

National Trust
**Castlefield Viaduct
Redevelopment**
Stage 3 Fire Strategy

Issue | 7 September 2021

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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1 Introduction

1.1 Purpose of this report

Arup have been commissioned by the National Trust to provide fire safety engineering support to the Castlefield Viaduct redevelopment project.

This concept fire strategy report has been prepared to support the development of the planning application for the pilot stage scheme and inform the design so that the functional requirements of Part B of the Building Regulations are met. To accompany this fire strategy report, a plan of the proposed layout is included in Appendix A.

1.2 Project description

Castlefield Viaduct is a Grade II listed structure located in the Castlefield area of Manchester, UK. It was built in 1892, with 56 arches supporting a wrought iron lattice viaduct spanning 330m.

The structure lies South-West of the city centre between the Bridgewater Street car park and Egerton Street. The viaduct extends further to the west where it meets the Metrolink corridor. The existing viaduct is shown in Figure 1.

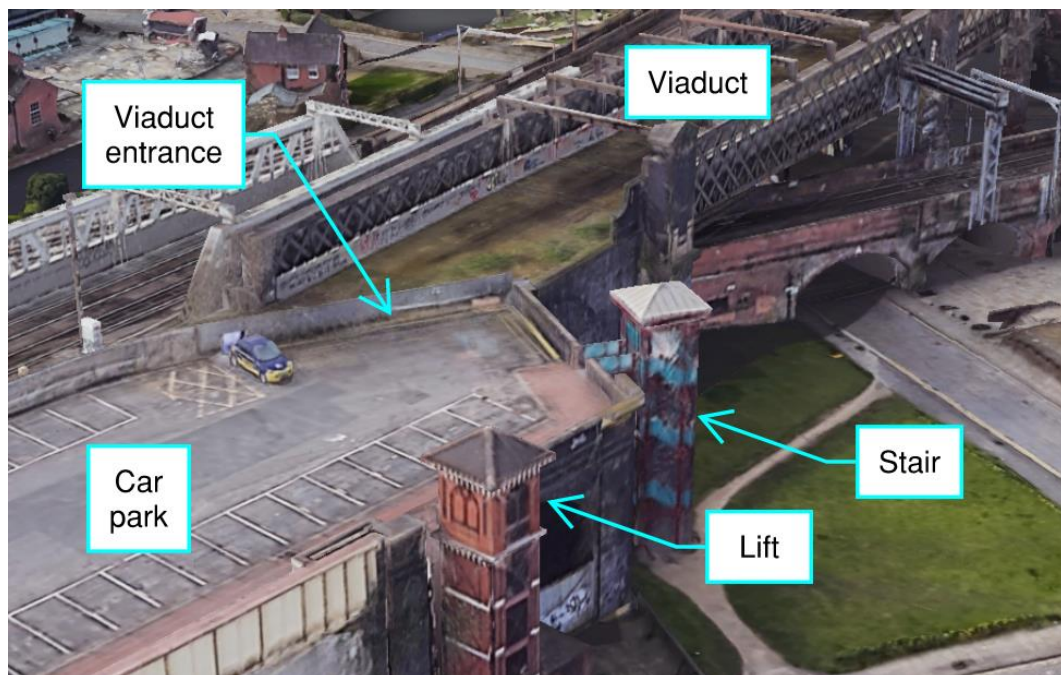


Figure 1: Current layout of viaduct.

The National Trust are aiming to bring the viaduct back into use and open it up to the public. The project will consist of two distinct phases:

Phase 1 – pilot scheme stage:

- The viaduct will be opened as a temporary managed park to test ideas and receive feedback.
- Visitors will need to book onto tours in advance and the occupancy will be restricted to 20 people at a time. One ‘special event’ each week will host a maximum of 50 people.
- There will be a minimum of 3 National Trust staff managing the public at all times.
- The viaduct will consist of:
 - A welcome area with kiosk located adjacent to the entrance.
 - A walkway through the central portion of the viaduct, with planting, landscaping and ‘partner plots’ throughout. This will extend for approximately 165m. The remaining ~180m of the viaduct will not be utilised in this stage.
 - A new single storey event building shall be located at the end of the 165m length.

Phase 2 – future development stage:

- Using feedback received from Phase 1, necessary changes will be implemented.
- The viaduct will be operated as a park rather than a tour model.
- The number of guests permitted at this stage is unknown.
- The layout and makeup of Phase 2 is unknown, but for forecasting purposes reasonably may consist of:
 - A welcome area with kiosk located adjacent to the entrance.
 - A walkway through the central portion of the viaduct, with planting, landscaping and ‘partner plots’ throughout. This may extend for the full length of the viaduct ~330m.
 - The single storey events building from Phase 1 may be removed. A viewing platform located at the end of the viaduct may be constructed.
 - A new ramp may be installed approximately 2/3rds of the way along the viaduct, providing views underneath the viaduct as well as to either side.

The Phase One proposed masterplan is shown in Figure 2 and Figure 3.

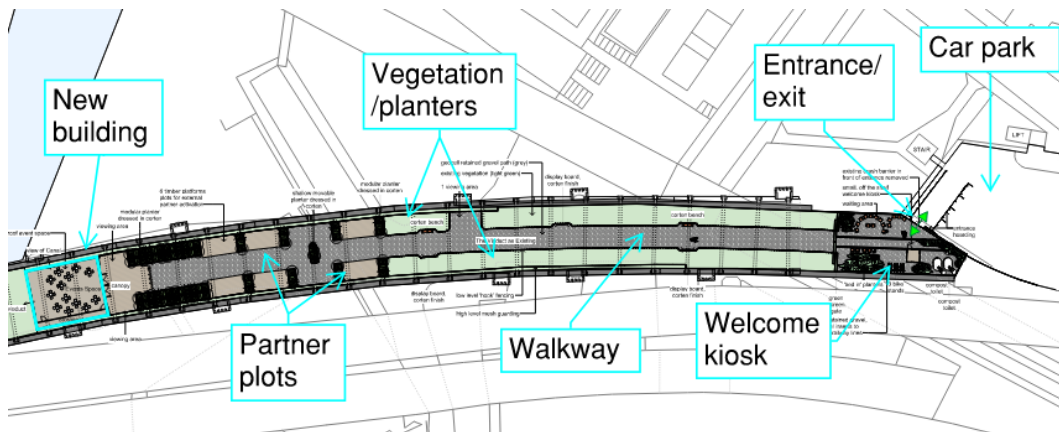


Figure 2: Phase One - Proposed use of viaduct



Figure 3: Architectural proposals for Phase One masterplan

This concept fire strategy outlines the requirements for Phase One of the project to be used as managed assembly and recreational area for a maximum of 50 persons. Consideration has been given to Phase 2 in certain elements of the design, however an independent concept fire strategy will need to be developed for the Phase 2 design once this has been further explored. Considerations to be given during Phase 2 are provided in Section 8.

1.3 Stakeholders

The viaduct itself is to be owned, operated and managed by the National Trust. It is currently accessed via a car park, which is believed to be owned by Transport for Greater Manchester.

Additionally, a live train line operated by Network Rail passes underneath the viaduct and the Metrolink, operated by Transport for Greater Manchester, passes alongside the viaduct.

Other land in the vicinity of the viaduct, such as the proposed location of the dry riser at street level, may have additional stakeholder involvement that impacts upon this fire strategy.

Consultation with all of the above parties is required following their review of this document.

1.4 Fire safety goals

As a minimum, the fire strategy must comply with legal requirements. The relevant fire safety legislation in respect of the design, construction, maintenance and operation of Castlefield Viaduct is summarised in Table 1. Fulfilling the legislative requirements is therefore the main goal of this fire strategy.

Additional fire safety goals noted by the National Trust relate to property protection i.e., protection of the listed heritage viaduct structure which is of primary importance. The measures proposed as part of the life safety strategy will to an extent assist with this property protection goal however we shall explore further protection measures with the National Trust as part of the project's development.

There are currently no specific property protection requirements for the new events building structure beyond those required for life safety.

Table 1: Statutory requirements.

Legislation	Aim of the Legislation	Requirement for the Completed Building
Part B of the Building Regulations 2010 (as amended)	Securing a reasonable standard of health and safety for persons in or about buildings (and any others who may be affected by buildings or matters connected with buildings).	The project is to be designed such that it complies with the functional requirements B1 to B5 of the Building Regulations.
Construction (Design and Management) Regulations 2015 (CDM)	Planning, management and monitoring of health, safety and welfare in construction projects. Control and management of the way in which construction work is carried out.	The project is to be planned and designed such that it can be built and managed in a way which complies with CDM Regulations. A CDM Risk Register is included within Appendix B of this report.
Regulatory Reform (Fire Safety) Order 2005 (RR(FS)O)	To ensure as far as is reasonably practicable, the safety of the occupants on the viaduct during operation; this only includes all occupants who are lawfully present on the premises. A fire risk assessment is required to be undertaken by the operator to demonstrate this.	Be manageable in accordance with RR(FS)O without relying on an unrealistic or unsustainable management regime.
Regulation 38 of the Building Regulations 2010	To ensure that the responsible person(s) is given the fire safety information so that they can adequately manage and maintain the building in terms of fire safety.	By providing all relevant fire safety information to the 'responsible person' it allows the owner/occupier or person in control of the building to fully understand any assumptions and philosophies that have been adopted as

		part of the fire safety strategy for the building. This also includes any assumptions regarding the fire safety management of the building. Please refer to Section 7.
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Therefore, to comply with the above legislation, the fire strategy goals for the completed scheme are to:

- Be designed to, as a minimum, meet the functional requirements of Part B of the Building Regulations.
- Be buildable and maintainable in accordance with CDM.
- Be manageable in accordance with RR(FS)O without relying on an unrealistic or unsustainable management regime.
- Be appropriately handed over from the design/construction to the occupation stages of this scheme, including all relevant fire safety information (including the fire strategy), as required by Regulation 38.

1.5 Relevant design guidance

The main guidance document that has been followed to help achieve compliance with the above legislation is BS 9999:2017. Fire strategy aspects that are not specifically discussed in this report at this stage are expected to be provided in line with BS 9999:2017. Where other supporting standards are referenced, the latest version of these standards should be used.

2 Means of escape

2.1 Evacuation strategy

The viaduct itself presents a unique fire safety challenge regarding evacuation. From the entrance at the upper-level car park, up to the proposed new event building it is entirely open air with only the event building being enclosed with a roof.

The distance from the viaduct entrance (from the car-park) to the events building is approximately 165m and is currently considered to be a single direction of travel in a fire event and subsequent evacuation. To assess the specific risks associated with this extensive travel distance a specific assessment (on a fire scenario basis) has been undertaken. See Section 2.4.1.

Upon exiting the viaduct structure, occupants shall enter the existing external car park at which point they are considered in a place of safety. From here, occupants shall have the option to continue towards Deansgate-Castlefield Metrolink station or Albion Street, or travel down the public stairs onto Beaufort Street. A lift is also available adjacent to this public stair.

In the event of a fire on the viaduct, under the viaduct, adjacent to the viaduct or within the car park a simultaneous evacuation of occupants shall be undertaken by the National Trust staff on site.

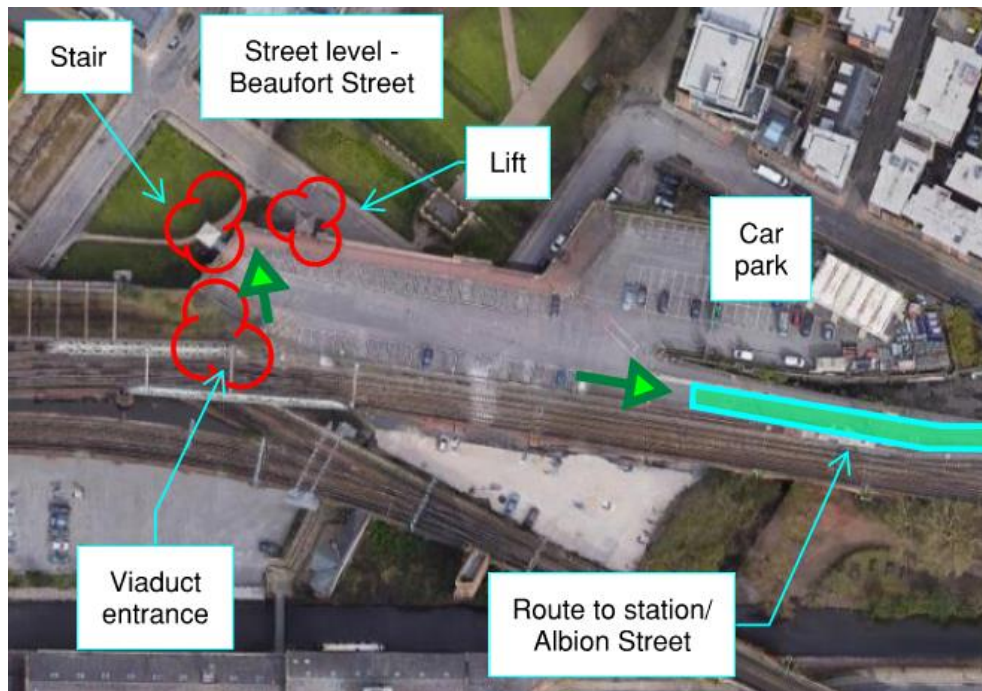


Figure 4: Available escape routes from viaduct entrance.

2.2 Fire detection and alarm system

The events building shall be provided with L1 detection designed and installed in accordance with BS 5839-1:2017, so that occupants are alerted to a fire as soon as possible. Alarm sounders linked to this detection system shall also be placed externally along the viaduct so that occupants externally are warned of a fire event in the building and to make their way to the exit.

The fire alarm system shall also incorporate a voice alarm throughout the viaduct (internal and external areas) to further aid the evacuation strategy depending on the fire scenario. This should be provided in accordance with BS 5839-8:2013. A dedicated point, such as the welcome kiosk, would need to be designated as the place that the National Trust operate this voice alarm from.

Manual call points are to be positioned in the external areas along the viaduct so that staff/visitors can alert occupants to a fire anywhere on the viaduct or in the vicinity of the viaduct (internally or externally) which has the potential to compromise the escape route. The call points are to be installed in line with BS 5839-1:2017, which requires the call points to be spaced no greater than every 45m along the viaduct's length.

2.3 Occupancy and risk profiles

Under BS 9999, a risk profile is assigned to each building or part of a building and this risk profile drives the appropriate means of escape and appropriate design features for life safety.

The events building and general external area shall be occupied by visitors who may not be familiar with the space. The anticipated furnishings both within the building and externally are expected to be similar to those in an office or similar events space. There will also be staff present who are involved in setting up/operating partner plots or supervising events.

A B2 risk profile in line with BS 9999 shall therefore be adopted as the most onerous condition.

2.4 Horizontal egress provisions

The events space building, shown in Figure 5 and Figure 6 below, is a new single storey space with a roof. As this is considered an internal building structure, all aspects of Part B of the Building Regulations are considered to be applicable.

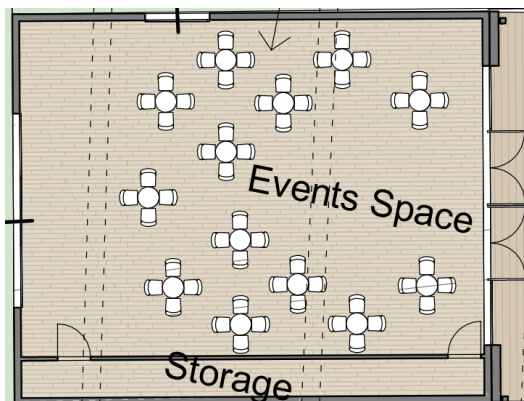


Figure 5: Central building layout.



Figure 6: Front view of building.

Travel distances within the building should be limited to 20m in a single direction following fit-out. The limited footprint of the building means that these should be achieved.

There is currently a single means of entering/exiting the building and as such this will permit 60 people to occupy the space, which is more than the anticipated number of people expected during Phase 1 (up to 50 people). The minimum exit width from the events building should be 850mm, which will permit the above occupancy.

Once outside the building horizontal means of escape should be available for all occupants at all times on the external viaduct. A minimum clear width of 850mm shall be maintained throughout the length of the viaduct and at the final exit to the car park to ensure this.

The distance from the events building to the viaduct entrance (car-park) is approximately 165m and is currently considered to be a single direction of travel in a fire event and subsequent evacuation. To assess the specific risks associated with this extensive travel distance a specific assessment (on a fire scenario basis) has been undertaken in Section 2.4.1 below.

These scenarios have only considered single fire scenarios and not assessed any security risks, which should be assessed by others to inform the design.

2.4.1 Extended single direction of travel

Guidance within BS 9999:2017 contains provisions for escape within buildings and within external areas such as rooftop plant. It limits single direction of travel for external normal fire hazard plant to 60m. BS 9999 does not provide specific guidance on external assembly spaces such as that proposed on the viaduct.

‘Fire safety risk assessment guide: open-air events and venues’ does not apply travel distances to open air events but instead considers the maximum amount of time it takes to escape and compares this to the risk category assigned. For a ‘normal’ risk space such as the viaduct, it permits escape times of between 5 to 10 minutes. Based on a walking speed of 0.8m/s, the 165m could be covered in less than 3.5 minutes once occupants are alerted.

The guidance notes that whilst the potential for smoke logging is largely absent in external areas as smoke can dissipate to atmosphere, there remains a danger to persons from the fire itself and the effects of radiative heat. That is, if the fire is large enough, it could prevent occupants from making their escape past it due to the pain felt from heat radiation when they get close.

In addition to the above, if the fire is large enough, it may damage the viaduct structure to an extent at which it is unusable for occupants to use for egress.

The introduction of a secondary escape route would remove the risk of the single direction of travel entirely. Arup have recommended that this be investigated by the design team as an option in consultation with all Stakeholders to understand the feasibility and subsequent implications to further inform the National Trust decision making process at the next stage of design.

Notwithstanding this, the following scenario-based assessment has been undertaken to understand the potential fire events which could compromise the 165m single direction escape route in order to determine whether there are viable mitigation measures which could be implemented in lieu of a secondary escape route.

Six fire scenarios that are deemed substantial and have the potential to compromise the single egress route from the viaduct have been considered. These are:

- Fire in one of the ‘partner plots’ along the viaduct.
- Fire in the welcome kiosk located towards the entrance of the viaduct.
- Fire in the car park adjacent to the entrance.

- Fire in a Metrolink tram that stops alongside the viaduct.
- Fire in a road vehicle below the viaduct.
- Fire in a train that stops underneath the viaduct.

We note that a fire may occur at any point along the viaduct involving singular items such as luggage that members of the public bring with them, a timber bench or bin fire. These fires are however considered to be localised/ small enough to be identified and extinguished by members of staff on site. These fires are therefore not considered to compromise the single exit in full.

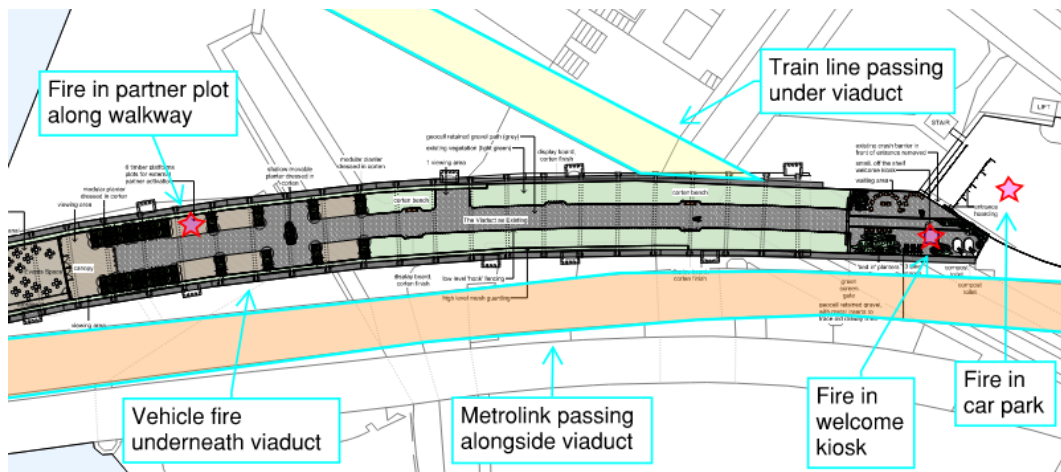


Figure 7: Illustration of fire scenarios.

2.4.1.1 Fire scenario on the viaduct

There is potential for a fire event to occur in one of the proposed ‘partner plots’ along the viaduct. Whilst in this event, occupants would be able to remain elsewhere on the viaduct in a place of relative safety while staff or the fire service extinguished the fire, it is considered that occupants should still have the option to escape past the fire should they wish to do so.

The partner plots are flexible areas which are proposed to be made available to external parties for a variety of uses such as art exhibitions, promotional stands or catering areas. An initial radiation assessment has therefore been carried out to determine whether occupants could escape past a potential fire in one of the plots safely.

The acceptance criteria in this scenario shall be the amount of radiation that has the potential to make the escape route impassable for escapees. CIBSE Guide E states that a radiant heat flux of less than 2.5kW/m^2 is tolerable for skin exposure for a time period no greater than 5 minutes.

As the full viaduct will not be exposed to this radiation, occupants will be able to move to other areas of the viaduct and be shielded from the radiation and as such they will only be exposed for a short period of time. Therefore, 2.5kW/m^2 is considered an appropriate assumption as escapees would not be exposed to the radiation for a prolonged period of time.

To determine the amount of radiation received by an occupant passing by the partner plots, the methodology outlined in BR 187 for parallel emitters has been utilised.

The proportion of the energy leaving the emitter and falling on the receiving surface, **I**, is related to the emissive power, **E**, as follows:

$$I_1 = \phi E$$

Where:

$$\phi = 4 \left[\frac{1}{2\pi} \left[\frac{a}{\sqrt{a^2 + c^2}} \tan^{-1} \left(\frac{b}{\sqrt{a^2 + c^2}} \right) + \frac{b}{\sqrt{b^2 + c^2}} \tan^{-1} \left(\frac{a}{\sqrt{b^2 + c^2}} \right) \right] \right]$$

And:

E – radiant heat flux from the given surface type (kW/m²). This can also be derived using expected fire temperature.

a, b – respectively half of the radiating panel height and width (m).

c – distance between the panels (m).

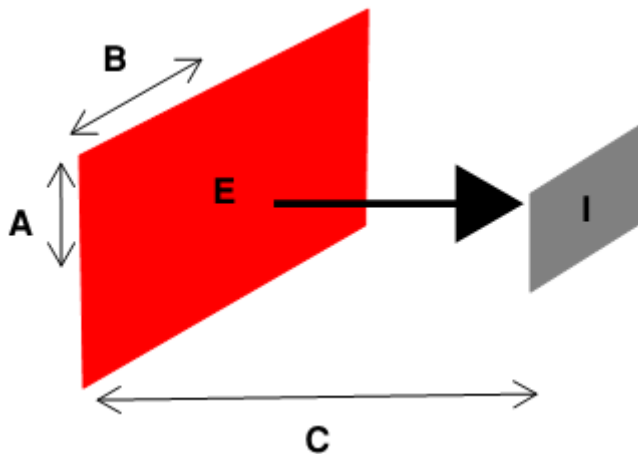


Figure 8: Parallel emitter diagram.

In order to provide the highest degree of flexibility of use for each plot, a worst case scenario of a 2m × 4m food truck has been used. The temperature of the fire is taken as a uniform 700°C¹ over the entire radiating panel based on the fuel load being equivalent to a small bus/truck where heat and smoke can dissipate to atmosphere. In order to permit all users of the viaduct to bypass the fire, a minimum clear width of 850mm for escape has been accounted for.

The factors shown in Table 2 were used for the calculation.

¹ Design Fires in Road Tunnels, IY Maevski, 2011.

Table 2: Variables used in partner plot scenario.

Case		Emitting temperature/ heat flux	Total height	Total width	Separation distance	Received heat flux
1	Partner plot	700°C / 45.8kW/m ²	2.0m	4.0m	6.65m	2.45kW/m ²

The results of this assessment indicate that the 2.5kW/m² acceptance criteria can be met if a 6.65m separation distance between the edge of the plot and the path of travel can be maintained. In order to achieve this, the plots would therefore need to be staggered to permit this travel path, as shown in Figure 9.

In order for the partner plots to be positioned opposite one another, an equivalent fuel load would be restricted to a size of 2m × 1.2m.

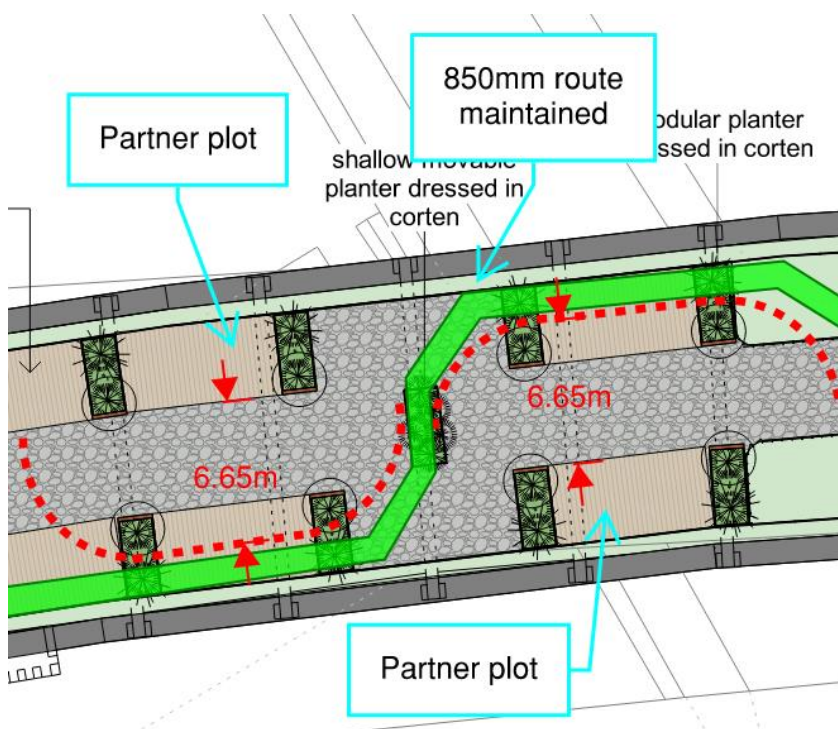


Figure 9: Illustration of the staggered/offset plots.

In any case, it is recommended that each plot is provided with localised manual suppression by staff in the form of fire extinguishers which are appropriate for the type of plot that is being used.

2.4.1.2 Fire scenario in the welcome kiosk

Aside from the partner plots, the only other substantial fuel load along the viaduct is the welcome kiosk adjacent to the main entrance. A fire in this kiosk could restrict visitors from escaping past it and so a radiation assessment has been conducted in line with the above methodology.

Figure 10 gives an indication of the scale of the welcome kiosk being considered for use in this area.



Figure 10: Indication of welcome kiosk.

It has conservatively been assumed that the temperatures associated with a fire in the welcome kiosk would not exceed that of a car fire, which is taken to have a temperature of 400°C^2 . Other variables used are shown in Table 3.

This demonstrates that if the booth remains 3.5m away from the 850mm escape route that the 2.5kW/m^2 threshold is not exceeded. The booth is therefore permitted in its location as shown on the latest plans.

Table 3: Variables used in welcome kiosk scenario.

Case		Emitting temperature/ heat flux	Total height	Total width	Separation distance	Received heat flux
2	Welcome kiosk	$400^{\circ}\text{C} / 10.5\text{kW/m}^2$	2.2m	2.2m	3.5m	1.17kW/m^2

2.4.1.3 Vehicle fire scenario adjacent to entrance

A vehicle parked immediately adjacent to the viaduct entrance would have the potential to compromise the main exit point from the viaduct were it to be on fire. The same acceptance criteria for radiation as outlined above is also used here.

As a small bus/truck could feasibly be parked in this vicinity, the temperature assumed of 700°C is the same as that used in Section 2.4.1.1.

Therefore, no vehicle parking spaces are permitted within 5.5m of the proposed exit/walkway/entry way. This would allow visitors to leave via the external stair

² Design Fires in Road Tunnels, IY Maevski, 2011.

or lift should a car elsewhere in the car park be on fire. This requirement should form part of the National Trust's management procedures. This arrangement is shown in Figure 11.

Table 4: Variables used in car park fire scenario.

Case		Emitting temperature/ heat flux	Total height	Total width	Separation distance	Received heat flux
3	Car	700°C / 45.8kW/m ²	1.5m	3.6m	5.5m	2.40kW/m ²

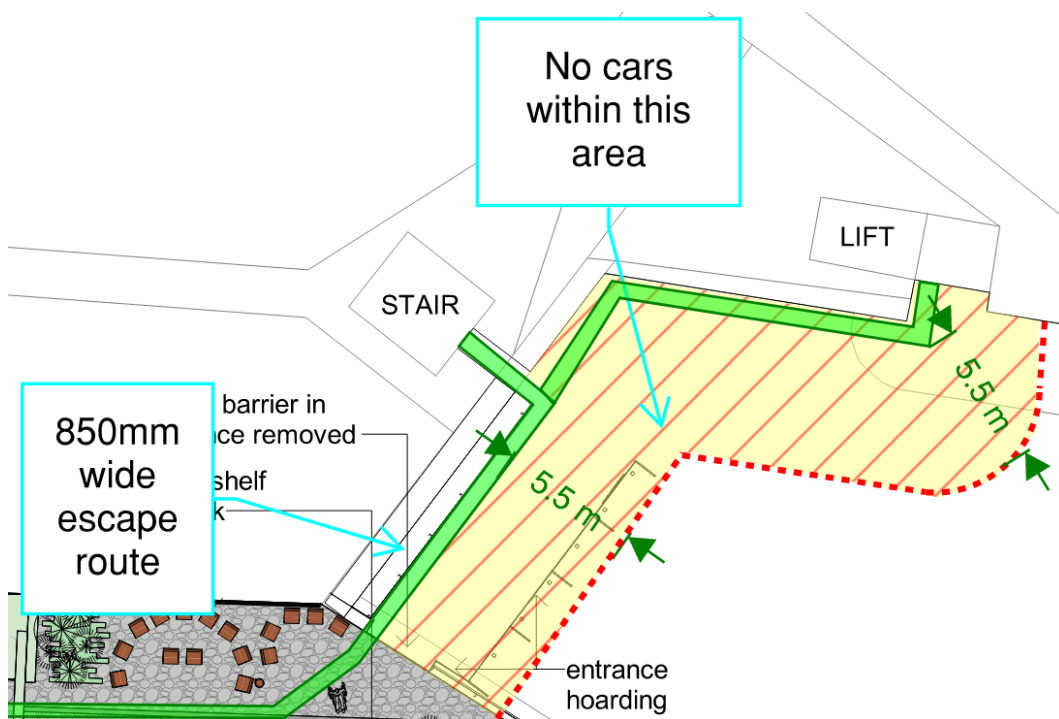


Figure 11: Restrictions on car parking adjacent to entrance.

2.4.1.4 Tram fire scenario adjacent to escape route

A tram line runs adjacent to the viaduct as shown in Figure 7 and at the closest point there is 3.3m between the edge of the tram line ballast and the accessible area of the viaduct. As in the case of the vehicle fire, there is the potential that a tram fire occurs adjacent to the viaduct, thus potentially compromising the single exit for occupants on the viaduct. The probability of such a scenario occurring is considered to be very unlikely given that it would require either:

- A tram to stop adjacent the viaduct then set alight; or
- For a fire to have started on the tram and then the driver to subsequently stop the tram adjacent the viaduct.

An initial radiation assessment has however been conducted to determine the minimum safe distance for occupants to be able to escape/walk past a tram on fire.

The methodology assumes a fire within a Metrolink carriage, and that the radiation from the fire will primarily be emitted from openings in the carriage such as windows and doors. Arup have previously modelled fires on trains using computational fluid dynamics to determine a suitable temperature profile for such an event. As a Metrolink carriage is deemed to contain less fuel load than a typical train carriage, this is considered a conservative initial approach.

The temperature profile has been taken as 950°C local to the fire location (assumed to be a stacked luggage) and 550°C elsewhere in the carriage to represent the slightly cooler smoke temperatures that would be present away from the fuel source. In the worst-case scenario, a fire is seated directly adjacent to a door which is the largest opening. An occupant is assumed to be facing the centre of this panel. This is shown in Figure 12.

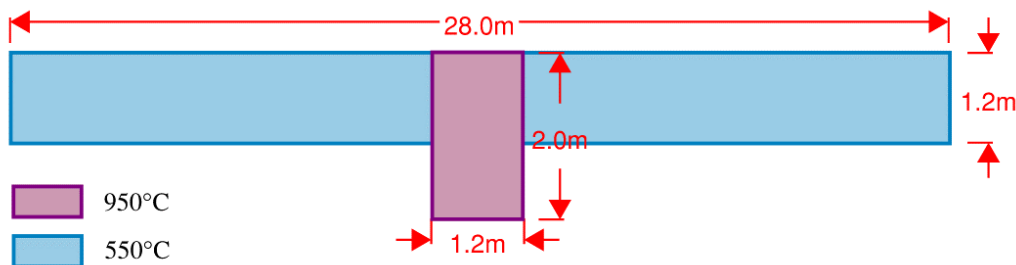


Figure 12: Indicative radiating panel in section view - tram fire scenario.

The results of the assessment show that the threshold of 2.5kW/m² is not exceeded if the receiver (occupant) is located more than 9.5m away. This means that the 850mm clear egress width is available on the walkway from the most onerous position, and so the risk of a tram fire compromising escape due to heat radiation is considered to be low and within acceptable limits. This arrangement is shown in Figure 13. Management should ensure that the minimum 9.7m is available at all times.

Table 5: Variables used in tram fire scenario.

Case		Emitting temperature/ heat flux	Total height	Total width	Separation distance	Received heat flux
4	Tram (door)	950°C / 114.2kW/m ²	2.0m	1.2m	9.7m	0.91kW/m ²
	Tram (window)	550°C / 23.4kW/m ²	1.2m	28.0m	9.7m	1.32kW/m ²
	Total radiation when adding the above and subtracting the overlap (which had a value of 0.11kW/m ²):					2.12kW/m ²

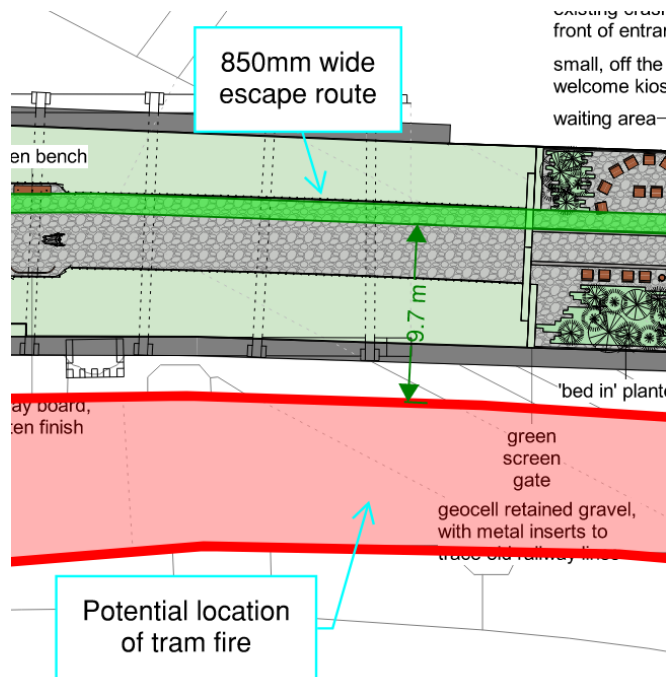


Figure 13: Escape past a tram fire scenario.

2.4.1.5 Vehicle fire scenario underneath viaduct

Due to the presence of roads and car parking spaces beneath the viaduct, a potential fire scenario exists where a vehicle below the viaduct catches fire and this fire impacts upon either the occupants escape either via direct flame impingement on the structural elements, which could cause structural collapse, or direct flame impingement on the sheet metal deck flooring which occupants will use for egress.

Structural impact review

We understand the primary structural columns are made of steel cylinder encasements which are filled with concrete with a 2.4m diameter. These are shown in Figure 14. Whilst it is expected that these concrete columns could therefore withstand a long heating duration before being adversely affected, the performance cannot be quantified due to the age of the existing materials. It is therefore recommended that in the event of a vehicle fire below the structure that the viaduct is evacuated. A fire that is significant enough to cause structural failure of the columns is considered to be sufficiently large enough that staff at the viaduct would become aware of the event by smoke, flames and heat within a short period of time and initiate a managed evacuation.



Figure 14: Image showing size of structural columns.

Staff can then alert occupants to make their escape by activating a manual call point. They should communicate via radio to each other throughout the evacuation process. For mobility impaired occupants (MIPs) travelling at 0.8m/s, it is expected that they can traverse the full length of the viaduct to the relative safety of the car park in approximately 207 seconds. It is expected that any vehicle fire that could potentially cause significant weakening or failure of the structural columns would take longer than the time required to complete a successful evacuation.

This approach should form part of the National Trust's management procedures, which are summarised in Section 7.

Metal deck flooring impact review

The viaduct deck is approximately 18m above street level. Due to the open-air environment below on all sides and associated height, it is considered unlikely that radiation will pose a risk to the viaduct metal deck floor above or to the occupants escaping on it. The 10mm steel deck plates are supported by steel beams and have a layer of ballast above which is considered to provide protection from any heat below. Notwithstanding this, an initial flame height calculation has

been undertaken to determine whether flame impingement on the steel deck plates and supporting beams could occur, which could locally affect structural elements based on a worst-case fire scenario of a Heavy Goods Vehicle below the viaduct. This scenario was observed during a site visit, shown in Figure 15.

A pool fire scenario has been used to indicatively determine the height of a fire in this location. The pool fire flame heights have been calculated using Equation 4.40 from Introduction to Fire Dynamics by Dougal Drysdale (2nd Edition):

$$l = 0.23Q_c^{2/5} - 1.02D$$

Where:

l = flame height (m)

Q_c = convective heat output of a fire (kW). A conservative 20MW has been taken to represent a garbage lorry fire, of which 70% is considered to be the convective heat portion.

D – diameter of the pool fire (m). The diameter has been taken to be 4m.

The calculation shows that the indicative flame height is 6.5m. As this is significantly less than the 18m deck height, even when allowing for a 5.0m tall vehicle, it is considered that even in a worst-case fire scenario flame would not impinge upon the deck of the viaduct. This risk is therefore considered to be low.



Figure 15: Example of goods vehicle below the viaduct.

2.4.1.6 Train fire scenario underneath viaduct

An active train line runs below the viaduct, as shown in Figure 7. A potential fire scenario is therefore present where a train fire located directly under the viaduct structure could occur. The combination of smoke and flames/heat in this event could compromise the single escape route from the viaduct, as well as threaten the structural stability of the viaduct itself. The common causes of train fires are generally related to freight trains carrying materials/cargo which ignite when either stationary or in motion or due to accidents/collisions on the railway.

A rail incident such as this is a catastrophic event and is considered extremely unlikely based on the following evaluation of this particular instance:

1. **Likelihood of a train being stationary below the viaduct:** The viaduct is located in between the Deansgate train station and a signal point where the train routinely stops. Both of these are considered to be the main 'resting point' for any train waiting on this line and both occur at a suitable distance away from the area under the viaduct structure. A train is therefore not typically expected to come to rest underneath the viaduct in any scenario as this would not be part of its typical routine i.e. trains are expected to be in motion when passing under the viaduct.
2. **Likelihood of a passenger train being in motion and a fire occurring whereby the train is then manually stopped by the conductor under the viaduct:** It is expected that in the event of a train carriage fire being identified, Network Rail's policy would be for a train to continue to the nearest station (where the risk is acceptable i.e. external station platforms), which in this case is Deansgate Station, and come to rest so that passengers can safely disembark. This particular scenario should be confirmed with Network Rail.
3. **Likelihood of a train being in motion and a fire occurring whereby subsequently the train comes to rest under the viaduct:** The total rail track length in the UK is 31,063,000m and it is estimated that the frequency of freight train fires (locomotive or cargo) is approximately 7 events per year, based on the RSSB Safety Risk Model version 8.1, HET 20A. The viaduct structure covers a very small portion of 2 lines of this track at a length of 60m each (when also accounting for the adjacent Metrolink line). It is therefore considered very unlikely that the events proposed above would collectively occur to result in a train fire directly below the viaduct entrance/exit.
4. **Likelihood of a train being in motion and an accident/collision occurring:** The ORR reported in 2018-2019 that there were 12 potentially higher risk passenger train accidents on the main line rail network and only 3 of these would be considered relevant and a risk in this particular scenario i.e. 2 collisions between trains and 1 derailment. The likelihood of a moving train carriage having a collision/accident and coming to rest directly underneath the viaduct structure is therefore considered to be very low.

As noted in the vehicle fire scenario, it is recommended that National Trust staff initiate the evacuation of occupants as soon as it becomes apparent that there is a train accident or fire below the viaduct i.e. signs of fire, heat, smoke and a stationary train. The steel plate floor and ballast above are considered to provide

immediate protection from potential flame impingement and heat radiation from a train fire below, however the distance between the top of a train carriage and the steel plate deck is within 2m which is considerably less than the vehicle fire scenario beneath the deck.

Therefore, in the unlikely worst case that the train fire prevented egress to the viaduct exit, occupants could be managed to remain in the events building at a distance of ~110m away (in a place of relative safety) at the far end of the viaduct until the incident had been dealt with. It is recommended however that the default approach for the National Trust in this scenario is to evacuate occupants.

It is a requirement that the above forms part of the National Trust's fire safety management plan so that staff are aware of the necessary course of action in the event of the various fire scenarios.

2.5 Vertical egress provisions

As noted in Section 2.1 (and shown in Figure 4), upon exiting the viaduct structure, occupants shall enter the existing external car park at which point they are considered in a place of safety. From here, occupants shall have the option to continue towards Deansgate-Castlefield Metrolink station or Albion Street, or travel down the public stairs onto Beaufort Street. A lift is also available adjacent to this public stair. Escape for MIPs is covered in the subsequent section.

2.5.1 Mobility impaired occupants (MIPs)

850mm wide escape routes are required throughout the building and the viaduct. Level egress should be available from the viaduct to the car park. There are then two available egress options for MIPs:

- 1) The lift on to Beaufort Street.
- 2) The pedestrian pavement towards Deansgate Castlefield Metrolink station (where another lift is available) or down the vehicle ramp onto Albion Street.

The National Trust should document their approach to the evacuation of MIPs within the fire safety management plan.

2.6 Assembly point

To avoid any conflict between escaping occupants and emergency/other vehicles that may be on the main road leading out of the car park, it is proposed that the car park be used as an assembly point in the event of a fire elsewhere on the viaduct. This should form part of the fire safety management plan.

2.7 Emergency lighting

Emergency lighting should be installed and comply with BS 5266-1:2016 to all internal and external areas of the building and the viaduct.

BS 5266 series requires external emergency lighting to be provided at designated muster (assembly) points. The muster point is understood to be the car park and the specific area should be identified by the National Trust.

2.8 Emergency power

The life safety systems on this scheme include the fire detection and alarm system and the emergency lighting. These should be provided with either an independent secondary power-supply or local battery back-up.

2.9 Emergency signage

Escape signage conforming to the Health and Safety (safety signs and signals) Regulations 1996 should be provided within the building and along the viaduct in accordance with BS 5499-4:2013. Signs containing symbols or pictograms need to comply with BS ISO 13864-1:2011.

3 Internal fire spread (linings)

The open-plan events building shall have linings that achieve a Class C-s3,d2 performance when classified in accordance with BS EN 13501-1. Any smaller rooms off the open-plan space should achieve a Class D-s3,d2 performance.

The external areas of the viaduct (structural elements above and to the side) where the single direction escape route is provided shall not be lined with any materials and shall remain as existing.

4 Internal fire spread (structure)

The events building is single storey of approximate height 4.0m. In accordance with Table 23 of BS 9999, it is not required to be provided with any structural fire resistance from a life safety perspective.

No internal fire resisting separation within the events building is required in accordance with BS 9999.

The existing heritage viaduct structure has been assessed by Arup structures and we understand consists of the following:

- 2.4m diameter steel columns filled with concrete.
- Steel beams spanning these columns.
- 10mm steel plate deck with stone ballast on top sitting above the steel beams.

This existing structure has no defined fire resisting performance. Notwithstanding this, the concrete filled columns and large steel structural beams including 10mm thick steel plate are expected to provide a degree of resistance to fire and would therefore provide sufficient structural integrity for occupants to egress the viaduct in a fire scenario.

It is noted that a fire involving the events building or an external fire event has the potential to damage the existing heritage structure, therefore we shall explore further property protection measures with the National Trust as part of the project's development.

5 External fire spread

5.1 Space separation

The viaduct should adequately resist the spread of fire over it in order to limit the risk to its occupants and to any neighbouring areas. As outlined previously, the existing viaduct is constructed from steel structure, which includes a steel panel deck with a layer of ballast above, both of which are non-combustible materials.

Where new combustible materials are proposed as part of the redevelopment project such as timber floor decking to exhibition areas, it is recommended that these are kept to a minimum.

The events building is located with a Metrolink line to the South and the Bridgewater Canal (and tow path) to the North. These have therefore been taken as the relevant site boundaries. The viaduct itself continues along the East and West and therefore no site boundaries exist in these directions.

Initial external fire spread calculations undertaken in accordance with the guidance within BR 187 show that the events building can have 100% unprotected area if is located at least 4.2m away from this boundary line to the North and South, which is achieved with the current proposals to the South measured to the centre line of the Metrolink.

There is however a small area of tow path to the North within 4.2m of the events building directly adjacent to and below the level of the viaduct. This is shown in Figure 16. It is noted that there is no risk of external fire spread currently as no building is present and it is unlikely that this area directly below would be developed. However, consultation with the owner of the land should be undertaken to confirm agreement of this in writing. Alternatively, the above approach could be discussed with Manchester City Council Building Control.

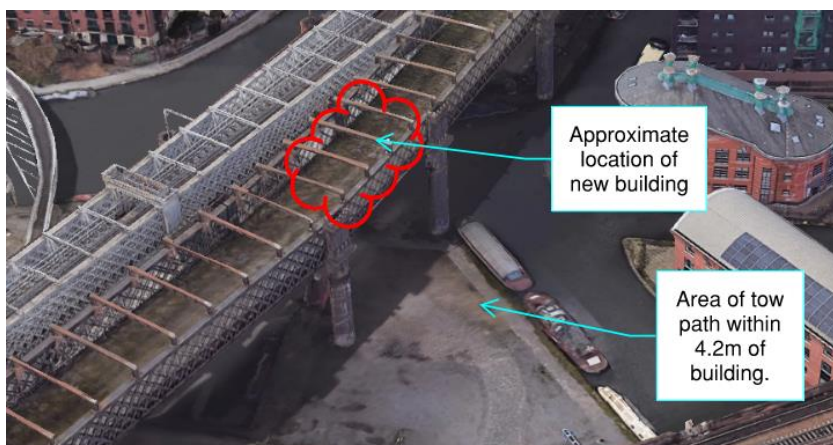


Figure 16: Area of tow path in relation to new building.

5.2 Green areas

As part of the Phase one masterplan, the viaduct is to provide an open-park type space with new greenery in localised planters and pots. It also proposed that the existing natural plants and greenery growing through the ballast is retained in areas. This localised greenery is not considered to represent a significant risk from fire.

For the future Phase 2 scheme, if continuous greenery is proposed (akin to a green roof), we would recommend that the principles of ‘The Green Roof Organisation’s Fire Risk Guidance Document’ are followed which is based on Approved Document B guidance and the Department for Communities and Local Government document “Fire Performance of Green Roof and Walls” (August 2013). The key measures we consider applicable to the viaduct project are:

- 1.0m wide ‘fire breaks’ proposed to be installed at a maximum of every 40m along the length of the viaduct where green areas are continuous. The breaks should be of Class A1 material, such as ballast, and be applied through the full depth of the viaduct (noting that the existing substrate already achieves this performance).
- Where no permanent irrigation system is installed, as on most extensive and biodiverse green roofs, the growing medium should contain less than 20% organic content where continuous.
- The organic material should be peat free where continuous.

Green areas should be designed to prevent the system from drying out completely as this will impact plant life and may impact fire performance. If the type of planting prevents a fire risk when dried out (dead) a suitable temporary or permanent irrigation system should be required.

The maintenance regime (recommended twice yearly as a minimum) for the viaduct should ensure that the 1.0m wide fire breaks are maintained and that replacement material is in line with the above specification.

6 Fire-fighting provisions

A fire tender vehicle can currently access the raised car park level and arrive at the viaduct main entrance, but it is understood that it could not progress onto the viaduct itself due to weight restrictions. No external hydrants were observed within the raised car park on site. Therefore, for the pilot stage scheme it is proposed that the fire service should arrive at street level adjacent the viaduct and gain access via the open stair to the car park.

A new horizontal dry riser is proposed to be provided along the length of the viaduct. The riser inlet is proposed to be provided at street level, adjacent and below the viaduct/car park, so that it is in closer proximity to an external hydrant, which is within 90m of this location. The location of the hydrant is shown in Appendix C.

The fire service will then be able to connect into the dry riser inlet from the appliance, walk up the open stair to the viaduct entrance and progress along the viaduct to the location of the fire.



Figure 17: Location of dry riser inlet at street level.

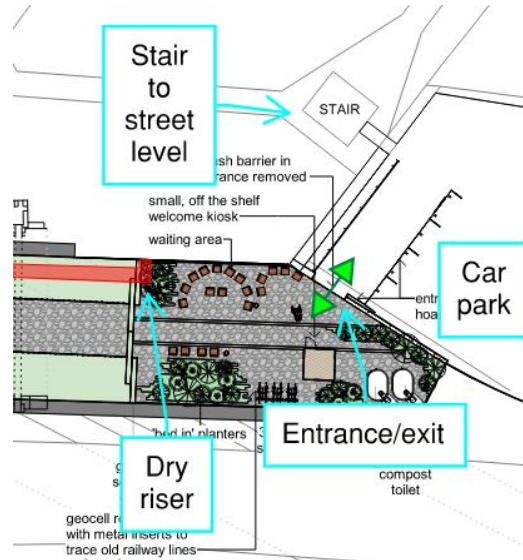


Figure 18: Fire-fighting access at viaduct level.

The viaduct entrance is approximately 165m from the events building at the very end of the viaduct. Therefore, the horizontal dry riser will be provided to enable the fire service to walk from the entrance along the viaduct and maintain suitable water provisions, as discussed in Section 6. Outlets should be provided at the entrance and end of the viaduct and at regular intervals (recommend every 40m) along its length.

This proposal will require consultation and formal agreement with the agency responsible for the upkeep and maintenance of the open car park stair, to permit and maintain fire service access to travel to/from the dry riser inlet and the viaduct's entrance.

It is noted that Greater Manchester Fire and Rescue Service have provided comments on the scheme prior to Arup's involvement. These comments are included in Appendix D along with Arup's responses for their review in conjunction with this report.

The events building is not required to be provided with any internal fire-fighting provisions in accordance with BS 9999. Access should be provided to at least 15% of the building's perimeter; this access will be provided along the main viaduct in line with the dry riser provisions set out in Section 6.

7 Management and maintenance

7.1 Regulatory Reform (Fire Safety) Order

The Regulatory Reform (Fire Safety) Order (RR(FS)O) 2005 places a general duty of fire safety care on employers, occupiers and owners of almost all premises and requires them to take such fire precautions as may be reasonably required to ensure that premises are safe for the occupants and those in the immediate vicinity. Greater Manchester Fire and Rescue Service have noted that they would consider the premises to be a workplace under Article 5 of the RR(FS)O.

As part of the ongoing fire safety management of the viaduct, the responsible person must make a suitable and sufficient assessment of the risks to which persons are exposed, for the purpose of identifying the general fire precautions they need to take to comply with the requirements and prohibitions imposed by the RR(FS)O. These assessments shall be undertaken periodically or be adapted as appropriate to take account of any new or changed risks.

7.2 Specific management considerations

There is a particular reliance on management during Phase 1 of this project if a secondary exit cannot be facilitated. In this event, an enhanced management system level in accordance with BS 9999 should be provided. This requires conformity with a management system such as PAS 7.

Thorough and robust training on the potential fire scenarios and hazards present is to be provided to all staff. Communication via radios is a requirement to alert staff to a risk and to assist in the management the evacuation. A minimum of 3 staff at all times are required, one of which is to remain at the entrance space to provide a watch for a fire that could affect the single entrance/exit. The management response in a fire event will need to be regularly tested on a monthly basis.

Table 6: A summary of management measures required.

Item	Summary of measures
Maintain clear escape routes	The National Trust management are required to keep escape routes clear e.g., free of items which would restrict the escape width to less than 850mm. Escape is provided by the adjacent car park, therefore formal agreements must be established between the Responsible Persons for each premise that a route for egress shall always be maintained. The exit into the car park is to be kept clear of all vehicles as per Section 2.4.1.3. Minimum widths of escape routes and distances from features on the viaduct should also be in accordance with the fire scenarios in Section 2.4.1. The restrictions on combustible outlined within this report are to be enforced.

Assembly area	The National Trust may wish occupants to travel to an assembly area following a fire incident. This should be documented as part of a fire safety management plan.
Maintain fire safety equipment	Planned inspection, maintenance and testing procedures should be established and used to ensure that all fire protection systems can operate effectively when required. Arrangements should be made for all fire safety equipment, installations and systems to be inspected and tested on a regular basis by a competent person. Alterations, additions, repairs or modifications to services and equipment should be carried out only by competent persons.
Fire breaks	The 1.0m fire breaks are to be maintained and kept clean and clear of vegetation.
Plant material	The responsible person should ensure that any vegetation used on the viaduct meets the criteria set out in this report.
Management of fire scenarios	The National Trust's evacuation plan under the scenarios noted in Section 2.4.1 and Section 7 are to be documented and appropriate training provided to staff so that these procedures can be followed.
Upkeep of stairs	The stairs located on the adjacent car park are owned by a separate company or Council. This fire strategy relies on these stairs being available for use by the fire service. The maintenance and upkeep of these stairs is therefore of importance to this fire strategy and the National Trust should ensure that they are kept in place (to a suitable standard) for the duration of the phase 1 pilot scheme as a minimum.
Management of MIPS	Specific consideration is to be given to the evacuation of mobility impaired occupants (MIPs) within the National Trust's fire safety management plan.
Fire extinguishers	Extinguishers are to be provided in strategic positions across the viaduct. Training is to be provided to staff in the use of extinguishers.
Meeting the fire service	This fire strategy should be presented to and discussed with Greater Manchester Fire and Rescue Service at the next available opportunity.

8 Future work – Phase 2 scheme

Whilst the design for Phase 2 is still under development, an initial study has been undertaken to inform potential works that will be required. These works include:

- The Phase 2 scheme will contain a longer single direction of travel and more occupants. It also has the potential to contain less managed scenarios if it opens as a park. An additional exit (stair) at the western end of the viaduct is therefore required in this phase. Consultation should be undertaken during the

pilot scheme stage to understand ownership of land below the viaduct, and the feasibility of providing a stair in this location.

- This stair will also provide a secondary access point for the fire service. At this time, it is envisaged that a secondary dry riser will be provided from this stair, up to the viaduct, and then across to meet the dry riser which is proposed in Phase 1.

These items are to be fully captured in the fire strategy associated with the Phase 2 works.

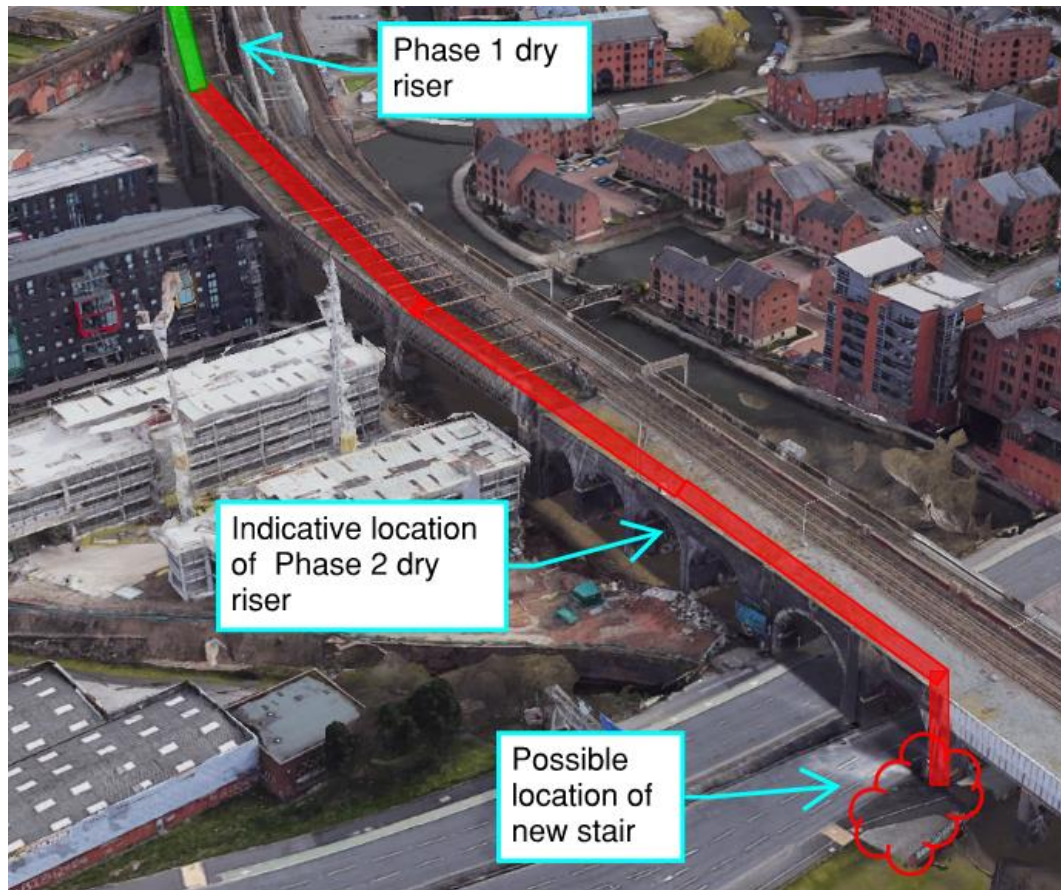


Figure 19: Possible location of secondary exit and dry riser provisions for Phase 2 design.

Appendix A

GA plans for the scheme



CDM Issues - Significant/Residual Hazards:		Hazard		Description		Measure/Location/Reference		Notes:		Key:		Rev.		Date		Description		Dm.		Chkd.		Appd.		Key Plan:		Issue Status:		PRE-PLANNING			
All designers involved in this drawing are to ensure that all foreseeable Significant Hazards relating to this drawing are indicated below. Significant Hazards are not necessarily those that result in the greatest risks, but those that are: • Unlikely to be obvious to a competent contractor or other designers; • Unusual; • Likely to be difficult to manage effectively. As a design and building project, the Main Contractor is deemed to be a designer under the CDM Regulations as well as the Client, Architect, Engineer or subcontractors. This risk schedule is not a design risk assessment of a full and complete risk schedule and should not be deemed as such. Copies of the designers' risk assessment along with risk schedules are to be available from the Main Contractor's site office upon request.		Fall from height		☐				1. Do not scale from this drawing.				A		23/07/21		Changes after public cons, cost analysis and pre-planning meeting.		IA		MC		IA									
		Falling objects		☐				2. Dimensions are in millimetres (mm) unless otherwise stated.																							
		Hazardous materials		☐				3. This drawing is to be read in conjunction with all relevant Architectural, Civil, Structural and Service Engineer's drawings, schedules and specifications.																							
		Uncontrolled substances		☐																											
		Site transportation		☐																											
		Crushing/entanglement		☐																											
		Hazardous operations		☐																											
		Confined spaces		☐																											
		Noise		☐																											
		Dust		☐																											
Vibration (HAV)		☐																													
Manual handling		☐																													
Asbestos		☐																													
Others		☐																													

Appendix B

CDM risk register

B1 CDM Risk register

Register reference										Rev 001
Project	Castlefield Viaduct					Job number	282210-00			
Package/Topic	Fire Engineering					Design stage	RIBA Stage 2			
Remember: Avoid – Reduce – Control and Communicate relevant information to others										
Date (+ initials)	Area/Location of Risk Exposure	Description of Hazard and Risk Exposure	Mitigation of Risk (Potential or Achieved)	A	R	C	Further Action	By	Status	
									Active / Closed	
	1.0 Fire protection									
2021-08-31 RW	High height spaces - installation and maintenance of fire protection systems (e.g. detection and sounders)	Working at height	Potential			X	Due consideration to CDM should be given to the system chosen in the context of the project and other work to be carried out at height.	detail TBC with specialist designers	Active	
	2.0 Means of escape									
2021-08-31 RW	Escape of disabled occupants	Level egress shall be provided for escape suitable for disabled occupants. However, effective evacuation of disabled occupants is also reliant on management.	Potential. Evacuation of disabled occupants to be managed by occupier, taking into account the provisions described in the Fire Strategy Report.			X	The client is to ensure that the occupier is aware of the limitations of the design for disabled occupant evacuation and that evacuation from the area is suitably managed	Client	Active	
2021-08-31 RW	Extended single direction of egress	Staff and visitors may be unaware of a fire which could compromise the single escape route, delayed evacuation.	Potential		X		A fire engineered assessment has been undertaken to assess the associated risk from fire. A residual risk shall always remain unless a secondary means of egress is provided which should be considered by the client and associated Stakeholders. Provide automatic and manual detection, sounders and beacons for alerting and radios for staff communication. Management is relied upon to enable a successful evacuation. The client should provide an FRA and fire safety management plan including training and procedures to follow based on the fire strategy report. Fire strategy to be reviewed by client and Building Control/GMFRS.	Client	Active	

Register reference									Rev 001
Project	Castlefield Viaduct				Job number	282210-00			
Package/Topic	Fire Engineering				Design stage	RIBA Stage 2			
Remember: Avoid – Reduce – Control and Communicate relevant information to others									
Date (+ initials)	Area/Location of Risk Exposure	Description of Hazard and Risk Exposure	Mitigation of Risk (Potential or Achieved)	A	R	C	Further Action	By	Status
									Active / Closed
	3.0 Fire-fighting provisions								
2021-08-31 RW	Fire tender access to viaduct, specifically events building.	Emergency access in the event of a fire has the potential to be impaired given the restricted vehicle access to the viaduct. This could potentially pose increased life-threatening risks to occupants in a catastrophic emergency scenario.	Potential. The developed RIBA Stage 2 includes for a dry riser to be provided to assist fire-fighting on the viaduct.		X	X	Dry riser system design to be developed.	Public Health Engineer & Client	Active
	4.0 Structural requirements								
2021-08-31 RW	Unknown fire performance of structure	Several fire scenarios pose the potential risk of structural damage, failure or collapse of the viaduct.	Potential. The fire scenarios have been assessed in the stage 2 fire strategy in relation to life safety. There is a residual risk of structural damage or failure due to a fire event.		X		Fire strategy to be reviewed by client and Building Control/GMFRS.	Client	Active
	5.0 External Fire Spread								
	Facade design	External fire spread to neighbouring properties/boundaries	Achieved			X	Mitigated by the provision of sprinklers, and avoiding the need for fire rated facades. Subject to approval from Building Control/Fire Service.	Design team	Active
	6.0 Miscellaneous								
	Fire safety risks during construction	Risk of fire starting and spreading within the construction site area. Risk exposure: 1. Life safety risk to construction occupants; 2. Property risk to viaduct structure; 3. Property/operational continuity risk to adjacent rail and metro network. There is a specific risk associated with this construction project due to	The risk of fire associated with the construction site shall be mitigated via fire risk assessment – this is the responsibility of the Principal Contractor. The specific risk in relation to the single egress route and access route for Fire Service should be addressed.		X	X	All Stakeholders should hold a meeting to discuss and identify responsible persons for managing the risk of fire safety on the site during the construction phase in order to implement an agreed plan of action to reduce the fire risk.	Contractor/Client	Active

Register reference

Rev 001

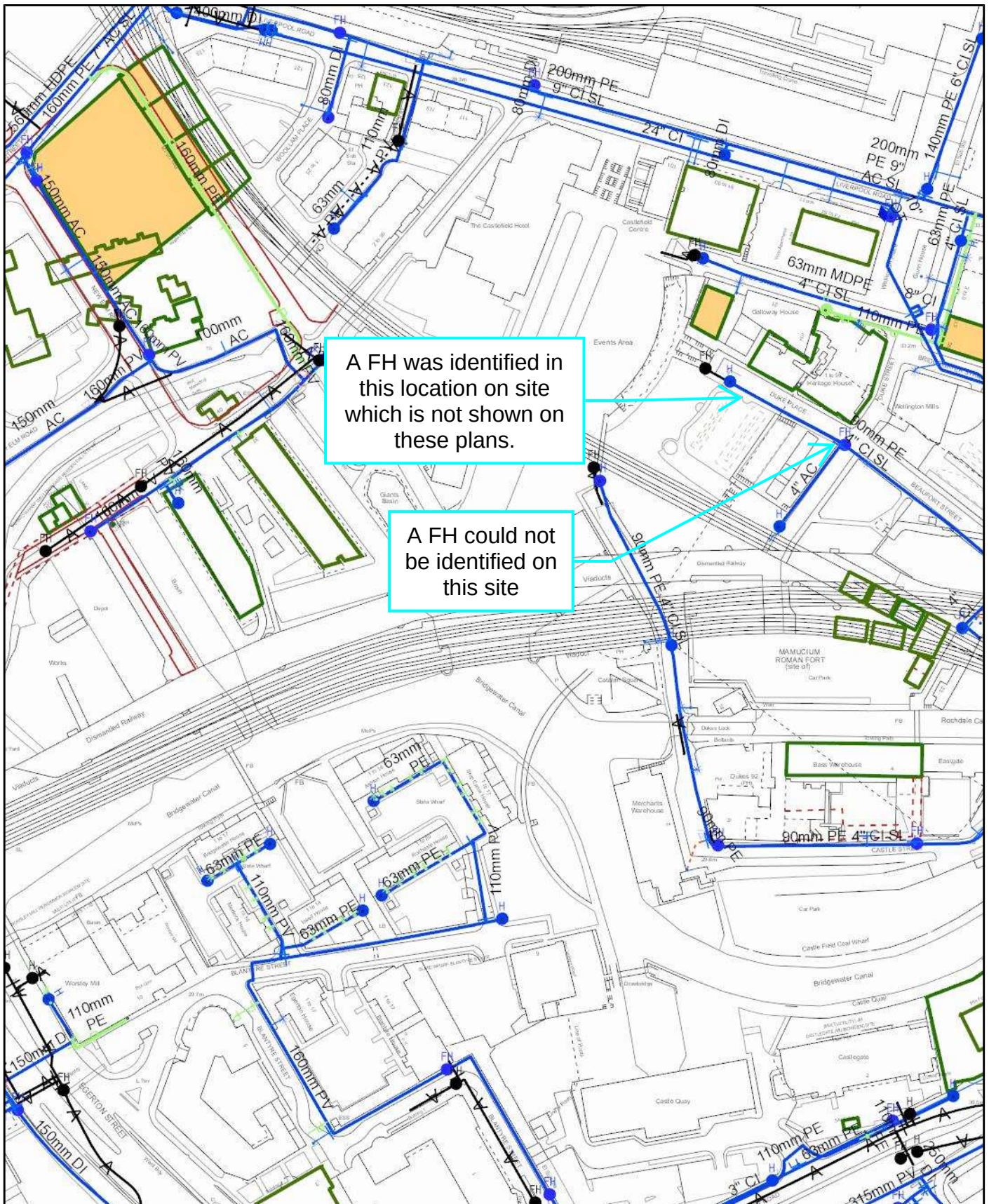
Project	Castlefield Viaduct	Job number	282210-00
Package/Topic	Fire Engineering	Design stage	RIBA Stage 2

Remember: Avoid – Reduce – Control and Communicate relevant information to others

Date (+ initials)	Area/Location of Risk Exposure	Description of Hazard and Risk Exposure	Mitigation of Risk (Potential or Achieved)	A	R	C	Further Action	By	Status
									Active / Closed
		the single egress route and fire service access route. The risk associated with this during the redevelopment work is a key risk.							
	Transportation and storage of dangerous substances on or under the viaduct.	Fire and explosion risk of transportation of dangerous substances through an uncontrolled area, associated with manual handling of dangerous substances.	Risks associated with dangerous substances should be mitigated via DSEAR risk assessments.	X	X	X	Client to undertake DSEAR assessments for all dangerous substances and equipment.	Client	Active

Appendix C

Fire hydrant location



A FH was identified in this location on site which is not shown on these plans.

A FH could not be identified on this site

Scale: 1:2179 Date: 10/04/2021	WATER MAINS RECORDS	 Water for the North West
Address or Site Reference: Castleford Vaiduct Printed by: Property Searches		
The position of the underground apparatus shown on this plan is approximate only and is given in accordance with the best information currently available. United Utilities Water will not accept liability for any loss or damage caused by the actual position being different from those shown. Crown copyright and database rights 2017 Ordnance Survey 100022432. Unauthorised reproduction will infringe these copyrights.		

Appendix D

Fire service comments and Arup responses

D1 Greater Manchester Fire and Rescue Service – initial comments

Neil Unsworth of Greater Manchester Fire and Rescue Service provided comment on the scheme on 19/04/2021, prior to Arup's involvement. Their comments are noted below with Arup's response alongside in blue.

1. There will be different requirements depending on the stage of the development. The pilot stage will need minimal additional hard infrastructure, but considerable management and staff considerations. *Agreed. We have outlined the management/staffing expectations within the concept fire strategy which shall be relied upon as part of the interim pilot stage.*

The main project aim of having a large amount of useable space will require substantial physical additions and alterations. *Agreed, where feasible/reasonable, we have incorporated several physical fire safety provisions into the pilot stage scheme where they are likely to provide benefit to the fire strategy in the future stage 2 scheme.*

2. If there is a long term plan or stretch objective such as enclosing the area with a roof, it would be beneficial to give this some thought at this early stage. *Agreed, at this point it is understood that enclosing significant areas of the viaduct with a roof is not part of the longer term design proposal for the scheme and specifically not proposed for the initial pilot stage scheme.*
3. The current main access point including vehicular access, lift and stair tower provide an excellent starting point to meet the requirements which will be required once occupation takes place. *Agreed, we have prepared a concept strategy around these entrance and access points.*
4. The fire service would consider the premises to be a workplace under Article 5 of the Fire Safety Order. Who is responsible for enforcing the Fire Safety Order would need clarification due to the number of stakeholders including the Department for Transport (Articles 25 and 26; possibly Crown Premises or HSE jurisdiction.) *Agreed, we have recognised and further communicated the complexities surrounding the multiple stakeholders and those responsible to the National Trust and recorded this in the fire strategy . Written legal agreements will need to be further discussed and developed as the project progresses.*
5. In order to meet the functional requirements of the Building Regulations and comply with the Fire Safety Order, a secondary access and egress point is the most obvious solution. Early consideration of an externally framed staircase or ramp, towards the Salford end of the site, could present a possible solution. *Agreed, Arup have recommended this as a solution which should be*

considered further by Stakeholders to understand the feasibility/costs associated with this. Notwithstanding this, we have developed a concept fire strategy on the provision of a single direction of egress only for the pilot stage scheme based on an assessment of the potential fire scenarios, in order to satisfy the functional requirements of the Building Regulations and future compliance with the Fire Safety Order upon occupation. We consider however that a secondary exit for the longer term scheme (Stage 2) would most definitely be a requirement.

Furthermore, provision of a lift would improve emergency egress for persons with mobility issues, while providing additional access facilities for firefighters. The creation of some dead-end conditions may be inevitable and could be considered acceptable as long as the situation is addressed within the dedicated fire strategy and subsequent fire risk assessment. [Agreed, please see Concept fire strategy for full details.](#)

6. Water supplies at the moment appear to be minimal. As the project develops, supplies for toilets and catering facilities could be upgraded to provide adequate facilities in the event of a fire. This may warrant the inclusion of a dry rising main at the Salford end, and a traditional hydrant supply at the main access car park area. A horizontal riser along one edge of the useable space, incorporating outlets at appropriate intervals, would give additional benefits for a variety of events which could be held within this space. [Agreed, we have incorporated a dry riser provision within the concept fire strategy design for the pilot stage scheme with the inlet located at the main car park side of the viaduct. The Stage 2 longer term scheme would likely have an equivalent dry riser provision from the Salford end with dedicated stair access, this is however subject to further design development at this early stage.](#)
7. Localised suppression or self-contained sprinkler units would provide slight improvements to life safety and massive improvements from a property protection perspective. They may also be utilised as a compensatory feature against the access difficulties operational crews may encounter. [Noted, we have however \(in consultation with the National Trust\) looked to address the fire risks associated with the pilot stage scheme without the need for localised suppression.](#)
8. Although minimal detection would be required for life safety, the use of flame detection or CCTV fire detection would provide enhanced property protection facilities. The monitoring of these systems (i.e. on site, remote, GMCA) must be clarified in order to get the maximum benefit. A public address system could be used in the event of a fire to improve the response times of relevant persons, having additional benefits with regards to other types of security incident or when evacuation may be necessary. The use of beacons and VADs to give an alarm signal which can be understood by persons with sensory difficulties may also be necessary. [Agreed, we have made the provision for automated detection with the large enclosed function space and manual call](#)

point sin external areas. We agree a PAVA system does provide added benefit for egress and have incorporated this within the strategy. The use of beacons and VADs is not considered to be needed given the continued management of the space during the pilot stage scheme although this should be considered for the longer term scheme.

9. Due to the complicated nature of the site, especially regarding the number of responsible persons/persons with responsibilities, work should be carried out to ensure that the appropriate legal framework, agreements, MOUs etc are in place in line with Article 22 Co-operation and Co-ordination of the Fire Safety Order. [Agreed, See response to item number 4.](#)
10. Decorations, advertisement hoardings, windbreaks must always be considered as part of a holistic risk assessment to ensure they do not unduly affect fire safety. [Agreed, the fire strategy shall place restrictions on these items based on acceptable fire scenarios.](#)
11. Lighting provision would be an obvious requirement; this should be supplemented by emergency lighting where appropriate. Additionally, a site such as this, which is predominantly outdoors, could make excellent use of photoluminescent signage and waymarking. [Agreed, included within Concept fire strategy.](#)
12. A decision would have to be made with regards to allowing smoking on site. Arson would also be a major risk for a site such as this. Therefore appropriate security measures, including CCTV and the use of staff, will need to be identified and implemented, in order to minimise any risk. [Agreed, National Trust to further review as the design and management plans develop.](#)
13. Extraordinary events such as the use of fireworks, Christmas markets, concerts could be carried out safely, but must be subject to a comprehensive and holistic risk assessment, involving all stakeholders. [Agreed, the use of fireworks and/or other ignition sources is not recommended given the current concept fire proposals. The use of the space is very restricted for the pilot stage scheme \(if the single exit option was to be progressed\) and any changes to the agreed occupancies or fuel load e.g. Christmas markets would need to be specifically risk assessed in order to understand the feasibility of the change.](#)
14. Engagement with a Fire Engineering Services provider could assist with many of these issues. This is a cost effective method of identifying potential issues, formulating possible solutions and minimising the need for any subsequent remedial works. [Agreed, Arup have been appointed by the National Trust to provide advice relating to fire safety.](#)