

# Thames Pedestrian and Cycle Bridge, Canary Wharf to Rotherhithe

## Chapter 6: Operational Parameters

February 2016



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# 1. Introduction

In order for the bridge to provide an effective means of crossing the river, it must ensure that it causes minimal disruption to cyclists and pedestrians, within the requirements of the bridge to allow unrestricted river traffic flow.

The bridge will need to lift to allow certain types of river traffic to pass, and therefore close temporarily to users crossing the bridge. This will lead to a gradual build-up of crowds on the banks.

This note presents the parameters for the operation of the bridge. The operation covers the management of crowds and user flows, communications with river traffic and the public, and emergency and maintenance access.

## 1.1 Operational Objectives

- Adhere to requirements by the Port of London Authority (PLA) to allow vessels to pass unrestricted at all times (subject to appropriate notice, etc.)
- Allow for smooth and safe user flows on the bridge
- Minimise disruption to those who rely on the bridge as a regular crossing point
- Ensure cost-effective operation of the bridge without compromising on user experience or safety
- Minimise impact on landing zones and neighbouring residents

## 1.2 References

- Equality Act (2010)
- Environmental Protection Act (1990)
- Office for Rail Regulation, Rail Passenger Experience (2014)
- Passenger Focus, Passenger Information when Trains are Disrupted (2014)
- Transport Focus, Short and Tweet: How Passengers Want Social Media During Disruption (2012)

## 1.3 Factors Explored

The following factors are discussed due to their impact on early design stages:

1. Crowd Management
2. Communications Protocol
3. Maintenance
4. Emergencies, Events and Incidents

## 2. Crowd Management

Managing crowds and user flows is crucial in order to maintain the safety of users, ensure uninterrupted and smooth flows over the bridge, avoid crowd build up or congestion, and minimise the impact crowds may have on the landing sites and surrounding areas.

### 2.1 Determining Crowd Size

Crowd size has been determined for both the 'most likely' scenario (probable expected crowd sizes) and 'worst credible' scenarios (improbable but theoretically possible crowd size, i.e. a cruise ship requiring a bridge lift during the morning peak hour).

Possible crowd sizes have been calculated by:

- examining the likely occurrences and duration of bridge lifts at different times of the day. This has been based both on the number of times Tower Bridge lifted over a given period (Table 1 below), and the vessel traffic data collected by Marico in Chapter 4 and the Marico Vessel Traffic Analysis report (Table 2 below)
- forecasting the number of users expected at different times of the day, and calculating the user flow rate (see Chapter 2 and Appendix B)
- multiplying the projected number of users per minute by the duration of the bridge lift process

A full breakdown of data can be found in Appendix B.

#### 2.1.1 Impact of Lift Duration on Crowd Sizes

In order to understand the likelihood of bridge lifts occurring during peak hours of bridge use, data was collected from two sources.

The number of lifts of Tower Bridge was noted during a 48 day period throughout August and September (collected from <http://www.towerbridge.org.uk/lift-times/>). During this period, the bridge was listed as lifting a total of 63 times, with 39 lifts occurring on weekdays. Table 1 below shows the total number and times of lifts that took place during weekdays at Tower Bridge.

In addition, Marico Marine Consultants were commissioned to undertake a vessel traffic analysis to survey the number and type of vessels that navigated the Thames at the bridge site. This was based on visual observations during two days in August 2015 and AIS (Automatic Identification System) data for the month of August 2014 (see Appendix C Vessel Traffic Analysis). The AIS data recorded the number of vessels passing through the bridge site and their air draught to determine whether they would require a bridge lift to take place. This calculation was based on the geometries deemed to be acceptable by the PLA, of a closed configuration with a headway clearance of 20m:

- All vessels with an air draught of 25m or more would be tall enough to require the bridge to lift
- Vessels with an air draught of 20m would sometimes require a bridge lift, depending on the height of the tide

Marico observed that during the month of August 2014, there were a total of 93 vessels navigating through the bridge site that would require a bridge lift:

- 77 vessels with an air draught of 25m or more
- 16 vessels (out of 21 in total) with an air draught of 20-25m that would require the bridge to lift

The findings are summarised in Table 2 on page 7. The estimated number of 93 bridge lifts per month (equivalent to 3.1 lifts per day), is noted by Marico to be pessimistic, as it presumes that the bridge will need to lift for each individual vessel. Marico, however, assert that in reality two or more vessels may be able to pass through the bridge at the same time.

| Start time             | End time     | No. of vessels requiring lift | Lifts occurring during weekday as % of total lifts |
|------------------------|--------------|-------------------------------|--|
| 00:00                  | 06:00        | 0                             | 0%   |
| 06:00                  | 07:00        | 2                             | 3%   |
| 07:00                  | 08:00        | 1                             | 2%   |
| <b>08:00</b>           | <b>09:00</b> | <b>2</b>                      | <b>3%</b>  |
| 09:00                  | 10:00        | 3                             | 5%   |
| 10:00                  | 11:00        | 5                             | 8%   |
| 11:00                  | 12:00        | 2                             | 3%   |
| 12:00                  | 13:00        | 0                             | 0%   |
| 13:00                  | 14:00        | 0                             | 0%   |
| 14:00                  | 15:00        | 4                             | 6%   |
| 15:00                  | 16:00        | 4                             | 6%   |
| 16:00                  | 17:00        | 3                             | 5%   |
| 17:00                  | 18:00        | 2                             | 3%   |
| <b>18:00</b>           | <b>19:00</b> | <b>8</b>                      | <b>13%</b>   |
| 19:00                  | 20:00        | 0                             | 0%   |
| 20:00                  | 21:00        | 0                             | 0%   |
| 21:00                  | 22:00        | 3                             | 5%   |
| 22:00                  | 23:00        | 0                             | 0%   |
| 23:00                  | 00:00        | 0                             | 0%   |
| <b>Total Instances</b> |              | <b>39</b>                     | <b>62%</b>   |

Table 1: Number of lifts at Tower Bridge for vessels of any height on weekdays between 20 August and 7 October 2015

**Darker shading indicates greater proportion of bridge lifts at this time (BST)**

| Start time             | End time     | No. of vessels requiring lift | Percentage of total vessels at each time of day |
|------------------------|--------------|-------------------------------|---|
| 00:00                  | 06:00        | 5                             | 5%  |
| 06:00                  | 07:00        | 2                             | 2%  |
| 07:00                  | 08:00        | 1                             | 1%  |
| <b>08:00</b>           | <b>09:00</b> | <b>3</b>                      | <b>3%</b>                                       |
| 09:00                  | 10:00        | 1                             | 1%  |
| 10:00                  | 11:00        | 5                             | 5%  |
| 11:00                  | 12:00        | 6                             | 6%  |
| 12:00                  | 13:00        | 6                             | 6%  |
| 13:00                  | 14:00        | 7                             | 8%  |
| 14:00                  | 15:00        | 10                            | 11%   |
| 15:00                  | 16:00        | 6                             | 6%  |
| 16:00                  | 17:00        | 5                             | 5%  |
| 17:00                  | 18:00        | 7                             | 8%  |
| <b>18:00</b>           | <b>19:00</b> | <b>3</b>                      | <b>3%</b>                                       |
| 19:00                  | 20:00        | 12                            | 13%   |
| 20:00                  | 21:00        | 2                             | 2%  |
| 21:00                  | 22:00        | 10                            | 11%   |
| 22:00                  | 23:00        | 2                             | 2%  |
| 23:00                  | 00:00        | 0                             | 0%  |
| <b>Total Instances</b> |              | <b>93</b>                     | <b>100%</b>                                     |

Table 2: Number of vessels passing bridge site with air draught of 20m or more requiring a bridge lift during August 2014.

**Darker shading indicates greater proportion of bridge lifts at this times (BST)**

Based on the number of bridge lifts of Tower Bridge shown in Table 1:

- 3% of weekday lifts at Tower Bridge occurred during the morning peak hour of 8am to 9am
- 13% of weekday lifts at Tower Bridge occurred during the evening peak of 6pm to 7pm

Based on the vessels navigating the bridge site in August 2014 shown in Table 2:

- 5% of bridge lifts would have occurred during the morning peak of 7am to 10am. This supports the expectation that there is a very low likelihood of bridge lifts occurring during the morning peak hour
- 3% of bridge lifts would have occurred during the morning peak hour of 8am to 9am. However, these 3 vessels were all recreational sailing vessels with an air draught of around 23m, and would not require a lift of a long duration (described as in Section 2.1.3 below). This supports the expectation that there is a very low likelihood of bridge lifts (particularly of longer durations) occurring during the morning peak hour

- 16% of bridge lifts would have occurred during the evening peak of 4pm to 7pm. This supports the expectation that the evening peak is more likely to be affected by a bridge lift than the morning peak
- 3% of bridge lifts would have occurred during the evening peak hour of 6pm to 7pm. This suggests that even though bridge lifts are more likely to occur during the evening peak, they are still less likely to impact the peak hour when evening user flows are at their highest

### 2.1.2 Usage Forecasts

Crowd sizes have been determined based on three forecasts of user flows from 2020 – 2030:

- **2020 Estimate:** These figures are based on the proportions of daily trips made in 2013 to the Isle of Dogs by bicycle and foot, which show a 4% cycling mode share. Estimates also factor in population growth and the increase in the total number of trips made at 5.5% per year, and an increase in the cycling mode share of 4.1% per year. Total daily usage is estimated at 10,200 trips per day (see Chapter 2: Business Case)
- **2030 ‘Linear Estimate’:** These figures are based on the same calculations as the 2020 estimate, assuming a constant growth in population, the total number of trips made and cycling mode share. Total daily usage is estimated at 11,028 trips per day
- **2030 ‘High Estimate’:** These figures are based on the same calculations as the 2020 estimate, assuming instead that there is a high (15%) mode share of cycling by 2030.<sup>1</sup> Total daily usage is estimated at 12,624 trips per day

The total daily usage forecasts are for the total number of trips made per day originating from south of the river both to and from Canary Wharf. Although there will be some additional trips in the reverse direction, the main crowding risk would result from trips from the south to the north, during the morning peak hour. Similarly, evening travel would reverse this flow, with the greatest crowding risk resulting from trips from north to south during the evening peak hour. Further information on usage forecasts and calculations can be found in Chapter 2, Section 6 and Appendix B.

The size of crowds during a bridge lift was calculated based on the estimated flow rate of users (i.e. the number of users arriving to cross the bridge per minute) multiplied by the duration of the bridge lift in minutes (see Appendix B). For the purpose of this section, it has been assumed that no users seek alternate routes, in order to calculate the maximum theoretical crowd sizes.

### 2.1.3 Scenario 1: ‘Worst Credible’

The ‘Worst Credible’ scenario is based on the following assumptions:

- **Timing:** A bridge lift occurs during the morning peak hour – the time of day during which there are the most users crossing the bridge
- **Duration:** The bridge lift lasts for 45 minutes – the maximum calculated duration of a bridge lift as advised by the PLA, in the case of a cruise ship or warship navigating the Thames
- **User Flows:** Usage is based on the ‘High Estimate’ in 2030 – a forecast based on a 15% cycling mode share and 5.5% population growth. The direction of flow at this time is assumed to be entirely from South to North (Rotherhithe to Canary Wharf). The total number of cyclists and pedestrians is estimated at 2,485 between 8am and 9am
- No prior warning has been received by any users, and therefore no alternate plans for their journeys are made

<sup>1</sup> High estimated forecast of cycling mode share in the Phil Jones Associates Cycle Demand Study, Southwark (2013)

Based on the above assumptions, the impact of scenario 1 would be a crowd build-up of 1,864 users during a bridge lift of 45 minutes duration taking place in the morning peak hour of 8am to 9am (see Table 3 below).

| Start time | End time | 2020 estimate | 2030 'linear estimate' | 2030 'high estimate' |
|------------|----------|---------------|------------------------|----------------------|
| 06:00      | 07:00    | 222           | 236                    | 263                  |
| 07:00      | 08:00    | 733           | 779                    | 868                  |
| 08:00      | 09:00    | <b>1,575</b>  | <b>1,673</b>           | <b>1,864</b>         |
| 09:00      | 10:00    | 1,029         | 1,093                  | 1,218                |
| 10:00      | 11:00    | 386           | 411                    | 457                  |
| 11:00      | 12:00    | 295           | 314                    | 349                  |
| 12:00      | 13:00    | 302           | 321                    | 357                  |
| 13:00      | 14:00    | 306           | 325                    | 362                  |
| 14:00      | 15:00    | 301           | 320                    | 356                  |
| 15:00      | 16:00    | 367           | 390                    | 435                  |
| 16:00      | 17:00    | 521           | 554                    | 617                  |
| 17:00      | 18:00    | 1,152         | 1,224                  | 1,363                |
| 18:00      | 19:00    | <b>1,370</b>  | <b>1,456</b>           | <b>1,622</b>         |
| 19:00      | 20:00    | 730           | 775                    | 864                  |
| 20:00      | 21:00    | 380           | 403                    | 449                  |
| 21:00      | 22:00    | 231           | 246                    | 274                  |

Table 3: Theoretical number of users prevented from crossing the bridge at different times of the day should a 45 minute lift occur

**Darker shading indicates greater proportion of bridge lifts at this time from Table 1.**

#### 2.1.4 Scenario 2: 'Most Likely'

The 'Most Likely' scenario is based on the following assumptions:

- **Timing:** A bridge lift occurs during the evening peak hour – the time of day during which it is most likely for a bridge lift to occur
- **Duration:** The bridge lift lasts for 21 minutes – the calculated duration of a lift required for most 'standard' vessels (see Appendix B)
- **User Flows:** Usage is based on the 'High Usage Estimate' in 2030 – a forecast based on a 15% cycling mode share and 5.5% population growth. The direction of flow at this time is assumed to be entirely from North to South (Canary Wharf to Rotherhithe). The total number of cyclists and pedestrians is estimated at 2,162 between 6pm and 7pm
- No prior warning has been received by any users, and therefore no alternate plans for their journeys are made. Although it is likely that users *would* receive prior warning, for the purpose of determining the maximum theoretical number this assumption has been made

Based on the above assumptions, the impact of scenario 2 would be a crowd build-up of 757 users during a bridge lift of 21 minutes duration taking place in the evening peak hour of 6pm to 7pm (see Table 4 below).

| Start time | End time | 2020 estimate | 2030 'linear estimate' | 2030 'high estimate' |
|------------|----------|---------------|------------------------|----------------------|
| 06:00      | 07:00    | 104           | 110                    | 123                  |
| 07:00      | 08:00    | 342           | 364                    | 405                  |
| 08:00      | 09:00    | 735           | 781                    | 870                  |
| 09:00      | 10:00    | 480           | 510                    | 568                  |
| 10:00      | 11:00    | 180           | 192                    | 213                  |
| 11:00      | 12:00    | 138           | 146                    | 163                  |
| 12:00      | 13:00    | 141           | 150                    | 167                  |
| 13:00      | 14:00    | 143           | 152                    | 169                  |
| 14:00      | 15:00    | 140           | 149                    | 166                  |
| 15:00      | 16:00    | 171           | 182                    | 203                  |
| 16:00      | 17:00    | 243           | 259                    | 288                  |
| 17:00      | 18:00    | 537           | 571                    | 636                  |
| 18:00      | 19:00    | 640           | 680                    | 757                  |
| 19:00      | 20:00    | 340           | 362                    | 403                  |
| 20:00      | 21:00    | 177           | 188                    | 210                  |
| 21:00      | 22:00    | 108           | 115                    | 128                  |

Table 4: Number of users prevented from crossing the bridge during a 21 minute lift time

Darker shading indicates greater frequencies of bridge lifts from Table 1.

## 2.2 Public Waiting Spaces During Lifts

In order to be able to safely manage a crowd of up to 1,864 users calculated for scenario 1, a number of options have been reviewed, including:

- clearing the bridge in its entirety (including approach ramps) and directing users to wait on the banks
- clearing the main span of the bridge directing users to wait on the ramps up to and including the waiting zone (no further than the sacrificial structure point of the bridge)

Facilities including waiting areas, benches, shelter or wifi could improve the user experience and demarcate the designated waiting area. However, these would need to be assessed against a possible (or perceived) increased risk of crime or antisocial behaviour.

Commercial opportunities such as cafés could also support crowd management but are outside the scope of this study.

## 2.2.1 Location of Users Waiting During Bridge Lifts

Based on a risk analysis of user flows and crowds, and the capacities of the bridge sections calculated in Section 2.2.2, it has been determined that it is most appropriate for crowds to assemble and wait on the approach ramps during bridge lifts.

The benefits of doing so include:

- overcrowding or risk of injury minimised by users spreading over the length of the ramps and waiting zone
- risk of bottlenecks occurring at the entrance to ramps at the landing zone is minimised
- impact on local residents and users of the landing site areas is minimised
- disruption to user flows is minimised by ensuring quick and efficient dispersal of crowds following a bridge lift

In order for this to be safely managed, however, the following considerations need to be made:

- The ramps can only be used for waiting up to and including the safe waiting area (shown in Figure 1 and Figure 2), in order to safeguard users from any potential vessel collision (see also Chapter 4)
- Each ramp's maximum capacity (see Table 5) must be adhered to, with flows restricted once capacities are reached. Flows will be monitored using cycle/people counters to ensure operating staff are notified when the bridge reaches its capacity
- Access to emergency services during a lift, and sufficient provision for evacuations, etc. must be made (see Section 5)

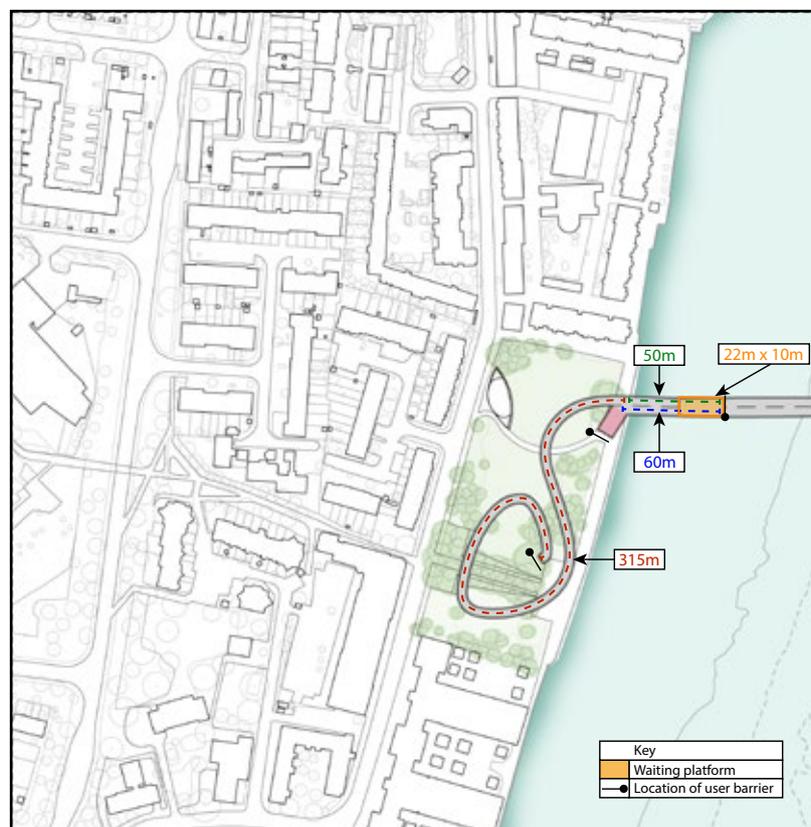


Figure 1: Length of the ramps used for waiting users at Rotherhithe landing site, and size of the waiting platform

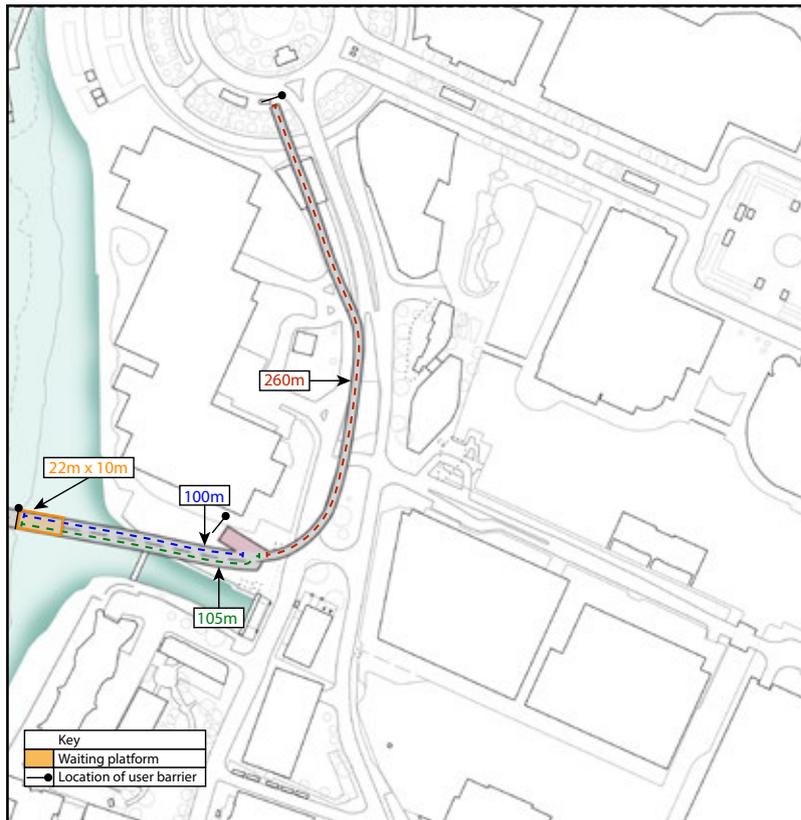


Figure 2: Length of the ramps used for waiting users at Canary Wharf landing site, and size of the waiting platform

## 2.2.2 Maximum Capacity of Ramps For Waiting Users

The maximum capacity of the area for users waiting to cross the bridge is shown in Table 5 below. The 'waiting area' includes both the ramps and the waiting platform shown in Figure 1 and Figure 2 above. A full breakdown of calculations for space requirements of users can be found in Appendix B.

|                   | Space required per user when waiting (m <sup>2</sup> ) | Maximum no. of users per m <sup>2</sup> when waiting | Rotherhithe landing site   |                                    | Canary Wharf landing site  |                                    |
|-------------------|--|--|--|------------------------------------|--|------------------------------------|
|                   |  |  | Total waiting area of ramps and waiting platform (m <sup>2</sup> ) | Capacity of waiting area (persons) | Total waiting area of ramps and waiting platform (m <sup>2</sup> ) | Capacity of waiting area (persons) |
| <b>Cyclist</b>    | 2.5  | 0.4  | 1,890  | 756.00                             | 1,890  | 756                                |
| <b>Pedestrian</b> | 1.25   | 0.8  | 305  | 244.00                             | 465  | 372                                |

Table 5: Space requirements per user and maximum capacity per waiting area

Data taken from Appendix B

Calculations for the ability of the waiting area to accommodate all users waiting to cross during a bridge lift are shown in Table 6 and Table 7 below. This is based on:

- estimated flow rate of users (i.e. the number of users arriving to cross the bridge per minute) multiplied by the duration of the bridge lift in minutes (see Appendix B)
- capacity of the waiting area (from Table 5)
- the assumption that no prior warning has been received by bridge users
- the assumption that all users who arrive on site choose to wait for the bridge lift duration

Where applicable, the above calculation indicates the number of users beyond that capacity who would contribute to a crowd build-up in the landing site, and the length of time taken for that capacity to be reached.

### 2.2.3 Numbers of Pedestrians in Waiting Areas During Bridge Lifts

Table 6 below estimates the time taken for the pedestrian ramps and waiting platform to reach capacity, and the subsequent size of the crowd building up in the landing site once capacity is reached.

|  | Duration of lift (minutes) | Estimated flow rate of users per hour | Flow rate of users per minute | No. of users arriving to cross bridge during lift | % users able to wait on bridge ramps | Time taken for ramps to reach capacity (minutes) | Size of crowd build-up in landing site once ramp reaches 100% capacity |
|--|----------------------------|---------------------------------------|-------------------------------|---|--------------------------------------|--|--|
| <b>Scenario 1: Worst Credible (Rotherhithe landing site)</b> | 45                         | 477                                   | 7.95                          | 358   | 68%                                  | 30.68  | 114  |
| <b>Scenario 2: Most Likely (Canary Wharf landing site)</b>   | 21                         | 415                                   | 6.92                          | 145   | 256%                                 | 53.75  | -  |

Table 6: Time taken for pedestrian ramps to reach 100% capacity

Data taken from Appendix B

Table 6 shows that:

- During the ‘worst credible’ scenario, the ramps would reach capacity after roughly 30 minutes, at which point the ramp would have to be closed to any additional users. A crowd of up to 114 people would build up in the landing site during the remaining 15 minutes of the bridge lift
- During the ‘most likely’ scenario, the ramps would be able to accommodate all waiting pedestrians

### 2.2.4 Numbers of Cyclists in Waiting Areas During Bridge Lifts

Table 2.7 estimates the time taken for the cycle ramps and waiting platform to reach capacity, and the subsequent size of the crowd building-up in the landing site once capacity is reached.

|  | Duration of lift (minutes) | Estimated flow rate of users per hour | Flow rate of users per minute | No. of users arriving to cross bridge during lift | % users able to wait on bridge ramps | Time taken for ramps to reach capacity (minutes) | Size of crowd build-up in landing site once ramp reaches 100% capacity |
|--|----------------------------|---------------------------------------|-------------------------------|---|--------------------------------------|--|--|
| <b>Scenario 1: Worst Credible (Rotherhithe landing site)</b> | 45                         | 2,008                                 | 33.46                         | 1,506   | 50%                                  | 22.59  | 750  |
| <b>Scenario 2: Most Likely (Canary Wharf landing site)</b>   | 21                         | 1,747                                 | 24.48                         | 514   | 147%                                 | 30.88  | -  |

Table 7: Time taken for cycle ramps to reach 100% capacity

Data taken from Appendix B

Table 7 shows that:

- During the ‘worst credible’ scenario, the ramps would reach capacity after roughly 23 minutes, at which point the ramp would have to be closed to any additional users. A crowd of up to 750 people would build up in the landing site during the remaining 22 minutes of the bridge lift
- During the ‘most likely’ scenario, the ramps would be able to accommodate all waiting cyclists

## 2.3 Measures to Mitigate the Build-Up of Crowds

Crowds can be minimised through:

- prior warning of bridge lifts, to allow users to make alternative arrangements in advance, to either alter their travel times or route (See Section 3.2 below)
- ensuring appropriate procedures to manage the flows and build-up of people, both during bridge lifts and during unimpeded crossing of the bridge (see Section 2.4 below)
- reducing the duration of bridge lifts, and encouraging multiple vessels to pass in a single lift (grouping)
- reducing the frequency of bridge lifts during peak hours for bridge users

Due to the requirements by the PLA to allow unobstructed navigation to vessels, there is very little control over the duration or timings of bridge lifts. Furthermore, vessels which need longer lifting times (e.g. cruise ships or war ships) have the times of their journeys dictated by tides, and so have little control over the time of day of their passage.

### 2.3.1 Change in Journey Times

Table 8 shows the impact prior warning could have on the size of a crowd build-up during the 'worst-credible' scenario:

- With only 20% of users receiving notice and choosing to travel at a different time, the number of people waiting to cross the bridge would be reduced by nearly 400
- If 50% of users travelled at a different time, the number of people waiting during a bridge lift would be reduced by over 900

| Percentage of users who avoid bridge lift by travelling earlier | 0%    | 20%   | 50% | 100%  |
|---|-------|-------|-----|-------|
| Total number of users who avoid bridge lift and crowds          | 0     | 373   | 932 | 1,864 |
| Size of crowd during bridge lift                                | 1,864 | 1,491 | 932 | 0     |

Table 8: Impact of change in journey time on crowd build-up

User flows have also been calculated to ensure that changes in journey times to avoid a bridge lift do not cause the bridge to exceed maximum capacities at other times. Table 9 and Table 10 show how flow rates and user numbers on the bridge change if users travel an hour before the peak morning hour to avoid a bridge lift of the 'worst-credible' scenario.

Both tables show that increased crowd densities during the earlier hour as a result of a change in journey times to avoid a bridge lift do not exceed maximum bridge capacities set out in Table 5.

| Percentage of cyclists who avoid bridge lift during morning peak hour by travelling earlier | 0%   | 20%  | 50%  | 100% |
|---|------|------|------|------|
| Maximum flow rate of users (cyclists per minute)  | 16   | 26   | 41   | 66   |
| Maximum number of users on bridge at once during earlier journey time                       | 69   | 114  | 181  | 293  |
| Crowd density of users on bridge (users per m <sup>2</sup> )                                | 0.03 | 0.04 | 0.07 | 0.11 |

Table 9: Impact of change in cyclist journey time on flow rate and capacity

| Percentage of pedestrians who avoid bridge lift during morning peak hour by travelling earlier | 0%   | 20%  | 50%  | 100% |
|--|------|------|------|------|
| Maximum flow rate (users per minute)   | 4    | 6    | 10   | 16   |
| Maximum number of users on bridge at once during earlier journey time                          | 22   | 36   | 57   | 91   |
| Crowd density of users on bridge (users per m <sup>2</sup> )                                   | 0.02 | 0.04 | 0.06 | 0.10 |

Table 10: Impact of change in pedestrian journey time on flow rate and capacity

### 2.3.2 Using Alternative Routes

It is expected that users wishing to cross the river would only choose an alternative crossing if it were affordable, in close proximity, and offered a time saving over waiting for the bridge to lift.

Unlike other lifting bridges, the location of the Canary Wharf to Rotherhithe bridge means that there are limited alternatives to cross the river in the event of users arriving at the time of a lift.

The current methods of crossing the river between these two sites are detailed in Table 11 below.

|   | Approximate distance by foot from Rotherhithe landing site | Approximate distance by bicycle from Rotherhithe landing site | Frequency of service  | Current cost to use service<br><br>Based on peak time single Journey TfL Oyster PAYG prices, September 2015 |
|---|--|---|-----------------------|---|
| Thames Clipper service:<br>Nelson Dock Pier (Hilton Hotel) to Canary Wharf Pier | 6 minutes  | 2 minutes   | Every 10 - 15 minutes | £3.90   |
| Thames Clipper service:<br>Greenland Pier to Canary Wharf Pier                  | 15 minutes   | 4 minutes   | Every 20 minutes      | £3.90   |
| Jubilee line (via Canada Water)   | 20 minutes   | 7 minutes*  | Every 3 minutes       | £1.70   |
| Tower Bridge  | 47 minutes   | 13 minutes  | -                     | -   |
| Greenwich foot tunnel.  | 1 hour 3 minutes   | 16 minutes  | -                     | -   |

Table 11: Alternatives to crossing the Thames from Rotherhithe site

\*As bicycles are not permitted on this section of the Jubilee line, this time is included to give an indication only

With the exception of the Thames Clipper services, most alternative methods would lack sufficient benefit to justify a detour – particularly by foot – if users were to arrive during the course of a bridge lift. It can therefore be assumed that such alternative journeys would only be made if the disruption were substantial enough (e.g. during a 45 minute lift in the morning peak hour), and the right systems of informing users were in place.

As it is expected that the Nelson Dock to Canary Wharf ferry service will no longer be operating once the bridge is in use, the nearest viable method to cross the river from the Rotherhithe landing site will be the Greenland Pier to Canary Wharf ferry service. Even so, a ferry's limited capacity would not be capable of servicing the high volumes of expected users, and would also come at a cost to the user. Improvements to the suitability of the existing ferry service to cyclists, such as an increase in the number of cycles permitted on board (currently limited to 8), and more comfortable access to embark, would also be needed.

The feasibility of operating an ad-hoc ferry service from Nelson Dock to Canary Wharf could be explored at a later stage. Such a service would operate only at the times of major disruption to users (e.g. a 45 minute bridge lift occurring during peak hour flow). However, given the cyclist capacity and therefore the number of ferries needed, it is expected that the cost of such a service would far outweigh the benefit to users.

The importance of effective communication and prior warning of bridge lifts to users is therefore essential to allow alternate journey decisions to be made before users reach the bridge (see Section 3.2).

## 2.4 Bridge Clearance and Lifting Procedure

As illustrated in Section 2.2 above, in order to safely manage crowds, users should be directed to wait on the bridge ramps during bridge lifts. To accommodate the anticipated volume of users and scale of the bridge, a specific sequence should be followed to manage user flows once the bridge lift process commences:

- Audible/visual warnings at key points inform users that bridge is about to close
- The main span of the bridge is closed to crossing users. Users already on the main span are allowed to continue their journey and exit the span onto the descending ramps
- Audible/visual warnings at key points inform users that the bridge is now closed. Users are allowed to enter the ramps and proceed up to the waiting zone until the bridge reopens
- Once the maximum capacities of the ramps are reached, access to additional users is restricted at the ramp entrance
- Main span unbolts, and lifts
- Vessel passes
- Main span lowers, and bolts
- Main span is reopened
- Ramps are reopened

As user flows are expected to be tidal (i.e. the majority travelling from Rotherhithe to Canary Wharf during the morning peak), movement across the bridge should be controlled to ease congestion. As more significant crowds will build up on the Rotherhithe ramp during the

morning peak, this user flow should be allowed to resume first. Careful control of barriers by staff, supported by signage or other visual aids (e.g. indicating to keep left), will allow flows to resume as quickly as possible.

## 2.5 Staffing During Bridge Lift

### 2.5.1 Number and Location of Staff Required

Between 8 and 10 staff are likely to be required to manage crowds safely during bridge lifts, located as follows:

- 1 staff member at each main span barrier (4 in total)
- 1 staff member at each ramp entry barrier (4 in total)
- 2 additional staff members to clear main span

As an alternative to having 2 additional members of staff clear the main span, the 2 staff members responsible for closing the main span pedestrian barriers could then proceed to the opposite bank's barrier, clearing the span of any remaining users. This process would only be feasible if the pedestrian barriers allowed automated one-way access (i.e. via a turnstile), which could continue to allow people to exit without allowing more users to enter.

It is reasonable to assume that a robust communications protocol will be required for bridge lifts of a long duration, including a required 7 day notice period. This will enable advanced notice and time to prepare staffing of the bridge. The assumption that 8 staff on the ground will be required is therefore the worst case scenario. Instead, given our recommendations on a robust communications system, 8 staff may only be required for exceptional events, and 2-4 staff are more appropriate.

### 2.5.2 Staffing Hours and Responsibilities

It is anticipated that bridge lift staff will only be required during operation, and on an on-call basis. A minimum of 24 hours advanced notice of all vessels requiring lifts will ensure that the necessary number of staff are present for safe operation (see also Section 3 Communications Protocol below).

Based on the frequency and timings of lifts at Tower Bridge (see Table 1 in Section 2.1.1), and the Navigational report (Chapter 4 and Appendix C Vessel Traffic Analysis), it is expected that the hours of operation will be predominantly between 6am and midnight, with the majority of lifts occurring between 6am and 12pm (33%), and 2pm and 7pm (49%).

It would therefore be feasible to have a small number of staff present throughout these core hours, with further on-call staff to support the lifting operation.

Outside of the staffing procedures during lifts, staff present during core hours would be able to engage in:

- general crowd management and support
- security
- managing incidents and emergencies
- general maintenance

In addition to core staff, a regular presence would be required in the control room. These staff would function both as bridge operator, and also to ensure that there is an on-site presence outside of core operating hours.

Facilities for staff, potentially integrated beneath the Rotherhithe cycle ramps, would provide storage and welfare facilities.

## 2.6 Barriers

In addition to staffing, physical barriers would:

- ensure the safety of users by physically preventing access onto the main span or ramp during lifts
- reduce the number of staff required and support them to manage user flows onto and across the bridge

### 2.6.1 Location and Number of Barriers

Eight sets of barriers would be required in total:

- 1 set at the end of each ramp (bottom of stairs and threshold of ramp): 4 in total
- 1 set at each main span entry point: 4 in total

### 2.6.2 Barrier Design

In order to facilitate the bridge clearance and operating procedure detailed in Section 2.4 above, barriers to allow one-way access should be used.

Barriers would either allow automated one-way use (e.g. through pedestrian turnstiles), or would require the physical closure of gates supervised by staff members allowing users to exit during a bridge clearance. Although the use of turnstiles or security gates would allow unsupervised one-way access, the use of such gates could impact maintenance costs, design aesthetics and user flows, as well as increasing risk associated with unstaffed gates.

Multiple staffed gates at each access point would allow control over the directional flow of users, preventing additional users entering the main span or ramps once closed off, while allowing any remaining users to exit. The use of multiple staffed gates would also allow staff to control the direction of flow of users immediately following a bridge lift. This would allow larger crowd build-ups to be dispersed first.

Barrier designs would need to be compliant with the Equalities Act 2010; across a 4m wide pedestrian deck, each gate would need to be at least 1.5 metres wide to allow wheelchair users to pass through.

Across a 5m wide cycling deck, two barriers of equal width would provide sufficient space for both standard and non-standard cycles to pass through when only one gate is open.

Figure 3 below show examples of pedestrian barriers on bridges.



Figure 3: Cycle and pedestrian barriers at the Gateshead Millennium Bridge<sup>2</sup>

### 2.6.3 Operation of Barriers

Although other examples of bridges demonstrate automated barrier control (e.g. remotely operated gates, in the case of Poole's Twin Sails Bridge), because of the high volumes of users expected and the scale of this bridge, this approach is deemed unsuitable.

Barriers are therefore expected to be manually operated by staff at each point.

## 2.7 Comparison to Similar Bridges

The expected user volumes and its scale mean that this bridge will differ from other opening bridges, and in particular pedestrian and cycle bridges (See Chapter 4).

Significant differences include:

- The number of approaches and geometries of ramps mean that there are multiple user access points to manage
- The possibility of bridge lifts lasting up to 45 minutes means that there is the potential for a far more substantial crowd build-up than at some other bridges
- The scale and volume of users make the bridge unsuitable for remote operation of barriers
- The location of the bridge and the lack of alternative crossings could lead to significant crowd build-ups if not managed effectively
- The length of the bridge requires a greater span to clear, and longer crossing times than other pedestrian/foot bridges

However, certain similarities can be drawn to other opening bridges, including:

- clearance protocols of the main span and ramps
- crowd management and use of barriers

<sup>2</sup> [www.northnews.co.uk/](http://www.northnews.co.uk/)

## 2.8 Discussion and Conclusion

Although the ‘worst credible’ scenarios outlined in this section are exceptional, the importance of safely managing user flows and minimising crowd build-up are clear. The risk based approach taken assumes very high levels of use, but shows that the problems are not insurmountable.

The crowd sizes detailed in Sections 2.1 and 2.2 all assume that no users received any prior warning of a bridge lift, and therefore all contribute to the crowd size. As detailed in Table 8, if only 20% of the 1,864 users in scenario 1 (‘worst credible’) received warning and were able to make alternate arrangements, crowd build-ups could be reduced by nearly 400 users.

However, even if crowds are minimised by effective communication ahead of bridge lifts, the volume of expected users will inevitably result in crowd build-ups of some extent. The emphasis will therefore need to be on having a comprehensive risk management process executed by well trained staff.

## 3. Communications Protocol

### 3.1 Handling of Opening Request Procedures

In order to meet the requirements of the PLA, it is expected that the handling of opening request procedures will largely follow that of Tower Bridge. The following is therefore based on current Tower Bridge procedures and consultation with the PLA.

All vessels navigating the Thames intending to pass through the bridge with an air draught exceeding the available clearance zone of the closed span will be required to book a bridge lift. In some cases, the tide levels may mean that a lift may not be required by the vessel (see Appendix C Vessel Traffic Analysis for bridge lift requirements).

Bridge lifts would be provided at no charge, 24 hours a day, 365 days of the year.

#### 3.1.1 Notice Period

Bookings would be required to be made in writing to the bridge operator at least 24 hours in advance.

Larger vessels such as cruise ships or war ships requiring a longer bridge lift time would be required to provide longer notice of at least 7 days .

#### 3.1.2 Communication Methods with Vessels

In addition to being provided with notice in writing from vessels, the bridge operator will require VHF communication to allow for two-way communication with vessels. It has also been recommended by the PLA that the member of staff operating the bridge lifting mechanism be physically present at the bridge with a view of the navigation, with facilities to map in real-time the location and movements of vessels based on AIS (Automatic Identification System) data.

#### 3.1.3 Managing Vessels on Approach

Operational procedures in line with the PLA's requirements would need to be followed. Based on operational procedures for Tower Bridge, these would include:

- Passage Plans submitted to the bridge operator detailing their Communication Abort Point (the points at which vessels can safely abort their approach to the bridge should timely communication not be established) and Bridge Lift Abort Points (the point at which vessels can safely abort their approach should the bridge not be lifted sufficiently)
- Passage Plan to be provided to London VTS (Vessel Traffic Services) to ensure bridge operators have a lift booking scheduled. Unscheduled bookings will require vessels to proceed to abort points
- VHF communications to establish two-way communication at least 30 minutes ahead of a scheduled lift, confirming their estimated time of arrival, whether the vessel will be swung around, the required lifting height of the bridge's bascules, and the Lift Abort Point
- Vessels must adhere to their passage plans. Any leeway greater than 5 minutes during peak flow usage times would not be accommodated

Specific protocol for the Canary Wharf to Rotherhithe Bridge would need to be developed by the PLA and the bridge operator. For efficiency, this could include coordination with existing Tower Bridge procedures.

## 3.2 Public Communications

As detailed in Section 2.3, the importance of effective communication with the public cannot be underestimated. This will not only minimise crowd build-up and support the safe use of the bridge, but will also improve the user experience by minimising disruption to journeys.

### 3.2.1 Reach of Public Communication

Based on the existing engagement of passengers receiving information about their journeys and the range of methods proposed in this section, it is estimated that through effective communication, at least 20% of users would receive advanced notice of disruption to their journey as a result of a bridge lift. However, this percentage is likely to be much higher and can be maximised by actively engaging with users in varied ways.

The Office for Rail Regulation noted that in 2010 during extensive improvement works at Reading Station, 76% of passengers were aware of possible disruptions before they arrived at the station.<sup>1</sup> Frequent passengers relied most heavily on notices at the station, while less frequent travellers relied on the internet.

Passenger Focus (2014) conducted a survey of 7,225 rail passengers, focus groups and interviews during the end of 2013. The research report identified that of those experiencing a disruption to their journey, 17% received advanced notice before arriving at their station, and 62% of those users received information through digital sources (e.g. online, via an app, social media or by text).<sup>2</sup>

### 3.2.2 Off-Site Methods for Public Communication

The following methods of communicating any disruption (i.e. of bridge lifts) to notify users before they begin their journey should be considered:

- Text alerts
- Email notifications
- Apps
- Social media
- Online information (both on bridge website, and integrated into journey planners, e.g. TfL and Google Maps).
- Telephone
- Dynamic route signage

Push notifications (e.g. those provided by SMS, email or as App notifications) should have the option of being customisable to alert the user of disruptions at specific times their journeys would most likely be impacted (e.g. weekdays between 7am and 9am, and 5pm and 7pm). Information should include times of lift, duration, and suggested alternatives for making the journey.

<sup>1</sup> Office for Rail Regulation, Rail Passenger Experience (2014), p42

<sup>2</sup> Passenger Focus, Passenger Information when Trains are Disrupted (2014), p35

Online and telephone information should allow users to plan journeys as far in the future as possible. However, it should be made clear that bridge lift schedules may change with as little as 24 hours' notice.

Dynamic route signage should be located along key feed-in routes leading to the bridge. These should provide live displays of bridge lift times and duration, and the nearest alternative crossings.

### 3.2.3 On-Site Methods for Public Communication

Appropriate communication with public on-site must also be implemented – both to inform users of current disruptions (e.g. while waiting during a bridge lift), as well as informing users of future disruptions.

Methods to be considered include:

- live displays (on ramps, in park and on approach)
- staffing
- visual alerts (e.g. warning lights)
- audio alerts (e.g. PA systems)

Live displays should detail upcoming bridge lift times and durations, and should be provided at several locations on site, including on the approach ways to the ramps (within the park), and at barriers (on ramps and at main span). Additional displays should also be considered along the length of the cycle ramps, being 365m long.

Displays located on the approach to the ramps should provide information on alternative crossing points and estimated journey times.

During bridge lifts, displays should provide a simplified indication of time remaining until the bridge reopens, similar to departure board information at train stations.

Warning lights or similar visual alerts could be used to inform users that they are entering a congested area. This would be particularly relevant where main span barriers are closed but additional cyclists are still entering the waiting area on ramps.

Audio alerts via PA systems would provide an additional source of information for waiting users.

In order to ensure the most effective reach of any communication, all methods of communicating with the public used must ensure compliance with the Equality Act (2010).

## 3.3 Impacts

### 3.3.1 On Design

The communication methods detailed above could be incorporated into the bridge without adversely impacting the design of the bridge, and could be used to complement the aesthetics and functionality of the bridge.

The possibility of incorporating information and displays into bridge and park facilities could also be explored, similar to 'Media Pods' located in the City of London. Each 'Recycling on the Go' unit incorporates two digital displays providing news and travel information.

### 3.3.2 On Cost

When considering the impact disruption might cause to journeys, users are generally not prepared to pay for alerts or information. The cost of such methods would therefore fall on the operator of the bridge, and would most significantly include:

- the cost of developing and maintaining website and apps and social media
- installation of live displays and signage
- staffing

With this reliance on electronic communications, any systems established should be low maintenance in order to reduce ongoing costs.

### 3.3.3 On Surrounding Area

Any use of PA systems, lighting or displays must comply with the Environmental Protection Act (1990), and ensure that it is not prejudicial to health or a nuisance to local residents.

## 3.4 Comparison to Similar Bridges

Because of the high number of users forecast, the methods employed by the Canary Wharf to Rotherhithe Bridge to communicate with the public need to be more substantial than other similar bridges. However, a number of communication methods detailed above are effectively used in similar bridges, including:

- information provided on the bridge's website and via telephone information line
- electronic variable-message signs to direct users to alternate crossings
- visual alerts (e.g. traffic lights and flashing warning lights)
- audio alerts such as PA systems to allow bridge operators to address public (particularly in the case of remotely operated bridges)

Although no lifting bridges currently use push notifications to alert the public of lifting times, this method is extensively used with public transport to alert users in advance of journeys (e.g. disruptions to train lines etc.).

## 3.5 Discussion and Conclusion

The 2014 Transport Focus report highlights the importance of informing users of travel disruptions in a timely manner in order to reduce stress and further delays. Accurate and up-to-date information is essential, and with a minimum of effort required on the part of the user to access this. Text alerts are stated as the preferred method; however, users are unwilling to pay for such a service.

Transport Focus (2012) also identified social media (e.g. Twitter and Facebook) as a vital source of information to users. Such platforms, particularly if filtered through journey personalisation, would provide an effective source of information giving live updates and details of the impact on users' journeys.<sup>3</sup>

The general preference is for information to be accessible and to not require the user to

<sup>3</sup> Transport Focus, Short and Tweet: How Passengers Want Social Media During Disruption (2012)

actively seek it out (such as browsing a website or calling an information line). With the increase in ownership of smartphones, this could include any method which incorporates push notifications, such as email, apps (with notifications enabled), or social media.

20% is a very conservative estimate of the number of users who would receive prior notification of lifts, based on research into passenger awareness of transport disruption. As the majority of peak time users will be commuters and frequent users, it is expected they will take an active interest in issues affecting their journey, and plan their journey accordingly.

**The varied means by which users access information, however, calls for as many methods as possible to communicate with the public to be considered. Effective communication will both reduce crowd build-up and improve user experience and confidence in the bridge as a practical transport route.**

## 4. Maintenance

The maintenance requirements and process for the bridge will be determined at detailed design stage. With a design life of 120 years for the primary frame, the design of the bridge will need to balance the expected durability and initial cost. Increased durability will have higher initial costs, but potentially lower ongoing maintenance costs.

### 4.1 Maintenance Requirements

Based on the inspection and maintenance requirements of other bridges, considerations of this bridge will include:

- regular inspections and maintenance, including inspection and repairs to surfaces, fixtures and mechanical features
- closer inspection and more extensive maintenance of all aspects of bridge less frequently, including repairs to driving mechanisms, gear boxes, bearings and repainting of steelwork
- access to the mechanical systems will be needed from both the deck and from the river
- maintenance needs to be carried out with the bridge in the 'open' position to enable river traffic to pass as normal

#### 4.1.1 Accessing the Bridge and Surrounding Areas

The bridge design would need to ensure that access for maintenance and inspection is not impeded. Considerations would need to be made, including ensuring that any barriers or fixtures in place to manage user flows would be removable to allow access for maintenance vehicles

#### 4.1.2 Impacts of Inspections and Maintenance Work

Aside from the cost implications of ongoing maintenance and repair works, there is a potential for a significant impact on users. Although certain maintenance work could be conducted outside of peak hours to minimise disruption (e.g. overnight or on weekend), this would come at a higher cost.

## 4.2 Comparison to Similar Bridges

Similar bridges undergo extensive maintenance works, which have significant cost and disruption implications, including:

- Tower Bridge: Planned maintenance closure to take place for three months in 2016, at a cost of £3.35 million. More regular maintenance takes place during night time closures, in addition to less frequent and longer maintenance closures (e.g. in 2005 Tower Bridge was closed for 24 hours a day from 0600 on 30th April to Sunday 8th May<sup>1</sup>)
- Twin Sails Bridge: Annual maintenance closes the bridge for up to one week. Annual

<sup>1</sup> <https://tfl.gov.uk/info-for/media/press-releases/2005/april/tower-bridge-to-close-for-essential-maintenance-diversions-into-the-congestion-charging-zone>

maintenance of Poole Bridge takes place at a different time, to ensure that one crossing is always accessible to users<sup>2</sup>

### 4.3 Discussion and Conclusion

Depending on the extent of the inspection or maintenance work, there would be varying degrees of cost and disruption. Maintenance works are inevitable, and the emphasis therefore needs to be both on minimising the need and impact this has through designing in durability, and planning maintenance and inspection programmes outside of peak usage (both seasonally and during week).

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<sup>2</sup> <http://www.poole.gov.uk/newsroom/march-2015/twin-sails-bridge-closure-planned-for-annual-maintenance/>

# 5. Emergencies, Events and Incidents

## 5.1 Factors Impacting Normal Operations

A number of incidents or events and resulting impacts on normal bridge operations need to be considered for design and planning. These could come as a result of public events, accidents, or malicious acts, and include:

- public events or celebrations and the additional crowds attracted. Events may either cause the bridge to be kept open or closed for prolonged periods (e.g. during sailing events such as the Clipper Race)
- medical emergencies taking place on the bridge
- suicides or attempted suicides
- impact with the bridge (either by a vessel or vehicle)
- antisocial behaviour
- crime against the person, including assault or the threat of bodily harm
- criminal damage or terrorist activity
- protests (particularly unplanned protests)

Although there are many high-profile targets in the nearby vicinity, the bridge may become a target as a way of securing public attention or media coverage for either of the latter two points.

## 5.2 Minimising Impacts

Proper procedures will be required by the bridge operator to minimise the risk of emergencies and incidents, and deal with resulting impacts. Such procedures would have to consider:

- evacuation of the bridge in the case of an emergency
- access to the bridge by emergency services
- procedures for dealing with crowds in the case of an emergency impacting the normal operation of the bridge (i.e. preventing users from crossing the bridge)
- managing events attracting larger than normal crowds

Managing crowds effectively is central to dealing with emergencies. Overcrowding in waiting areas would not only pose a risk of injury in itself, but also restrict evacuation or emergency access. The management of crowds and user flows should therefore take into account the need to potentially evacuate waiting users from a confined space.

Several elements of the bridge design at this stage support emergency procedures:

- The waiting platform at the point where both pedestrian and cycle ramps meet provides two access routes off the bridge at each landing site. This ensures a level of redundancy; should one ramp be inaccessible, there will still be an evacuation route off the bridge

- Audio and visual communications systems for user information provides an extra level of robustness to be able to quickly communicate with the public in the event of an emergency

### 5.3 Discussion and Conclusion

Relatively small-scale incidents could quickly escalate if the impacts are not handled appropriately. The importance of managing crowds and user flows safely and effectively as outlined in Sections 2.3 and 3.2 are crucial to managing incidents.

Crowd modelling is needed at the next stage of design to identify any further risks and ensure that the procedures and mitigations are appropriate for the numbers of waiting users expected.

In all cases, managing risk and providing effective communication are essential to ensuring the safety of the public and minimising the disruption to users.