CSO Discharge Designers Risk Assessment Permanent Case – Heathwall Pumping Station

Document no: 665397CH-HEAPS-DRA-Permanent-Rev.1
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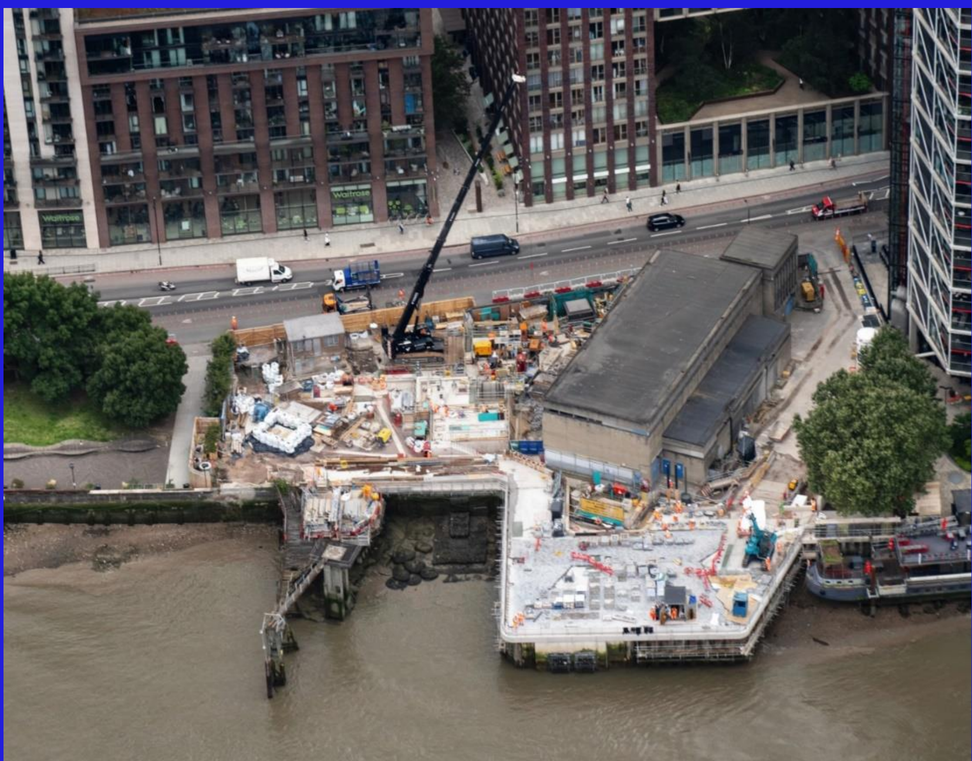
Bazalgette Tunnel Limited

Tideway
27 October 2024



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1	21/10/2024	Revised to suit Golden thread conditions	PR/JS
1 (1)	22/10/2024	9.2.6 comment added regarding Thames Barrier closures	PR
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Required Approvals

	Name	Role	Signature	Date
Checked by	Phil Reed	Lead Marine Civil Engineer	PR	27/10/2024
Reviewed by	Ed Davies	CDM Advisor (Ports and Maritime)	ED	27/10/2024
Reviewed by	Simon Fricker	Head of Design Authority	SF	27/10/2024
Approved by	James Smith	Jacobs Project Manager	JS	27/10/2024

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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 that could be created by the HEAPS CSO discharge flows to vessels on the Thames at the Heathwall pumping station (HEAPS) site.

1.2 It has been undertaken for the permanent phase when the existing CSO is diverted to the new CSO that is situated in the new HEAPS structure above the riverbed.

1.3 This designers risk assessment has assessed the risk to all types of vessels that transit past the site for the impact of a CSO discharge on the vessels drift angle and the consequential harm that could be caused.

1.4 Unlike other CSO discharges there is a controlled rate of discharge from the pumps. The 1:15-year event is therefore realistic as the highest discharge rate.

1.5 The MLWN tidal condition has been summarised as the worst-case discharge and the impacts to vessels within zones of impact and vessel accessibility have been analysed at that condition.

1.6 It has been concluded that the risk to powered vessels and unpowered vessels is low when the potential mitigations of a warning system of lights and signs is adopted.

1.7 It has been concluded that there is minimal impact to the fairway for a very brief period but the tidal window for the inshore zone has been determined to occur between the mid-ebb to mid-flood. This is due to the impact being present for the whole study period of low water +/- 50 minutes and there being no evidence to identify the point between low water +/-50 minutes and mid ebb/mid flood where the impact is no longer present.

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

1.9 The main works contractor FLO will need to consider the detailed design and the NRA to develop an operational plan, in consultation with the PLA, outlining how they will manage a CSO discharge event with the use of a warning system in line with Tideway's "Technical Memorandum on CSO warning performance specification and strategy"

1.10 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.

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Acronyms and abbreviations

Abbreviation	Abbreviation Description
ALARP	As Low As is Reasonably Practicable
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
FLO	Ferrovial Laing O'Rourke
GPS	Global Positioning System
HEAPS	Heathwall Pumping Station
ICM	Integrated Catchment Model
LTT	London Tideway Tunnel
NRA	Navigational Risk Assessment
PLA	Port of London Authority
PS	Pumping Station
SCADA	Supervisory Control and Data Acquisition
SWSRS	Sout West Storm Relief Sewer
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 South West Storm Relief (SWSR) Combined Sewer Overflow (CSO) and the Heathwall Pumping Station CSO has been constructed at Heathwall Pumping Station (HEAPS).

2.1.2 At the HEAPS site the existing South West Storm Relief CSO outfall will be retained, however the Heathwall Pumping Station CSO outfall will be relocated from its original location, which was below the surface near the main channel, to the river wall in the new 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 designers 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 CS16X/CS17X/TA the impact of the scour was considered under risk reference CDM-HEAPS-024, as presented below in Table 2-1.

Table 2-1 Extract from Designers Risk Assessment CS16X/CS17X/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-HEAPS-024	Scour - Permanent works	Operation and Maintenance	New permanent structure in the river	Scour damage following bed erosion triggered by increasing river velocity	Potential injury due to settlement or collapse of river walls and jetties affecting third parties and public.	3	2	Medium	Unable to eliminate hazard.	Fluvial modelling studies carried out as part of design and design modified to minimise increase in bed velocities. The design envisages the Contractor s is competent to reduce/manage risk further during construction. It is envisaged the Contractor will include this in the H&S file	3	1	Low	Potential injury due to settlement or collapse of river walls and jetties affecting third parties and public.	"Scour and fluvial modelling reports in SI of ITT. "

2.1.7 Whilst CDM-HEAPS-24 recognises that there is a risk produced by increases in river velocity it does not consider any direct risk to vessels in the river or that mitigations may be required.

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

2.1.9 This designer's risk assessment (DRA)considers:-

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

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

2.1.10 The DRA makes the assessment based on the information that has been produced by the contractor, document 4410-FLOJV-HEAPS-520-VZ-RG-100001_Ver6 P02 CSO discharge modelling for permanent works Heathwall Pumping Station and by Jacobs - the interim DRA 665397CH-HEAPS-DRA-Interim-REV.1 Ver 2 and the updated rainfall information produced by Tideway.

2.1.11 The DRA should be read in conjunction with HR Wallingford document 4410-FLOJV-HEAPS-520-VZ-RG-100001_Ver6 P02. Within the HR Wallingford report the total 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 includes additional information:-

(a) LL1658-R-01 Navigational Risk Assessment Review Port of London Authority, which was undertaken by Rendel Limited with Waves Group; and

(b) CCTV river traffic survey from Tideway Central ALBEF Traffic Survey Report 015I02

(c) The outputs of the HR Wallingford Ship Simulation centre.

2.2 Report Structure

2.2.1 The Structure of this report is as follows:

a. Section 3 - Outline methodology

b. Section 4 - Site discharge activity

c. Section 5 - Impact on vessels on the river

d. Section 6 - Ship simulation comparison

e. Section 7 - Risk assessment

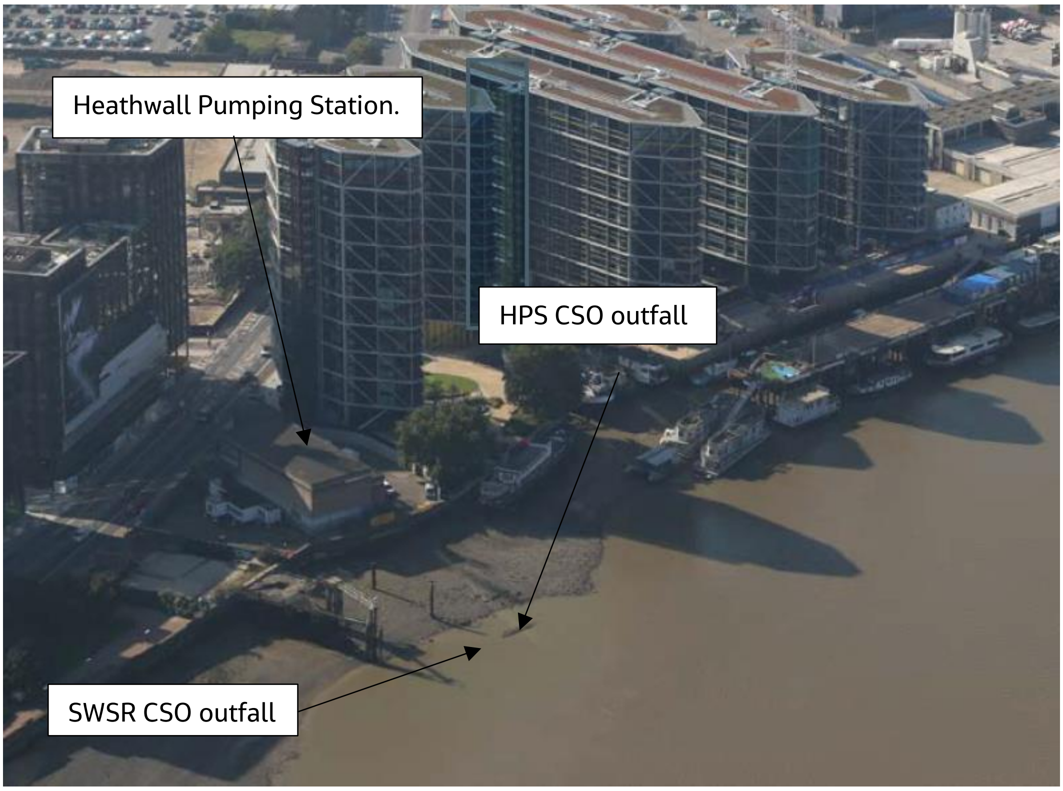
f. Section 8 - Mitigations

g. Section 9 - Summary

2.3 The site and CSO discharge location

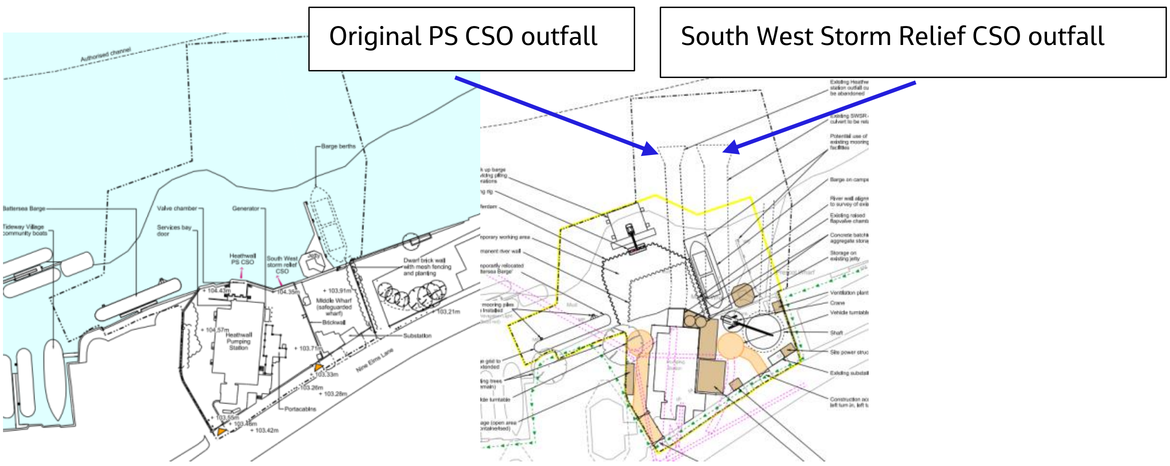
2.3.1 The HEAPS site is located on the south bank of the river Thames next to the Riverside development in the London Borough of Wandsworth. The site is small and takes in the existing Heathwall Pumping Station and Middle Wharf, which is a safeguarded wharf. The site will intercept the flows of the South West Storm Relief, which discharges through a CSO located within the river bed near to the channel edge and the Heathwall Pumping Station discharges which also discharges through a CSO outfall below the river bed near the channel edge, as presented in Figure 2-1.

Figure 2-1 Heathwall Pumping Station Pre-Tideway



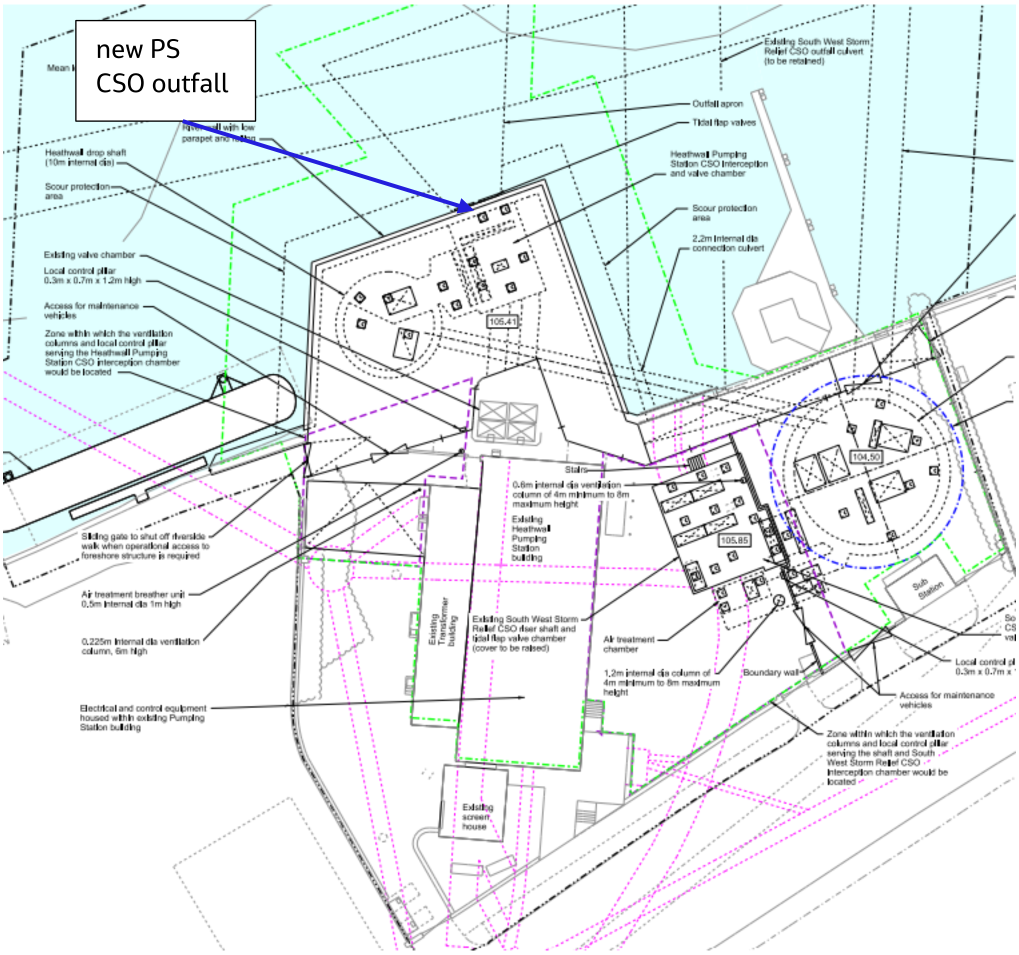
2.3.2 Figure 2-2 presents the original Heathwall Pumping Station and the construction phase 1 drawing which shows the CSO outfalls for the Pumping Station and the South West Storm Relief sewer. Figure 2-2 is used for a physical comparison from the existing to the new structure, the notes are superfluous.

Figure 2-2 Extract of DCO-PP-14X-HEAPS-160002 showing the original HEAPS site and CSO discharge points



2.3.3 The new foreshore structure projects into the river and moves the Pumping Station outfall to the new river wall which projects 18m into the river. Figure 2-3 presents the permanent works arrangement with the new outfall location and scour apron for the Pumping Station CSO, whilst the existing SWSR CSO outfall is retained unchanged.

Figure 2-3 Extract of DCO-PP-14X-HEAPS-160007 showing the permanent works arrangement.



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

2.3.5 The new HEAPS CSO outfall will discharge through the tidal flaps and discharge onto the new scour apron. The new outfall will be 1.6 times larger than the original CSO outfall. Whilst the SWSRS CSO outfall will remain unchanged.

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 HRW CSO discharge modelling for permanent works report 4410-FLOJV-HEAPS-520-VZ-RG-100001_Ver6 P02.

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

i) Confirming areas of the river

ii) Confirming vessels that use the river in this area

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

iv) Summarise impacted vessels on the river

3.1.3 Risk assessment

i) Hazards

ii) Receptors – Interpretation of the ALBEF river traffic survey data.

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 550km2, 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 100-year 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 flow rates included in the projects works information (WI 7706). These WI flows are shown in Table 4-1. The instantaneous peak flow from Heathwall Pumping Station CSO was found to be 12m³/s for a 15-year storm, whilst the instantaneous peak flow from the South West Storm Relief is 31m³/s

4.1.8 Notwithstanding the above, the CSO at Heathwall is different to others in that it is pumped, not gravity. This means that, whatever the magnitude of a storm, the discharge rate is effectively fixed.

4.1.9 The pump rates at Heathwall mean the CSO discharge is limited to approximately 12m3/s, no matter the storm return period. These flows are recorded in the projects works information (WI 7706) as shown in Table 4-1.

Table 4-1 Instantaneous peak discharge rates from WI 7706

CSO	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
HEAPS	WI 7706	Instantaneous Peak Flow (m3/s)	11.6	11.6	12	12	12	12
SWSR	WI 7706	Instantaneous Peak Flow (m3/s)	16	18.1	24.4	29.2	31	37

4.2 Discharge frequency

4.2.1 At the design phase of the project, 40 years of recorded rainfall data was available, spanning 1970-2010. It was determined that, in an average year, the Heathwall Pumping Station CSO was predicted to discharge approximately 39 times a year.

4.2.2 Once operational, the Tideway Tunnel would reduce the number of spills from approximately 39 times a year to approximately 4.

4.2.3 In 2019 an event duration monitor (EDM) was installed for the Heathwall Pumping Station 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 Heathwall PS EDM started being reported from 2020 and since installation the EDM has recorded between 21 and 45 discharges per year with a current average of 35 discharges per year. From the EDM records the Southwest Storm Relief CSO has discharged between 27 and 106 times a year with a current average of 49.5 discharges per year.

Climate change

4.2.4 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.

4.2.5 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.

4.2.6 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 HEAPS.

Table 4-2 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)
CS16X	Cat 1	Heathwall Pumping Station	63,000	4	26	82,400	3	22	111,000	5	31	159,300	6	38
CS17X	Cat 1	South West Storm Relief	3,900	1	3	14,900	1	5	30,200	1	9	44,800	1	12

4.2.7 Table 4-3 demonstrates that the predicted CSO discharge frequency from HEAPS or SWSR is not expected to increase significantly. Hence there being no plans to increase the discharge rate from the HEAPS CSO. It is recognised that the PLA would need to be consulted if consideration needed to be made to increase the discharge rate from HEAPS CSO.

4.2.8 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.

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

Table 4-3 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%

4.2.10 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.

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

4.3 Tidal Considerations

4.3.1 This section considers the HR Wallingford report titled "CSO discharge modelling for permanent works at Heathwall Pumping Station site" to establish the worst-case scenario and the impact of a CSO discharge across the full tidal range.

4.3.2 HEAPS is a controlled, pumped discharge and only varies between 11.6 m^3/s and 12.0 m^3/s between a typical year and 1:15 respectively as detailed in Table 4.1.

4.3.3 12.0m^3/s is therefore the worst-case scenario and as stated in 4.3.2 is also representative of a typical year through to 1:30 event as set out in WI 7706.

4.3.4 For the zone of impact of the lateral flow on the river, and associated tidal window, the HR Wallingford 1:15-year plumes are used to understand the most probable worst-case scenario that could occur without warning.

4.3.5 The HR Wallingford document 4410-FLOJV-HEAPS-520-VZ-RG-100001 REV: P02 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 events at the following tide states shown in Table 4-4 . 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. Notably the results are only presented for 1:15 event due the negligible difference of 0.4m^3/s between events.

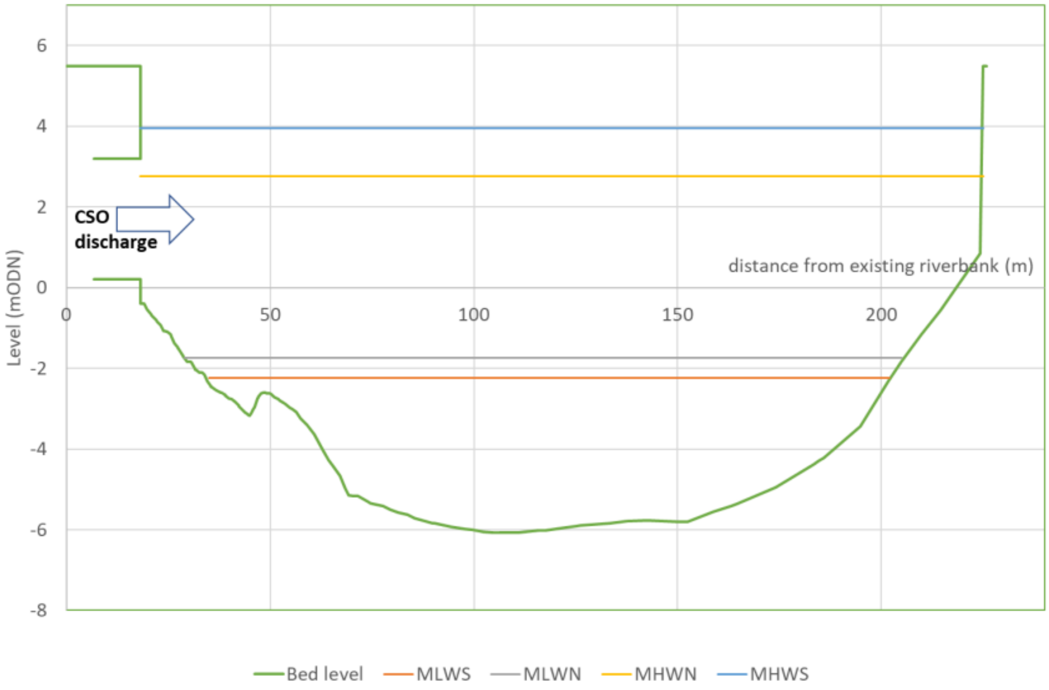
4.3.6 The report states that in considering the results it should be remembered that the model is 2D depth-averaged and hence will not model the detail of 3D aspects of the jet, especially within the distance taken for the expanding jet to mix fully with the receiving waters. Therefore, care should be 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 4-4 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

4.3.7 The height of the new CSO, relative to the riverbed and river level, is presented in Figure 4-1.

Figure 4-1 River section showing the new CSO outfall position relative to the riverbed.



4.3.8 The analysis of the tidal cases undertaken by HR Wallingford identified that despite the occurrence of the event at slack water, the jet only just reaches the limit of the Fairway with a difference of 0.2 m/s at the time of maximum discharge. Figure 4-2 presents the high-water slack, Figure 4-3 presents the mid-ebb and Figure 4-4. represents the mid flood. The three figures show that none of the depth averaged discharges extend beyond approximately 12 m from the new CSO outfall.

Figure 4-2 Depth average currents at peak 1:15-year return period peak discharge at High Water Slack.

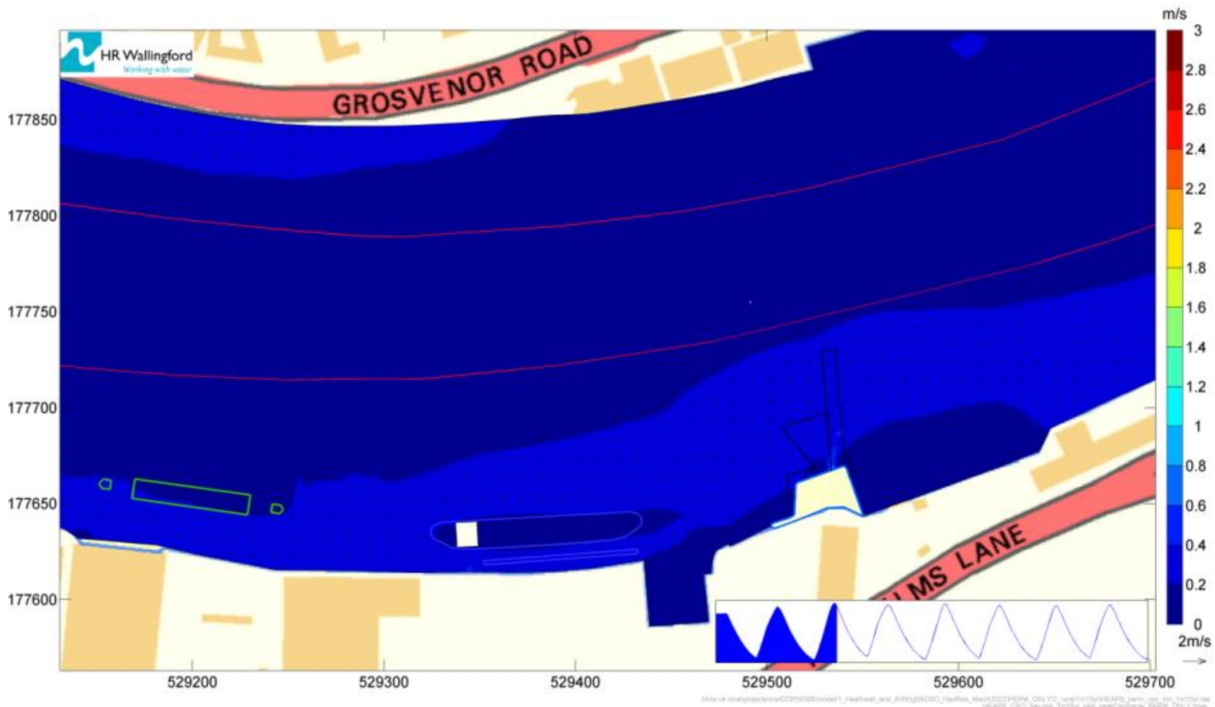


Figure 4-3 Depth average currents associated with a 1:15 return period peak discharge at mid flood

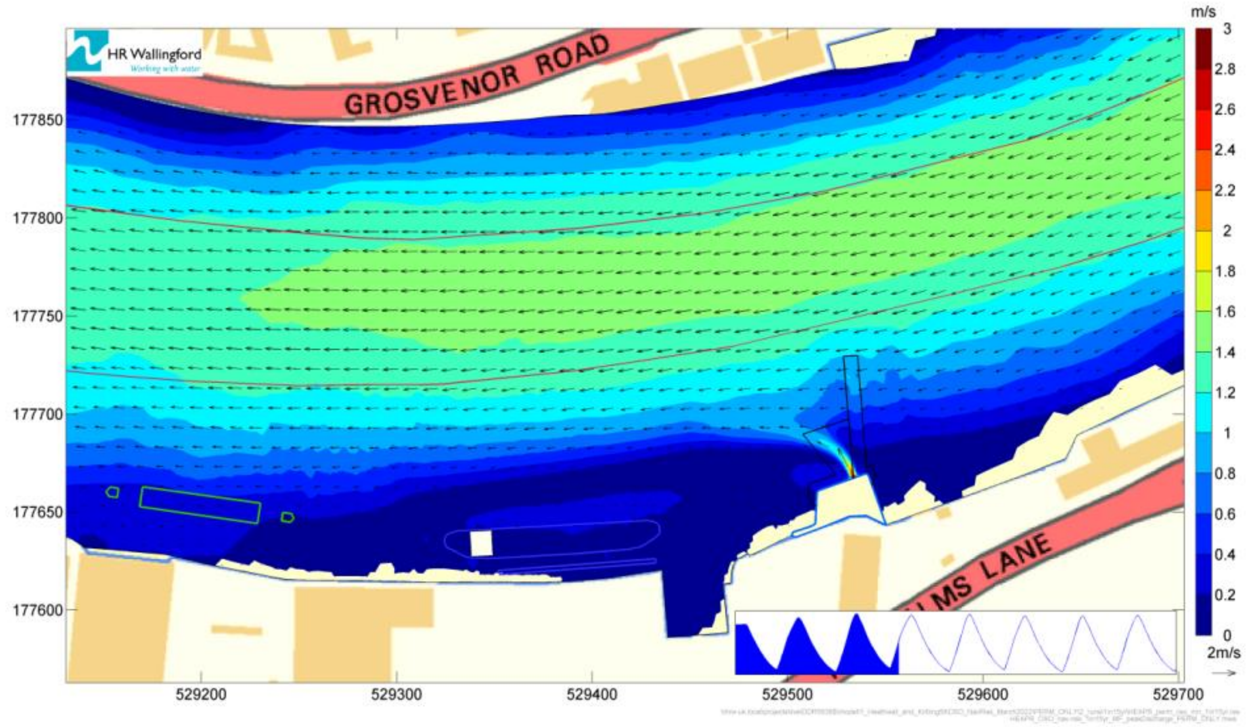
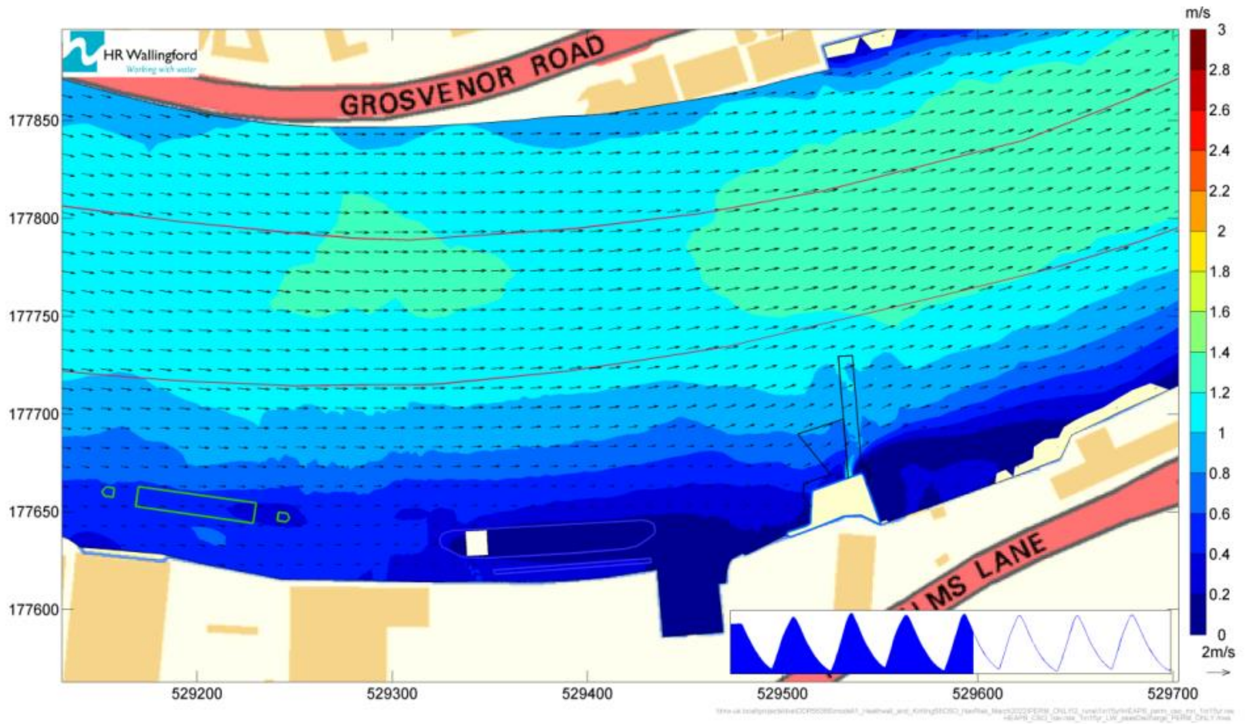
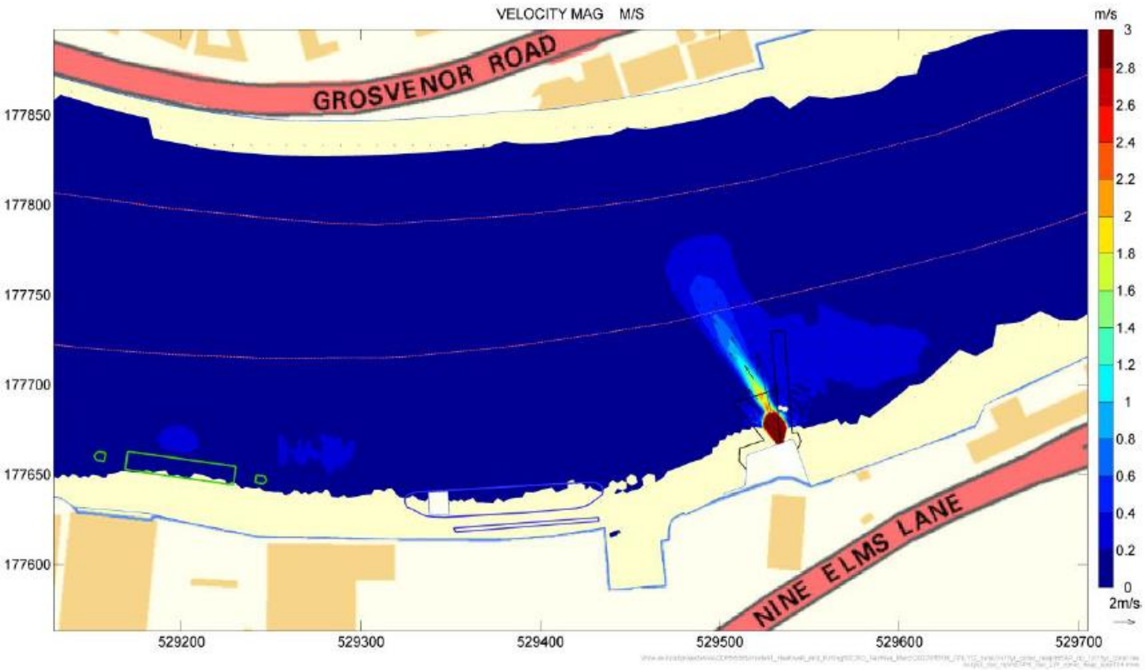


Figure 4-4 Depth average currents associated with a 1:15 return period peak discharge at mid ebb



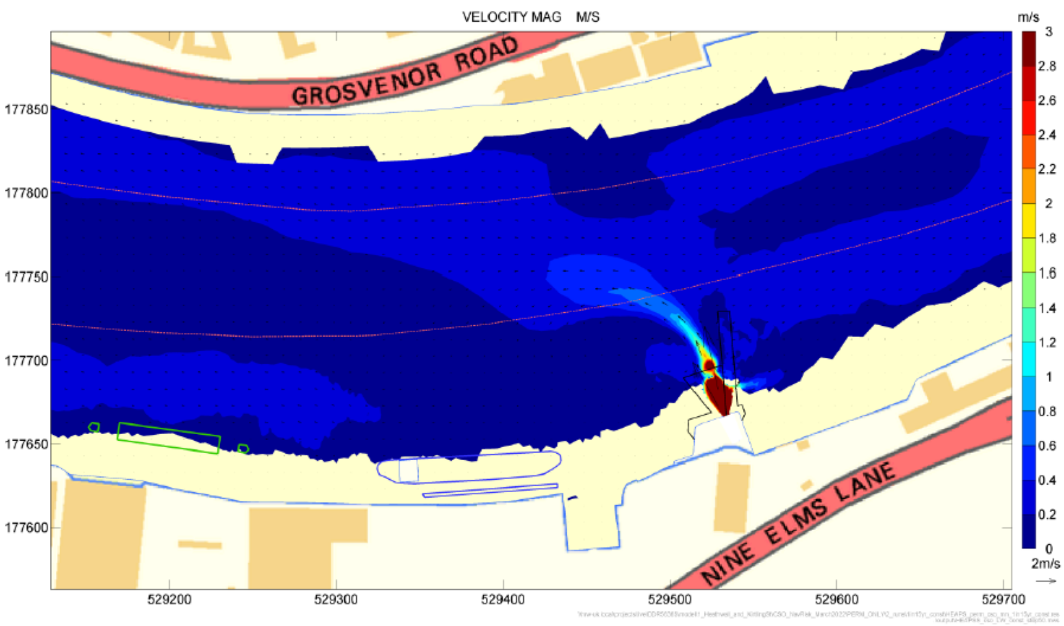
4.3.9 After analysing the scenarios over the low water periods, it has been determined that the worst case is shown in Figure 4-5, the depth averaged flows for a 1:15 year discharge at 10 minutes after neap low water slack. This is the worst case as the discharge enters the main channel perpendicular to the main flow. This is established as the worst-case scenario where the lateral flow is at its strongest due the shallowness of the water in the HR Wallingford document 4410-FLOJV-HEAPS-520-VZ-RG-100001 REV: P02 paragraph 3.1.

Figure 4-5 Depth average currents associated with a 1:15 return period peak discharge 10 minutes after neap low water slack.



4.3.10 For completeness Figure 4-6 shows the 1:15 year return peak discharge 20 minutes after spring low-water slack. This is the worst-case discharge over the low water spring scenario. In this case the lateral flow does enter the main channel but veers to run in the same direction as the main flow. This is no worse than the neap low water slack which will be used for the assessment.

Figure 4-6 Depth average currents associated with a 1:15 return period peak discharge 20 minutes after spring low water slack.



4.3.11 In summary, the most likely worst cast was the 1:15 year return period discharge ($12m^3/s$) at neap low water slacks as presented in and the period of impact in the area of the CSO is 5 minutes after low water to 25 minutes after low water within the main fairway, outside of this period the main river flow is dominant. In the inshore zone the impact of the CSO is from mid ebb to mid flood.

5. Impact on vessels on the river

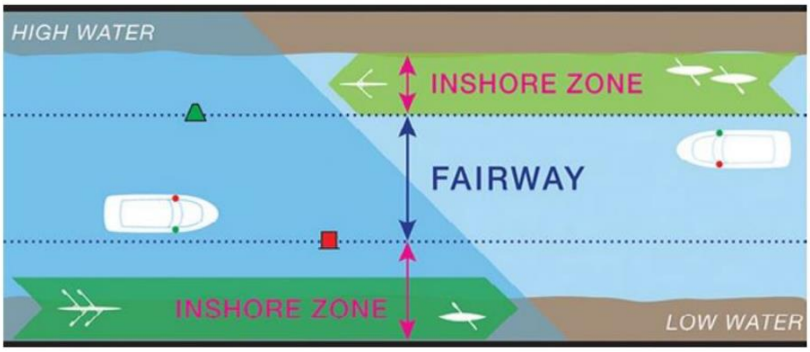
5.1 Assessment of the discharges

5.1.1 The 1:15 year event discharge plumes and sections are taken from document 4410-FLOJV-HEAPS-520-VZ-RG-100001 REV: P02

5.1.2 As stated in 4.3.1 the assessment for the impact on vessels on the river will be carried out using a 1:15 return period HEAPS CSO discharge of 12 m^3/s at low water neaps 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, which have been chosen to represent the different types of vessels on the river that could be affected by a CSO discharge at Heathwall Pumping Station (HEAPS)

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

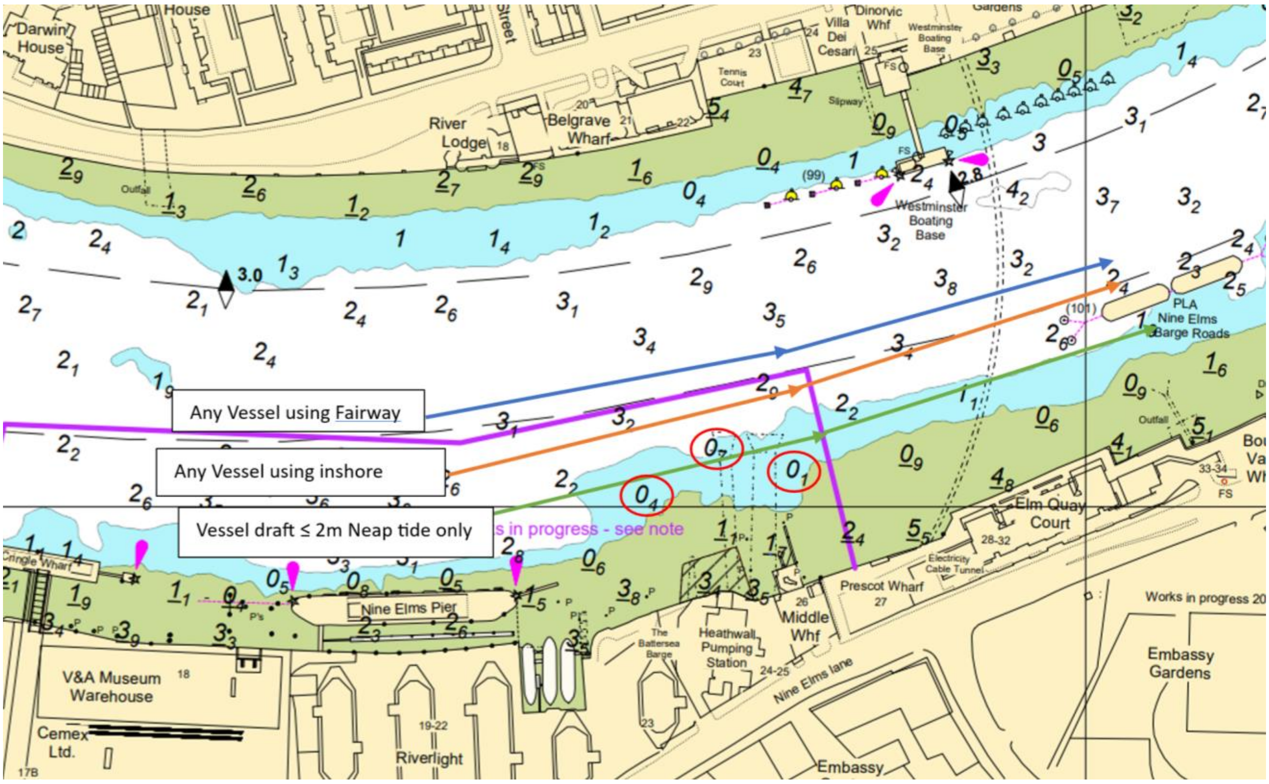
5.3 Impacts of discharge on the different classes of vessel.

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 of document '665397CH-HEAPS-DRA-Interim-Rev. 1 Ver 2' established the zone of HEAPS CSO discharge impact and displays the plan of the zone in figures 4-3 to 4-6.

5.3.3 For the purposes of identifying the magnitude of HEAPS CSO impacts occur Figure 5-3, an extract of PLA chart 314, has been produced to identify the normal course of a vessel undertaken passages downstream past the site.

Figure 5-2 Extract of PLA chart 315 marked with vessel operating zones governed by draft.



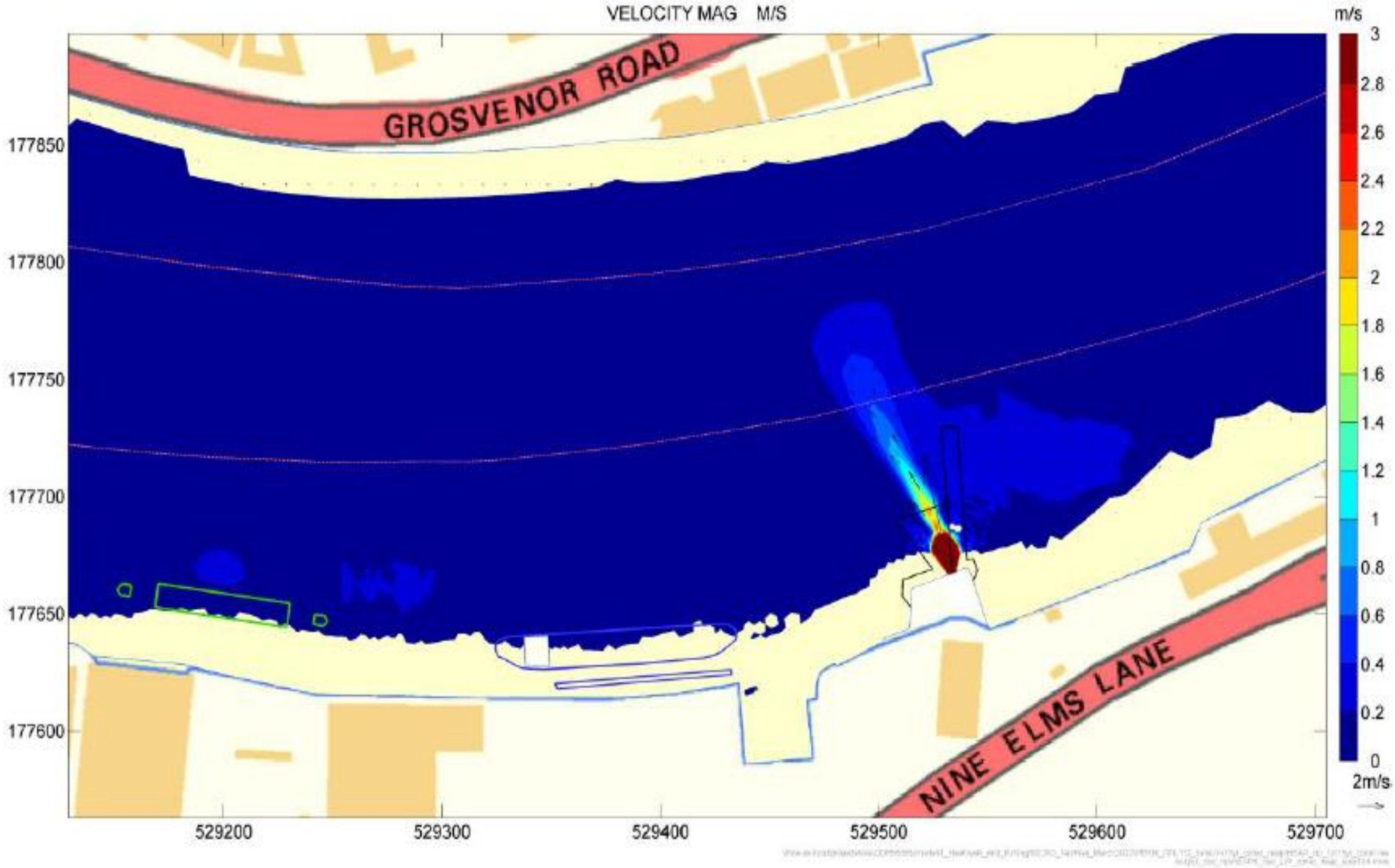
5.3.4 Figure 5-2 is an extract of PLA chart 315, which covers the Nine Elms Reach and highlights the passage of vessels transiting through the area. The Green arrowed line shows the closest potential running position for shallow draft vessels transiting downstream at low water. The orange arrowed line is a running position for reporting vessels transiting downstream in the inshore zone.

5.3.5 For vessels with a draft less than 2m transiting downstream in the inshore zone the CSO discharge impact could be 1.6m/s to 1.8m/s. For vessels transiting downstream in the normal running position in the fairway the CSO discharge impact could be 0.2m/s to 0.6m/s depth averaged velocity. For vessels transiting upstream in normal running position in the fairway the CSO discharge would be negligible as the minimal lateral flow will reach that distance.

5.3.6 Whilst considering the passage of a vessel past the CSO there will be minimal time from the start of discharge before it reaches its peak discharge of 12m^3/s due to being a pumped CSO.

5.3.7 Modelled flow velocities from HEAPS CSO outfall discharge during a 1:15-year event at ten after minutes before neap low water is shown in Figure 5-3.

Figure 5-3 Modelled flow velocities for 1:15-year discharge at ten minutes after low water neaps



5.3.8 Figure 5-3 shows the CSO discharge velocity starting at approximately 6.5m/s. This flow continues across the scour apron before contacting the water and starting to slow. As the flow reaches the end of the scour apron the velocity has reduced to approximately 1.8-2m/s. As it is not in deeper water the lateral flow continues to slow across the inshore zone, reducing to 0.6-0.8m/s as it reaches the edge of the main channel. The lateral flow continues into the channel, reaching approximately half way, but the velocity is only 0.2-0.4 m/s greater than the background flow at this point.

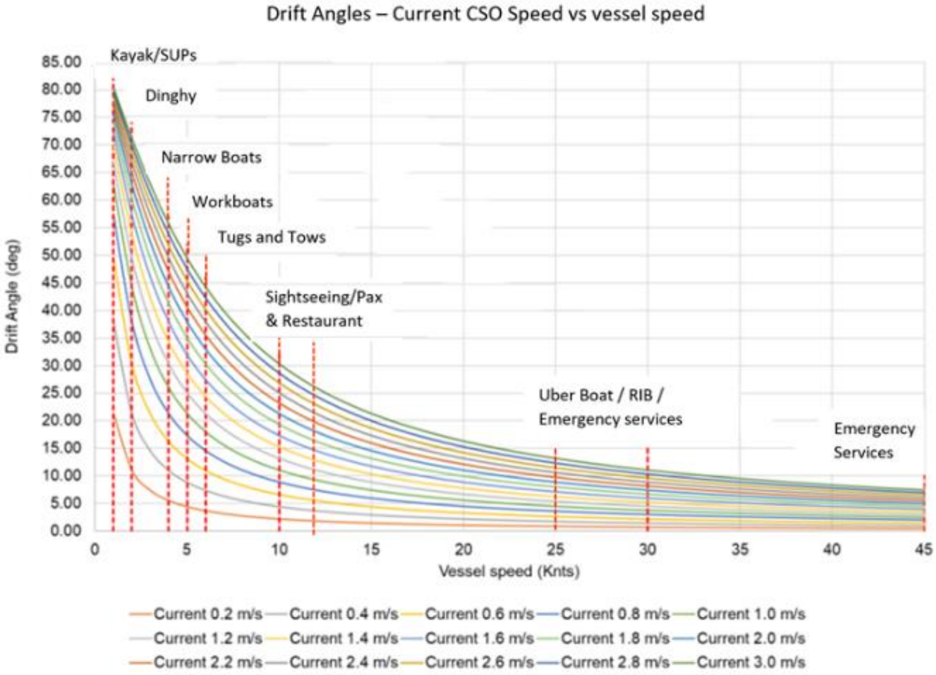
5.3.9 The governing parameter of the draft of a vessel determines the minimum depth of water that the vessel needs to safely operate without grounding. This parameter is therefore listed in Table 5-2.

5.3.10 In this area at low tide most vessels will operate in the fairway due to the lack of traffic. Shallow draft vessels (draft ≤ 2m) can transit the inshore zone and be approximately 60m from the CSO outfall therefore these vessels have been assessed passing at this distance.

5.3.11 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.

5.3.12 The drift angles of the vessels are a function of the vessel speed while impacted by the HEAPS 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



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

5.3.14 Modelled flow velocities from HEAPS CSO outfall discharge during a 1:15-year event at ten after minutes before neap low water is shown in Figure 5-3.

5.3.15 Table 5-2 presents the assessed impact of a 1:15-year HEAPS CSO discharge on the different vessel types, using the drift angle curves when the vessels are operating at the different distances with the channel and from the CSO.

5.3.16 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 during a 1:15-year CSO discharge at MLWN in the fairway and inshore zone

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 in the fairway	Approximate Distance from CSO to allow safe draft clearance at chart datum plus 1.7m	Approximation of drift angle when passing the CSO in the inshore zone.
Uber Boat (i.e., Hunt Class)	6 knots	1.2	1.7	7º	60m	17º
RIB/Emergency Services	3 knots	0.5	1.0	14º	60m	37º
Sightseeing/Pax	3 knots	1.5	2.0	14º	90m	33º
Restaurant/Pax (i.e., Symphony)	3 knots	1.8	2.3	14º	90m	33º
Tug vessel pushing	3 knots	3	3.5	14º	90m	33º
Tug vessel towing	3 knots	3	3.5	14º	90m	33º
Workboats	3 knots	0.5	1.0	14º	60m	37º
Narrowboats/Motor cruisers	3 knots	1.0	1.5	14º	60m	37º
Dinghy	1 knot	0.8	1.3	37º	60m	70º
Kayak/Rower	1 knot	0.2	0.2m	37º	60m	70º

5.3.17 Table 5-2 has determined that there is minimal impact on vessels transiting downstream in the fairway, with the exception of non-powered vessels which are moderately impacted. Vessels transiting downstream in the inshore zone are moderately impacted with the exception of unpowered vessels which will be significantly impacted as they pass HEAPS CSO.

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 state of tide is presented in Table 5-3 below.

Table 5-3 Impact of 1:15-year CSO discharge on vessels at different states of tide.

Vessel Type	Fairway / Inshore	Impact on vessel	
		Normal Running Position	Minimum achievable distance from CSO at MLWN
Uber Boat	Fairway	Minimal impact	
	Inshore	Minimal impact	Minimal impact
RIB/Emergency services	Fairway	Minimal impact	
	Inshore	Moderate impact Adjustment of course and/or speed required	Moderate impact Adjustment of course and/or speed required
Sightseeing/Pax	Fairway	Minimal impact	
	Inshore	Moderate impact Adjustment of course and/or speed required	Moderate impact Adjustment of course and/or speed required
Restaurant/Pax	Fairway	Minimal impact	
	Inshore	Moderate impact Adjustment of course and/or speed required	Moderate impact Adjustment of course and/or speed required
Tug vessel engaged in pushing/Towing	Fairway	Minimal impact	
	Inshore	Moderate impact Adjustment of course and/or speed required	Moderate impact Adjustment of course and/or speed required
Workboats	Fairway	Minimal impact	
	Inshore	Moderate impact Adjustment of course and/or speed required	Moderate impact Adjustment of course and/or speed required
Narrow boat/Motor cruisers	Fairway	Minimal impact	
	Inshore	Moderate impact Adjustment of course and/or speed required	Moderate/High impact Potential risk of collision with other vessels due to inability to maintain course
Dinghy/Kayak/SUP//Rower	Fairway	Moderate/High impact Potential risk of collision with other vessels due to inability to maintain course	
	Inshore	High impact Unable to maintain course and/or speed, Risk of collision with other vessels due to inability to maintain course.	High impact Unable to maintain course and/or speed, 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 vessels transiting downstream in the fairway past the CSO when it is discharging at low water neaps, except for a Kayak/Dinghy/SUP/Rower which will be moderately/highly impacted.

- There is moderate impact on most vessels transiting downstream in the inshore zone past the CSO when it is discharging at low water neaps except for the Uber boat which receives a minimal impact and a Kayak/Dinghy/SUP/Rower which will be highly impacted.

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 of the interim DRA. 665397CH-HEAPS-DRA-Interim-Rev. 1 Ver 2. which identified the periods 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 The HR Wallingford ship simulation centre did not have a suitable model that would represent Class V vessels. It was proposed, and agreed by the mariners at both simulation sessions, that the impact of the CSO and the response of Narrowboats, Tug Pushing and clippers would be representative of the response of a range of Class V vessels.

6.1.4 The simulations for Heathwall Pumping Station were undertaken at the HR Wallingford Ship Simulation Centre during on the 5th of March 2024 with representatives from HR Wallingford, Tideway, Waves and the Port of London Authority.

6.1.5 The full table of simulations undertaken for HEAPS on the 5th March 2021 are presented Figure 6-1, which include the comments on the run, which were agreed by the attendees following each simulation.

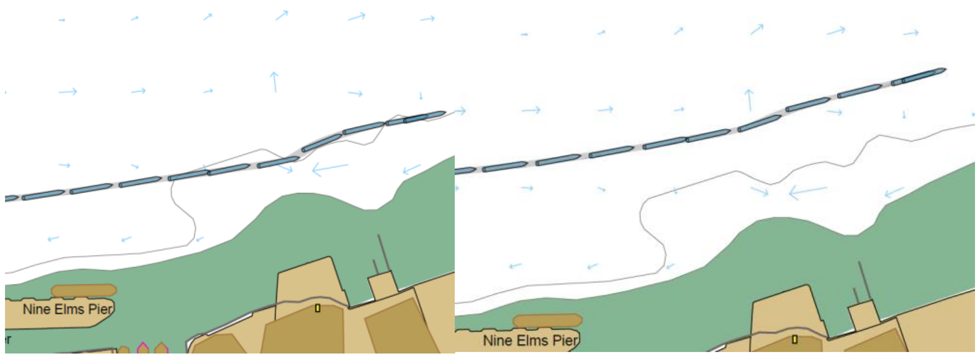
Figure 6-1 Extract of simulated cases for HEAPS

Run ID	CSO	Ship	Manoeuvre	Bridge arch	Tidal condition	Comments
15	HEAPS	Narrowboat close to bank (Inshore)	Outbound 4 knots	-	Low water slack	The vessel experienced a marginal deviation (3-4 m) but was able to safely recover
16	HEAPS	Narrowboat on edge of fairway	Outbound 4 knots	-	Low water slack	Vessel unaffected by the discharge
17	HEAPS	Kayak close to bank (Inshore)	Outbound 3 knots	-	Low water slack	Vessel initially diverted rapidly and then more gradually 40 m towards the main fairway
18	HEAPS	Kayak on edge of fairway	Outbound 3 knots	-	Low water slack	Vessel unaffected by the discharge
19	HEAPS	28 m tug pulling 50 m unladen barge - on edge of fairway	Outbound 3 knots	-	10 minutes before slack water	Vessel unaffected by the discharge

6.1.6 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, whilst the track of each simulation was recorded so that it could be reviewed.

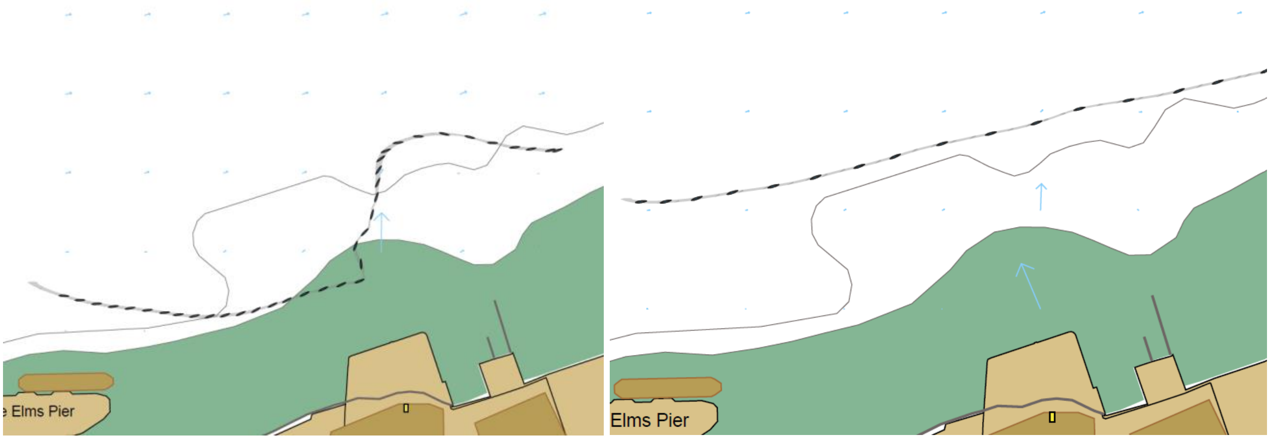
6.1.7 Figure 6-2 shows tracks 15 and 16 which were undertaken at low water slacks. Track 15 is of a narrow boat transiting the site outbound at 4 knots within the inshore zone. Track 16 is a narrow boat transiting the site outbound at 4 knots at the edge of the main fairway. Whilst the course of the narrow boat in the inshore zone was deviated due to the discharge it was not significant and it regained control recovering its course easily. The narrow boat at the edge of the main fairway was unaffected.

Figure 6-2 Record of runs 15 and 16



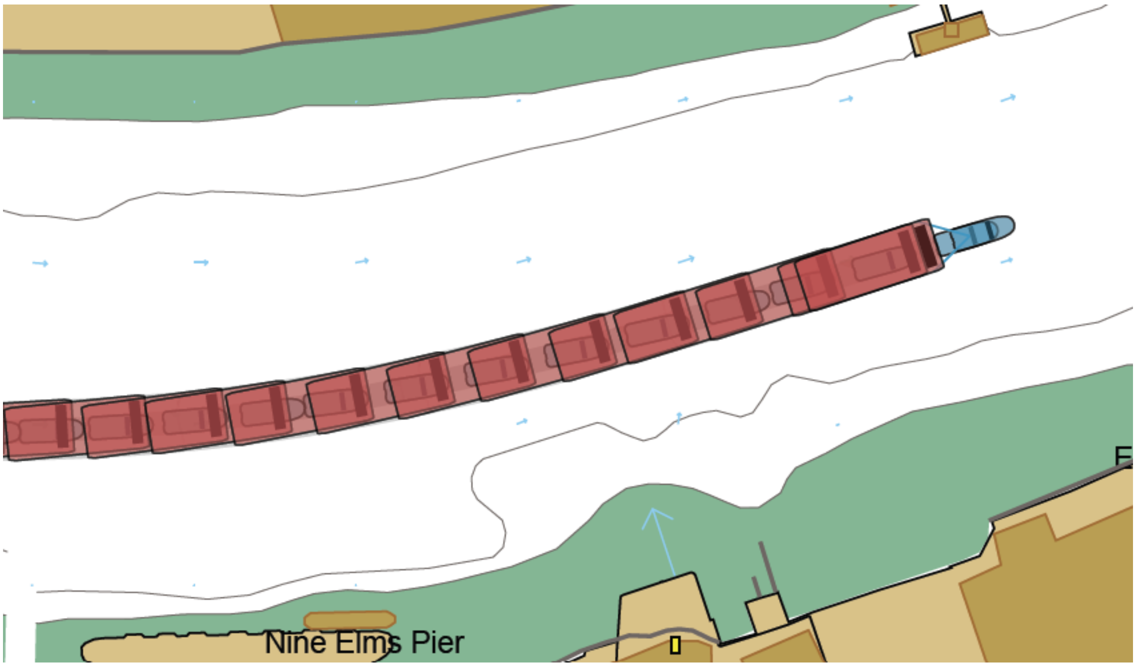
6.1.8 Figure 6-3 shows tracks 17 and 18 which were undertaken at low water slacks. Track 17 is of a kayak transiting the site outbound at 3 knots within the inshore zone. Whilst track 18 is a kayak transiting the site outbound at 3 knots at the edge of the main fairway. The course of the kayak in the inshore zone was significantly deviated due to the discharge and pushed the kayak out to the edge of the main fairway but the kayak was able to recover its course. It should be noted that the course of the kayak was not deviated into the main fairway and would be unlikely to impact the course of a powered vessel transiting downstream. The kayak at the edge of the main fairway was unaffected. It should be noted that the whilst the model of the kayak and its response to flows is reasonably accurate, the steering mechanism is basic and presents a more extreme outcome than the true control of a kayaker.

Figure 6-3 Record of runs 17 and 18



6.1.9 For completeness Figure 6-4 shows track 19 which is of a tug towing at the edge of the fairway. undertaken at low water slacks. The tug undertook the passage at 3 knots at 10 minutes after low water slacks and the tug and tow was unaffected by the CSO discharge.

Figure 6-4 Record of run 19



6.1.10 Following the completion of the ship simulations past the HEAPS CSO outfall the impacts on the vessels were considered against the desk top assessment presented in Table 5.3. The summary of these changes are presented in Table 6-1 The key changes provided by the simulations were a reduction of the impacts in the majority of cases.

Table 6-1 Record of changed of impact on vessels

Vessel Type	Fairway / Inshore	Impact on vessel	
		Normal Running Position	Minimum achievable distance from CSO at MLWN
Uber Boat	Fairway	No Impact	Not Applicable
	Inshore	No change	No change
RIB/Emergency services	Fairway	No Impact	Not Applicable
	Inshore	Minimal impact	Minimal/Moderate Adjustment of course and/or speed required
Sightseeing/Pax	Fairway	No Impact	Not Applicable
	Inshore	Minimal impact	Minimal/Moderate Adjustment of course and/or speed required
Restaurant/Pax	Fairway	No Impact	Not Applicable
	Inshore	Minimal impact	Minimal/Moderate Adjustment of course and/or speed required
Tug vessel engaged in pushing/Towing	Fairway	No Impact	Not Applicable
	Inshore	Not Applicable	Not Applicable
Workboats	Fairway	No Impact	Not Applicable
	Inshore	Minimal impact	Minimal/Moderate Adjustment of course and/or speed required
Narrow boat/Motor cruisers	Fairway	No Impact	Not Applicable
	Inshore	Minimal impact	Minimal/Moderate Adjustment of course and/or speed required
Dinghy/Kayak/SUP/Rower	Fairway	Minimal Impact	Not Applicable
	Inshore	No change	No change

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 HEAPS 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 during for the permanent state of the HEAPS CSO discharge.

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 HEAP 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

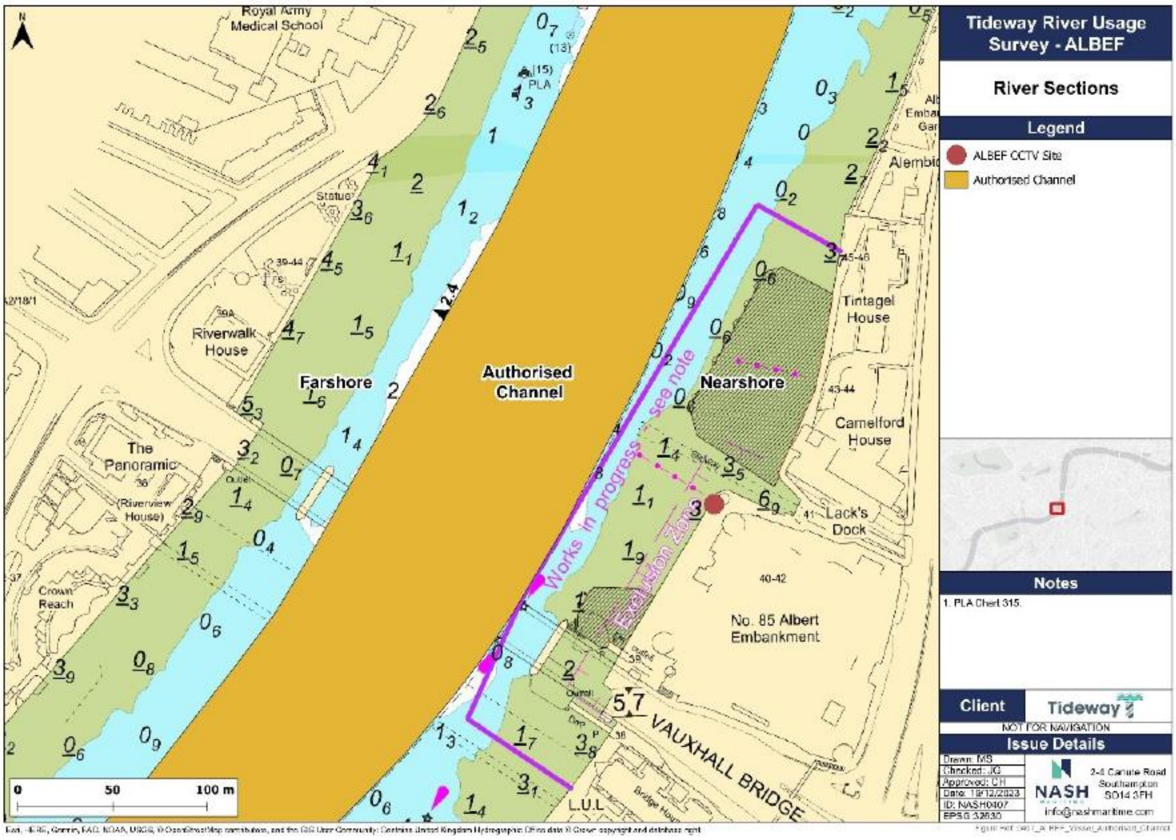
iv) Collision between unpowered vessels and powered vessels

7.3 Receptors

7.3.1 CCTV surveys of the river were undertaken at ALBEF from the 22nd September 2023 to the 31st December 2023, but data has been processed from the period 22nd September 2023 to 10th of November 2023 giving a 7 week data set and the analysis of the data is presented in document "Tideway Central ALBEF Traffic Survey Report 12I05". As the HEAPS CSO outfall is on the same bank of the river and only half a mile upstream of the Albert Embankment Foreshore site it is a reasonable assumption that the vessels that were recorded passing the ALBEF would have also passed HEAPS.

7.3.2 The analysis of the CCTV data was carried out to determine the class of vessels transiting past the site 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 ALBEF



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

Table 7-1 Nearshore, Authorised Channel, Nearshore and Farshore sections of the River Thames at HEAPS

PLA Vessel Class	Nearshore	Authorised Channel	Farshore	Total
Uber Boat	15	3,581	0	3,596
RIB/Emergency Services	10	387	15	412
Class 5 Passenger	2	742	3	747
Tug	32	278	86	396
Tug (Pushing)	9	71	0	80
Tug (Towing)	1	225	1	227
Workboat	97	670	13	780
Recreational Cruiser	0	170	1	171
Narrowboat	0	32	0	32
Sailing Dinghy	0	26	8	34
Kayak	4	5	23	32
Rowing Boat	0	18	5	23
SUP	0	3	1	4
Coach / Safety Boat	0	15	1	16
Total	170	6,194	148	6,512

7.3.4 From the analysis undertaken in section 5, the vessels that receive the largest impact are the unpowered vessels such as the kayak, SUP, sailing boat and rowing boat. As such these will be the primary focus in understanding the numbers that transit the site eastbound, which would be the most likely route which would expose them to a CSO discharge.

7.3.5 There were 93 unpowered vessels transiting the site during the study period, of the 93 there were just 21 east bound transits, which would be the most likely to be exposed to a CSO discharge. The 21 east bound transits consisted of 9 kayaks and 12 rowing boats however the Kayaks transited the site at around high water, whereas the rowing boats split the transits of the site with 6 transiting with an hour of low water and the remaining 6 transiting at high water.

7.3.6 Table 6-1 Record of changed of impact on vessels, only vessels with a draft less than 1.5m have been assessed as operating in the inshore zone at low water neaps.

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 4410-FLOJV-HEAPS-520-VZ-RG-100001 REV: P02. The risk assessment has also established the $12m^3$/sec to be the most probable worst-case scenario.

7.5.3 It has been established from the desk top study that the peak flow velocity plumes presented in the 2-d HR Wallingford report, will impact vessels operating on the Thames for a period of 20 minutes, from 5 minutes after low water to 25 minutes after low water within the main fairway and from mid ebb to mid flood in the inshore zone. Outside of these periods the main river flows are dominant.

7.5.4 The tidal window for the inshore zone identified in 7.5.3 is considered conservative due to the inability to identify the point between mid-ebb and mid flood when the inshore zone will not be impacted by the lateral flow from the CSO discharge. In addition, river users transiting downstream are likely to take avoiding action as they would be able to see the CSO discharging and the flow running over the scour apron.

7.5.5 Once the tunnel is in operation the number of discharges is predicted to be reduced to between 4 and 5 discharges in a typical year, reduced from 35 (average) CSO discharges a year.

7.5.6 The analysis was undertaken for neap 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.

7.5.7 Taking all the above-mentioned factors into consideration then the likelihood of harm is considered highly unlikely for vessels using the main fairway at periods of low water and unlikely for vessels using the inshore channel at low water neaps during a 1:15 year return period CSO discharge.

8. Mitigation

8.1.1 The ERIC 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 The HEAPS CSO outfall is needed to allow sewers to discharge when they reach capacity and prevent the risk of flooding upstream in the catchment area. To eliminate the flows entirely would require the closing of the CSO outfall and would flood the upstream catchment area during storm events and is therefore not feasible.

8.3 Reduce

8.3.1 The number of discharges will be reduced by bringing the main tideway tunnel into operation. This will reduce the number of discharges from the average of 35 per typical year down to 4 discharges anticipated in a typical year from HEAPS CSO. In addition, the SWSR CSO discharges will reduce from the average of 49.5 discharges down to 1 discharge in a typical year.

8.3.2 To reduce the risk of impact to vessels transiting the site a warning system could be adopted for the permanent works in line with the proof of concept which is being developed in consultation with the PLA and main works contractors.

8.3.3 Consideration was made to the use of cardinal posts to warn vessel users of the potential hazard. These were not considered to be not reasonably practicable due to the size of the post due to the large tidal range and because they would be redundant for the majority of the time.

8.4 Inform

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

8.4.2 As part of the work for the proof of concept a key measure is developing a method of informing the PLA via a live feed dashboard displaying the status of the CSO's.

8.4.3 Promulgation of the operational plan to river users.

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 to identify that there could be an increase in the frequency of a CSO discharge.

8.5 Control

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

8.5.2 Operation plan for the warning system to include warning trigger points, which 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 are required and can be adopted that can reduce the risks to an acceptable level.

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

(a) Limited impact of CSO discharges on powered vessels in the fairway,

(b) The limited number of unpowered vessels that transit the site eastbound.

(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 and to proceed with caution.

Powered Vessels

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

9.1.4 In the case of powered vessels, the risk is considered negligible (very low) as all powered vessels can pass, with minimal impact, within the fairway during a discharge.

9.1.5 The risk to powered vessels operating in the inshore zone is considered low as the vessel would be exposed to the lateral flow for a very small amount of time.

Unpowered Vessels

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

9.1.7 In the case of manually operated or unpowered vessels the risk is considered low as any impact of a discharge on one of the vessels would be unlikely to deviate it into main fairway.

Navigational Risk Assessment

9.1.8 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 HEAPS CSO outfall.

9.1.9 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

9.1.10 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,
- 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,

9.1.11 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.

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

9.1.13 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 for the permanent works.

9.2 Key information

9.2.1 The most credible worst case CSO discharge is for a 1:15 year return period storm with a discharge of 12m^3/s from HEAPS CSO. The frequency of discharges once the tunnel is in operation is expected to between 4 and 5 in a per year.

9.2.2 Consideration has not been made to the impact of the SWSR CSO due it being a historical outfall, but using the same criteria of the most credible worst-case discharge is for a 1:15 year return period event with a discharge of 31m^3/s. The frequency of discharges once the tunnel is in operation is expected to be a single discharge in a typical year.

9.2.3 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.

9.2.4 The assessment considers the river as defined in Figure 5-1 and the critical discharge occurring at low water neaps. The discharges are considered to impact the inshore zone nearest the CSO and the main fairway within the following tidal windows in Table 9-1.

Table 9-1 Times of impact

Inshore Zone		Main Fairway	
Start	End	Start	End
Mid Ebb	Mid Flood	LW +5 minutes	LW +25 minutes

9.2.5 It should be noted it is not possible to predict the discharges within 30m of the CSO outfall at any state of the tide.

9.2.6 It is noted that during any slack periods such as the closure of the Thames barrier that the same consideration should be given to the discharge as if it were at LW slack.

9.2.7 The proof-of-concept document (LONDON TIDEWAY TUNNELS PROOF OF CONCEPT - CSO DISCHARGE WARNING DRAFT 27/02/24) provides the discharge hydrographs that should be utilised in the development of suitable warning times in the development of the detailed design undertaken by the MWC.

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

9.2.9 A warning 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.
10. Multiple fatalities and catastrophic event

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 HSEID residual
Medium	HSEID risk resulting from design is permitted with appropriate design controls and management oversight in place.
Low	HSEID risk resulting from design is permitted.

RISK

LIKELIHOOD					
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-HEAPS-024-A	Non-powered craft underway - Low tide	Permanent	Kayak/Rower/Dinghy 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 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and/or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-B	Non-powered craft underway -Low tide	Permanent	Kayak/Rower/Dinghy 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 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and/or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-C	Non-powered craft underway -Low tide	Permanent	Kayak/Rower/Dinghy 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 3. Reduction in number of discharges by intercepting flows.	1	4	4	Public:Major injury or illness due to exposure to sewage	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-D	Non-powered and Rec. powered vessel underway - Low Tide	Permanent	Kayak/Rower/Dinghy 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 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-E	Non-powered and Commercial powered vessel underway - Low tide	Permanent	Kayak/Rower/Dinghy navigating in the inshore zone and commercial powered vessel navigating 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 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-F	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	4	4	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	4	4	Public: Major injury	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-G	Rec. Powered Vessel and Commercial Powered Vessel underway - Low 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 3. Reduction in number of discharges by intercepting flows.	1	4	4	Public: Major injury	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-H	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 3. Reduction in number of discharges by intercepting flows.	1	3	3	Public: Injury	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-I	Non-powered craft underway - All other states of tide	Permanent	Kayak/Rower/Dinghy 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 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Illness due to exposure to sewage or Drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents

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DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date

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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 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-HEAPS-024-J	Non-powered craft underway - All other states of tide	Permanent	Kayak/Rower/Dinghy navigating 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 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Illness due to exposure to sewage or Drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-K	Non-powered and Rec. powered vessel underway - All other states of tide	Permanent	Kayak/Rower/Dinghy and recreational powered vessel navigating 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 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-L	Non-powered and Commercial powered vessel underway - All other states of tide	Permanent	Kayak/Rower/Dinghy and commercial powered vessel navigating 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 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-M	Rec. Powered Vessel underway -All other states of tide	Permanent	Rec. Powered Vessel navigating 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 3. Reduction in number of discharges by intercepting flows.	1	3	3	Public: Injury or illness due to exposure to sewage	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-N	Rec. Powered Vessel and Commercial Powered Vessel underway - All other states of tide	Permanent	Rec. Powered Vessel navigating 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 3. Reduction in number of discharges by intercepting flows.	1	4	4	Public: Major injury	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-HEAPS-024-O	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 3. Reduction in number of discharges by intercepting flows.	1	3	3	Public: Injury/ illness due to exposure to sewage	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM- HEAPS- 024-P	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	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	3	3	Public: Injury/ illness due to exposure to sewage	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents