.

7.5.6 The current annual frequency of discharge has been established as an average of 93 with a maximum record of 158 discharges which could impact river users. However, when the tunnel starts to intercept flows it is anticipated that this will be reduced to one discharge a year and be less than half of a 1:15 year event discharge without the tunnel in operation.

7.5.7 The analysis was undertaken for spring periods of low water but due to the variability of tides from residual effects the risk assessment will consider impacts to vessels at all states of low water.

7.5.8 Taking all the above-mentioned factors into consideration the likelihood of harm is considered unlikely for vessels using the main fairway and the nearshore zone at low water springs during a LTT maintenance period and highly unlikely for vessels using the main fairway and the nearshore zone at low water when the tunnel is in operation and intercepting discharges due to the reduced frequency and reduced discharge rate.

8. Mitigation

8.1 The ERIC the hierarchy of risk management approach will be adopted to review mitigation for this DRA.

- ERIC stands for Eliminate, Reduce, Inform and Control.
- This is a four -level hierarchy that outlines the steps it should take to mitigate risk.

8.2 Eliminate

8.2.1 Once the LTT is commissioned the Putney Bridge CSO discharges will be substantially eliminated as most discharges will be intercepted with a prediction of a single discharge from the new PUTEF CSO outfall.

8.2.2 To eliminate the discharges entirely would require the closing of the new PUTEF CSO outfall and would flood the upstream catchment area during storm events and is therefore not feasible.

8.3 Reduce

8.3.1 To reduce the risk of impact to the vessels a warning system could be adopted. Vessels could be warned of a current discharge with the use of lights and signs. The lights and signs would need to be strategically placed to ensure the optimum sight by the river vessel users

8.4 Inform

8.4.1 During the development in the interim phase warning signs have been developed and designed by the MWC and offered for to the PLA for acceptance. Any warning sign installed as part of the agreed interim arrangements to adopted for the permanent case.

8.4.2 During the development in the interim phase warning lights have been developed and designed by the MWC and offered for to the PLA for acceptance. Any warning lights installed as part of the agreed interim arrangements to be adopted for the permanent case.

8.4.3 Promulgation of the operational plan to the local water sports clubs and Thames River Rowing Council.

8.4.4 It is likely that the PLA will need to provide a new notice to mariners identifying new CSO operation and mitigations.

8.4.5 It is likely that the PLA will need to issue a notice to mariners during periods of LTT maintenance, following a notification from tideway or TWUL, to identify that there could be an increased in the frequency and severity of a discharge.

8.4.6 It is recommended to retain options 1 and 2 from the Tideway code page 98 relating to Putney Bridge and crossing which would advise against recreational vessels navigating upstream under Putney Pier.

8.5 Control

8.5.1 All agreed CSO signage and warning lights to be installed or adopted.

8.5.2 Operation plan for the of the warning system, to include warning trigger points, will need to be considered and agreed with the PLA.

9. Summary

9.1 Summary

9.1.1 Jacobs as Designer for the reference design have a duty to eliminate and reduce risks so far as reasonably practicable (SFARP) and to identify residual risks. Jacobs have undertaken this risk assessment to assess the magnitude of this risk for each vessel type and to consider whether mitigation measures can be adopted that can reduce the risks to an acceptable low level.

9.1.2 It has been recognised that there are limitations within the information used to undertake the assessment, however these limitations and the why particular cases have been selected are discussed within the document.

9.1.3 Overall, the residual risk has been determined as low due to: -

(a) Limited number of CSO discharges once the tunnel in is operation.

(b) The limited impact of CSO discharges on powered vessels,

(c) The introduction of a warning light and sign to advise powered vessels that the CSO is discharging and to proceed with caution.

(d) The introduction of a warning light and sign to advise non powered vessels that the CSO is discharging.

(e) The use of an approved operational plan to communicate with VTS to operate the warning sign/light information vessels a discharge is occurring and to proceed with caution past PUTEF CSO outfall.

(f) The use of the HR Wallingford Ship Simulations corroborating the assessment that there is minimal impact of discharges on vessels passing the PUTEF CSO during a 1:15 year return period discharge.

(g) The ship simulations were run at 5m3/sec for a 1:15 year event but during the permanent operation the peak discharge will be 2.4m3/sec other than during periods of maintenance when the tunnel is not available.

Powered Vessels

9.1.4 Jacobs has assessed it sufficient to provide signage and lighting to warn river users that the CSO is a discharging.

9.1.5 In the case of powered vessels, the risk is considered negligible (very low) as all powered vessels can pass within the navigation channel during a discharge with only minor and recoverable impact recorded in the simulations.

9.1.6 RIBS, Workboats and Narrowboats are the only powered vessels that are physically able to access the inshore zone due to draft restrictions.

Unpowered Vessels

9.1.7 Jacobs has assessed it sufficient to provide signage and lighting to warn river users that the CSO is a discharging.

9.1.8 In the case of manually operated or unpowered vessels the risk is considered low assuming the use of an effective warning system and that the vessel operator is following any advice concluded in the NRA and promulgated by the PLA.

Operational Plan

9.1.9 The operational plan will be developed by Tideway and the Main Works Contractor, BMB, in consultation with the Port of London Authority, to define the communication and warning systems that will be in place to for a CSO discharge.

9.1.10 The plan will clarify what the warning system consists of, how the warning of a discharge will be raised and verified, how the warning system will be activated and how the end of a discharge will be verified and communicated.

Navigational Risk Assessment

9.1.11 A Navigational Risk Assessment (NRA) is to be undertaken by navigational specialists with expert knowledge of waterway traffic and the conditions in the area of the PUTEF CSO outfall.

9.1.12 This designers risk assessment will be considered by the MWC in addition to the navigation risk assessment as part of the iterative process to develop the detailed design and Operational Plan. The navigational risk specialists will need to consider both the DRA and the Operational Plan to produce the Navigational Risk Assessment.

9.1.13 The MWC should consider the following in the development of the detailed design and the operational plan.

- The recommendations of the NRA,
- the optimal "on" time for the live warning signal(s), taking account of the discharge hydrograph and the actions to be taken by powered vessels and unpowered vessels or a member of the public on the foreshore nearby,
- the locations, lux, visibility, and particulars of the warning signs,
- the optimal "off" time for the warning signal,
- Consideration of operational mitigations (e.g. lights and signs) in consultation with the PLA.
- Consider the operational plan that will include the manner of promulgation of information and communication with the river community, including what is required of Tideway, the PLA and the river users,

9.1.14 The NRA will consider the residual risks from the DRA, the detailed design and the Operational Plan to determine the most appropriate mitigation in consultation with the PLA and other river users. In particular the NRA should consider:

- the necessary responses of powered vessels to a discharge (e.g., adjust course as require, proceed with caution and look out for unpowered vessels affected by a discharge) and the time needed to action the responses,
- the necessary responses of unpowered vessels to a discharge (e.g. exit the river at a fixed egress point, etc.) and the time needed to action the responses,
- the assessment of any increased risk to normal river operations arising from the implementation of mitigations

9.1.15 In the development of the NRA the timings of the mitigation implementation should also be considered and detailed for agreement with the PLA.

9.1.16 The updated NRA with its proposed mitigations will be reviewed by the MWC to confirm that the design risks have been mitigated insofar as is reasonably practicable.

9.2 Key Information

9.2.1 The most credible worst case CSO discharge is for a 1:15 year return period storm without the tunnel in operation with a discharge of $5m^3/s$. The frequency of discharges once the tunnel in in operation is expected to be 1 per year when the tunnel is in operations. When the tunnel is to be taken out of operation additional information will need to be made available to stakeholders outlining the potential for increased frequency of discharges.

9.2.2 The assessment considers the river in three zones as defined in figure 7-1, and the critical discharge occurring at low water springs. The discharges are considered to impact within the following tidal windows.

Table 9-1 Tidal Windows of Potential Impact

Inshore Zone (beyond 30m)		Main Fairway	
Start	Finish	Start	Finish
LW slack -3 hours	LW slack+3 hours	LW -40 minutes	LW +20 minutes

9.2.3 It should be noted that Table 9-1 should be considered for passing vessels at any slack period at high water or during a Thames barrier closure.

9.2.4 It should be noted it is not possible to predict the discharges within 30m of the CSO at any state of the tide and that area should be avoided at any state of the tide during a discharge.

9.2.5 This document provides information on the timing and intensity of the discharges and the hydrographs are presented in Figures 4.1 and 4.2. The proof of concept document (LONDON TIDEWAY TUNNELS PROOF OF CONCEPT - CSO DISCHARGE WARNING DRAFT 27/02/24) provides further detailed discharge hydrographs that should be utilised in the development of suitable warning times in the development of the detailed design undertaken by the MWC.

9.2.6 Any unmitigated risks arising from the detail design development, such as insufficient warning time, should be identified in the MWC’s design documentation and potential mitigation measures identified for consideration by the PLA.

9.2.7 A warning a system, such as lights and signs has been established as a mitigation measure suitable to reduce the risk to vessels, during the development of the NRA and the operational plan the MWC should assess the suitability of the mitigation measures and substantiate their proposals within the detailed design documentation.

Appendix A. Designers Risk Assessment

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DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date

Update Critical Risk Summary Tab

Phase	
C	Construction
M	Maintain/Clean
U	Use as a Workplace
D	Demolish

Project Name:	Tideway
Project Number:	665397CH
Client:	Bazalgette Tunnel Limited

Probability

1: Highly Unlikely
2: Unlikely
3: Possible
4: Likely
5: Highly Likely

Worst Potential Severity (WPS) of Impact

1: Nil or slight injury / illness, property damage or environmental issue.
2: Minor injury / illness, property damage or environmental issue.
3: Moderate injury or illness, property damage or environmental issue.
4: Major injury or illness, property damage or environmental issue.
5: Fatal or long term disabling injury or illness. Significant property damage or environmental issue.

Risk Rating

NOTE: The purpose of Risk Rating is to determine which risks are significant. It is a subjective assessment and not an absolute or precise determination

High – HSEiD risk resulting from design is unacceptably high. Revise design to reduce

Medium – HSEiD risk resulting from design is permitted with appropriate design controls and management oversight in

Low – HSEiD risk resulting from design is permitted.

LIKELIHOOD	RISK				
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5
	SEVERITY				

1 Risk ID.	2 Formal Review Description	3 Phase	4 Activity	5 Potential Hazard	6 Person(s) Most at Risk	7 Prob	8 WPS	9 Initial Risk Rating	10 Discipline	11 Design Measures to Eliminate Hazards	12 Design Measures to Reduce Risk	13 Residual Prob	14 Residual WPS	15 Residual Risk Rating	16 Residual Risk Description	17 Included on Drawing No(s) or other doc. (give ref.)
CDM-PUTEF-016-A	Non-powered craft underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP navigating in the inshore zone in the vicinity of a CSO discharge	Swamping due to CSO discharge event	Public: Major injury and/or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Major injury and/or drowning	Notice to Mariners
CDM-PUTEF-016-B	Non-powered craft underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP navigating in the inshore zone in the vicinity of a CSO discharge	Capsizing due to a CSO discharge event	Public: Major injury and/or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Major injury and/or drowning	Notice to Mariners
CDM-PUTEF-016-C	Non-powered craft underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP navigating in the inshore zone in the vicinity of a CSO discharge	Grounding due to a CSO discharge event	Public:Major Injury or illness due to exposure to sewage	1	4	4	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	4	4	Public:Major Injury or illness due to exposure to sewage	Notice to Mariners
CDM-PUTEF-016-D	Non-powered craft underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP navigating in the inshore zone in the vicinity of a CSO discharge	Contact with bridge pier leading to capsize and entrapment	Public: Major injury and/or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Major injury and/or drowning	Notice to Mariners
CDM-PUTEF-016-E	Non-powered and Rec. powered vessel underway - Low Tide	Permanent	Kayak/Rower/Dinghy/SUP and recreational powered vessel navigating in the inshore zone in the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Major injury and or drowning	Notice to Mariners
CDM-PUTEF-016-F	Non-powered and Rec. powered vessel underway - Low Tide	Permanent	Kayak/Rower/Dinghy/SUP navigating in the inshore zone and recreational powered vessel navigating in the fairway, in the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Major injury and or drowning	Notice to Mariners
CDM-PUTEF-016-G	Non-powered and Commercial powered vessel underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP navigating in the inshore zone and a commercial powered vessel navigating in the fairway, in the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Major injury and or drowning	Notice to Mariners

Jacobs

DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date	
Phase	
C	Construction
M	Maintain/Clean
U	Use as a Workplace
D	Demolish
Project Name:	Tideway
Project Number:	665397CH
Client:	Bazalgette Tunnel Limited

Update Critical Risk Summary Tab

Probability	Worst Potential Severity (WPS) of Impact
1: Highly Unlikely	1: Nil or slight injury / illness, property damage or environmental issue.
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3: Possible	3: Moderate injury or illness, property damage or environmental issue.
4: Likely	4: Major injury or illness, property damage or environmental issue.
5: Highly Likely	5: Fatal or long term disabling injury or illness. Significant property damage or environmental issue.

Risk Rating

NOTE: The purpose of Risk Rating is to determine which risks are significant. It is a subjective assessment and not an absolute or precise determination

High	HSEiD risk resulting from design is unacceptably high. Revise design to reduce
Medium	HSEiD risk resulting from design is permitted with appropriate design controls and management oversight in
Low	HSEiD risk resulting from design is permitted.

LIKELIHOOD	RISK				
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
SEVERITY	1	2	3	4	5

1 Risk ID.	2 Formal Review Description	3 Phase	4 Activity	5 Potential Hazard	6 Person(s) Most at Risk	7 Prob	8 WPS	9 Initial Risk Rating	10 Discipline	11 Design Measures to Eliminate Hazards	12 Design Measures to Reduce Risk	13 Residual Prob	14 Residual WPS	15 Residual Risk Rating	16 Residual Risk Description	17 Included on Drawing No(s) or other doc. (give ref.)
CDM-PUTEF-016-H	Rec. Powered Vessel underway - Low tide	Permanent	Rec. Powered Vessel navigating in the inshore zone, in the vicinity of a CSO discharge	Swamping due to CSO discharge event	Public: Injury/illness due to exposure to sewage or Major injury	1	4	4	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	4	4	Public: Injury/illness due to exposure to sewage or Major injury	Notice to Mariners
CDM-PUTEF-016-I	Rec. Powered Vessel underway - Low tide	Permanent	Rec. Powered Vessel navigating in the inshore zone, in the vicinity of a CSO discharge	Grounding due to a CSO discharge event	Public: Major injury	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	3	3	Public: Major injury	Notice to Mariners
CDM-PUTEF-016-J	Rec. Powered Vessel and Commercial Powered Vessel underway - Low tide	Permanent	Rec. Powered Vessel navigating in the inshore zone and a commercial powered vessel navigating in the fairway, in the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing Rec.Powered vessel to drift from its previous course	Public: Major injury	1	4	4	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	4	4	Public: Major injury	Notice to Mariners
CDM-PUTEF-016-K	Commercial Powered Vessel underway - Low tide	Permanent	Commercial powered vessel navigating in the inshore zone, in the vicinity of a CSO discharge	Swamping due to CSO discharge event	Public: Injury/ illness due to exposure to sewage	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	3	3	Public: Injury/ illness due to exposure to sewage	Notice to Mariners
CDM-PUTEF-016-L	Commercial Powered Vessel underway - Low tide	Permanent	Commercial powered vessel navigating in the inshore zone, in the vicinity of a CSO discharge	Grounding due to a CSO discharge event	Public: Injury	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	3	3	Public: Injury	Notice to Mariners
CDM-PUTEF-016-M	Commercial Powered Vessel underway - Low tide	Permanent	Commercial powered vessel navigating in the inshore zone, in the vicinity of a CSO discharge	Contact with bridge abutment due to a CSO discharge event	Public: Injury Property damage (bridge pier), Disruption	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	3	3	Public: Injury Property damage (bridge pier), Disruption	Notice to Mariners
CDM-PUTEF-016-N	Non-powered craft underway - All other states of tide	Permanent	Kayak/Rower/Dinghy/SUP navigating in the inshore zone, in the vicinity of a CSO discharge	Swamping due to CSO discharge event	Public: Illness due to exposure to sewage or Drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Illness due to exposure to sewage or Drowning	Notice to Mariners
CDM-PUTEF-016-O	Non-powered craft underway - All other states of tide	Permanent	Kayak/Rower/Dinghy/SUP navigating in the inshore zone, in the vicinity of a CSO discharge	Capsizing due to a CSO discharge event	Public: Illness due to exposure to sewage or Drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Illness due to exposure to sewage or Drowning	Notice to Mariners

Jacobs

DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date

Phase	
C	Construction
M	Maintain/Clean
U	Use as a Workplace
D	Demolish

Project Name:	Tideway
Project Number:	665397CH
Client:	Bazalgette Tunnel Limited

Update Critical Risk Summary Tab

Probability

1: Highly Unlikely
2: Unlikely
3: Possible
4: Likely
5: Highly Likely

Worst Potential Severity (WPS) of Impact

1: Nil or slight injury / illness, property damage or environmental issue.
2: Minor injury / illness, property damage or environmental issue.
3: Moderate injury or illness, property damage or environmental issue.
4: Major injury or illness, property damage or environmental issue.
5: Fatal or long term disabling injury or illness. Significant property damage or environmental issue.

Risk Rating

NOTE: The purpose of Risk Rating is to determine which risks are significant. It is a subjective assessment and not an absolute or precise determination

High	HSEiD risk resulting from design is unacceptably high. Revise design to reduce
Medium	HSEiD risk resulting from design is permitted with appropriate design controls and management oversight in
Low	HSEiD risk resulting from design is permitted.

LIKELIHOOD	RISK				
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5
	SEVERITY				

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Risk ID.	Formal Review Description	Phase	Activity	Potential Hazard	Person(s) Most at Risk	Prob	WPS	Initial Risk Rating	Discipline	Design Measures to Eliminate Hazards	Design Measures to Reduce Risk	Residual Prob	Residual WPS	Residual Risk Rating	Residual Risk Description	Included on Drawing No(s) or other doc. (give ref.)
CDM-PUTEF-016-P	Non-powered and Rec. powered vessel underway - All other states of tide	Permanent	Kayak/Rower/Dinghy/SUP navigating in the inshore zone, in the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Major injury and or drowning	Notice to Mariners
CDM-PUTEF-016-Q	Non-powered and Rec. powered vessel underway - All other states of tide	Permanent	Kayak/Rower/Dinghy/SUP navigating in the inshore zone and recreational powered vessel navigating in the fairway, in the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Major injury and or drowning	Notice to Mariners
CDM-PUTEF-016-R	Non-powered and Commercial powered vessel underway - All other states of tide	Permanent	Kayak/Rower/Dinghy/sup navigating in the inshore zone and commercial powered vessel navigating in the fairway, in the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Major injury and or drowning	Notice to Mariners
CDM-PUTEF-016-S	Rec. Powered Vessel underway - All other states of tide	Permanent	Rec. Powered Vessel navigating in the inshore zone in the vicinity of a CSO discharge	Swamping due to CSO discharge event	Public: Injury or illness due to exposure to sewage	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	3	3	Public: Injury or illness due to exposure to sewage	Notice to Mariners
CDM-PUTEF-016-T	Rec. Powered Vessel and Commercial Powered Vessel underway - All other states of tide	Permanent	Rec. Powered Vessel navigating in the inshore zone in the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing Rec.Powered vessel to drift from its previous course	Public: Major injury	1	4	4	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	4	4	Public: Major injury	Notice to Mariners
CDM-PUTEF-016-U	Powered Emergency Vessels underway - Low tide	Permanent	Powered Emergency Vessels responding to an emergency in close proximity of a CSO discharge	Grounding due to CSO discharge event	Public: Injury/ illness due to exposure to sewage	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	3	3	Public: Injury/ illness due to exposure to sewage	Notice to Mariners

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DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date	
Phase	
C	Construction
M	Maintain/Clean
U	Use as a Workplace
D	Demolish
Project Name:	Tideway
Project Number:	665397CH
Client:	Bazalgette Tunnel Limited

Update Critical Risk Summary Tab

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Low	HSEiD risk resulting from design is permitted.

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3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5
	SEVERITY				

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Risk ID.	Formal Review Description	Phase	Activity	Potential Hazard	Person(s) Most at Risk	Prob	WPS	Initial Risk Rating	Discipline	Design Measures to Eliminate Hazards	Design Measures to Reduce Risk	Residual Prob	Residual WPS	Residual Risk Rating	Residual Risk Description	Included on Drawing No(s) or other doc. (give ref.)
CDM-PUTEF-016-V	Powered Emergency Vessels underway - All other states of tide	Permanent	Powered Emergency Vessels responding to an emergency in close proximity of a CSO discharge	Swamping due to CSO discharge event	Public: Injury/ illness due to exposure to sewage	1	4	4	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	4	4	Public: Injury/ illness due to exposure to sewage	Notice to Mariners
CDM-PUTEF-016-W	Powered Emergency Vessels underway - All other states of tide	Permanent	Powered Emergency Vessels responding to an emergency in close proximity of a CSO discharge	Contact with bridge abutment due to CSO discharge event	Public: Injury Property damage (bridge pier), Disruption	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	3	3	Public: Injury Property damage (bridge pier), Disruption	Notice to Mariners
CDM-PUTEF-016-X	Non-powered craft underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP, Westbound, navigating in the inshore zone in the vicinity of a CSO discharge	Contact with Livetts Pier leading to capsize and entrapment	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light	1	5	5	Public: Major injury and or drowning	Notice to Mariners