10 Daylighting

10.1 Introduction

10.1.1 Arup has been commissioned by Moda Living to prepare an assessment of the impact on daylight and sunlight, to accompany a planning application for the proposed development at Princes Dock, Liverpool, L3 1QP.

10.1.2 The purpose of the daylight and sunlight appraisal is as follows

- Analyse the existing (i.e. baseline) daylighting conditions on the windows of neighbouring buildings around the Site which may be affected by Princes Reach. See Figure 10.1.
- Analyse the effect of the Princes Reach development on the baseline scenario see Figure 10.2
- Analyse the effect of the Princes Reach development and Liverpool Waters Masterplan on the baseline scenario. See Figure 10.3.

10.1.3 The objective is therefore to compare and report on the impact of the proposed redevelopment on the neighbouring windows.

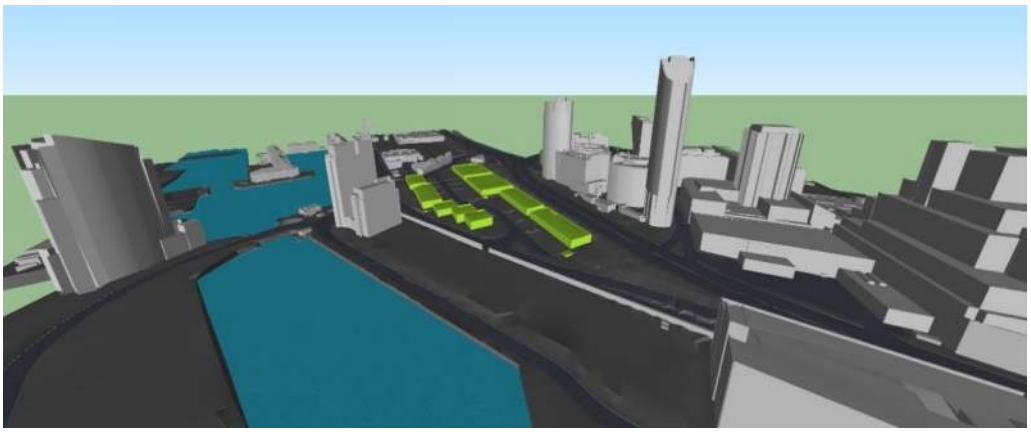


Figure 10.1: Baseline Scenario

10.1.4 The buildings coloured green in Figure 10.1 are destined for demolition in the Liverpool Waters Masterplan.

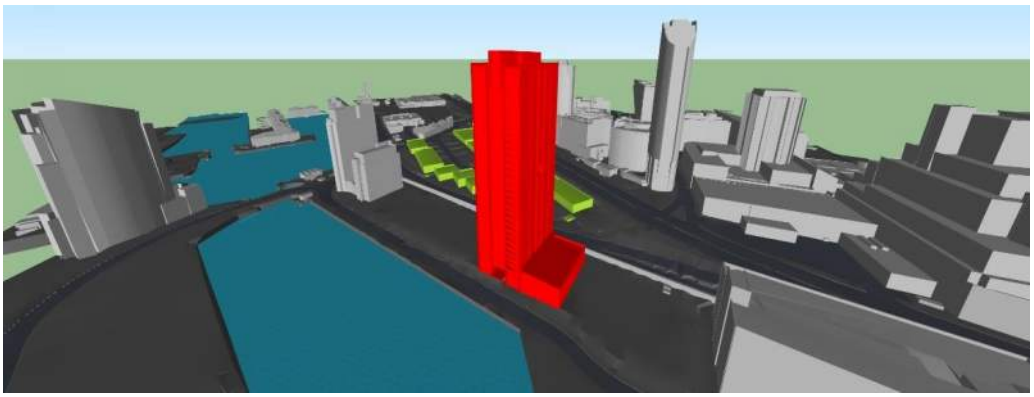


Figure 10.2: Development Scenario 1, Princes Reach (red)

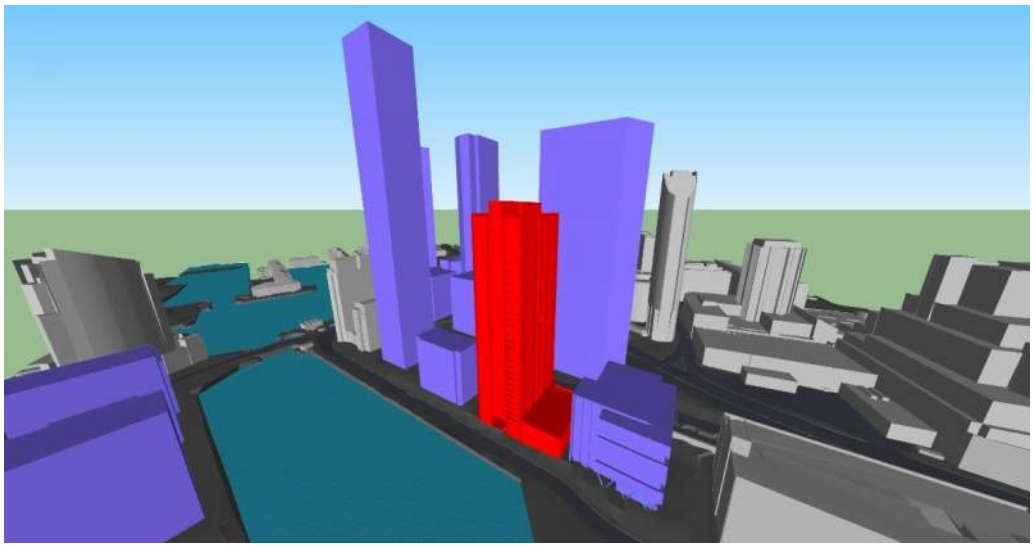


Figure 10.3: Development Scenario 2, Princes Reach (red) + Masterplan (blue)

10.1.5 This report aims to provide stakeholders with an insight into two aspects of daylight performance at the proposed development, specifically daylight availability and sunlight exposure (sunlight hours).

10.2 Methodology and Scope

10.2.1 Natural lighting forms a crucial part of good building design and is known to positively affect human behaviour by creating an attractive visual environment that encourages well-being and productivity. The design of a building can have a significant effect on the availability of natural light internally and externally.

10.2.2 This section sets out the guidance used in this assessment, and the approach to modelling. Specifically, it covers:

- The best practice guidance applied in this assessment (and the scope)
- Definition of the Vertical Sky Component
- Definition of the Annual Probably Sunlight Hours
- An overview of the approach to modelling
- The approach to impact assessment.

10.2.3 To provide a prediction of change in daylight/sunlight performance following development of the Site, three assessments have been undertaken which draw on specific guidance for assessments of this nature. These are in accordance with the guidelines described in the Building Research Establishment (BRE) document 209 Site Layout Planning for Daylight and Sunlight (referred to throughout as BRE209). Specifically, they include:

- **Daylight Availability (VSC):** According to BRE209 daylight within existing buildings will be adversely affected if the Vertical Sky Component (VSC) is reduced to less than 27% and the VSC is less than 0.8 times its baseline value because of a new development. Analysis of daylight availability has been completed at each window of neighbouring buildings.

- **Annual Probable Sunlight Hours (APSH):** Where a window is within 90° of due south, BRE209 proposes it should receive at least 25% of the total Annual Probable Sunlight Hours (APSH) in summer months and at least 5% of APSH in the winter months (Sept 21 – March 21). An adverse impact on sunlight will be experienced if the total number of sunlight hours falls below these recommendations and is less than 0.8 times its former value and the reduction is greater than 4% of APSH. Analysis has been completed at each window of neighbouring buildings.

- **Amenity Space Sunlight Exposure (ASSE):** For garden/amenity spaces, BRE209 recommends that at least half the space should receive at least two hours of sunlight on 21 March. The result a new development should not reduce this to less than 0.8 times its baseline value. Otherwise, the impact will be noticeable. This is considered applicable to the neighbouring landscape and canal/leisure areas.

10.2.4 Daylight availability and sunlight hours have been analysed using 3D computer simulation techniques. The computer simulation predicts sunlight and daylight performance in the baseline scenario and development scenario. Comparison of the simulation results enables conclusions to be made on daylight/sunlight impact of the proposed development.

10.2.5 To do this, this appraisal requires a series of specific inputs relating to the development and the environment. The assessment has used the following source data:

- 3D Model of the proposed development
- Arup 3D City Model of the surrounding area
- Shadowing Sky Model: CIE[24] standard clear sky model
- Vertical Sky Component Model: CIE standard overcast sky model
- Daylight data: local Energy Plus Weather (EPW[25]) weather data files (from the Aughton weather station at: 53.55°N, 2.92°W)
- Site Co-ordinates: 53.484°N, 2.228°W. 1.6. Grid Reference SJ337907 (Easting 333734 Northing 390789)

10.2.6 The analyses use the standard CIE S003 Spatial distribution of daylight. The standard lists a set of luminance distributions, which model the sky under a wide range of conditions, from the heavily overcast sky to cloudless weather. It is intended for two purposes: i) to be a universal basis for the classification of measured sky luminance distributions and ii) to give a method for calculating sky luminance in daylighting design procedures.

10.2.7 It should be noted that fences, trees and other organic planting are excluded from this analysis (and are not required as part of BRE based analysis).

[24] Commission internationale de l'éclairage (CIE).
[25] EPW: EnergyPlus Weather data, http://apps1.eere.energy.gov/buildings/energyplus/

10.2.8 Using the Radiance Lighting Simulation and Rendering System, natural lighting is modelled to predict the natural lighting conditions due to the proposed development. This software is recognised across the industry as being best practice software ideally suited to accurately model light behaviour in complicated environments, with much academic research to support this statement.

10.2.9 Three metrics are used to consider the impact of the development on the baseline lighting conditions namely Vertical Sky Component, Annual Probable Sunlight Hours and Amenity Space Sunlight Exposure. These are described below.

Vertical Sky Component (VSC)

10.2.10 VSC is proposed in BRE209 as a measure of daylight availability. It is described as the ratio of illuminance (incident light on a surface) on the vertical plane and the unobstructed illuminance on the horizontal plane.

10.2.11 In simple terms, this metric represents the area of visible sky from each window as a proportion of the whole sky hemisphere (Figure 10.).

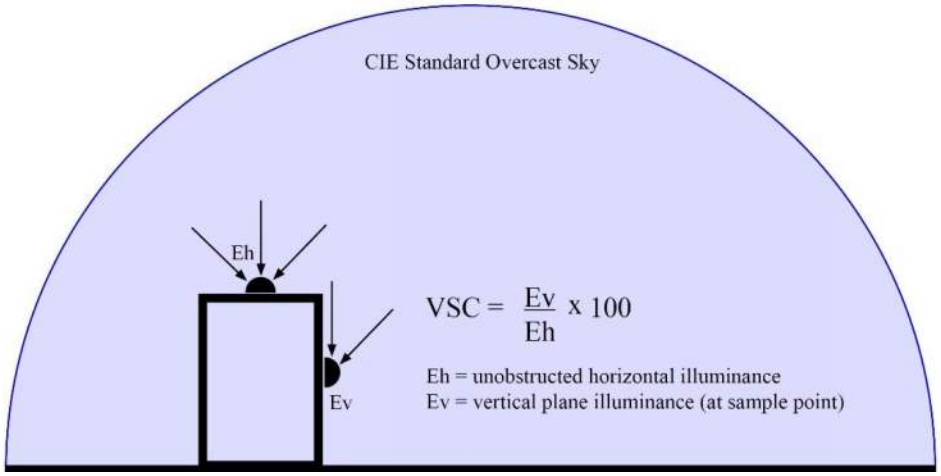


Figure 10.4: Vertical Sky Component

10.2.12 This metric represents the area of sky visible from each sample point (i.e. window) and therefore, BRE209 requires the CIE standard overcast sky to be used in this analysis.

10.2.13 The software described above is used to calculate the illuminance in the vertical plane (Ev) at a set of sample points. The same algorithms are used to calculate the unobstructed horizontal plane illuminance (Eh). The VSC is the ratio of Eh/Ev expressed as a percentage, Figure 10..

10.2.14 The results are then checked against BRE209 guidance, which in summary, states that daylight may be adversely affected in an existing building if either the VSC measured at centre of existing window is less than 27% and less than 0.8 times its former value as a result of the new development.

10.2.15 The data is presented as a set of coloured sample points mapped over the 3D geometry of the surrounding buildings. Each sample point represents a window location (or in some cases, where detailed 3D models were unavailable, it

represents an approximate window location). The samples points are coloured as follows:

- Blue: VSC is greater or equal to than 27%
- Red: VSC < 27%
- Magenta: VSC < 27% and VSC < 0.8 of former value

Annual Probable Sunlight Hours (APSH)

10.2.16 APSH is the probable number of hours that sunlight will shine on unobstructed ground, allowing for average levels of cloudiness for a given area. Weather data is available for a number of weather stations across the UK, with Aughton (53.55°N, 2.92°W) being the closest to the Site. The EPW dataset provides various climate measurements taken at every hour of a typical year including the time and duration of any sunlight. The CIE clear sky model is used to calculate the sunlight at the times recorded in the EPW dataset. Windows are only considered where they face within 90° of due south.

10.2.17 Sunlight hours modelling will predict the extent and duration of sunlight shadowing experienced by and due to the proposed redevelopment. The computer analyses the direct sunlight landing on the sample points for every daytime hour of the year, excluding overcast hours, based on the EPW weather data.

10.2.18 The sunlight hours ASPH data is presented as coloured points, mapped over the 3D geometry of the buildings, which illustrate the change in sunlight hours in terms of the BRE209 guidance. Windows on the north façade of a building are beyond 90° of due south and are therefore excluded from this analysis.

10.2.19 Two aspects of ASPH are considered; annual and winter probable sun hours (wASPH). The winter period runs from 21 September to 21 March. Both the baseline and development scenario are presented side-by-side for visual comparison. The samples points are coloured as follows:

- Blue: APSH > 25%
- Red: APSH < 25% or wASPH < 5%
- Magenta: APSH < 25% or wASPH < 5%, APSH/wASPH, < 0.8 of former value and the reduction in APSH is >4% (new development scenario)

Amenity Space Sunlight Exposure (ASSE)

10.2.20 The sunpath is defined as the progress of the sun in the sky over the site (Figure). This is presented as a sunlight simulation within a hemispherical projection of the sky above. Coloured bands indicate the position of the sun in the sky above in an annual snapshot; each coloured cell represents one hour of each day/month.

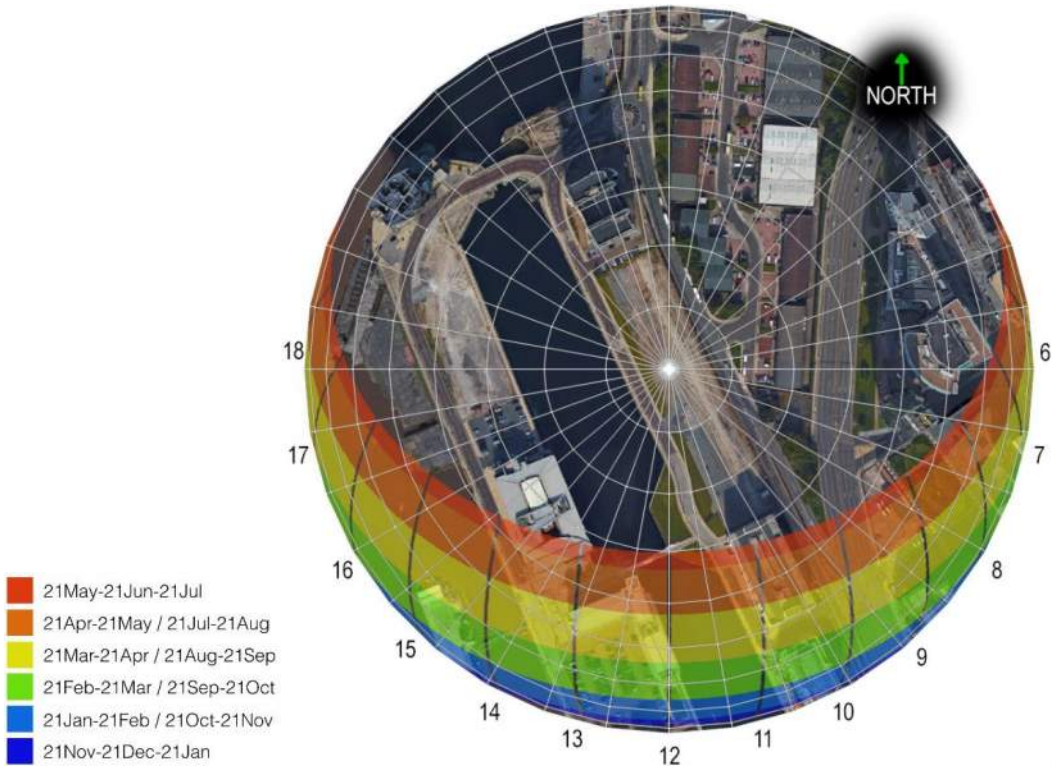


Figure 10.5: Annual sunlight hours and sunpath

10.2.21 The Radiance software models the sunlight exposure and shadowing for each hour of 21 March (assuming all hours are sunny) of the 3D model. The output is a cumulative model of the sunlight-hours exposure for one day.

10.2.22 Sunlight availability is also presented around the site for 21 March. As proposed by BRE209, garden/amenity spaces should receive at least two hours of sunlight on 21 March and the impact of a new development should not reduce this by more than 80%.

10.2.23 Three amenity spaces are in close proximity to the site (Figure 1). One is located between New Quay and Bath Street, the other is near the footbridge adjacent to William Jessop Way. The amenity space near Princes Parade is wholly due south of Plot 3 and therefore will not be affected by any shadowing from the proposed development.

Figure 10.6: Local amenity spaces

10.2.24 The simulation data is presented as two falsecoloured images placed side-by-side for visual comparison. By inspection of the images, any areas where sunlight changes or becomes available can be identified. Each colour indicates the number of hours a particular area is exposed to sunlight.

10.2.25 The falsecolour images are scaled from blue to yellow, with blue showing the areas with the fewest sunlight hours and yellow showing the areas with the most sunlight hours, as described above.

10.2.26 An example is shown below in Figure 10.7, below. The image below represents a plan view of the site and the proposed development is marked with a black outline.

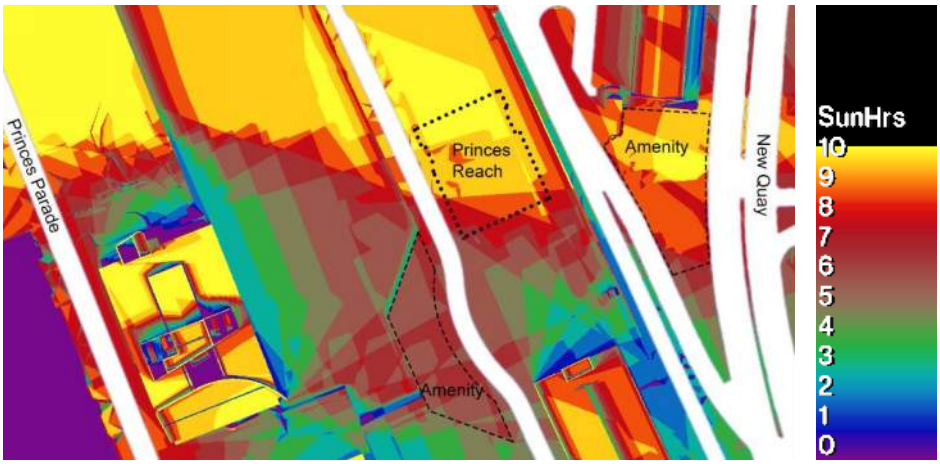


Figure 10.7: Example of sunlight exposure simulation output

10.2.27 The sunlight exposure on 21 March, resultant from the shadowing effects of the proposed building, and others in the locality, is represented by colours representing the total number of hours exposed to sunlight. The output from this modelling, including a baseline and development scenario image is presented in Appendix 5.1.

Computer Based Lighting Simulation Overview

10.2.28 A concise overview of the approach to modelling the change in daylight/sunlight is as follows:

- Construct 1:1 scale 3D model of the redevelopment, terrain and existing buildings.
- Insert sky model. Two sky data sets are used; a) standard CIE clear sky model for the shadowing simulation and b) CIE overcast sky model for the daylight availability simulation.
- Combine scene geometry, materials, sky model data, sample points and viewpoints (facades) into the Radiance simulation model.

- Use of Radiance software to execute two models, sunlight hours (APSH) and daylight availability (VSC), and extract lighting data for each receptor.

10.2.29 Computer simulations were carried out to analyse the change in natural light availability on the neighbouring windows/facades expressed in terms of sunlight hours and daylight availability.

10.3 Consultation

10.3.1 The Liverpool Waters Parameter Plan Report (November 2011) was consulted for information in the massing and building heights of the proposed development around the site.

10.4 Limitations and assumptions

10.4.1 The limitations on the analyses presented in this chapter are principally due to the undefined massing of the Liverpool Waters Masterplan. The masterplan indicates the following proposed development plots (Figure 10.8). This plan offers an indication of the building footprints, but the exact massing is not defined. The buildings heights are also provided in the masterplan (Figure 10.9). Therefore, for the purposes of modelling sunlight and daylight performance around the site, the building footprints marked in yellow in Figure 10.8 have been extruded to the building heights indicated in Figure 10.9

Figure 10.8: Proposed masterplan development plots.

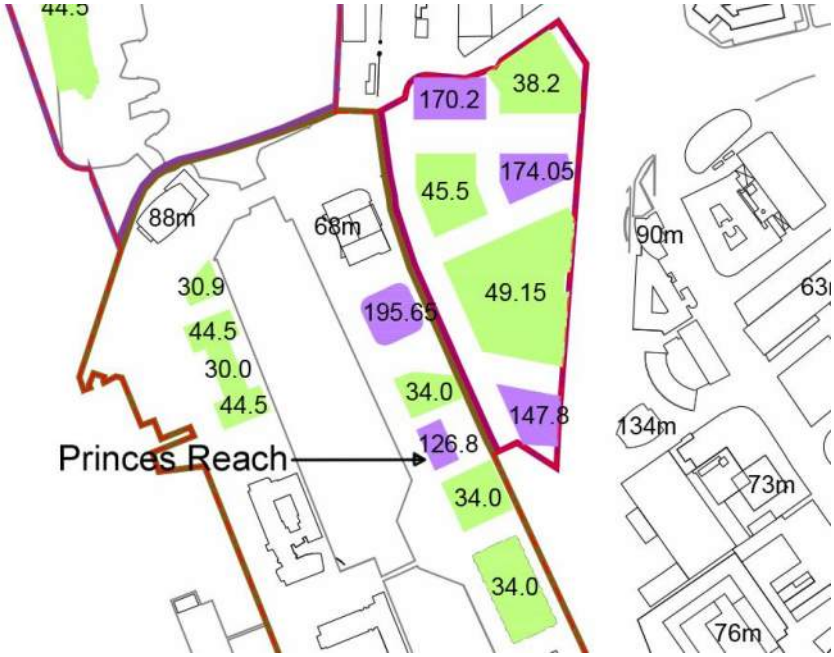


Figure 10.9: Proposed masterplan development building heights.

10.5 Baseline Conditions

10.5.1 This section presents the outputs of the daylight/sunlight modelling, carried out for the proposed development at the Site. The assessment focuses on three daylighting characteristics, as set out in BRE209 and discussed in the methodology section of this report, namely:

- Vertical Sky Component (VSC, i.e. daylight availability)
- Annual Probable Sunlight Hours (ASPH)
- Amenity Space Sunlight Exposure (ASSE) maximum exposure on 21 March

10.5.2 This section should be read in conjunction with Appendix 5.1, where the predicted daylight and sunlight performance is identified in detail. All outputs, presented in Appendix 5.1, show net changes in sunlight/daylight availability. This means that the modelling simulation accounts for the existing baseline conditions, and the change in daylighting due to the proposed development.

10.5.3 A number of buildings are considered in the analysis, which may be affected by the new development. These are identified below in Figure 10.10 and Table 10.1.

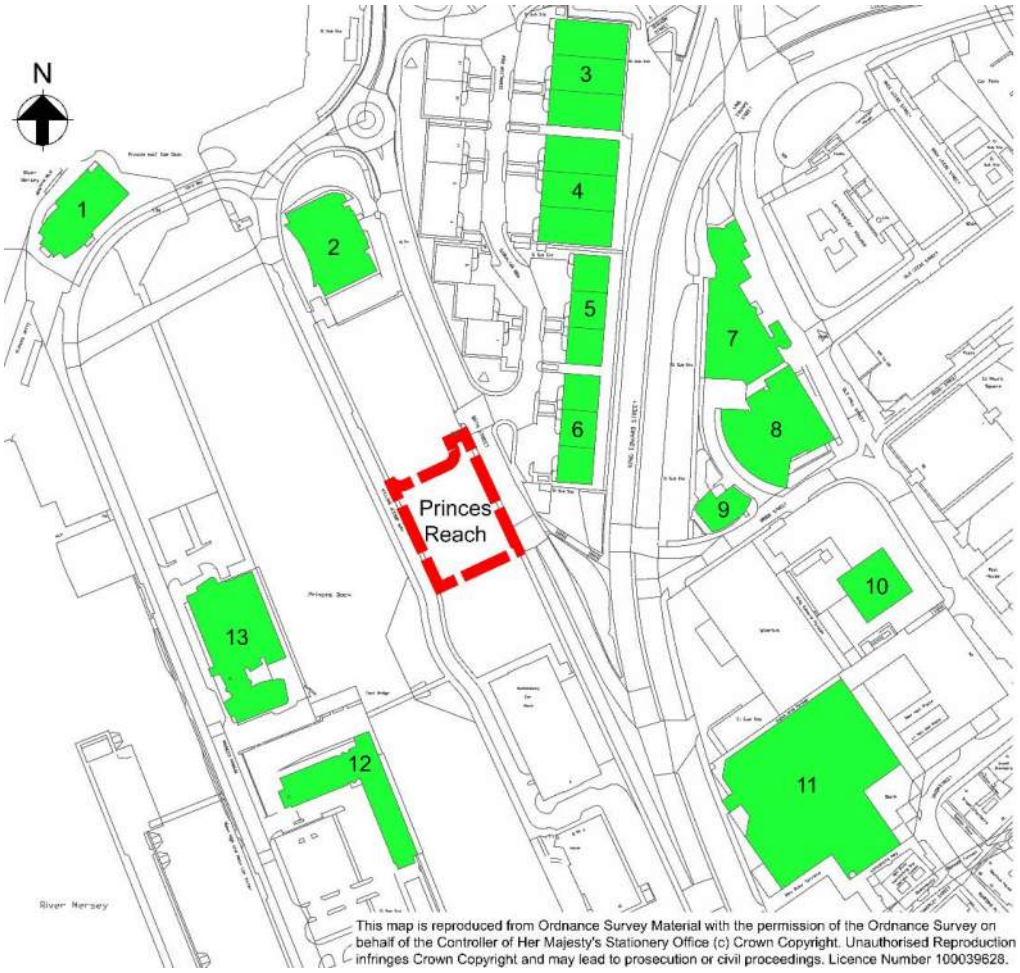


Figure 10.10: Neighbouring buildings

10.5.4 It is noted that the buildings on Gibraltar Way are destined for future demolition as part of the Liverpool Waters Masterplan.

Ref.	Building	Type	Ref.	Building	Type
1	Alexandra Tower	R	8	HM Passport Office	C
2	1 Princes Dock	R	9	West Tower	RC
3	No. 20-24 Gibraltar Way	L	10	Metropolitan House	C
4	No. 14-18 Gibraltar Way	L	11	Liverpool Echo Offices	C
5	No. 10-12 Gibraltar Way	L	12	No. 10 Princes Parade	C
6	No. 04-08 Gibraltar Way	L	13	No. 12 Princes Parade	C
7	Radisson Hotel	RC			

Table 10.1: Neighbouring buildings (R=Residential, C=Commercial, L=Light Industry)

Façade Analysis

10.5.5 The sunpath analysis (Figure 10.5) identifies adjacent building windows that may experience a reduction in sunlight or daylight as a result of the Princes Reach development. In order to carry out the sunlight/daylight modelling and impact

assessment, a series of facades have been selected (Figure 10. to Figure 10.) to examine daylighting conditions on windows of adjacent buildings potentially affected by the new development.

10.5.6 With reference to Table 10.1, the relevant facades are identified below. Window locations are identified with yellow markers on each relevant façade. Daylight has been modelled at each of these locations.

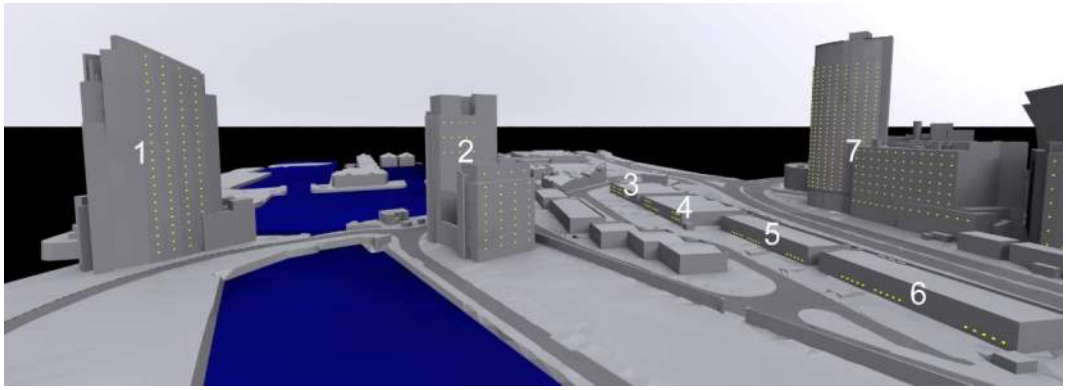


Figure 10.11: Buildings 1-7 (north of the development)

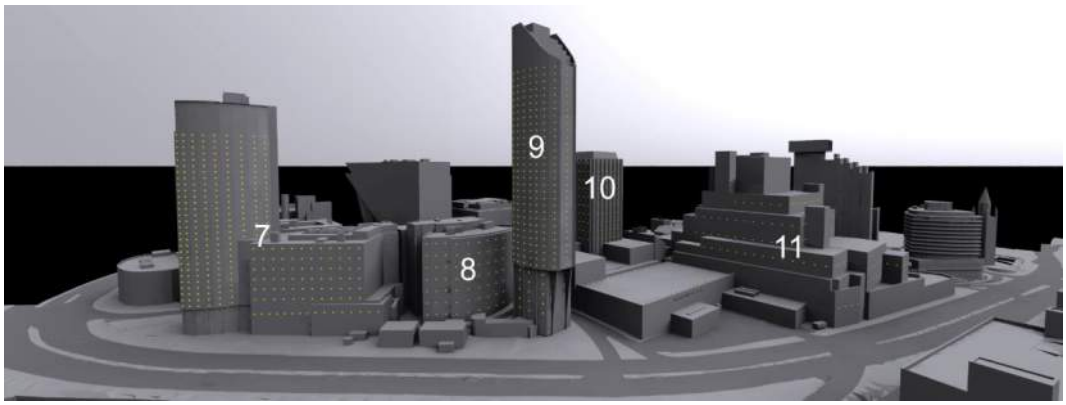


Figure 10.12: Buildings 7-11 (east of the development)

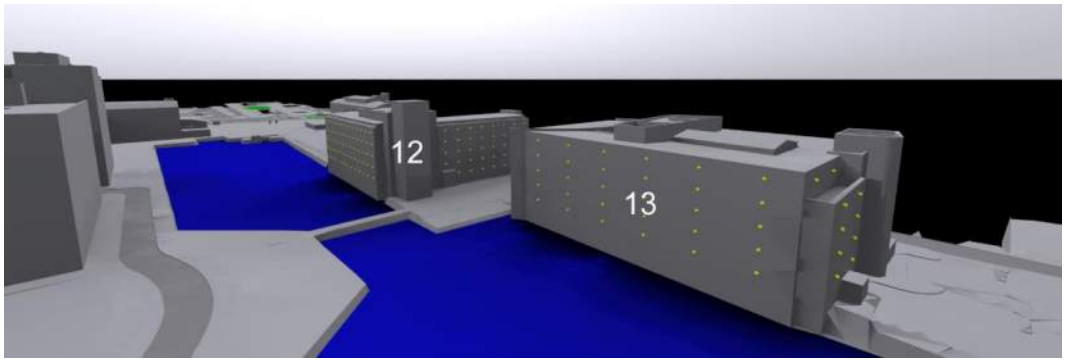


Figure 10.13: Buildings 12-13 (south-west of the development)

10.5.7 The full findings from the modelling and impact assessment on these facades are presented in detail in the appendices of this report. The findings are presented as 3D views towards the adjacent building façades, with coloured markers identifying the performance of daylight/sunlight at each window (or approximate window location where this detail is not available in the 3D city model). The

findings of the baseline and development scenarios are presented side-by-side in these appendices for comparison.

Baseline Daylight Availability (VSC)

10.5.8 VSC is recommended in BRE209 guidance as a measure of the availability of daylight.

10.5.9 Analysis of daylight availability using the VSC measurement has been completed at each window of neighbouring buildings.

10.5.10 In summary of BRE209, daylighting may be adversely affected if the VSC is less than 27%. This effect is considered more significant in an existing building if the VSC is reduced to lower than 80% of its former value as a result of the new development. The daylight simulation data has therefore been assessed against three scenarios described below:

- VSC ≥ 27%
- VSC < 27%
- VSC < 27% and < 0.8 of former value

10.5.11 Note: the third scenario is only a consideration in comparison with the baseline scenario. The first two can occur at the baseline.

10.5.12 A typical example of the analysis output is provided in Figure 10.14, which shows how daylight availability has changed compared to the baseline scenario.

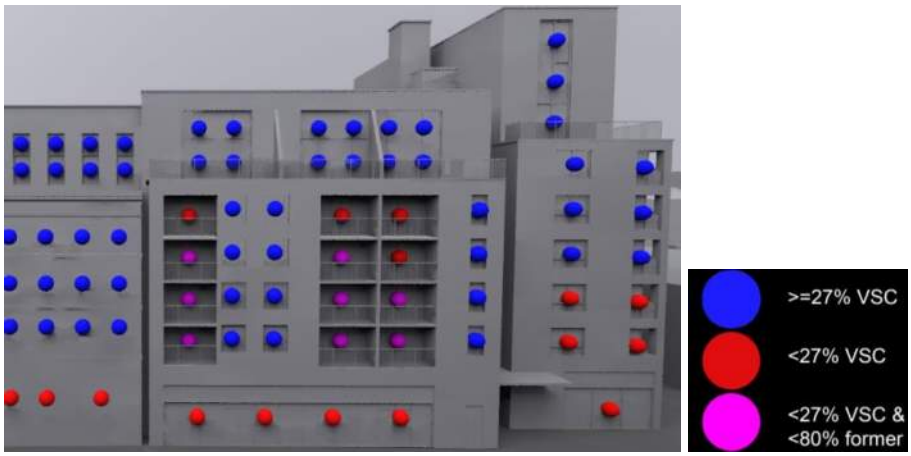


Figure 10.14: Typical output of daylight modelling

10.5.13 The findings of baseline the VSC daylight availability analysis on the neighbouring buildings are summarised in Table 10.2. Each sample point (see Figure 10.11 to Figure 10.13) represents a window on the neighbouring buildings.

Ref.	Building	Total Samples	Scenario 1 VSC≥27%	Scenario2 VSC<27%
1	Alexandra Tower	89	89	0
2	No. 1 Princes Dock	51	51	0
3	No. 20-24 Gibraltar Way	25	25	0
4	No. 14-18 Gibraltar Way	25	25	0
5	No. 10-12 Gibraltar Way	15	15	0
6	No. 04-08 Gibraltar Way	15	15	0
7	Radisson Hotel	316	316	0
8	HM Passport Office	63	41	22
9	West Tower (commercial)	15	15	0
9	West Tower (residential)	240	240	0
10	Metropolitan House	120	112	8
11	Liverpool Echo Offices	101	96	5
12	No. 10 Princes Parade	104	104	0
13	No. 12 Princes Parade	40	40	0

Table 10.3: Summary of baseline VSC sample points (windows)

Baseline Annual Probable Sunlight Hours (APSH)

10.5.14 BRE209 recommends the use of Annual Probable Sunlight Hours for use in assessing change in sunlight hours.

10.5.15 Where a window is within 90° of due south of the proposed development, BRE209 proposes it should receive at least 25% of the total Annual Probable Sunlight Hours (APSH) in summer months and at least 5% of APSH in the winter months from September 21 to March 21 (wAPSH).

10.5.16 In summary of BRE209, sunlight may be adversely affected if APSH<25% or wAPSH<5%. A more significant effect will be experienced if the APSH/wAPSH is reduced to less than 80% of its former value and the reduction is greater than 4% of APSH. The sunlight availability data has therefore been assessed against three conditions, described below, and an example is provided in Figure 10.

- APSH ≥ 25% or wASPH > 5%
- APSH < 25% or wASPH < 5%
- APSH < 25% or wASPH < 5%, APSH/wASPH < 80% of former value and reduction in APSH is >4%

10.5.17 Note: the third scenario is only a consideration in comparison with the baseline scenario. The first two can occur at the baseline.

10.5.18 A typical example of the analysis output is provided in Figure 10.10, which shows how sunlight availability has changed compared to the baseline scenario.

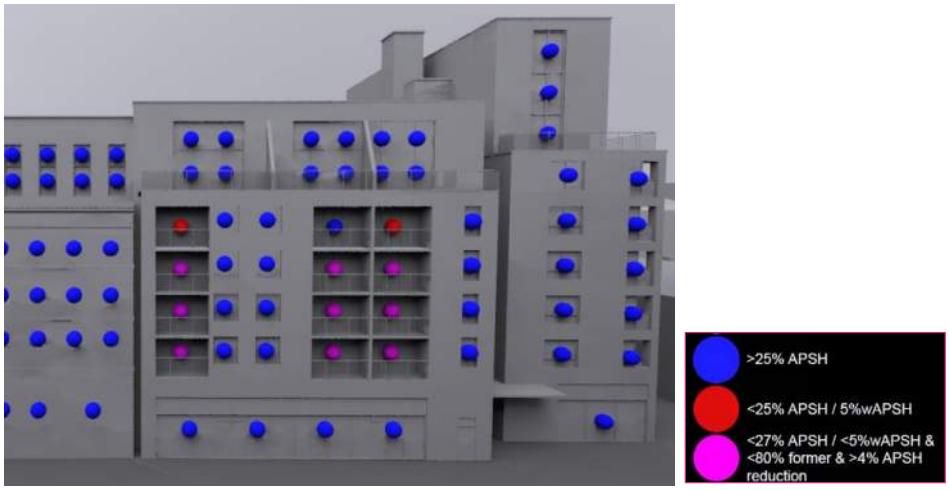


Figure 10.15: Example output of sunlight APSH modelling

10.5.19 Analysis has been completed at each window of neighbouring buildings, shown in (Figure 10.11 to Figure 10.13) and is presented using the analysis facades. The predicted percentage change in sunlight hours on the façades of all adjacent buildings analysed can be observed in full in the images in Appendix 5.1. The change in APSH on the selected buildings is summarised in Table 10.3.

Ref.	Building	Total Samples	Baseline APSH≥25% or wASPH > 5%	Baseline APSH<25% or wASPH < 5%
1	Alexandra Tower	89	89	0
2	No. 1 Princes Dock	51	51	0
7	Radisson Hotel	228	228	0
8	HM Passport Office	63	60	3
9	West Tower	30	30	0
10	Metropolitan House	60	60	0
11	Liverpool Echo Offices	55	52	3

Table 10.3: Summary of baseline ASPH sample points (windows)

Baseline Amenity Space Sunlight Exposure

10.5.20 Presently the site is generally undeveloped apart from No. 1 Princes Dock and the multi-storey car park to the south, as shown in Figure 10.4. Two amenity spaces were considered in detail. One is located between New Quay and Bath Street, the other is near the footbridge adjacent to William Jessop Way.

10.5.21 The Amenity Space Sunlight Exposure simulation calculates the total accumulated sunlight for 21 March (it is not a measure of average exposure). The total possible sunlight exposure on this day is presented in Appendix 5.1 and Figure 10.12/Figure 10.13 overleaf.

10.5.22 BRE209 recommends that for a space to appear adequately sunlit throughout the year at least half of the amenity area should receive at least two hours of sunlight

on 21 March. If this reduced to 80% of its former value then the loss of sunlight is likely to be noticeable.

10.5.23 The hours of sunlight predicted in the baseline scenario in a clear day are indicated below in Figure 10.16. Discrete sunlight exposure values and the outline of the development plots are also shown for clarity.

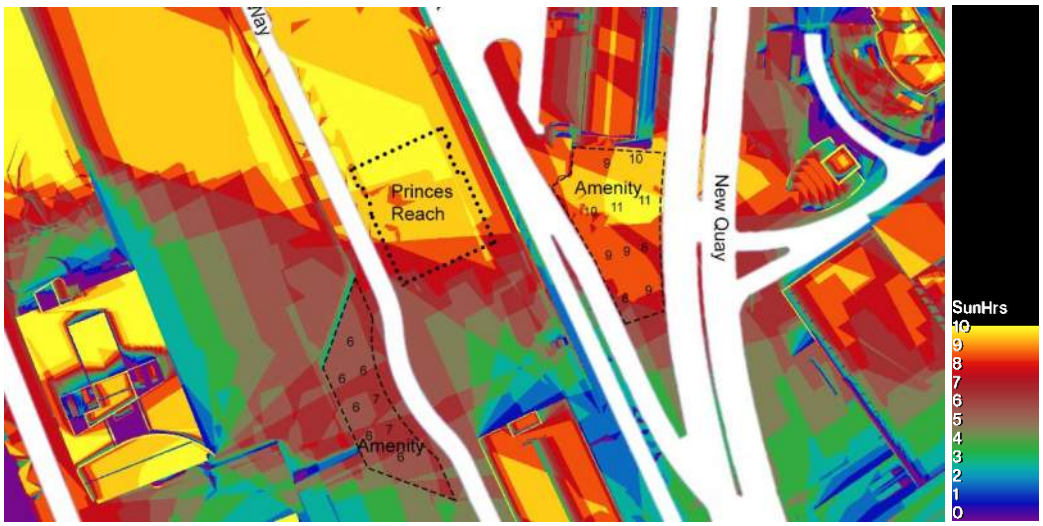


Figure 10.16: Baseline scenario sunlight exposure

10.5.24 In summary, the average sunlight exposure on 21st March experienced by the amenity sites is indicated below:

Amenity Space Location	Sunlight Hours
New Quay	9.4
William Jessop Way	6.3

Table 10.4: Sunlight exposure, baseline

10.5.25 No point on each site receives less than two hours of sunlight on 21 March.

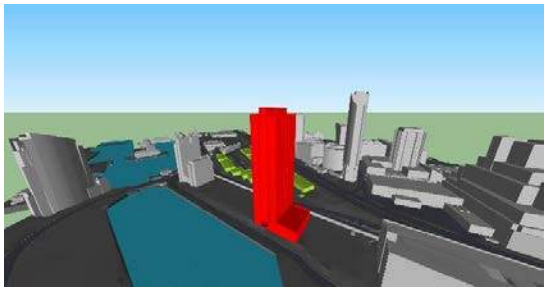
10.6 Assessment

10.6.1 The following section describes the operational impacts of the two development scenarios i.e.:

1) Princes Reach development as shown in Figure 10.2
2) Princes Reach development and Liverpool Waters Masterplan as shown in Figure 10.3

10.6.2 Using the same methodology used for the assessment of the baseline scenario, the same window sample points were tested using the scenarios described above. The findings are provided in the following section.

Development Scenario 1, VSC and APSH



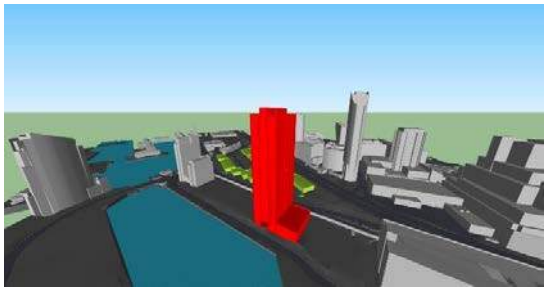
Ref.	Building	Total Samples	VSC ≥27%	VSC <27%	VSC<27%, <80% former	% change from baseline	
						Min	Max
1	Alexandra Tower	89	89	0	0	0	0
2	No. 1 Princes Dock	51	51	0	0	0	0
3	No. 20-24 Gibraltar Way	25	25	0	0	0	0
4	No. 14-18 Gibraltar Way	25	25	0	0	0	0
5	No. 10-12 Gibraltar Way	15	15	0	0	0	0
6	No. 04-08 Gibraltar Way	15	12	0	3	72	72
7	Radisson Hotel	316	316	0	0	0	0
8	HM Passport Office	63	36	27	0	0	0
9	West Tower (commercial)	15	15	0	0	0	0
9	West Tower (residential)	240	240	0	0	0	0
10	Metropolitan House	120	108	12	0	0	0
11	Liverpool Echo Offices	101	96	5	0	0	0
12	No. 10 Princes Parade	104	104	0	0	0	0
13	No. 12 Princes Parade	40	40	0	0	0	0

Table 10.5: Vertical Sky Component (VSC), Development Scenario 1

Ref.	Building	Total Samples	APSH ≥25% or wASPH > 5%	APSH <25% or wASPH < 5%	APSH <80% former	% change from baseline	
						Min	Max
1	Alexandra Tower	89	89	0	0	0	0
2	No. 1 Princes Dock	51	51	0	0	0	0
7	Radisson Hotel	228	228	0	0	0	0
8	HM Passport Office	63	60	3	0	0	0
9	West Tower	30	30	0	0	0	0
10	Metropolitan House	60	60	0	0	0	0
11	Liverpool Echo Offices	55	52	3	0	0	0

Table 10.6: Annual Probable Sunlight Hours (APSH), Development Scenario 1

Development Scenario 1, ASSE



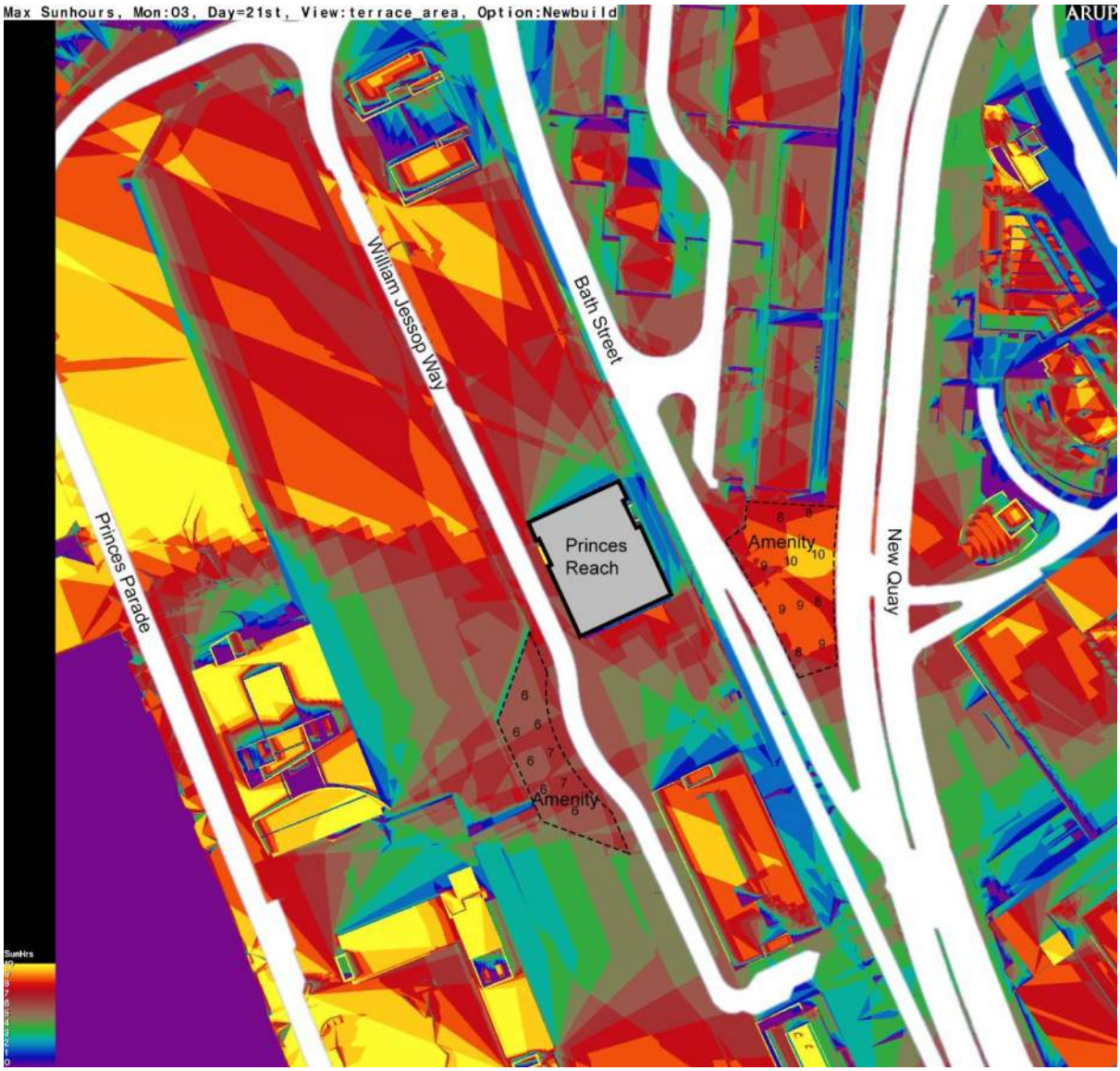


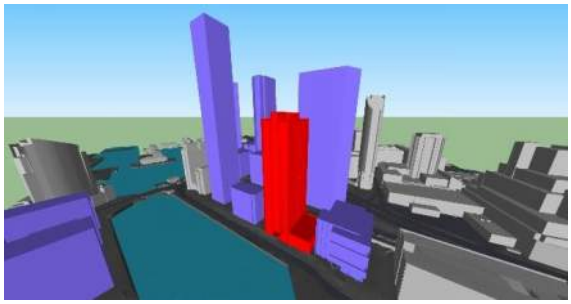
Figure 10.17: Amenity Space Sunlight Exposure, Development Scenario 1

10.6.3 The average sunlight exposures to each amenity space are provided below.

Amenity Space Location	Sunlight Hours	% of baseline
New Quay	8.8	95%
William Jessop Way	6.3	100%

Table 10.7: Sunlight Exposure, Development Scenario 1

Development Scenario 2, VSC and APSH



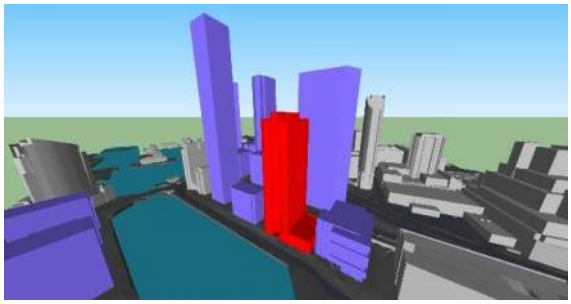
Ref.	Building	Total Samples	VSC ≥27%	VSC <27%	VSC<27%, <80% former	% change from baseline	
						Min	Max
1	Alexandra Tower	89	75	0	14	57	72
2	No. 1 Princes Dock	51	10	0	41	26	68
7	Radisson Hotel	316	128	0	188	42	68
8	HM Passport Office	63	0	0	63	47	69
9	West Tower (commercial)	15	0	0	15	46	58
9	West Tower (residential)	240	145	0	95	55	71
10	Metropolitan House	120	97	23	0	0	0
11	Liverpool Echo Offices	101	96	5	0	0	0
12	No. 10 Princes Parade	104	65	32	7	78	80
13	No. 12 Princes Parade	40	7	0	33	67	74

Table 10.8: Vertical Sky Component (VSC), Development Scenario 1

Ref.	Building	Total Samples	APSH ≥25% or wASPH > 5%	APSH <25% or wASPH < 5%	APSH <80% former	Range of change from baseline	
						Min	Max
1	Alexandra Tower	89	89	0	0	0	0
2	No. 1 Princes Dock	51	48	0	3	29	31
7	Radisson Hotel	228	210	0	18	41	70
8	HM Passport Office	63	14	0	49	48	66
9	West Tower	30	30	0	0	0	0
10	Metropolitan House	60	60	0	0	0	0
11	Liverpool Echo Offices	55	52	3	0	0	0

Table 10.9: Annual Probable Sunlight Hours (APSH), Development Scenario 1

Development Scenario 2, ASSE



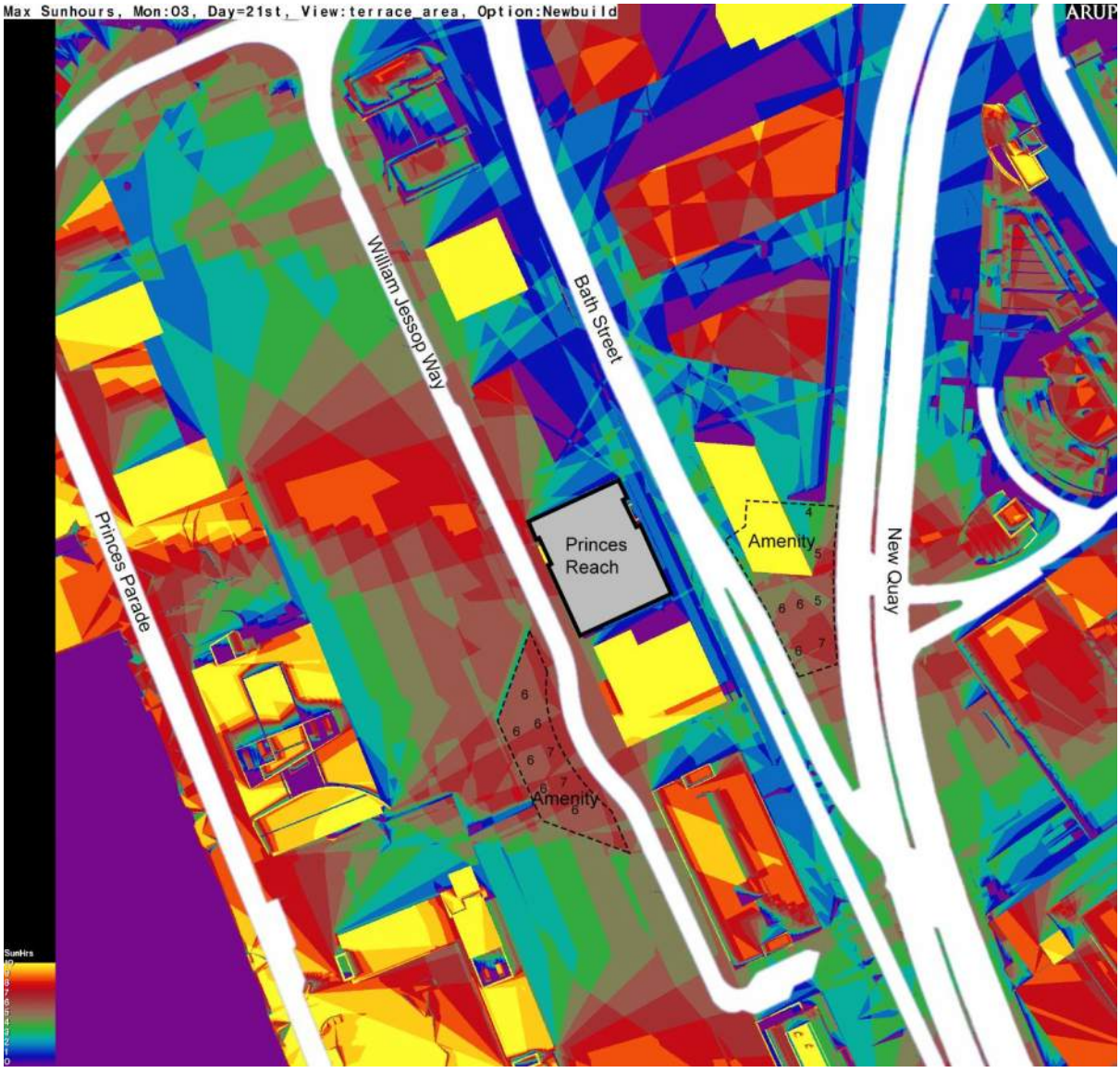


Figure 10.18: Amenity Space Sunlight Exposure, Development Scenario 1

10.6.4 The average sunlight exposures to each amenity space are provided below.

Amenity Space Location	Sunlight Hours	% of baseline
New Quay	5.6	60%
William Jessop Way	6.3	100%

Table 10.10: Sunlight Exposure, Development Scenario 1

Summary of Findings, Development Scenario 1

10.6.5 Generally, all neighbouring residential premises are predicted to be unaffected by the proposed Development Scenario 1.

10.6.6 The Passport Office, Metropolitan House, and the Liverpool Echo Offices are predicted to experience a VSC<27%. However, this only applies to a small number of windows and the change is not less than 80% of the baseline value. It is noted that the majority of affected windows have VSC<27% in the baseline scenario. This is mainly the due to the proximity of adjacent existing buildings.

10.6.7 The greatest change in VSC is predicted on Nos. 04-08 Gibraltar Way, where a number of windows are predicted to see a reduction to 72% of the former value; i.e. less than the 80% recommendation of BRE209.

10.6.8 In the baseline scenario, all windows facing within 90° of south on all adjacent buildings are generally not predicted to experience APSH<25%.

10.6.9 Three windows on the Passport Offices and three windows Echo Offices experience wAPSH<5% in the baseline scenario. The same three windows on each building continue to experience wAPSH<5% in Development Scenario 1, but still remain above 80% of the baseline value.

10.6.10 The specific windows affected can be identified by inspection of the images in Appendix 5.1.

10.6.11 No point on each amenity site receives less than two hours of sunlight on 21 March in Development Scenario 1.

10.6.12 The greatest change to the ASSE on the New Quay amenity space is found to the north of the site (reduced by approximately 1 hour). It can be observed in Figure 10. that the William Jessop Way amenity space is predicted to experience no change in sunlight exposure in Development Scenario 1.

10.6.13 There is no other designated public amenity space considered relevant for consideration in this study. However, the results for the wider area are provided for inspection in Appendix 5.1 and these sunlight exposure maps are worthy of consideration when planning any planting etc. in the future.

Summary of Findings, Development Scenario 2

10.6.14 Generally, in terms of daylighting, all neighbouring residential premises are predicted to be affected by the proposed Development Scenario 2. The affected windows on these properties all experience VSC>27% in the baseline and see the VSC reduce to between 26% and 72% of the baseline value depending on location. The impact is highest at low level and it is considered that the effect will be noticeable to the affected occupants.

10.6.15 All windows on the Radisson hotel will experience VSC>27% in the baseline scenario. The hotel will experience a noticeable change in daylight availability, particularly on the lower eight storeys.

10.6.16 The lower commercial storeys of West Tower experience VSC>27% in the baseline scenario. All windows will be noticeably affected in Development Scenario 2.

10.6.17 A number of windows on Metropolitan House and the Liverpool Echo Offices are predicted to experience a VSC<27% in Development Scenario 2. However, this only applies to a relatively small number of windows and the change is not less than 80% of the baseline value. It is noted that all the Liverpool Echo Office windows have a VSC<27% in the baseline scenario. This is mainly the due to the proximity of the adjacent existing buildings.

10.6.18 Over 30 windows on No. 10 Princes Parade are predicted to experience VSC<27%. However the effect is unlikely to be noticeable as the reduction is only marginally less than 80% of the baseline value. The reduction is greater on No. 12 Princes Parade where over 30 windows experience a reduction between 67% and 74% of the baseline value.

10.6.19 In the baseline scenario, all windows facing within 90° of south on all adjacent buildings are generally not predicted to experience APSH<25%. It is not predicted that there will be any significant change in the baseline sunlight conditions experienced by the south facing windows of Alexandra Tower, West Tower (residential), Metropolitan House or the Echo Offices.

10.6.20 It is predicted that there will be a highly noticeable reduction in the sunlight availability to three windows on No. 1 Princes Dock, where the APSH will be reduced to below 31% of the baseline.

10.6.21 A small proportion of windows (18 of 210) on the Radisson hotel tower are predicted to experience a noticeable reduction in sunlight availability.

10.6.22 Over 50% of the windows of the Passport Offices will experience a noticeable reduction in sunlight availability.

10.6.23 The specific windows affected can be identified by inspection of the images in Appendix 5.1.

10.6.24 The William Jessop Way amenity site experiences no significant change in sunlight availability. The New Quay amenity site will experience a noticeable reduction in sunlight.

10.7 Additional Mitigation Measures

10.7.1 It is not considered that any mitigation measures are required to Development Scenario 1 to improve the daylight or sunlight conditions presently experienced by the existing local buildings.

10.7.2 Mitigation measures to improve the daylighting and sunlighting conditions to the existing neighbours to the Liverpool Waters Masterplan would need to include reductions to the building massing, in particular the building heights. However, outline planning permission has already been given to the masterplan and it is not anticipated that any significant reduction in massing will be considered acceptable.

10.8 Cumulative Impacts

10.8.1 By observation of Table 10. to Table 10., it can be considered that the resultant impact from Development Scenario 1 is insignificant compared to the scale of the impact resultant from Development Scenario 2. The additional proposed buildings in Development Scenario 2 (highlighted in Figure 10.3 and Figure 10.8) dominate the impact effects on daylight and sunlight on the existing neighbours.

10.8.2 For example, of the 1219 windows assessed:

- 47 (4%) of windows experience VSC<27% in Development Scenario 1
- 516 (42%) of windows experience VSC<27% in Development Scenario 1

10.8.3 The cumulative impacts from Development Scenario 1 are only expressed on a small number of windows on three commercial buildings, which presently experience lower daylight and sunlight availability.

10.8.4 The cumulative impacts from Development Scenario 2 are expressed on 516 of 1139 windows, particularly to the north and east of the site. These windows were generally unaffected in Development Scenario 1 and the baseline scenario.

10.9 Residual Effects

10.9.1 Taking into account that no mitigation options can be considered at this stage, the significance residual effects are considered unchanged.

10.10 Assessment Summary

10.10.1 The following assessment summaries (Table 10.11 and Table 10.12) are based in the following matrices.

Criteria	Type	Description	Commentary
Sensitivity of receptor	Residential	Medium	City centre apartments are generally occupied by professionals rather than families and therefore daytime use generally limited to evenings and weekends
	Hotel	Low	Bedrooms generally in evening use only, short-term occupation
	Offices	Medium	Offices have a moderate capacity to absorb change without significantly altering their present character
	Light Industrial	Low	The properties on Gibraltar Way are destined for demolition in the Liverpool Waters Masterplan
	Amenity Space	Medium	Includes the provision of seating, calm/relaxing environment
		Low	Noisy or close to traffic, no provision for seating
Magnitude of impact	Negligible	VSC/APSH/ASSE ≥ 80% of baseline	BRE209 considers a reduction to less than 80% of the baseline value to be noticeable
	Slight	VSC/APSH/ASSE ≥ 60% of baseline	A reduction of 20% is considered noticeable, a further reduction of 20% is therefore considered significant
	Substantial	VSC/APSH/ASSE < 60% of baseline	Any further reduction is considered very significant

Table 10.11: Sensitivity of receptor and magnitude of impact assumptions

10.10.2 The interaction of sensitivity and magnitude are considered to determine the significance of an environmental effect on a scale.

Sensitivity of Receptor	Magnitude of Impact			
	Substantial Magnitude	Moderate Magnitude	Slight Magnitude	Negligible Magnitude
Very High	Major	Major – Intermediate	Intermediate	Minor
High	Major – Intermediate	Intermediate	Intermediate – Minor	Neutral
Medium	Intermediate	Intermediate	Minor	Neutral
Low/Negligible	Intermediate - Minor	Minor	Minor – Neutral	Neutral

Table 10.12: Determining the significance of an environmental effect

10.10.3 A tabular summary of the effects and additional mitigation is provided in the tables below. The tables identify the receptor buildings and the proportion of windows (expressed as a percentage) which experience a particular impact. The impacts on local amenity spaces are also described. Table 10.13 describes the effects predicted in Development Scenario 1 and Table 10.14 describes the effects in Development Scenario 2.

	Receptor Name	Sensitivity of Receptor	Impact Magnitude	Nature of the impact	Significance	Mitigation	Residual Impact Magnitude	Residual Significance of Effects	Confidence Level
Development Scenario 1	Alexandra Tower (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	1 Princes Dock (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	04-08 Gibraltar Way (80%)	Low	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	04-08 Gibraltar Way (20%)	Low	Slight	Permanent, Direct	Neutral	None Required	Slight	Neutral	High
	10-12 Gibraltar Way (100%)	Low	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	14-18 Gibraltar Way (100%)	Low	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	20-24 Gibraltar Way (100%)	Low	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Radisson Hotel (100%)	Low	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Passport Office (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	West Tower Residential (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	West Tower Offices (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Metropolitan Tower (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Echo Offices (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	10 Princes Parade (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	12 Princes Parade (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Amenity Space, William Jessop Way	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Amenity Space, New Quay	Low	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High

Table 10.13: Summary of effects, Development Scenario 1

	Receptor Name	Sensitivity of Receptor	Impact Magnitude	Nature of the impact	Significance	Mitigation	Residual Impact Magnitude	Residual Significance of Effects	Confidence Level
Development Scenario 2	Alexandra Tower (84%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Alexandra Tower (16%)	Medium	Substantial	Permanent, Direct	Intermediate	None Required	Slight	Minor	High
	1 Princes Dock (20%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	1 Princes Dock (80%)	Medium	Substantial	Permanent, Direct	Intermediate	None Available	Substantial	Intermediate	High
	04-24 Gibraltar Way	These buildings are destined for demolition in the Liverpool Waters Masterplan							
	Radisson Hotel (41%)	Low	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Radisson Hotel (59%)	Low	Substantial	Permanent, Direct	Minor[26]	None Available	Substantial	Minor	High
	Passport Office (35%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Passport Office (65%)	Medium	Substantial	Permanent, Direct	Intermediate	None Available	Substantial	Intermediate	High
	West Tower Residential (60%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	West Tower Residential (40%)	Medium	Substantial	Permanent, Direct	Intermediate	None Available	Substantial	Intermediate	High
	West Tower Offices (100%)	Medium	Substantial	Permanent, Direct	Intermediate	None Required	Substantial	Intermediate	High
	Metropolitan Tower (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Echo Offices (100%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	10 Princes Parade (63%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	10 Princes Parade (37%)	Medium	Slight	Permanent, Direct	Minor	None Available	Slight	Minor	High
	12 Princes Parade (18%)	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	12 Princes Parade (82%)	Medium	Slight	Permanent, Direct	Minor	None Available	Slight	Minor	High
	Amenity Space, William Jessop Way	Medium	Negligible	Permanent, Direct	Neutral	None Required	Negligible	Neutral	High
	Amenity Space, New Quay	Low	Slight	Permanent, Direct	Neutral[27]	None Required	Substantial	Minor	High

Table 10.14: Summary of effects, Development Scenario 2

[26] The significance of the effect is considered 'minor' rather than 'intermediate' due to the short-term nature of hotel room occupancy.

[27] A portion of this amenity space is being built upon as part of the masterplan and therefore, the importance of this amenity spaces is not considered significant.

10.11 Conclusions

Context

10.11.1 Densely populated urban areas by definition will contain many more site constraints and consequently, neighbouring buildings may see a reduction in natural light, especially at ground level.

10.11.2 The applied guidance (BRE209) enables an assessment of the impact of a proposed building on its neighbours. The metrics and thresholds set out in the guide are designed to indicate where a change in daylight will be experienced and whether it will be noticeable. BRE209 also states the guidance it contains is advisory in nature, and there to help the daylight designer. There is no formal requirement to comply with the advice it contains.

10.11.3 Therefore, in the context of this report, BRE209 provides an indication of where sunlight or daylight availability will be affected within the neighbouring buildings. The findings should also be considered in the context in which the development is proposed; a densely populated urban environment, which will inherently result in a compromise in daylight and sunlight availability and therefore some flexibility in interpretation of the BRE209 guidelines is required.

10.11.4 The proportion of the neighbouring residential properties that are likely to experience levels of daylight and sunlight below the guide levels is low. The impacts are therefore relatively localised and do not extend across all residential properties surrounding the site.

10.11.5 The results of this study should also be considered in context with the wider masterplan of the area, which has been subject to an on-going development programme prior to the development of many of the neighbouring developments.

Development Scenario 1

10.11.6 Applying the BRE209 guidance to this assessment it can be concluded that the impact on all windows ranges from negligible to slight. Only one commercial property (04 Gibraltar Way) experiences a noticeable reduction in daylight availability, but this is only marginally lower than 80% of the baseline value. IT is also noted that the affected windows on the Passport Office, Metropolitan House and the Liverpool Echo offices typically experience lower than ideal levels of daylight and sunlight exposure in the baseline scenario.

10.11.7 The amenity spaces are predicted to experience only marginal changes in this scenario and the impact is therefore considered negligible. It is predicted that both spaces (Figure 10.4) will receive at least two hours of sunlight on 21 March.

Development Scenario 2

10.11.8 Applying the BRE209 guidance, the calculations have generally indicated that the impact on 623 of 1139 the windows assessed is negligible. The unaffected

windows are generally those above Level 5 of any building or those more distant from the proposed Liverpool Waters Masterplan.

10.11.9 A more substantial effect is experienced by lower five storeys of the adjacent existing buildings, in particular those properties located immediately to the north and east of the Liverpool Waters Masterplan. The commercial accommodation on Princes Parade experiences a slight/negligible impact.

10.11.10 It is predicted that both spaces (Figure 10.4) will receive at least two hours of sunlight on 21st March. The William Jessop Way amenity space is predicted to experience only marginal changes in this scenario and the impact is therefore considered negligible. With reference to Figure 10., it appears that the New Quay amenity space is being built upon as part of the masterplan and therefore, the significance of this impact is only considered slight.

10.11.11 Mitigation of the impacts would only be possible through adjustment to the massing of the proposed buildings. However, outline planning permission has already been given to the Liverpool Waters Masterplan and it is not anticipated that any significant reduction in massing will be considered acceptable.

10.11.12 The William Jessop Way and New Quay amenity spaces will only experience a negligible impact on the available sunlight. The development reduces the available sunlight to >80% of the baseline value on 21st March.

10.12 Appendices

10.12.1 Appendix 5.1 graphically illustrate the location and effect on daylight/sunlight at each receptor. The baseline, Development Scenario 1 and Development Scenario 2 are presented for comparison by observation.

11 Ground Conditions and Contamination

11.1 Introduction

11.1.1 This Chapter assesses the likely significant effects of the Development with respect to ground conditions and contamination. This Chapter also describes: the methods used to assess the effects; the baseline conditions currently existing at the Site and surrounding area; the mitigation measures required to prevent, reduce or offset any significant negative effects; and the likely residual effects after these measures have been adopted.

11.1.2 Adverse environmental effects on geological resources encompass loss of mineral resources or agricultural soils or damage to geological features of significance. Adverse environmental effects associated with ground contamination principally concern:

- pollution of groundwater;
- pollution of surface waters;
- human health and safety on and off site;
- ground conditions aggressive to construction materials; and
- plant growth restriction.

11.2 Methodology and Scope

Legislative and policy context

11.2.1 This chapter describes the policies which are relevant to ground conditions with which the proposed development must comply.

11.2.2 National planning policy is set out in the National Planning Policy Framework (NPPF).[28] The underlying principle of the NPPF is a presumption in favour of sustainable development. It requires both that geology and ground conditions are considered as a resource and that the effects that they may have, including as a result of contamination, are taken into account in the planning process.

11.2.3 Paragraph 109 of the NPPF identifies that:

"The planning framework should contribute to and enhance the natural and local environment by:

… protecting and enhancing… geological conservation interests and soils

….remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate."

[28] Department of Communities and Local Government (March 2012). *National Planning Policy Framework.* London, DCLG.

11.2.4 Paragraph 121 provides further detail requiring the site to be suitable for its new use, taking into account the effects of ground conditions, land instability and pollution, and the potential effect of any mitigation or remediation measures on the environment. It requires that, as a minimum, the land should not be capable of being determined as contaminated land under Part 2A of the Environmental Protection Act 1990 after any remediation has been completed.

11.2.5 Part 2A comprises the primary UK legislation specifically relating to land contamination. Section 78A[29] states that : "contaminated land" is any land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land that:

- significant harm is being caused or there is a significant possibility of such harm being caused; or
- significant pollution of controlled waters is being caused, or there is a significant possibility of such pollution being caused.

11.2.6 This definition is intended as an upper bound level of contamination, where intervention is legally required. The NPPF, however, places emphasis on the requirement for the developer to appropriately demonstrate and ensure that a site is safe for its new use in relation to contamination and ground stability issues.

11.2.7 The National Planning Practice Guidance (NPPG) has been produced by the Government to support the NPPF. The guidance refers to hazardous substances, land remediation and brownfield land. It highlights that a core principle of the NPPF is to:

"…encourage the effective use of land by reusing land that has been previously developed (brownfield land), provided that it is not of high environmental value".

11.2.8 The guidance section on land affected by contamination outlines the approach that should be taken within the planning regime and states that if contamination could be an issue:

"…developers should provide proportionate but sufficient site investigation information (a risk assessment) to determine the existence or otherwise of contamination, its nature and extent, the risks it may pose and to whom/what (the 'receptors') so that these risks can be assessed and satisfactorily reduced to an acceptable level".

11.2.9 It also states that the risk assessment should:

"…identify the potential sources, pathways and receptors ('pollutant linkages') and evaluate the risks. This information will enable the local planning authority to determine whether further, more detailed investigation is required, or whether any proposed remediation is satisfactory".

[29] Department for Communities and Local Government (2013): *National Planning Practice Guidance: http://planningguidance.planningportal.gov.uk/blog/guidance/land-affected-by-contamination/land-affected-by-contamination-guidance/*

11.2.10 For the land to be determined as 'contaminated' in a regulatory sense, and thereby require remediation (or a change to a less sensitive use), all three elements (source-pathway-receptor) of a significant pollutant linkage must be present.

Data sources

11.2.11 The following sources have been reviewed:

- Publically available data from the British Geological Survey (BGS) and Environment Agency (EA);
- Groundsure Geoinsight Report, Groundsure Enviroinsight Report, and Historical Mapping;
- Groundsure Preliminary UXO Risk Assessment Report;
- Arup Archives – Malmaison Hotel Development 2002;
- Arup Archives – Princes Dock Infrastructure 1998;
- Arup Archives – Princes Dock Infrastructure 1995;
- Historical mapping;
- Liverpool City Council Environmental Protection Unit contaminated land search information

Assessment methodology

11.2.12 The role of the planning process is to ensure that land is made suitable for its proposed future use, both in relation to land contamination and geotechnical hazards, and to protect important geological sites. The National Planning Policy Framework (NPPF) aims to encourage sustainable development and the reuse of brownfield land. The national legislative framework for contaminated land set out in Part 2A of the Environmental Protection Act 1990 (EPA) is risk based, where remedial action is only required if there are unacceptable risks to health or the environment, taking into account the use of the land and its environmental setting.

11.2.13 The assessment of existing contamination is risk-based and is in accordance with government guidance and the UK framework for the assessments of risk arising from contaminated land. The assessment takes into account principles adopted by the Environment Agency in Model Procedures for the Management of Land Contamination, Technical Report CLR 11[30]. The significance of impacts takes into account the principles of assessment identified in CIRIA Report C552, "Contaminated Land Risk Assessment – a guide to good practice"[31].

11.2.14 The assessment of contaminated land is a tiered approach, whereby information relating to the site is gathered and used to define a conceptual site model (CSM)

[30] Environment Agency, Model Procedures for the Management of Land Contamination, CLR11, September 2004.

[31] Rudland DJ, Lancefield RM, Mayell PN, Contaminated Land Risk Assessment – A guide to good practice (C552), CIRIA, London. 2001.

for the site. From this an assessment of risk is made in terms of the proposed use and should risks be identified further information is gathered through investigation and assessment to determine the extent of the risk and whether mitigation measures may be required. The assessment also considers potential geotechnical hazards and the presence of geologically important protected sites.

Significance criteria

11.2.15 Where PPLs have been identified by the CSM, the likely significant effects associated with the proposed development during construction have been assessed using the significance assessment criteria detailed below.

11.2.16 The assessment of effects uses an incremental scale of significance ranging from a major adverse effect to a major beneficial effect. These criteria consider water resources and the human, ecological and property receptors listed in Tables 11.1 and 11.2 of the Statutory Guidance. The significance of effects is assessed based upon the known or potential ground conditions revealed by the baseline investigation and the proposed extent and anticipated method of ground works disturbance and construction. These criteria have been derived by taking account of the guidance provided in the Construction Industry Research Information Association (CIRIA) report C522.[32] This describes the magnitude of potential consequences (severity) of risk occurring.

11.2.17 This assessment examines the contamination-related effects upon water resources, but does not assess the physical effects on water resources (hydrology and hydrogeology).

Table 11.1 Significance scale of ground conditions effects

Effect	Description
Major Adverse Effect	Severe, temporary or irreversible, moderate detrimental effect to human health. Severe, temporary or irreversible, reduction in the quality of a potable groundwater or surface water resource of local, regional or national importance. Irreversible or severe temporary detrimental effect on animal or plant populations. Irreversible detrimental effect to nationally important geological feature. Irreversible detrimental effect to building structure resulting in collapse or demolition.
Moderate Adverse Effect	Long-term minor or short-term moderate detrimental effect to human health. Slight or moderate, local-scale reduction in the quality of potable groundwater or surface water resources of local, regional or national importance, reversible with time. Reversible widespread reduction in the quality of groundwater or surface water resources used for commercial or industrial abstractions. Medium-term, reversible detrimental effect on animal or plant populations. Medium-term, reversible detrimental effect to nationally important geological feature. Detrimental effect to building structure requiring remedial engineering works.

[32] CIRIA, Contaminated Land Risk Assessment, A Guide to Good Working Practice, C552, 2001

Effect	Description
Minor Adverse Effect	Short-term minor detrimental effect to human health. Slight or moderate detrimental effect in the quality of groundwater or surface water resources that are used for, or have the potential to be used for, commercial or industrial abstractions. Short-term, reversible detrimental effect on animal or plant populations. Short-term, reversible detrimental effect to nationally important geological feature. Detrimental effect to building structures not requiring remedial engineering works.
Negligible Effect	No appreciable impact on human, animal or plant health, potable groundwater or surface water resources or geological feature of importance.
Minor Beneficial Effect	Minor reduction in risk to human, animal or plant health. Slight, local-scale improvement to the quality of potable groundwater or surface water resources. Moderate, local-scale improvement to groundwater or surface water resources that are used for, or have potential to be used for, industrial or commercial abstractions.
Moderate Beneficial Effect	Moderate reduction in risk to human, animal or plant health. Moderate local-scale improvement to the quality of potable groundwater or surface water resources. Significant local-scale, or moderate wide-scale, improvement to the quality of groundwater or surface water resources used for commercial or industrial abstraction only
Major Beneficial Effect	Major reduction in risk to human, animal or plant health. Significant local-scale/ moderate to significant regional scale improvement to the quality of potable groundwater or surface water resources.

11.2.18 In this assessment, based on professional judgement, 'significant' environmental effects are those assessed to be either Moderate or Major.

Baseline methodology

11.2.19 The baseline conditions have been established through desk study and through interpretation of previous intrusive ground investigation, monitoring and chemical testing undertaken on adjacent sites. In addition a preliminary stage of ground investigation has been undertaken (March 2016) and has also been used to assess baseline conditions at the site.

Assessment methodology for construction effects

11.2.20 A semi-quantitative assessment of the effects of the development arising from the ground conditions and contamination has been carried out within this section, based on the proposed development. The assessment has considered the extent and methods of foundation construction, the anticipated degree of disturbance of the ground, the final form of the development, and the relevant national and local policies for contaminated land assessment and management. Measures required to mitigate risks are identified and the residual risks assessed.

Assessment methodology for operational effects

11.2.21 A qualitative assessment of the effects of the operation of the development arising is described within this chapter. The assessment has considered the likely residual risks to workers, visitors and maintenance personnel which may exist during the operational phase. Measures required to mitigate risks are identified and the residual risks assessed.

11.3 Consultation

11.3.1 A scoping report was prepared for the EIA for the proposed development, which was submitted to Liverpool City Council for consideration[33]. As part of the formal process the Scoping Report is understood to have been circulated to appropriate statutory consultees to obtain their comments to inform Liverpool City Council's Scoping Opinion. At the time of writing no comments have been received by key stakeholders and the case officer has advised that no problematical comments are expected.

11.4 Limitations and assumptions

11.4.1 The limitations and assumptions made in compiling this chapter are detailed below. Notwithstanding the limitations and assumptions made, it is considered that this assessment is sufficiently robust for the purposes of this EIA.

11.4.2 This assessment is based entirely on existing information. Limited information exists which confirms the current ground conditions and contamination within the Site and further intrusive investigation will be required prior to development.

11.5 Baseline Conditions

Desk study information

Site history

11.5.1 The Site is located within Princes Dock to the north of Liverpool's iconic Pier Head and is located within the Liverpool Maritime Mercantile City World Heritage Site Buffer Zone and is adjacent to a World Heritage Site Character Area.[34]

11.5.2 Arup produced a Geotechnical and Geoenvironmental Desk Study (January 2016) for the proposed development, which includes copies of selected historical plans and other information relevant to obtaining an understanding of the historic development of the Site.

[33] Moda Living, Princes Reach, Princes Dock, Environmental Statement – Scoping Report, 10th March 2016.
[34] LCC World Heritage Site SPD, 2009

11.5.3 Prior to the development of closed docks in this area in the late 18th century, the Site boundary includes the river bank, river wall and extends into the channel of the River Mersey (Figure 11.1 in Appendix 6.2). Within the Site, modifications to the alignment of the river wall are identified on historic maps which date from 1803 (Figure 11.2 in Appendix 6.2). Princes Dock was completed in 1821 with a new dock wall constructed some 10m to the west of the original river wall (cf. Figure 11.1 and 11.3 in Appendix 6.2). Princes Dock remained the largest dock in Liverpool until 1832.

11.5.4 A series of transit sheds and offices stood on the east side of the dock and although a fire in 1894 destroyed a section of these sheds, they were subsequently repaired. Between the east sheds and Bath Street to the east, a series of rail lines were laid to facilitate goods handling and transfer from the sheds and the docks in general. These rails are first shown on the 1893 map (Figure 11.4 in Appendix 6.2) however, by the early twentieth century, the number of rails had increased. The Liverpool overhead railway (which is understood to have opened in 1893), also ran along the boundary of the site with Bath Street.

11.5.5 In 1929, the east side of the dock was re-built with the construction of new sheds on an enlarged dock-side goods handling area. In order to increase the dock-side area, concrete staging was built which projected over the former dock wall and over the impounded water. The section of this staging which extended over the water was supported by a grid of reinforced concrete stanchions which are understood to have been founded in the sandstone bedrock into which the dock had been cut. The new sheds straddled the old dock wall being partly built off the quayside and partly off the concrete staging (Figure 11.5 in Appendix 6.2).

11.5.6 After its closure in 1981, Princes Dock was regarded as a potential area for new office development, and following the preparation of a masterplan in 1992, the first phase of development at the southern end commenced. The transit sheds and other dock buildings were cleared, the east quay was widened to create larger development sites, and the dock walls were partly rebuilt.

11.5.7 A revised masterplan prepared in 1998, provided a framework for the remainder of the site, including road access and the partial infilling of the dock. The concrete staging was removed as far east as the original dock wall, with the grid of vertical stanchions used to support the staging and the overlying sheds broken down to an approximate level of 4.8mOD (approximately 2.6m below current ground level). After construction of an anchored sheet pile revetment along which the current William Jessop Way was built, areas between the roadway and the original dock wall were infilled. Further revisions were made in 2002, when a greater mix of uses was approved including higher development densities and indicative heights for each development plot. A new footbridge across the dock was constructed in 2001, lifted to accommodate the passage of canal boats. Alterations were made to the north and south walls for the canal link, which opened in 2009.

Published geology

11.5.8 The British Geological Survey (BGS) indicates that the bedrock geology is the Sherwood Sandstone Group – Chester Pebble Beds Formation. Superficial

deposits are indicated to be Tidal Flat Deposits, associated with the tidal zone of the River Mersey. Given the known development of the site, with dock basins understood to have been excavated into the sandstone, natural superficial deposits are understood to be absent from the site.

Hydrology and hydrogeology

11.5.9 There are no surface watercourses present within the site. A sheet pile wall forms the current boundary of Princes Dock, which lies approximately 16m west of the site boundary. The River Mersey is at the western side of Princes Dock, approximately 140m west of the site.

11.5.10 The Environment Agency has classified the superficial deposits in the area as 'unproductive'. This means they are low permeability and have negligible significance to water supply or base flow. As discussed above, from the archive information obtained, it is thought unlikely that natural superficial deposits remain on site and that sandstone is overlain directly by made ground (which includes silt deposits laid down during dock operations – dock silt). It is likely that the made ground has the potential to hold groundwater at a local scale, which is likely to be influenced by the water level of the dock.

11.5.11 The Environment Agency[35] has designated the bedrock geology as a Principal Aquifer, defined as 'layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale'.

11.5.12 No groundwater or surface water abstraction licences have been identified on the site, however four have been identified within a 500mm search radius of the site, including a large abstraction used for a ground source heat pump identified by the EA as located approx. 100m east of the site. The site is not within a groundwater source protection zone.

Landfills and waste

11.5.13 There are no known historic landfills or waste treatment sites within the site boundary. Three formerly licensed landfills have been identified within 1km of the site. These are between 350m and 700m to the north and northwest. In addition, a number of waste treatment sites (generally associated with vehicle dismantling) are recorded at distances of between 300m and 950m to the north of the study site.

[35] Environment Agency Interactive Mapping, http://maps.environment-agency.gov.uk/wiyby/wiybyController?x=357683&y=355134&scale=1&layerGroups=default&ep=map&textonly=off&lang=_e&topic=groundwater [accessed 14/12/2015]

Radon

11.5.14 The site is not within an area where radon protection measures are necessary, according to the map information published online by Public Health England on the UK Radon website.

Mining

11.5.15 The site does not lie within a Coal Mining Report Area indicating that the site is not at risk from historical coal mining activity.

Unexploded Ordnance (UXO)

11.5.16 CIRIA Report C681 "Unexploded ordnance – a guide for the construction industry" sets out a framework for the management of risks posed by UXO to the construction industry. The framework for the risk management process is divided into four distinct stages: preliminary risk assessment; detailed risk assessment; risk mitigation; and implementation. This is intended to ensure that the potential risk from UXO is addressed in an efficient and cost effective way.

11.5.17 Following completion of the Arup desk study report, an Explosive Ordnance Desktop Threat Assessment was commissioned from BACTEC[36] and this is included in this report in Appendix 6.1. This assessed the potential for a UXO hazard to occur at the site and was based on a desktop review of historical information, previous site development, wartime bombing records etc.

11.5.18 Sources consulted by BACTEC indicate bomb strikes on or immediately adjacent to the site during at least five separate air raids. Furthermore, it is known that large fires destroyed dockside warehousing on the west side of Bath Street. There is no evidence to suggest that the site had any use that could have led to contamination with British / Allied items of UXO.

11.5.19 The BACTEC report concluded that the risk from UXO at the site was Medium-High. The most likely scenarios under which a UXO could be encountered during construction works were considered to be during ground investigation, or during piling works. It was noted however, that shallow excavations into the fill placed at the Site in the 1990s would not encounter WWII-era deposits and there were therefore, no identifiable significant UXO risk associated with this specific made ground type.

11.5.20 BACTEC made a number of recommendations in their report, including:

- Site Specific Explosive Ordnance Safety and Awareness Briefings are required for all personnel involved in intrusive works at the Site.
- Personnel working on the Site should be instructed on the identification of UXO and the actions to be taken. Written instructions should be retained on site.

[36] Dynasafe BACTEC Limited, Explosive Ordnance Desktop Threat Assessment, Princes Reach, ref 6426TA, 22 Feb 2016.

- An Explosive Ordnance Disposal (EOD) Engineer should attend site during shallow intrusive works into at-risk areas of the Site. When on site, the role of the EOD Engineer would include; monitoring works using visual recognition and instrumentation; response to reports of suspicious objects or suspected items of ordnance; providing Explosive Ordnance Safety and Awareness briefings and advice on the need to modify working practices to take account of the ordnance threat, and finally to aid Incident Management which would involve liaison with the local authorities and Police should ordnance be identified and present an explosive hazard.
- Intrusive Magnetometer Surveys of any pile / borehole locations down to the maximum bomb penetration depth.

Previous ground investigation information

11.5.21 There have been several phases of ground investigation in the general vicinity of the proposed development and one preliminary investigation within the Site. These ground investigations are summarised below. The location of the exploratory holes that are considered relevant to this review are presented on Figure 11.6 in Appendix 6.2. Additional ground investigation and interpretation is planned to inform the development design.

Ian Farmer Associates 2001/2 – Malmaison Hotel development

11.5.22 The Malmaison Hotel is a nine storey hotel on the west side of Princes Dock, approximately 300m south-west of the Site. The Malmaison Hotel, Liverpool, Geotechnical Report (May 2002) prepared by Ove Arup and Partners has been reviewed.[37]

11.5.23 In December 2001, and March 2002, Ian Farmer Associates (IFA) under the supervision of Arup carried out a ground investigation that comprised four light cable percussion boreholes to 5m below rockhead to a maximum depth of 18m, two hand dug pits to a maximum depth of 1.3m, and two machine dug trial pits to a maximum depth of 4.5m. Following the completion of the boreholes, monitoring standpipes were installed. These enabled soil-gas conditions and water levels to be monitored. Soil, rock and groundwater samples were taken from boreholes and trial pits and were sent for geotechnical and contamination testing.

11.5.24 As shown on Figure 11.5 in Appendix 6.2, for the purposes of reporting ground conditions, the site was divided into two areas, separated by the dock wall; Area A to the east of the wall (landside), and Area B to the west of the wall (dockside).

11.5.25 It can be seen from Figure 11.5 in Appendix 6.2 that made ground is present to the eastern side of the dock wall to between 4.25m and 7.5m below ground level. This is underlain by 'Bunter Sandstone' (renamed by the BGS as the 'Sherwood Sandstone Group'). Rockhead dips towards the dock wall (westerly) at an approximate angle of 22˚ from +2.75mOD in the east to -0.5mOD (probable depth) beneath the dock wall. To the western side of the dock wall (Area B) there

[37] Ove Arup & Partners (May 2002), MWB Developments, Malmaison Hotel Liverpool, Geotechnical Report.

are four different types of fill overlying the Bunter Sandstone. Between William Jessop Way there is approximately 0.7m of engineered fill, understood to comprise sub-base, overlying uncontrolled fill and dock silt deposits. There was some uncertainty in terms of the depth to rockhead. Vibrocompaction ground treatment was undertaken beneath the new highway but this ground treatment does not extend into the development site. The stratigraphy encountered as reported in the Malmaison Geotechnical Report is presented in Table 11.2 below.

Table 11.2: General stratigraphy from IFA 2001/2

Stratum	Area A thickness (m)	Area B thickness (m)
Made Ground	4.15 – 6.00	*ca*. 5.00 – 7.5
Recently Placed Fill	Not Present	6.70m
Dock Silt	Not Present	4.70 – 5.00
Sandstone Bedrock	Rockhead was >6.35 however the full thickness of sandstone was not encountered.	Rockhead was >4.25 however the full thickness of sandstone was not encountered.

Made Ground

11.5.26 The made ground in Area A generally comprised an upper layer of loose to medium dense brown and orange brown gravelly sand. With depth it graded into a soft brown sandy clay. The made ground in Area B was placed in 1999 as part of the dock reclamation scheme. It is understood that this material was end tipped and is generally loose brown, gravelly sand containing some demolition debris, some places in large concrete blocks up to 1m³ in size.

Dock Silt

11.5.27 Dock silt encountered in Area B, was recovered as a soft brown/black, locally peaty, slightly sandy silt.

Sandstone Bedrock

11.5.28 Boreholes 1,2 and 4 encountered a thin layer of weathered sandstone on top of the bedrock. This weathered layer was generally described as a very dense, red brown, slightly silty, gravelly, fine to coarse sand/sandy gravel of weak sandstone.

11.5.29 The underlying bedrock was generally found to be moderately weak to moderately strong brown and red brown medium grained sandstone with horizontal to sub-horizontal bedding. Occasional sub vertical clay filled joints were observed. The laboratory testing indicated a slightly higher strength than the visual description although this could be as a result of the sampling methods, where typically stronger layers are tested. Laboratory test results indicate the sandstone to be moderately strong although grading to moderately weak at the surface. No trend of an increase in strength with depth was observed.

Groundwater

11.5.30 Groundwater was not encountered in Area A to the eastern side of the dock wall and subsequent monitoring in the made ground indicated it to be generally dry. It appears that the presence of the original dock wall results in the groundwater levels in Area A being substantially lower in comparison to Area B where the groundwater level corresponds to the water level in the dock.

Dock Wall

11.5.31 Two trial pits were carried out as part of the 2002 site investigation to investigate the location and geometry of the dock wall. The trial pits encountered the top of the dock wall at a depth of 1.40m with a width of 1.90m. The front face of the dock wall was found to slope at a gradient of 1 in 12.5 to a depth of 2.50m below the top of the wall. Original construction drawings of the wall that were found as part of this project show a gradient of 1 in 9 to a depth of 6.70m where a step of 0.20m is seen. A further step is seen at a depth of 9.68m where the wall gradient increases to 1 in 3.3. The drawing indicates a wall height of 11m. The trial pits indicate the back of the wall to be vertical to a depth of 4m however earlier investigations suggest it is founded at an elevation of -0.5mOD (some 4m lower). It is possible that the wall widens towards the base. The geometry of the dock wall shown in Figure 11.5 in Appendix 6.2 is based on archive photographs[38] and was considered the most likely construction.

Dock Boundary Wall

11.5.32 Trial pits were excavated to determine the founding details of the boundary wall and these were proved to a depth of 1.10m below pavement level, stepping out from the wall line by up to 0.55m. One pit was excavated next to a cast iron column associated with the former overhead railway and it was found that the railway was founded on concrete pads sitting directly on the wall foundations.

Concrete Staging

11.5.33 The Malmaison ground investigation did not encounter evidence of concrete staging that may remain in place. The report provides evidence from discussions with the Arup Manchester team that the bracing was removed during the dock reclamation and the columns were broken down to an elevation of 4.8mOD (2.6m below existing ground level).

Below Ground Obstructions

11.5.34 The 2002 site investigation revealed the presence of many obstructions in the fill up to depths of around 6m and it was recommended that excavation of pile positions would be required prior to piling. It is not known whether obstructions were an issue during the subsequent piling works for the hotel.

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[38] Adrian Jarvis (1991), A Magnificent Monument of Mural Art – The Story of Princes Dock. National Museums and Galleries on Merseyside.

Contamination

11.5.35 Chemical testing was undertaken on 18 soil samples for metals, cyanide, sulphide, sulphate, pH, phenols, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), mineral oils and polychlorinated biphenyls (PCBs). The assessment did not identify any widespread contamination that was considered to be a risk to human health however concentrations of copper, zinc and boron were reported to pose a phytotoxic risk to plants.

11.5.36 One groundwater sample was tested for metals, sulphate, PAH, mineral oil, chloride and BTEX. No significantly elevated concentrations of contaminants were reported in groundwater. Ground gas monitoring was undertaken on several occasions over a three month period. Elevated concentrations of methane up to 8.6% were reported and the gas risk assessment indicated that gas protection measures would be required in new buildings.

11.5.37 It should be noted that the ground investigation data is over 13 years old and therefore may be unreliable due to changes in logging testing and risk assessment guidelines.

Foundation and Exploration Services (FES) 1998 – Princes Dock Infrastructure

11.5.38 The Princes Dock Infrastructure development included the construction of a new sheet pile wall and construction of a new highway as well as the provision of new services. Arup were appointed by Princes Dock Development Company as the Consulting Engineers. Between April and June 1998, and November and December 1998 Foundation and Exploration Services carried out ground investigation under the supervision of Arup.

11.5.39 The factual report produced by Foundation and Exploration Services[39] has been reviewed, alongside the Interim Geotechnical Report[40] and the following section presents the relevant information. The site investigation was undertaken in three phases and the relevant exploratory holes from these have been considered as follows.

Table 11.3: Relevant exploratory holes from FES 1998

Phase	Exploratory hole	Notes
1	TP106, TP107, TP111	Phase 1 was completed at the time Princes Dock was in the process of being reclaimed by infilling

[39] Foundation and Exploration Services Limited (July 1998), Princes Dock Development Company, Princes Dock, Liverpool, Factual Report on Site. Foundation and Exploration Services Limited (February 1999), Princes Dock Development Corporation, Princes Dock, Liverpool – Phase II, Factual Report on Ground Investigation.

[40] Ove Arup & Partners (May 1998), Princes Dock Development Company, Princes Dock: Infrastructure, Interim Geotechnical Report.

2	BH201/A, BH202, BH203, BH205, BH206	Phase 2 was completed following the completion of the filling operation.
3	No relevant data	

Table 11.4: General stratigraphy inferred from FES 1998

Stratum	Approximate thickness (m)	Approximate elevation of top (mOD)
Made Ground	6.10 to 12.10	Ground Level
Dock Silt	1.0	-3.03
Sandstone Bedrock	>0.6	-4.03 to -4.93

Made Ground

11.5.40 The made ground encountered in the relevant exploratory holes was generally described as light brown subangular fine to coarse gravel including brick and limestone with some fine to coarse sand and a little to some silt. Occasional fragments of tarmac, metal and ceramic were encountered.

Dock-Silt

11.5.41 Dock-silt was encountered in one borehole (BH201A) which is located south of the site. The silt is described as very soft and black in colour, with a little fine and medium sand.

Sandstone Bedrock

11.5.42 Generally the sandstone encountered was described as red-brown highly weathered, fine and medium grained sandstone, moderately weak. All boreholes were terminated after a short depth into the sandstone and therefore less weathered material was not proven.

Below Ground obstructions

11.5.43 Photographs taken around the time of this investigation show the infill material to be general construction fill. It appears that some attempt has been made to sort the material, however it is likely that obstructions are present.

Exploration Associates 1995 – Princes Dock, Liverpool

11.5.44 As part of a proposal for the development of Princes Dock, Liverpool in 1995, Exploration Associates (EA) carried out a ground investigation,[41] supervised by Arup. It should be noted that this investigation was carried out prior to works to infill the docks and associated infrastructure works. The investigation was carried out between 23 January and 22 February 1995 and comprised twenty four

[41] Exploration Associates (May 1995), Princes Dock, Liverpool, Factual Report on Ground Investigation.

boreholes excavated using cable percussion and rotary coring techniques, and twenty two trial pits excavated by both machine and by hand.

Stratum	Approximate thickness (m)	Approximate top elevation (mOD)
Made Ground	5.80	1.36
Sandstone Bedrock	>1.2m	0.16

11.5.45 The works were carried out across the full extent of the dock, and therefore only certain exploratory holes have been considered relevant to this site. The exploratory holes considered are BH11(A) and TP21(A). A ground probing radar survey was also carried out to investigate the existence of possible subsurface voiding. The stratigraphy encountered is presented in Table 11.5 below.

Table 11.5: General stratigraphy from relevant borehole records from the 1995 EA ground investigation

Made Ground

11.5.46 The made ground encountered in the two exploratory holes that are relevant to the Site is generally described as a loose red and brown sandy clay fill with fragments of brick, concrete and sandstone.

Sandstone Bedrock

11.5.47 The sandstone bedrock encountered in the two relevant exploratory holes is generally described as yellow brown weathered sandstone. BH11 was terminated 1.2m into the sandstone and did not prove less weathered material.

Groundwater

11.5.48 Standpipe piezometers were installed within the boreholes, including BH11 however no data was included in the factual report. The trial pit record for TP21A records water ingress at 3.40m depth.

Dock Wall

11.5.49 Trial Pit TP21A exposed the sandstone masonry of the dock wall. From a section provided in the factual report it appears that the dock wall consists of sandstone masonry and is approximately 2.0m thick.

11.5.50 To the eastern (landside) of this dock wall, another section of sandstone masonry was recorded. No further details with regards to this wall are provided. It is possible that this is the river wall. The factual report noted that a number of potential voids and hard and soft spots were indicated by the radar survey.

Stage 1 Ground Investigation: Soil Engineering Ltd – March 2016

11.5.51 As part of the initial design for the proposed Princes Reach development, Soil Engineering Ltd (SEL) undertook a preliminary trial pitting and trial trenching investigation of the Site in March 2016. The Stage 1 GI was supervised by Arup and was intended primarily to locate and identify historic features (e.g. the river wall and dock wall) and other in-ground constraints that may affect the layout and design of the proposed building.[42]

11.5.52 The Stage 1 GI was also intended to provide an initial characterisation of the different types of fill/made ground present at the site. Additional ground investigation is planned to inform the scheme design.

Made Ground

11.5.53 The full depth of made ground was not proven during the Stage 1 GI as the depth of the excavations was limited to around 4m by pit instability and groundwater ingress. Two distinct types of made ground were encountered:

- On the land side (east) of the dock wall - orange/yellow, slightly clayey gravelly fine to coarse sand with sandstone fragments and occasional pottery and brick fragments. This fill is thought to have originated from the excavation of Princes Dock in the 19th century when sandstone excavated for the construction of the dock is likely to have been used as fill between the dock wall and the remains of the earlier river wall.
- On the river side (west) of the dock wall, made ground was encountered as dark brown, yellow, or grey gravelly sandy clay. This fill is more variable than the sandstone fill, as brick and wood fragments, limestone gravel, concrete (ranging from gravel-sized to large slabs), plastic, granite boulders, and metal pipes were noted in the trial pits and trenches. This fill is considered to have been placed on the site during the reclamation works in the mid-1990s.

Groundwater

11.5.54 Groundwater was noted as often rapid ingress from depth of approximately 3.0m to 3.5m below ground level. This is consistent with the water level in Princes Dock.

In-Ground Constraints

11.5.55 Figure 11.7 in Appendix 6.2 presents the locations of the trial pits and trial trenches undertaken during the Stage 1 GI. In addition, the position of the various in-ground constraints that were encountered is shown.

11.5.56 Remains of what is considered to be the late-1700s river wall were identified at depths of 3.5-3.7m bgl in TT304 and TT306, within the fill. Given the depths encountered, groundwater ingress, and the instability of the excavations, direct

[42] Moda Living, Princes Reach, Liverpool, Stage 1 Geotechnical Interpretative Report. Ref PRL_ARP_XX_XX_RP_GE_00002, 6 April 2016.

inspection of these sandstone blocks was not possible. Given their appearance, depth, and location, these features have been interpreted as the remains of the river wall which appears to have been partially removed at some point in the past, perhaps during the construction of Princes Dock.

11.5.57 The 19th century dock wall was identified in TT301/305/307 and TT302/303. Arup site records noted the top of the dock wall was encountered at around 0.7m depth in TT301/305/307 and 0.3m depth in TT302/303, immediately beneath the modern car park hardstanding. An approximately 1m wide, 1.2m deep cut was observed in the top of the wall. This feature may represent the original granite coping stone which has since been removed. Alternatively, the cut in the dock wall may represent the position at which the edge beam of the concrete staging was supported off the dock wall.

11.5.58 The locations of two broken-off concrete stanchions were confirmed during the Stage 1 GI at depths in the order of 3.5m (Stanchions A1 and B1 as shown on Figure 11.7 in Appendix 6.2). In addition, two other features have been tentatively identified as broken-off stanchions (Stanchions B2 and B3 as shown on Figure 11.7 in Appendix 6.2). These were deeper than had been anticipated at desk study stage and were therefore, at or below groundwater level. The instability of the excavations and the presence of groundwater hindered the identification of the stanchions.

Contamination

11.5.59 A limited number of soil samples were taken from the Stage 1 ground investigation for laboratory analysis. Statistical analysis was not appropriate for assessing the results of laboratory analysis due to the limited number of test results obtained. The current dataset will be supplemented with further analysis in subsequent stages of ground investigation.

11.5.60 Two samples of the 19th century sandstone fill underwent laboratory analysis which indicated very low concentrations of metals, PAH, and SVOC that were well below the relevant GACs. No asbestos was detected in the soil samples. VOC, PCB, TPH, and BTEX were recorded below the laboratory limit of detection (LOD).

11.5.61 Five samples of the mid-1990s fill were recovered from TT301/305/307 and TT302/303 and underwent laboratory analysis. This analysis indicated very low concentrations of metals, PCB, TPH, and SVOC that were well below the relevant GACs. No asbestos was detected from the soil samples. VOC and BTEX were recorded below the LOD. A number of instances of slightly elevated PAHs were recorded in these samples, as summarised on Table 11.6.

Table 11.6: Summary of contaminants exceeding GAC in the general construction fill

Determinand	GAC (mg/kg)	Maximum Concentration (mg/kg)
Naphthalene	2.3	7.9
Benzo (a) anthracene	11	40
Chrysene	30	48

Benzo (b) fluoranthene	3.95	48
Benzo (a) pyrene	3.17	37
Dibenzo (ah) anthracene	0.31	6.4

Contaminated Land – Preliminary Conceptual Site Model

11.5.62 The January 2016 Arup Desk Study Report presented a preliminary conceptual site model based on the information that had been collated during the desk-based review of the Site. This has been supplemented by a limited phase of intrusive investigation: the Stage 1 GI undertaken in March 2016 (see above).

11.5.63 A conceptual site model describes the scenario in which the risks to human health and the environment posed by contaminated land are assessed. It describes the ground and surface conditions, and the activities performed on site in terms of the proposed ground works and the final form of the development. In particular the model identifies and describes the sources of the potential contamination, the behaviour of the contamination in the environmental media such as soil and groundwater, surface water and air. It also identifies and characterises potential human health and environmental receptors, and plausible pathways.

11.5.64 The potential risks to human health and the environment have been considered in the context of a conceptual source-pathway-receptor (SPR) model of the site, identifying:

- The principal pollutant hazards associated with the site (the sources);
- The principal receptors at risk from the identified hazards; and
- The existence, or absence, of plausible pathways which may exist between the identified hazards and receptor.

11.5.65 For risks to be present at the site, all three elements (source-pathway-receptor) of a plausible pollutant linkage must be present. Potential SPR linkages are described below based on the proposed site end-use.

Potential Sources

11.5.66 A number of potential sources of contamination associated with historical land uses that may be present within the site. Potential contaminants were identified, where possible, from the Department of Environment 'Industry Profiles' publications.[43] These potential sources are summarised Table 11.7 below.

Receptors

11.5.67 The following receptors have been identified at the site:

- Construction workers (during site construction/redevelopment);
- Users of neighbouring sites (during site construction/redevelopment);

[43] Department of Environment Industry Profiles [inline] Available at https://www.gov.uk/government/publications/department-ofenvironment-industry-profiles#history

- Future building resident/ building user;
- Future maintenance worker;
- Perched groundwater within made ground
- Bedrock groundwater (Principal Aquifer);
- Surface Water (Princes Dock)
- River Mersey;
- Vegetation in soft landscaping areas
- Structural concrete; and
- Services and utilities.

Potential Source	Potentially Contaminative Materials	Comments
Made ground associated with dock construction/infill	Asbestos Heavy metals Hydrocarbons (including petroleum hydrocarbons, phenols, Polyaromatic hydrocarbons (PAHs)) Inorganics (e.g. sulphate, sulphide, chloride, cyanide, ammonia/nitrate) Ground gases (methane, carbon dioxide, carbon monoxide, hydrogen sulphide, volatile organic compounds (VOCs)	Source of fill used in original dock construction unknown but is likely to have included waste materials from the local area (e.g. industrial waste, building rubble, marine dredgings). Fill used in reclamation work in mid 1990s known to be general construction waste. Potential for generation of ground gas will depend on the organic content of the material
Historical dock activities including cargo storage, handling plant and equipment, ship repair/maintenance	Asbestos Heavy metals Tributyltin Hydrocarbons (including petroleum hydrocarbons, phenols, Polyaromatic hydrocarbons (PAHs)) Solvents Polychlorinated biphenyls (PCBs) Inorganics (e.g. sulphate, sulphide, chloride, cyanide, ammonia/nitrate)	The contaminants will largely depend on the nature of cargo stored and the ancillary activities that were undertaken. Spillages/ onsite disposal Regulations historically less stringent
Railway	Heavy metals Asbestos Hydrocarbons (including petroleum hydrocarbons, phenols, Polyaromatic hydrocarbons (PAHs)) Ethylene glycol Creosote Sulphates	
Car parking	Heavy metals Hydrocarbons (including petroleum hydrocarbons, phenols, Polyaromatic hydrocarbons (PAHs)) Solvents	Site covered in part in hardstanding. Minor fuel leaks from parked cars unlikely to have caused widespread contamination.

Table 11.7: Potential sources of contamination

Pathways

11.5.68 Potential pathways that may be present during redevelopment and operation include:

- Human health – Ingestion of soils or dust;
- Human health – Inhalation of dust, vapour or soil gas;
- Human health – Dermal contact with soils or groundwater;
- Controlled waters – Migration of mobile or leachable contamination;
- Controlled waters (and human health by vapours) – Transport of non-aqueous phase contaminants (such as petroleum hydrocarbons and solvents);
- Ground gas – Ingress of ground gas into buildings;
- Vegetation – Uptake via root system;
- Building structures and utilities – Direct contact with aggressive ground conditions.

Preliminary Assessment of Potential Pollutant Linkages

Human Health

11.5.69 During any excavations and earthworks required as part of the development, dermal, inhalation and ingestion pathways will be present to construction workers and site neighbours.

11.5.70 Post development, ingestion, inhalation dermal contact and dust pathways will only be present in areas of soft landscaping.

11.5.71 Gas and vapour pathways may be relevant in terms of the proposed building and protective measures may need to be incorporated into the building design.

Controlled Waters

11.5.72 The potential for pathways exists between possible contaminants in the made ground and the sandstone Principal Aquifer (via vertical and lateral migration of leachate).

11.5.73 Shallow groundwater is considered to be in hydraulic continuity with Princes Dock and consequently a pathway exists between any contamination in groundwater and surface water within the dock and subsequently the River Mersey. Groundwater in the bedrock is also likely to provide baseflow to the River Mersey.

Ecological Receptors and Vegetation

11.5.74 Existing soils in any areas of soft landscaping may present a risk to vegetation via uptake through root systems.

Buried Structural Concrete and Utilities

11.5.75 Buried structures such as water supply pipes, foundations (including piled foundations) and ground-floor slabs may come into direct contact with chemically aggressive ground which may reduce the integrity and design life of these structures.

Summary of conceptual site model

11.5.76 A summary of the preliminary conceptual site model is presented in Table 11.8 below:

Table 11.8: Preliminary conceptual site model

Source		Pathway		Receptor	Comment/Possible Mitigation
Construction					
Made Ground*# *(Asbestos, heavy metals and metalloids, hydrocarbons, solvents, PCBs, sulphate, sulphide, chloride, cyanide, ammonia/nitrate)*	→	Ingestion of soil and soil dust	→	Construction Worker	Mitigated using appropriate PPE and site briefings on risks associated with the contaminants of concern
		Dermal contact with soil and soil dust	→	Construction Worker	
		Inhalation of soil vapours	→	Construction Worker	
		Inhalation of soil dust	→	Construction Worker	Mitigated using appropriate PPE, site briefings and dust suppression
			→	User of neighbouring site	Mitigated using dust control measures and monitoring
Made Ground stockpiles*# *(Containing contaminants above)*	→	Leaching and run off along ground surface	→	Princes Dock	Mitigated with stockpile bunding and placement of stockpiles away from Princes Dock
Shallow Groundwater *(Containing contaminants above)§*	→	Ingestion	→	Construction Worker	Mitigated using appropriate PPE and site briefings on risks associated with the contaminants of concern
		Dermal contact	→	Construction Worker	
Ground Gas from Made Ground§ *(Carbon dioxide, methane, carbon monoxide, hydrogen sulphide, VOC including light alkanes)*	→	Accumulation and inhalation of hazardous gases at asphyxiating/ toxic concentrations	→	Construction Worker (working in confined space)	Mitigated using gas monitoring alarms and following confined space working procedures (if necessary)
		Accumulation and ignition of hazardous gases at explosive concentrations	→	Construction Worker	Mitigated using monitoring alarms (if necessary)
Operation					
Soft landscaping (potentially site Made Ground)* #	→	Ingestion of soil and soil dust	→	Future building resident/ user/ maintenance worker	Maintenance worker most likely to become exposed to soils in soft landscaping.

Source		Pathway		Receptor	Comment/Possible Mitigation
Asbestos, heavy metals and metalloids, hydrocarbons, solvents, PCBs, sulphate, sulphide, chloride, cyanide, ammonia/nitrate)		Dermal contact with soil and soil dust	→	Future building resident/ user/ maintenance worker	
		Inhalation of soil dust	→	Future building resident/ user/ maintenance worker	
		Uptake via root system	→	Vegetation	
Made Ground*[#] *(Heavy metals and metalloids, hydrocarbons, solvents, PCBs, sulphate, sulphide, chloride, cyanide, ammonia/nitrate)*	→	Inhalation of soil vapours	→	Future building resident/ user/ maintenance worker	Volatile contaminants only
	→	Leaching and vertical migration	→	Groundwater	
	→	Direct contact	→	Buried concrete and services	
Shallow groundwater *(Containing dissolved contaminants listed above)*[§]	→	Lateral flow of shallow groundwater	→	Princes Dock	
			→	River Mersey	
		Vertical flow of shallow groundwater	→	Sherwood Sandstone (Principal aquifer)	
		Preferential vertical flow along building piles	→	Sherwood Sandstone (Principal aquifer)	
		Direct contact	→	Building foundations	Shallow groundwater may be chemically aggressive to concrete
Ground Gas from Made Ground[§] *(Carbon dioxide, methane, carbon monoxide, hydrogen sulphide, VOC including light alkanes)*	→	Accumulation and inhalation of hazardous gases at asphyxiating/ toxic concentrations	→	Future building resident/ user/ maintenance worker	
		Accumulation and ignition of hazardous gases at explosive concentrations	→	Future building resident/ user/ maintenance worker	
			→	Building	

Notes:

* - Although no evidence for asbestos fibres was identified in samples recovered from the March 2016 Stage 1 GI, this does not preclude the possibility that asbestos may be present within the Site.

[#] - Except for the PAHs detailed in Table 11.6, the concentrations of potential contaminants identified during the Stage 1 Ground Investigation of March 2016 were generally less than the relevant GACs. These findings will need to be verified by subsequent stages of ground investigation at the Site.

[§] - The Stage 1 Ground Investigation of March 2016 was limited to the excavation of trial pits and trenches. Borehole installations will be required during subsequent stages of ground investigation to allow the recovery of appropriate groundwater samples and to allow gas monitoring to be undertaken.

11.6 Assessment

Identification and Evaluation of Significant Effects

11.6.1 At the time of producing this chapter, proposals for comprehensive ground investigation had not been fully implemented and it has therefore been necessary to undertake the assessment based on desk study information supplemented by the limited data available from the March 2016 Stage 1 Ground Investigation. However this dataset is considered adequate to assess potential impacts for the purposes of this EIA, as discussed below.

11.6.2 The principal effects of any existing ground contamination are considered to relate to the construction phase, when disturbance of soils during excavation works could result in construction workers, visitors to site and surrounding neighbours being exposed to potentially contaminated soil, dust or groundwater, or result in pollution of controlled waters.

11.6.3 A preliminary qualitative assessment of the effects of the development arising from the ground conditions during construction and subsequent operation is described within this section.

Construction (including Site Clearance and Earthworks)

Human Health

11.6.4 A number of potential pollutant linkages were identified in the Preliminary Conceptual Site Model which relate to construction workers (direct contact/ingestion and inhalation) and neighbours (from dust emissions). These linkages are most relevant during phases of excavation or other ground disturbance but may still be relevant at other times if existing made ground soils are exposed at the surface.

11.6.5 Of the ground investigation data that was considered in the desk study, limited information on contamination was available. It is not clear which of the fill types present within the development site this data relates to however, the analysis that was undertaken did not identify any widespread contamination that was considered to be a risk to human health. Concentrations of copper, zinc and boron were however, reported to pose a phytotoxic risk to plants.

11.6.6 The limited analysis undertaken as part of the March 2016 Stage 1 GI established concentrations of potential contaminants within the sandstone fill which were below the GAC or laboratory LOD. In the general fill to the west of the buried dock wall, marginally elevated concentrations of PAH were the only

contaminants detected in excess of the relevant GACs (see Table 11.6). Asbestos was not detected in the 2016 soil samples selected for analysis, however this does not preclude the presence of asbestos in made ground elsewhere across the site.

11.6.7 It is considered that the concentrations of contaminants that have been identified to date, do not present a significant constraint on the proposed residential end use and that it will be possible to address the risks presented by adoption of routine PPE and dust control measures. Due to the limited testing undertaken during this Stage 1 GI however, further analysis will be required during subsequent stages of ground investigation to confirm these findings. Furthermore, contingency measures will be required to deal with the potential for encountering unidentified contamination during construction.

11.6.8 It is recommended that specific precautions are taken during any future earthworks to reduce potential exposure to potentially contaminated soils in accordance with the principle of 'as low as reasonably practical' (ALARP). This would include appropriate briefings, dust suppression and protective equipment (PPE).

11.6.9 Assuming that appropriate mitigation procedures are implemented during construction it is assessed that the risk of harm to construction workers and neighbours can be reduced to acceptable levels.

11.6.10 In accordance with Table 11.1, during the construction phase, existing soil and groundwater contamination at the Site is considered to present a Minor Adverse potential risk to human health. Please note this conclusion has been assessed WITHOUT consideration of control measures or other forms of mitigation. The risks to human health following the adoption of appropriate mitigation and control measures are addressed below.

Controlled Waters

11.6.11 The conceptual site model identified a possible pollutant linkage between any leachable or mobile contamination within the made ground and the underlying Sherwood Sandstone Principal Aquifer (by vertical migration) and with the water in the adjacent Princes Dock and the River Mersey (by horizontal migration).

11.6.12 The only data available to date which relates to groundwater quality was a single groundwater sample recovered during the 2002 GI which was tested for metals, sulphate, PAH, mineral oil, chloride and BTEX. No significantly elevated concentrations of contaminants were reported.

11.6.13 During the subsequent stage of further intrusive ground investigation that has been proposed, groundwater samples will be recovered from purpose-built borehole installations (after purging) and analysis undertaken to determine the condition of groundwater with respect to a range of common contaminants. Samples of made ground will also undergo leachate tests to determine whether mobile contaminants are present that may impact groundwater, which may in turn impact the Principal Aquifer, Princes Dock or the the River Mersey.

11.6.14 Given that made ground at the site is understood to directly overlie sandstone, particularly in the areas of the site in which excavation of the dock basin was

undertaken into bedrock, none of the anticipated construction activities (excavation of the lift pit, borings for piled foundations etc.) will introduce new migration pathways for mobile or leachable contaminants in the made ground.

11.6.15 Linkages between mobile contaminants in the made ground and controlled waters may be exacerbated temporarily during the initial stages of the proposed development works, when the existing piecemeal hardstanding is removed (note: there is currently no hardstanding in the north west part of the Site). The removal of surface hardstanding during construction will temporarily expose a greater area of made ground to infiltration, which may create larger volumes of leachate. The magnitude of this temporary enhanced risk will depend on the findings of proposed further ground investigation. The risk from leachable soil and groundwater contamination at the Site during the construction phase is considered to present a Minor Adverse potential risk to controlled waters. The risks to controlled waters following the adoption of appropriate mitigation and control measures are addressed below.

Operation

Human Health

11.6.16 The proposed development does not include private gardens and except for limited areas of soft landscaping, the proposed development will result in the provision of hardcover (ground floor slabs, external paving etc) across the majority of the development. Except for proposed landscape areas, soil/dust ingestion, dust inhalation and dermal pathways will be broken by the proposed development works resulting in there being no residual risk to human health.

11.6.17 In soft landscaping areas, it is considered likely (subject to review of additional data) that the provision of a layer of clean cover soil will be sufficient to address residual human health risks. The requirements for mitigation are discussed in more detail below.

11.6.18 A potential pollutant linkage exists between contaminants in the soil and groundwater and maintenance workers who may need to dig through the soil, for example to repair utilities or general landscaping maintenance. As maintenance workers are likely to have a much lower frequency and duration of exposure to contaminated soils than residents, and maintenance workers are likely to be excavating for services which are typically laid in clean backfill, this risk is assessed as being Minor Adverse.

11.6.19 A potential pollutant linkage exists between users of the developed site and ground gas (principally methane and carbon dioxide, as the site is not within an area where radon protection is required). The only data available was collected during the 2002 GI when monitoring was undertaken on several occasions over a three month period. Elevated concentrations of methane up to 8.6% were reported and the gas risk assessment indicated that gas protection measures would be required in new buildings. Given the age of the data and changes that have been made in the interim to methods of hazardous soil gas risk assessment, further monitoring and risk assessment will be required before the significance of ground gas risks on the proposed development can be fully assessed.

Controlled Waters

11.6.20 As discussed above no significant groundwater contamination has been identified by previous ground investigation. Although this needs to be reviewed following future ground investigation, it should be noted that the proposed development will result in the majority of the site being covered with new buildings and hardstanding, which will reduce infiltration into the made ground. During the operation phase therefore, the proposed development is considered to have a Negligible to Minor Beneficial Effect on the risk to controlled waters.

Ecological / phytoxicity

11.6.21 Previous phases of ground investigation have identified concentrations of potentially phytotoxic elements within made ground at the site. A potential pollutant linkage therefore exists between existing made ground and plants in any proposed soft landscaping areas. During the operation phase, without mitigation, existing soil and groundwater contamination at the Site is considered to present a Minor Adverse potential phytotoxic risk. The risks from phytotoxic effects following the adoption of appropriate mitigation and control measures are addressed below.

Buried structures and services

11.6.22 Buried concrete structures in contact with made ground may be subject to degradation, particularly from elevated concentrations of sulphates in the soil or groundwater. These issues are to be addressed following subsequent stages of ground investigation. Until such further assessment has been undertaken the significance of contamination on buried concrete can not be fully assessed.

11.6.23 A potential linkage exists between certain (mainly hydrocarbon) contaminants in the made ground and potable water supply pipes, in that contaminants may permeate pipe materials, or the pipe materials may be degraded as a result of contaminants within the made ground. This may taint water supplies as well as shortening the lifespan of the supply pipes themselves. Once a robust set of contaminant data is available for the made ground, the local water supply company should be consulted regarding the specification of the potable supply pipe to be used as well as the specification of backfill used within potable supply pipe trenches.

Mitigation and offsetting of construction impacts

11.6.24 There are potential risks posed to construction workers and site neighbours during construction as a result of exposure to site soils and inhalation of soil-derived dust, fibres and vapours. In order to mitigate these risks, it is recommended that further stages of detailed ground investigation are undertaken at the site. This proposed ground investigation should take account of the different types of made ground that have been identified on site, which the emphasis placed on more fully characterising the recent fill that was placed in the 1990s to the west of the dock wall.

11.6.25 Once the site conditions are understood, specific precautions can be taken to reduce potential exposure in accordance with the principle of 'as low as reasonably practical' (ALARP). This should include appropriate safety briefings, protective equipment (PPE) and dust suppression. In addition, any areas of contamination identified during construction should be removed and/or treated. The implementation of these measures will mitigate the risks to **Negligible**.

11.6.26 The potential pollutant linkage between ground gases and construction workers can be mitigated by completing additional ground investigation to determine the gassing regime within the site. Specific precautions routinely implemented on brownfield sites, such as installation of a gas membrane in buildings, can be taken once the regime is understood to reduce potential exposure to ground gases in accordance with the ALARP principle. The implementation of appropriate control measures will mitigate the risks to **Negligible**.

11.6.27 A potential pollutant linkage has been identified between mobile contaminants in the made ground and both the sandstone aquifer and the water in the adjacent Princes Dock and the River Mersey. Further ground investigation is required to more fully understand this risk. Should the potential for mobile or leachable contamination be identified, this will need to be addressed by limiting the exposure of the relevant made ground to infiltration during construction, coupled with groundwater quality monitoring to identify any deterioration in quality such that action can be taken. The implementation of these measures will mitigate the risks to **Negligible**.

11.6.28 Although piled foundations are required for the proposed development, the absence of an aquitard overlying the sandstone aquifer (for example a low permeability clay layer) suggests that under pre-development conditions the made ground is in continuity with the sandstone. As such, the proposed development is not considered to increase the risk of mobile contaminants impacting the underlying sandstone aquifer.

Mitigation and offsetting of operational impacts

11.6.29 Given the provision of hardstanding and floor slabs, for most of the site there will be no viable pathway between contaminants in made ground and users/occupiers of the operational Site.

11.6.30 A potential pollutant linkage has however, been identified between the existing made ground on site and future site residents in landscaping areas via dermal contact, ingestion and inhalation of dusts. As the assessment is based on historic data with only limited data obtained recently, it is proposed that further ground investigation is carried out in order to obtain sufficient information for use in an assessment of the potential risks. Should unacceptable concentrations of soil contamination be identified, it is recommended that all soft landscaping areas are capped with an appropriate thickness of clean soil cover, in order to provide an effective barrier to prevent frequent contact between residents and the existing soil. Provided this mitigation measure is adopted, the risk to future site users from existing contaminated soils can be reduced to **Negligible**.

11.6.31 The risks to maintenance workers from any contaminated soils remaining following construction can be reduced to **Negligible** by implementing specific precautions to reduce potential exposure in accordance with the principle of 'as low as reasonably practical' (ALARP). This should include appropriate briefings, protective equipment (PPE) and hygiene facilities.

11.6.32 A potential pollutant linkage has been identified between ground gases and future site residents, via the ingress of such gases into buildings and enclosed spaces. As the current assessment is based only on historic data, it is proposed that further gas monitoring data will be obtained and a risk assessment will be undertaken in accordance with current best practice. Should the gas regime at the site be found to be adverse, the risks from ground gases can be mitigated to adoption of appropriate gas protection measures (which may include gas barriers and passive venting provision). Provided such appropriate mitigation measures are adopted, the risk to future site users from hazardous soil gasses can be reduced to **Negligible**.

11.6.33 A potential pollutant linkage has been identified between mobile contaminants in the soil and controlled waters (groundwater and water in Princes Dock and the River Mersey). The dataset is currently limited and it is recommended that further soil testing and groundwater analysis is carried out to confirm the potential level of risk. However, following development, the site will be largely covered with hardstanding and the quality/integrity of this hardstanding will be better than the conditions that exist across the site in its current undeveloped state. As such the proposed development is considered to reduce infiltration into the made ground which will provide a **Minor Beneficial** outcome for this specific potential contaminant pathway.

11.6.34 A potential pollutant linkage has been identified between potentially contaminated soils and plants in areas of soft landscaping. Should phytotoxic contamination be identified by proposed future ground investigation, it is recommended that a clean cover in the order of 300mm is provided in soft landscaping areas. Provided that the recommendations for mitigation are followed, residual phytotoxic effects are assessed to be **Negligible**.

11.6.35 A potential pollutant linkage has been identified between potentially contaminated soils and buried concrete structures within the ground. Further ground investigation is proposed to further address this issue. Should elevated concentrations of contaminants be identified, the concrete used within the development should be designed in accordance with BRE Special Digest 1[44]. The specification of suitably resistant concrete should reduce the risk to building materials to **Negligible**.

11.6.36 A potential pollutant linkage has been identified between soil contamination in the made ground and potable water supply pipes. It is recommended that United Utilities are consulted regarding the pipe material backfill and the specification of pipe materials for potable water supplies. It is likely that they will require an assessment to be undertaken in line with the current UKWIR document[45]. The

[44] Building Research Establishment (2005) Special Digest 1: Concrete in aggressive ground.
[45] UKWIR (2010) Guidance for the selection of water supply pipes to be used in brownfield sites.

adoption of mitigation measures in accordance with the guidance will reduce the risk to **Negligible**.

11.6.37 The potential ecological risks posed by invasive plant species are dealt with in Phase 1 Habitat Survey (June 2016)

Offsetting and enhancement measures

11.6.38 No offsetting or enhancement measures are recommended/considered necessary.

11.7 Cumulative Impacts

11.7.1 No significant cumulative effects with other developments have been identified with respect to ground and groundwater conditions for the construction or operation of the proposed development.

11.8 Residual Effects

Construction

11.8.1 Provided that the recommended mitigation measures are adopted, the residual risks to the following are assessed to be **Negligible**:

- Construction workers and site neighbours as a result of exposure to site soils and inhalation of soil-derived dust, fibres and vapours and ground gases;
- Mobile contaminants in soil and groundwater in the sandstone Principal Aquifer and surface water in the adjacent Princes Dock and the River Mersey;

Operation

11.8.2 Provided that the recommended mitigation measures are adopted, the residual risks to the following are assessed to be **Negligible**:

- Future site residents via exposure to soils in landscaping areas via dermal contact, ingestion and inhalation;
- Maintenance workers via exposure to any residual contaminated soils;
- Future site residents and the ingress of soil gases into buildings and enclosed spaces;
- Mobile contaminants in the soil and controlled waters (groundwater and adjacent surface water (Princes Dock and the River Mersey);
- Soil contamination and phytotoxic effects on plants;
- Soil contamination and potable water supply pipes;
- Contaminated soils and buried concrete structures.

11.9 Assessment Summary

11.9.1 The matrix below summarises the findings of the preceding assessment.

Summary description of the identified impact	**Significance of potential impact**	**Nature of the impact**	**Mitigation** (in addition to further ground investigation and refinement of risk assessment)	**Residual effect**	**Confidence Level**
Construction Phase risk to Human Health (all sources and pathways)	Minor Adverse	Temporary, direct	Construction workers – adoption of health and safety precautions, PPE etc Neighbours of the site – safeguarded by control measures such as dust suppression	Negligible	High
Construction Phase risk to Controlled Waters (all sources and pathways)	Minor Adverse	Temporary, direct	Minimise exposure of made ground to infiltration through appropriate site management procedures	Negligible	High
Operation Phase risk to occupants/users of the Site from soil contamination in landscaped areas	Minor Adverse	Permanent, direct	Provision of clean cover soils	Negligible	High
Operation Phase risk to maintenance staff from soil contamination	Minor Adverse	Infrequent, direct	Adoption of health and safety precautions, PPE etc	Negligible	High
Operation Phase risk to human health from hazardous ground gas	Not determined	Permanent, direct	Depending on outcome of further investigation and assessment, provision of appropriate gas protection measures	Negligible	High
Operation Phase risk to Controlled Waters (all sources and pathways)	Minor Beneficial	Permanent, direct	None	NA	High
Operation Phase risk to plants in landscaped areas (phytotoxicity)	Minor Adverse	Permanent, direct	Provision of clean cover soils	Negligible	High
Operation Phase risk to buried structures and services	Not determined	Permanent, direct	Depending on outcome of further investigation and assessment, provision of appropriate material specification	Negligible	High

11.10 Conclusion

11.10.1 The most significant impacts of the proposed development are considered to be during the construction phase when development work will expose existing made ground. On the basis of available information, made ground does not appear to contain significantly elevated concentrations of contaminants and it is considered that the enhanced risks identified during the construction phase can be adequately addressed by commonly used control measures. Further ground investigation is proposed to provide additional data on ground contamination within the Site.

11.10.2 During the operational phase, most of the site will be covered by the floor slab of the building or by areas of adjacent hardstanding. As such, users/occupiers of the site will not be able to come into contact with any contaminants present in the made ground and risks to human health will therefore be negligible. Provision of clean cover in any limited areas of landscaping will address risks to human health associated with any contamination present in the un-paved areas of the site.

11.10.3 The provision of floor slabs and hardstanding will reduce infiltration from the surface into the made ground. This will reduce the potential for mobile or leachable contaminants to be leached from within the made ground underlying the Site and will therefore, slightly reduce the risk to Controlled Waters.

11.10.4 Buried concrete and other construction materials (e.g. potable water pipes) may be adversely affected by certain contaminants in the made ground. Further assessment is required to address this issue.

11.10.5 Hazardous ground gases may present a risk to the proposed development. Further assessment is required to address this issue.

11.10.6 Overall, contamination in made ground at the Site is considered to represent only Minor Adverse environmental effects which can be reduced to Negligible residual effects by the adoption of appropriate routine control measures.

11.11 Appendices

11.11.1 Explosive Ordnance Desktop Threat Assessment can be found in Appendix 6.1.

11.11.2 Historic maps and investigative plans can be found in Appendix 6.2

12 Townscape and Visual Impact

12.1 Introduction

12.1.1 This chapter assesses the impact of the proposed development on Townscape and Visual amenity. In particular, it considers the potential effects on townscape character, for both the site and the surrounding area, and the potential visual effects on a number of selected viewpoints that are considered to represent the principal view of the proposed development.

12.1.2 The chapter describes the methods used to assess the impacts, the baseline conditions currently existing at the site and surroundings, the potential direct and indirect impacts of the development arising from potential townscape and visual effects, the mitigation measures required to prevent, reduce, or offset the impacts and the residual impacts. This chapter has been written by Planit I.E LLP.

12.2 Legislative and Policy Context

Legislation

12.2.1 The European Landscape Convention (ELC, 2000) (Ref. 11.1) provides a foundation for closer co-operation on landscape issues across Europe and was ratified in the UK on the 21 November 2006, and became binding on 1 March 2007. The convention identifies the need to recognise landscape in law, to develop and promote landscape policies dedicated to the protection, management and creation of landscapes, and to establish procedures for the participation of the general public and other stakeholders in the evolution and implementation of landscape policies. It also encourages the integration of landscape into all relevant areas of policy, including cultural, economic and social policies.

12.2.2 The ELC defines landscape as ‘an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors’. It recognises that landscape has important cultural, ecological, environmental and social dimensions and is a key element of achieving sustainable development. In this context the use of the word ‘landscape’ is more appropriately termed ‘townscape’ though the constituent factors remain consistent.

National Planning Policy Framework

12.2.3 The National Planning Policy Framework (NPPF) was published in March 2012 and consolidates the previously adopted Planning Policy Statements and Planning Policy Guidance Notes for use in England. It contains a number of criteria relating to the importance of good design and sustaining and enhancing the significance of heritage assets.

12.2.4 Section 7 of the NPPF deals with the requirements of good design. The overarching statement an be found at paragraph 57, which states: 'It is important to plan positively for the achievement of high quality and inclusive design for all development, including individual buildings, public and private spaces and wider area development schemes.'

12.2.5 Key aspects of the NPPF which apply to the Townscape and Heritage Assessment are the paragraphs below:

12.2.6 Paragraph 56: The Government attaches great importance to the design of the built environment. Good design is a key aspect of sustainable development, is indivisible from good planning, and should contribute positively to making places better for people.

12.2.7 Paragraph 61: Although visual appearance and the architecture of individual buildings are very important factors, securing high quality and inclusive design goes beyond aesthetic considerations. Therefore, planning policies and decisions should address the connections between people and places and the integration of new development into the natural, built and historic environment.

12.2.8 Paragraph 128: In determining applications, local planning authorities should require an applicant to describe the significance of any heritage assets affected, including any contribution made by their setting. The level of detail should be proportionate to the assets' importance and no more than is sufficient to understand the potential impact of the proposal on their significance. As a minimum the relevant historic environment record should have been consulted and the heritage assets assessed using appropriate expertise where necessary. Where a site on which development is proposed includes or has the potential to include heritage assets with archaeological interest, local planning authorities should require developers to submit an appropriate desk-based assessment and, where necessary, a field evaluation.'

Liverpool Unitary Development Plan (Liverpool City Council, 2002)

12.2.9 A Local Plan is currently being prepared by Liverpool City Council, until that has been adopted the Unitary Development Plan (UDP) forms the statutory development plan for the city. A number of policies contained within the UDP relate to the conservation of the existing landscape, character, and views within the UDP area. Full details of these policies are contained within Appendix 5.6 Liverpool Unitary Development Plan. In summary, these policies are:

- HD5 Development Affecting the Setting of a Listed Building
- HD12 Development Adjacent to Conservation Areas
- HD22 Existing Trees and Landscaping
- HD23 New Trees and Landscaping
- OE4 The Mersey Coastal Zone
- OE16 The Leeds and Liverpool Canal

Liverpool Maritime Mercantile City World Heritage Site Supplementary Planning Document (Adopted October 2009)

12.2.10 "*The overarching aim of this Supplementary Planning Document (SPD) is to provide guidance for protecting and enhancing the outstanding universal value (OUV) of Liverpool Maritime Mercantile City World Heritage Site, whilst encouraging investment and development which secures a healthy economy and supports regeneration."*

12.2.11 The site lies within the World Heritage Site buffer zone, this Townscape and Visual Impact Assessment (TVIA) identifies and assesses the potential impact of the development upon selected Strategic and City viewpoints that are located within WHS. The potential impact upon these views and mitigation to reduce the impact upon the views is taken into consideration within the assessment.

12.2.12 The SPD has been produced to provide detailed guidance for new development, regeneration and conservation in the WHS and its Buffer Zone. It is intended to supplement the existing "saved" UDP, and will deal with the management of the site, acting as a guide to future development in and around the site and embodying the principles in the existing WHS Management Plan.

12.2.13 In addition to policies and guidance relating to the WHS as a whole, the document includes a section on the Stanley Dock Conservation (Character Area 3), which makes reference to the adjoining areas that are within the Buffer Zone. The Council's declared vision for this area includes the following statement:

"The Princes Dock redevelopment programme will be completed with significant townscape character benefits for the WHS and wider cityscape"

12.2.14 Paragraph 6.4.29 of the SPD requires that the completion of Princes Dock should be a priority. The principles for redevelopment of the Princes Dock should be:

(i) strong urban form with active frontages and an ordered overall perspective;

(ii) enhanced linkages and connectivity;

(iii) comfortable relationships with surroundings, especially important will be Plot 7 which is most visible from the Pier Head;

(iv) protection of view corridors;

(v) increased activity; and

(vi) respect for heritage and response to historical context.

12.2.15 Paragraph 6.4.8, refers to development that takes place west of the Dock Boundary Wall and states:

"…development must respect the integrity and setting of the Dock Wall and the opportunity should be taken to conserve the wall and its associated features such as gates, shelters and drinking fountains. Development should retain and conserve surviving historic surfaces, kerbs, rail tracks and other ancillary historic structures. Any new buildings west of the Dock Wall should generally be set back at least 9 metres from the wall in order: to provide an adequate setting

for that wall; to enable these historic surfaces and features to be retained and; to create a useable corridor for cycling and walking."

Liverpool Urban Design Guide, Liverpool City Council 2003

12.2.16 The Liverpool Urban Design Guide has two overriding objectives in guiding development within Liverpool. These objectives are used as a planning tool to guide general development within the city.

- To guide the physical development of the city; and,
- To assist in the implementation of statutory planning control.

This document is used as general planning guidance within the planning system and it therefore can be used to refine the baseline townscape character.

12.3 Methodology and Scope

12.3.1 This assessment has been carried out with reference to the Guidelines for Landscape & Visual Impact Assessment, 3rd Edition, 2013 (referred to hereafter as "the Guidelines").

12.3.2 An assessment of townscape value and susceptibility of townscape to change enables the overall sensitivity of townscape receptors to be determined. This forms the baseline from which the impact of the proposed development can be assessed.

12.3.3 The assessment has considered the proposed development against the site as it currently stands. Cumulative impacts of the proposed development in conjunction with other relevant schemes has focussed on assessing the proposed development in conjunction with the adjacent William Jessop House permitted development and the outline parameters of Liverpool Waters, Princes Dock neighbourhood. Please refer to Figure 1.10 of Appendix 7.3.

Baseline Townscape Value

12.3.4 Townscapes may be valued at community, local, national level or above. Existing Townscape designations have been taken as the starting point for this assessment, as shown in Table 12.1 below. However, the value attached to undesignated townscapes also needs to be assessed and this is considered in Table 12.2.

12.3.5 Table 12.1 sets out the relative importance of generic townscape designations and descriptions, identifying those designations applicable to the study area in the third column.

Table 12.1: Value of Designated Townscapes

Typical Designation	Description	Actual Designation of the Site	Importance (Value) where present
World Heritage Site	Unique sites, features or areas of international importance with settings of very high quality.	Lies within the buffer zone of the designated World Heritage Site	High
Curtilage of Grade I, II and II*, Conservation Areas Listed Buildings, Registered Parks and Gardens of Special Historic Interest, Scheduled Monuments.	Sites, features or areas of national importance with settings of high quality.	N/A	N/A
Local nature site, long distance recreational routes	Sites, features or areas of regional importance with intact character.	N/A	N/A
Tree Preservation Orders (TPO)	Sites, features or areas of district importance.	N/A	N/A
Public Space or local route	General townscape area valued at the local level.	N/A	N/A

12.3.6 Whilst the assessment of value is partly based on the Planning Policy importance of the townscape, other criteria used to assess townscape value in more detail, including that of undesignated townscape, are set out in Table 12.2 below. The criteria are taken from the Planning Practice Guidance which supports the National Planning Policy Framework.

Table 12.2: Criteria for Assessing the Value of Non-designated Townscapes

Attribute	Criteria
Functional	A building or place should be fit for purpose, designed and delivered in a way that delivers the intended function and achieves value for money in terms of lifetime costs
Mix of uses	Mix of uses to ensure easy access to facilities and encourage a healthier environment, reducing the need to travel.
Well designed public space	Functional and attractive hard and soft landscape elements, well orientated and designed routes, inclusion of facilities such as seats and play equipment and public art.

Table 12.2: Criteria for Assessing the Value of Non-designated Townscapes

Attribute	Criteria
Buildings designed to be adaptable.	Flexibility to be able to respond to a range of future needs – how easily buildings change be adapted for change of use, places that are easy and practical to manage with good access, natural surveillance and hard wearing materials that are easy to repair.
Distinctive character	Consideration of: the local pattern of street blocks and plots; building forms; details and materials; style and vernacular; landform and gardens, parks, trees and plants; and wildlife habitats and micro-climates.
Attractive spaces	Consideration of streetscapes, landscapes, buildings and elements within them all, microclimates and views should all be considered.
Promotes ease of movement	All users should be able to move safely, conveniently and efficiently to and within a place, appropriate number of legible routes to and through it, good connections with each other and other destinations.

12.3.7 An overall assessment of value has been made for each townscape receptors (refer to Appendix 7.1), based on an overview of the assessments made using each of the above criteria, in terms of high, medium and low value.

Baseline Susceptibility of Townscape Receptors to Change

12.3.8 Susceptibility of townscape receptors to change has been assessed using the criteria identified in Table 12.3, with reference to the baseline conditions.

Table 12.3: Townscape Receptor Susceptibility to Change

Susceptibility	Criteria
High	Little ability to accommodate the proposed development without undue harm.
Medium	Some ability to accommodate the proposed development without undue harm.
Low	Substantial ability to accommodate the proposed development without undue harm.

Overall Sensitivity of Receptor

12.3.9 The assessment of receptor sensitivity combines judgements on the susceptibility of the receptor to the specific type of development proposed and the value attributed to that receptor.

Baseline Visual Assessment

12.3.10 The baseline visual assessment is set out in Appendix 7.2.

Type of View and Number of Viewers

12.3.11 In terms of assessing the baseline visual sensitivity, key factors to consider are the type of view and the likely numbers of viewers (the visual receptors). The type of view and the number of viewers are described in the following terms:

(i) Glimpsed (i.e. in passing)/Filtered/Oblique/Framed/Open Views; an

(ii) ii) Few/Moderate/Many Viewers

Value of Views

12.3.12 The value attached to views has regard to a number of factors, including:

- recognition through planning designations or heritage assets; and
- the popularity of the viewpoint, its appearance in guidebooks, literature or art, on tourist maps and the facilities provided for its enjoyment.

12.3.13 The assessment of the value of views is summarised in Table 12.4 below, in terms of High, Medium and Low value. These criteria are provided for guidance only and are not intended to be absolute.

Table 12.4: Value Attached to Views

Value	Criteria
High	Views from townscapes/viewpoints of national importance, or highly popular visitor attractions where the view forms an important part of the experience, or with important cultural associations.
Medium	Views from townscapes/viewpoints of regional/district importance or moderately popular visitor attractions where the view forms part of the experience, or with local cultural associations.
Low	Views from townscapes/viewpoints with no designations, not particularly popular as a viewpoint and with minimal or no cultural associations.

Susceptibility of Visual Receptors to Change

12.3.14 The susceptibility of different types of visual receptor to changes in views is mainly a result of:

- The occupation or activity of the viewer at a given location; and
- The extent to which a person's attention or interest may therefore be focussed on a view and the visual amenity experienced at a given view.

12.3.15 The assessment of a visual receptor to change is specific to the proposed development. However the Guidelines for Landscape and Visual Impact Assessment offers the generic guidance identified in Table 12.5 as a starting point for the assessment.

Table 12.5: Visual Receptor Susceptibility to Change	
Susceptibility	**Type of Receptor**
High	• Residents; • People engaged in outdoor recreation, including users of public rights of way, whose attention is likely to be focussed on the townscape and on particular views; • Visitors to heritage assets or other attractions where views of the surroundings are an important part of the experience; • Communities where views contribute to the townscape setting enjoyed by residents; and • Travellers on scenic routes.
Medium	• Travellers on road, rail or other transport routes, where the view is moderately important to the quality of the journey.
Low	• People at their place of work, where the setting is not important to the quality of working life; and • Travellers on road, rail or other transport routes, where the view is fleeting and incidental to the journey. • People engaged in outdoor sport or recreation, which does not involve appreciation of views;

12.3.16 The Guidelines for Landscape and Visual Impact Assessment qualifies the above examples as follows:

"This division is not black and white and in reality there will be a gradation in susceptibility to change. Each project needs to consider the nature of the groups of people who will be affected and the extent to which their attention is likely to be focussed on views and visual amenity." ***(page 114, paragraph 6.35).***

Overall Sensitivity of Visual Receptors

12.3.17 The assessment of receptor sensitivity combines judgements on the susceptibility of the receptor to the specific type of development proposed and the value attributed to that receptor.

Predicted Townscape and Visual Impacts

12.3.18 The predicted townscape and visual impacts of the proposed development are set out in Appendices 7.1 and 7.2.

12.3.19 The assessment of receptor sensitivity combines judgements on the susceptibility of the receptor to the specific type of development proposed and the value attributed to that receptor.

Size and Scale of Effects

12.3.20 The size and/or scale of effects relates to the scale of changes in the townscape, such as the loss or addition of features and the scale of the change in views.

Geographical Extent of Effects

12.3.21 The geographical extent of effects relates to:

- the area over which townscape effects are likely to be experienced, i.e. this could be at the site level, the immediate setting of the site, or townscape character type or area;
- the area over which visual effects are likely to be visible; and duration.

12.3.22 Effects may be temporary, permanent or reversible over time. For example, visual effects arising from construction activities may be limited solely to the construction period and therefore only temporary or they may be permanent, for example, where construction necessitates some clearance of existing vegetation.

Reversibility

12.3.23 Effects may be reversible, for example, restoration of a quarry following mineral extraction. The assessment therefore considers the practicality of effects being reversed with an approximate timeframe for reversibility.

Magnitude of Effects

12.3.24 The magnitude of a townscape or visual effect is assessed in terms of its size or scale, the geographical extent of the area influenced by that effect, and its duration and degree of reversibility.

12.3.25 The size and/or scale of change in the townscape takes into consideration the following factors:

- the extent/proportion of townscape elements lost or added;
- the contribution of that element to townscape character and the degree to which aesthetic/perceptual aspects are altered; and whether the effect is likely to change the key characteristics of the townscape, which are critical to its distinctive character.

12.3.26 The criteria used to assess the size and scale of townscape effects are based upon the amount of change that will occur as a result of the proposals, as described in Table 12.6, below:

Table 12.6: Townscape Effects: Magnitude

Category	Criteria
Substantial adverse townscape effect	The proposals will result in a total change in the key characteristics of townscape character; will introduce elements totally uncharacteristic to the attributes of the receiving townscape; and/or will result in a substantial or total loss, alteration or addition of key elements/features/characteristics.

Table 12.6: Townscape Effects: Magnitude	
Category	**Criteria**
Moderate adverse townscape effect	The proposals will result in a partial change in the key characteristics of townscape character; will introduce elements partially uncharacteristic to the attributes of the receiving townscape; and/or will result in partial loss, alteration or addition of key elements/features/characteristics.
Minor adverse townscape effect	The proposals will result in a small change in the key characteristics of townscape character; will introduce elements that are not uncharacteristic to the attributes of the receiving townscape; and/or will result in a minor loss, alteration or addition of elements/features/characteristics.
Negligible adverse townscape effect	The proposals will result in a just discernible change to townscape character/elements/features/characteristics.
Neutral	The proposals will not cause any change to the townscape character/elements/features/characteristics.
Negligible townscape benefit	The proposals will result in a just discernible improvement to the townscape character/elements/features/characteristics.
Minor townscape benefit	The proposals will achieve a degree of fit with the townscape character/elements/features/characteristics and go some way towards improving the condition or character of the townscape.
Moderate townscape benefit	The proposals will achieve a good fit with the townscape character/elements/features/characteristics, or would noticeably improve the condition or character of the townscape.
Substantial townscape benefit	The proposals will totally accord with the townscape character/elements/features/characteristics, or would restore, recreate or permanently benefit the condition or character of the townscape.

Magnitude of Visual Effects

12.3.27 The magnitude of a visual effect is assessed in terms of its size or scale, the geographical extent of the area influenced and its duration and degree of reversibility.

12.3.28 The size or scale of change in the view relates to the degree of contrast or integration likely to result from the proposed development and is influenced by the relative time over which a view is experience and whether it is a full, partial or glimpsed view.

12.3.29 The criteria identified in Table 12.7 are used to assess the size and scale of visual effects, based on the degree of change to the view or composition.

Table 12.7: Visual Effects: Magnitude	
Category	**Criteria**
Major adverse or beneficial visual effect	The proposals will cause a dominant or complete change or contrast to the view, resulting from the loss or addition of substantial features in the view and will substantially alter the appreciation of the view.
Moderate adverse or beneficial visual effect	The proposals will cause a clearly noticeable change or contrast to the view, which would have some affect on the composition, resulting from the loss or addition of features in the view and will noticeably alter the appreciation of the view.
Slight adverse or beneficial visual effect	The proposals will cause a perceptible change or contrast to the view, but which would not materially affect the composition or the appreciation of the view.
Negligible adverse or beneficial visual effect	The proposals will cause a barely perceptible change or contrast to the view, which would not affect the composition or the appreciation of the view.
No change	The proposals will cause no change to the view.
Neutral	There will be a change to the composition of the view, but the change will be in keeping with the existing elements of the view.

Nature of Effects

12.3.30 The nature of effects may be positive or negative (beneficial or adverse), direct or indirect. Direct effects are those which result directly from a development itself, whereas indirect or secondary effects may arise as a consequential change resulting from development, for example, changes to downstream vegetation as a result of alterations to a drainage regime.

Significance of Effects

12.3.31 The scale shown in Table 12.8 is used to guide the assessment of the significance of both townscape and visual effects, from a combination of the assessment of receptor sensitivity and the magnitude of effects:

Table 12.8: Assessment of Townscape or Visual Significance					
Sensitivity of Receptor	**Major Effect**	**Moderate Effect**	**Minor Effect**	**Negligible Effect**	**Neutral Effect**
High	Significant	Significant/ Moderately Significant	Moderately Significant	Not Significant	Not Significant
Medium	Moderately Significant	Moderately Significant	Not Significant	Not Significant	Not Significant
Low	Moderately Significant	Not Significant	Not Significant	Not Significant	Not Significant

12.3.32 The table has regard to guidance in the Guidelines for Landscape and Visual Impact Assessment, Third Edition, 2013, at paragraph 5.56, page 92 (significance of landscape effects) and paragraph 6.44, page 116 (significance of visual effects). This matrix is used as a guide to determine significance, along with professional judgement.

12.3.33 For the purposes of this Townscape and Visual Impact Assessment, Moderately Significant effects are not considered to be Significant in the meaning of the Town and Country Planning (EIA) Regulations 2011.

Confidence

12.3.34 The predicted impact is assessed against the criteria set out below in order to attribute a level of confidence to the visual assessment.

High - The predicted impact is either certain, or very likely to occur, based on reliable information or previous experience.

Medium – The predicted impact and its level are best estimates, based on on-site and desktop study.

Low – The predicted impact and its level are best estimates, based on given knowledge and experience. More information may be needed to improve the level of confidence.

12.4 Consultation

12.4.1 The principal viewpoints were identified through a three-stage process. The first was to identify the views which were selected as part of the original full Liverpool Waters masterplan. This was then used to predict which of these views were relevant for the Princes Reach application. In addition to this an assessment of the existing three dimensional model was used to assess if any additional views were required for particular application. An initial viewpoints plan was agreed with Liverpool City Council and then refined following further pre-application consultation with Liverpool City Council and other stakeholders. At these meetings it was also agreed that in addition to the baseline impact assessment, the cumulative part of the impact assessment would include the consented parameters for Princes Dock.

12.5 Limitations and assumptions

12.5.1 This townscape and visual impact assessment has made assumptions based on the modelling information available at this time. The contextual modelling utilises ordnance survey and topographical information, proposed information is based on modelling supplied by Falconer Chester Hall architects and the parameter modelling is based on the original Liverpool Waters parameter model utilised in the original outline application. Any discrepancies which may occur between these models have been rectified where possible, any outstanding issues which may occur are a result of the differences in timescales and mixed media of the modelling information. We have assumed that the comprehensive model used in

the production of the verified views, is as accurate as can be given the limitations outlined above.

12.6 Baseline Conditions

Site location

12.6.1 The Princes Reach site lies within the Princes Dock neighbourhood, a water front development which is part of the wider Liverpool Waters masterplanning proposals which received planning consent in 2012.

12.6.2 The site is situated between Bath Street and the historic dock wall to the east and the dock basin to the west. The site is currently cleared and undeveloped, however a number of existing buildings already exist as part of the Princes Dock redevelopment. The site location is illustrated in Figure 1.1 of Appendix 7.3.

Historical Development

12.6.3 For an in depth analysis of the historical development of Princes Dock, please refer to the Heritage Statement (June 2016) which accompanies this application.

Heritage Designations

12.6.4 There are no scheduled ancient monuments within the proposed development site. There is one listed building – the Princes Dock Boundary Wall directly adjoining it, which is Grade II, and the stone surface materials and rail tracks which are regarded as undesignated heritage assets. The site is considered to be within the setting of the Royal Liver Building, which is listed Grade I. The site directly adjoins the Stanley Dock Conservation Area and is also within the setting of the Pier Head Conservation Area. It is within the Buffer Zone of the World Heritage Site. These boundaries are illustrated in Figure 1.3 of Appendix 7.3.

12.6.5 A Buffer Zone was identified around the WHS, to ensure that development proposals within it, that might adversely affect the setting of the WHS, can also be carefully considered.

12.6.6 Within the WHS original dockyard surfaces and dock walls often survive and there are areas where groups of buildings retain their historic character. Hard surfaces, edges, stock brick, stone and iron define the character of the area and will be retained. The dock wall is an integral part of the WHS. It has much architectural interest, great historic importance and still provides cohesion; it defines the relationship between the docks and the City.

12.6.7 A number of structures, buildings and features are protected by statutory listing, including the dock walls, the boundary walls and gates, and structures such as Victoria Tower and the accumulator tower at Bramley-Moore Dock. In accordance with national and local planning policy, a high priority must be given to the physical preservation and setting of the listed buildings in any development proposals.

Townscape Character Areas

12.6.8 The site is located within Liverpool City Centre, as defined by the Local Plan. The built form surrounding the site can be described in several differing character areas. These are highlighted in Figure 1.4 of Appendix 7.3.

12.6.9 To the south of the site lies the Pier Head, which includes the Royal Liver Building, The Cunard Building and the Port of Liverpool Building. These lie within the World Heritage Site Boundary and are key landmark buildings which are recognised worldwide and make up the townscape identity of Liverpool. They are significant townscape features of the Liverpool waterfront.

12.6.10 In contrast, to the east of the site beyond the historic dock wall is a small scale industrial site, made up of low rise, box development and areas of car parking.

12.6.11 The fringe of the commercial district lies to the south eastern edge of the site on the other side of New Quay and the Strand. This area has a distinctive character parts of which lie within the WHS boundary.

12.6.12 The historic docks continue to the north of the site, and are part of the future Liverpool Water proposals.

Urban Grain

12.6.13 The urban grain of Princes Dock is largely made up of single buildings set within their own plot. The footprints of the buildings are fairly large and are surrounded on all sides by car parking and public realm. This is illustrated in Figure 1.5 of Appendix 7.3.

12.6.14 This type of urban grain can be found along the river frontage. The main road which runs parallel to the river (New Quay and The Strand) defines a change in grain from a more traditional perimeter block layout to single buildings surrounded by public realm.

Land Use

12.6.15 Figure 1.6 of Appendix 7.3 illustrates land uses. The area is generally mixed-use, with the predominant use being commercial. Residential, hotels, and a small amount of retail make up the surrounding uses. Some industrial uses can be found adjacent to the site and several cultural buildings are located nearby.

Building Heights

12.6.16 Figure 1.7 of Appendix 7.3 illustrates building heights in the wider context. The site is currently vacant, and as such makes no contribution to the general datum of the area. The area immediately around the site range from 9 – 20 storeys, but there are some larger scale buildings towards the east, which form a back drop to the site from the river edge.

Movement and Linkages

12.6.17 The surrounding movement and access has been illustrated in Figure 1.8. Vehicle access into the site is currently provided along William Jessop Way, this is part of an almost circular route around the Princes Dock. William Jessop Way is a cul-de-sac and does not connect through to the wider road network surrounding Princes Dock. One of Liverpool's major north south vehicular routes passes close to the south eastern edge of the site. Bath Street and Waterloo Road provide vehicle access to areas North of the site.

12.6.18 The Princes Dock site is accessible by pedestrians. A number of existing openings within the historic dock wall help to provide existing pedestrian access to the site. However the location and legibility of these openings is poor in places. A pedestrian bridge crosses the dock enabling pedestrian permeability across the dock. Pedestrian access is provided along the river edge towards the Pier Head.

12.6.19 The site is quite well served by public transport, with a bus route along Princes Parade. The nearest station is Moorfields approximately 5 minutes' walk from the site.

Environmental Designations and Public Open Space

12.6.20 The surrounding public open spaces have been illustrated in Figure 1.9 of Appendix 7.3. The site sits adjacent to a number of different water bodies, dock edge, canal and river which makes for an interesting and unique situation. There are no significant public parks close to the site, the majority of the public space is provided in and around the existing water bodies.

12.6.21 However, several existing public open spaces are located nearby, with the Pier Head public square focused around the new canal link and the gardens of Our Lady and St Nicholas Church on the other side of the Strand.

Principal Viewpoints

12.6.22 A total of 18 viewpoints have been identified in conjunction with Liverpool City Council. The location of the key viewpoints is illustrated in Figure 1.11 of Appendix 7.3.

12.6.23 The distribution of viewpoints indicates that the site is highly visible, particularly from the Wirral looking across towards Liverpool City centre. This is largely due to the open nature of the river frontage and the prominent position of the site along the dock edge. Views mostly utilise strong movement corridors which allow longer vistas. Wider viewpoints are located to the slightly higher ground to the north-east and the south east and the western bank of the River Mersey.

12.6.24 Some of the views lie within the World Heritage Site boundary, some are located within the WHS buffer zone.

12.6.25 The selection of long range and close to views, provide the opportunity for a comprehensive assessment from many different perspectives.

12.7 Assessment

12.7.1 This section identifies the likely significant environmental effects (positive and negative) resulting from the proposed development. Construction and operational effects are considered separately.

Construction Phase Impacts

12.7.2 The proposed development is at a relatively early stage in the design and construction programme. It is therefore difficult to predict with certainty the precise methodology that will be adopted for construction and site management. However, it is possible to identify some broad impacts that may arise during the construction phase:

12.7.3 The summary of potential construction phase effects for the application site only, and their significance prior to any supplementary mitigation is provided in the table below:

Table 12.9: Potential construction phase impacts

Feature/Nature of Impact	Timescale	Sensitivity of Receptor	Magnitude of Impact	Significance of Impact	Confidence Level
The visual impact of HGV movement & general construction works	Temporary	High/ medium	Moderate Adverse	Significant/ Moderately Significant	Medium
The visual impact of site lighting around construction areas	Temporary	High/ medium	Minor Adverse	Moderately Significant	Medium
The visual and landscape impacts of remodelling ground levels/cut and fill operations	Temporary	High/ medium	Minor Adverse	Moderately Significant	Medium
The landscape impacts of incorporating services and utilities.	Temporary	High/ medium	Minor Adverse	Moderately Significant	Medium
The visual impacts of temporary screening measure and protective fencing.	Temporary	High/ medium	Moderate Adverse	Significant/ Moderately Significant	Medium
The landscape and visual impacts of temporary parking, on-site	Temporary	High/ medium	Minor Adverse	Significant/ Moderately Significant	Medium

accommodation and work areas.					
The landscape and visual impact of material stockpiles.	Temporary	High/ medium	Minor Adverse	Moderately Significant	Medium

Operational Phase Impacts

12.7.4 The design proposals have been formulated through a lengthy iterative process involving environmental assessment and consultation. This process has allowed site constraints and opportunities to directly influence the evolution of the building and the public realm proposals. As a result, mitigation measures are embedded within the proposals as part of the detailed design of the landscape and surrounding built form. Consideration has been given to alternative designs, and a number of iterations have been amended in order to take account of feedback within the professional team and that received through the community and stakeholder engagement process.

12.7.5 A summary of mitigation measures which have been 'designed in' to the proposals in order to reduce or where possible, avoid townscape and visual impacts is provided below, and is described further within the Design and Access Statement that accompanies this application.

12.7.6 The building has been developed in accordance with good urban design principles, which avoids, reduces or offsets potential impacts on the townscape and views. The key design principles incorporated into the design are outlined below, and are described in full within the Design and Access Statement which accompanies this application:

- Residential uses, in keeping with planning policy and the original Liverpool Waters outline planning application.
- Scale, massing and height of building responds to surrounding context.
- The building addresses and helps to improve the frontage along the dock edge.
- Design of movement and linkages prioritising pedestrian movement. Vehicular access and servicing carefully considered and controlled to minimise impact.
- Appropriate application of materials which contribute to the character of the area.

Mitigation Measures

12.7.7 The supplementary mitigation for the development is described below. Supplementary mitigation measures are proposed to reduce and where possible offset/remedy any significant adverse townscape and visual effects identified.

Construction Phase

12.7.8 The precise methodology that will be adopted in order to mitigate against potential construction phase impacts will be formulated as part of the ongoing design development. However, it is anticipated that measures to control construction impacts as outlined in the following table, which can be incorporated into a Construction Environmental Management Plan (CEMP), and should include:

- Site compounds to be positioned close to the proposed access points and as remote from existing developed areas as feasible;
- Use of directional lighting will be used across the site.
- Where possible, hoarding lines will also utilise existing areas of woodland and scrub cover to help visually break up the extent of the fencing.
- Stockpiles will be located on site to limit visual impacts where possible.

12.7.9 Through the adoption of a Code of Construction Practice (CoCP), good site management shall be achieved through the following measures:

- Protection of existing vegetation to be retained where practicable;
- Strict adherence to the self storage areas and construction access roads;
- Use of site hoarding where appropriate; and
- A phased planting programme.

12.7.10 The implementation of good site management, maintenance and housekeeping would ensure that temporary deterioration to landscape resources, character and visual amenity will be kept to a practicable minimum. Despite these better practice measures, there would still remain inevitable adverse effects during construction works. However in overall terms the residual effects upon townscape features, character and the visual envelope are not anticipated to be significant and the majority of which short term, temporary and local.

Operational Phase

12.7.11 A Public Realm and Landscape Management Plan may be employed to provide further mitigation once the site is operational. The Plan would ensure the longevity of planting, and promote native species and diversity.

12.8 Cumulative Impacts

12.8.1 In accordance with the Landscape Institute Guidelines, the cumulative impacts of the site in conjunction with proposed and committed sites are considered.

12.8.2 William Jessop House received planning permission in 2015, work has not started on site, therefore it has not been considered as part of the baseline, rather as a

cumulative effect. This has been illustrated within the photomontages by a solid block model.

12.8.3 The wider parameter plans for Princes Dock which received planning consent in 2012 have been included within the photomontages as a solid outline, and have been considered as part of the cumulative impacts. Committed developments within the vicinity of the site are shown on Appendix 7.3 figure 1.10.

12.8.4 Assessment of cumulative impacts on the townscape will result in some beneficial impacts notably around urban grain, land use and movement and linkages. The cumulative impact will have an adverse effect on the WHS heritage designation, the townscape character, building heights and environmental designation and public open space. The scale and height of the proposed Shanghai Tower parameter is much taller in height than any existing or indeed the proposed Princes Reach building. The parameter proposal for the plot closest to the Royal Liver Buildings, is of a scale and mass which obscures the existing view from the Pier Head to the Princes Dock itself and is of a height which competes with the significance of the Royal Liver Buildings. These two plots in particular have the potential to have an adverse effect on heritage designation, townscape character, building heights and environmental designations and public open space. However, the Princes Reach building itself does not contribute to the negative effects. The character and detail of the cumulative applications are yet to be defined so any mitigation information is not available at this stage.

12.8.5 Assessment of cumulative impacts on the agreed key viewpoints will result in some adverse effects, some of which are slight or moderate. These views are; view 2, from the bottom of Wallasey Town Hall steps; view 7 from the South West corner of the Albert Dock; view 10, from the Pier Head; view 12 William Brown Street; view 17, Waterloo Road and view 18, Victoria Clock Tower. The adverse impact from view 2, 7 and 10 is due to the cumulative impact on the WHS, particularly the setting and visibility of the Royal Liver Buildings. View 17 and 18, the cumulative impact is assessed as adverse due to the scale and height of the proposed Shanghai Tower parameter in relation to existing and proposed buildings. Apart from view 7, the Princes Reach building itself does not contribute to the adverse effects for the cumulative visual impact assessment.

12.9 Residual Effects

12.9.1 The residual impact assessment assumes that all mitigation described in the section above has been implemented. The predicted townscape effects are set out in Appendix 7.1, and are summarised below.

Heritage Designations

12.9.2 Please refer to the ‘Heritage Impact Assessment’ which accompanies this application for a full assessment of the heritage impacts.

12.9.3 The features of the site which make up the value of the World Heritage Site buffer zone are the dock boundary wall, the setting of the Princes Dock, areas of historic surfacing and the key views in and around Princes Dock of the WHS.

12.9.4 The dock boundary wall will not be altered by the proposed building; it is substantially higher than the wall which may have some effect on its setting. The wall, a horizontal structure, will still be visible from the city centre and will maintain its integrity. Its historical function and importance will not be compromised.

12.9.5 The proposed development continues the regeneration of Princes Dock. The impact of a high density development will not have a significant effect on setting, due to the existing presence of tall buildings in Princes Dock and within the central business district behind. Historic surfaces will be maintained where possible and incorporated into the wider landscape proposals.

12.9.6 The views of the Pier Head from Princes Dock will not be obscured by the proposed building. Other views have been assessed as part of the visual impact assessment. Please refer to Appendix 7.2.

12.9.7 Taking into account all of the above the impact on the heritage designations has been assessed as moderate neutral. Taking the cumulative effects into account then the impact has been assessed as major adverse, this is because the plot closest to the Pier Head obscures views of the Royal Liver Building from Princes Dock and has a significant impact on its setting. Princes Reach does not contribute to this negative effect.

Townscape Character

12.9.8 The existing site forms a gap in the existing townscape of Princes Dock. Princes Dock is surrounded by several differing character areas, there is no one character which dominates. The proposed building will go some way to completing the townscape of Princes Dock. The grain of the building, a single building, surrounded by public realm corresponds with the existing character of the buildings within the dock and along the River Mersey frontage. The overall impact has therefore been assessed as Slight Beneficial, with the vast majority of the impact benefitting Princes Dock. The provision of further development to complement the Princes Dock has also been considered as part of the cumulative effects and has been assessed as Slight Adverse.

Urban Grain

12.9.9 The existing site represents a large urban void in the urban grain of Princes Dock. Any change, compared against the baseline void would represent a large-scale change in the urban environment. The proposals show an urban grain which is in keeping with the existing surrounding buildings, enclosing the dock edge and improving the public realm along the dock edge. This creates a minor improvement to pedestrian movement and aid legibility. The overall urban grain impact has therefore been assessed as Moderate Beneficial. Later development phases support this new urban grain, and helps to knit the remaining site together. This results in the cumulative impact as Slight Neutral.

Land Use

12.9.10 There is no current land use of the site. However, there are several different land uses within Princes Dock, hotel, residential, office and a small amount of retail. New residential space is proposed. This will supplement the surrounding mix of uses and support high quality public realm. The overall impact on land use has therefore been assessed as Moderate Beneficial. The cumulative impact of the mix of uses of later phases has been assessed as Major Beneficial.

Building Heights

12.9.11 The site as exists is undeveloped. The proposed development will be 34 storeys high and will form part of a cluster of tall buildings which exist within and behind Princes Dock. The majority of buildings within Princes Dock are between 6 and 20 storeys high. The overall townscape impact has therefore been assessed as Moderate Neutral. Further committed development also permits some buildings of a taller scale similar to Princes Reach and one tower of up to 55 storeys. The cumulative impact has been assessed as Moderate Adverse, due to the impact of the scale and mass of the Shanghai tower parameter and the parameter plot adjacent to the Royal Liver Buildings.

Movement and Linkages

12.9.12 Vehicle access into the site is currently provided along William Jessop Way, the proposed development will maintain this as the main vehicle access adjacent to the site. The Princes Dock site is accessible by pedestrians. A number of existing openings within the historic dock wall help to provide existing pedestrian access to the site. However, the location and legibility of these openings is poor in places. The proposed building does not impinge on the existing opening within the dock wall and forms a clear frontage with the access along the dock edge. Therefore, the movement impact has been assessed as Slight Beneficial. The further committed development improves pedestrian legibility through the Princes Dock area, so has been assessed as Moderate Beneficial.

Environmental Designations and Public Open Space

12.9.13 Proposals seek to improve the public realm around the footprint of the building and address the edge of Princes Dock. Existing areas of public realm, including existing water bodies will be enhanced. Therefore the impact has been assessed as Slight Beneficial. The cumulative impact of later phases will continue to improve the activity and vitality of the existing public realm in some places within Princes Dock, however the view of the dock water body from the Pier Head will be obscured and has therefore been assessed as Moderate Adverse.

Key Views

12.9.14 Appendix 7.3 sets out in detail the predicted visual effects for each of the 18 identified principal viewpoints, and are summarised below.

12.9.15 The baseline analysis of the key viewpoints concludes that 8 of the views are ‘high’ in terms of the overall sensitivity of the visual receptors. Two views have

been assessed as ‘high/ medium’ in terms of the sensitivity of the visual receptors, with the remaining views assessed as ‘medium’ or ‘low’.

12.9.16 View 7 has been assessed as resulting in a Slight Adverse impact due to it’s impact on the silhouette of the Royal Liver Buildings from this location and its prominence on the skyline. The cumulative effects on this view and views, 2,10, 12, 17 and 18 have been assessed as Adverse, due to the effect that the Shanghai Tower parameter and the parameters for the plot closest to the Royal Liver Buildings has on the setting of the World Heritage Site and the impact on views to and from the WHS.

12.10 Conclusion

12.10.1 This report has assessed the townscape and visual impacts of the proposed development within the application site boundary. The assessment has been carried out with reference to the Landscape Institute’s Guidelines for Landscape & Visual Impact Assessment, 3rd Edition, 2013.

12.10.2 A three-stage assessment process has been adopted; firstly the nature of receptors (sensitivity) has been assessed, secondly the nature of the effects (magnitude) likely to result from the proposed developed have been assessed. From this the overall significance of the identified effects on receptors have been assessed. The assessment also considers the cumulative townscape and visual effects.

12.10.3 The site is currently cleared of any previous buildings associated with Princes Dock. It sits within an area of undeveloped land at the back of Princes Dock. Existing buildings within Princes Dock lie close by with the back drop formed by the commercial district. The site lines the edge of the Princes Dock water body.

12.10.4 When the cumulative impacts are taken in to consideration, then there are several adverse impacts on the townscape elements, including; Heritage Designations, Townscape Character, Building Heights and Environmental Designations and Public Open Space. This is due to the scale and height of the proposed Shanghai tower parameter and the scale and height of the parameter closest to the Royal Liver Buildings. The Princes Reach building does not contribute to the negative townscape effects. The proposals have been developed through an iterative process, and mitigation has been embedded into the design. As a result, the proposed development is predicted to result in mostly ’beneficial impacts’ to the townscape elements assessed, with the impact on Heritage Designations and Building Heights has been assessed as ‘neutral’.

12.10.5 The scale and massing of the proposed development, and its relationship with the nearby listed Royal Liver Building is also a key consideration. The height of the proposed development although higher than any existing buildings on Princes Dock, is consistent with that of the buildings that characterise this area of the city, and the commercial district behind. The building becomes part of an existing cluster of taller buildings. This relationship with the Pier Head and the Three Graces is largely neutral. It doesn’t alter the townscape setting of these buildings.

12.10.6 The visual assessment of the site demonstrated that the site is in a very prominent waterfront location, which is highly visible from the Wirral side of the River

Mersey, from areas of higher ground to the east and south of Liverpool and certain framed view points from within the city centre.

12.10.7 A total of 18 principal viewpoints were identified and agreed with Liverpool City Council. Only one of the identified viewpoints is predicted to result in a Slight Adverse visual effect at the baseline assessment. This viewpoint (no. 7) is from the south west corner of the Albert Dock and is considered a highly sensitive view. The proposed building would slightly alter the silhouette of the Royal Liver Buildings against the skyline from this location.

12.10.8 When the cumulative assessment is included, several more views are assessed as having an adverse impact, these are views 2, 10, 12, 17 and view 18. This negative assessment is mainly due to the scale and height of the Shanghai tower parameter and the scale and height of the parameter adjacent to the Pier Head. The scale and proportion of both of these parameters are out of keeping with any existing buildings, and obscure views of the Royal Liver Buildings from the north and west and obscure views into Princes Dock from the Pier Head. These parameters do not improve the setting of the proposed Princes Reach building; in fact, they detract from the largely beneficial or neutral impacts of the building.

12.10.9 In conclusion this study provides a townscape and visual impact assessment of the proposed development at Princes Reach, Princes Dock. The building will have a largely beneficial effect on the townscape of the Princes Dock neighbourhood. The building although tall and highly visible can become a part of the cluster of tall buildings which already exist with Princes Dock and the central business district.

12.11 Appendices

12.11.1 Appendix 7.1 – Townscape Baseline and Sensitivity

12.11.2 Appendix 7.2 –Baseline and Sensitivity Assessment

12.11.3 Appendix 7.3 – TVIA Site Location Figures

12.11.4 Appendix 7.4 – TVIA Views

13 Wind

13.1 Introduction

13.1.1 This Chapter of the ES, prepared by Arup, assesses the effects of the Proposed Development on pedestrian wind comfort and safety. It also describes the methods used to assess the baseline conditions on the Site and in the surrounding area; measures required to prevent, reduce or offset any significant negative effects; and the likely residual effects after these measures have been adopted.

13.1.2 The existing site is largely unsheltered from wind across the Mersey and any isolated building on the site will result in wind conditions that exceed the normally acceptable target criteria for windiness around buildings in typically more sheltered urban areas. The windiness along the Liverpool waterfront is well known.

13.1.3 Although this application is a standalone submission to the Liverpool Waters outline consent (10O/2424) this site has consent for a 126.8m high building and forms part of the wider Princes Dock neighbourhood as part of the outline permission. There is potential to create a clustering effect of mutual shelter, which, in conjunction, with local mitigation and urban landscaping shows promise towards achieving acceptable conditions for everyday public access as the Liverpool Waters masterplan is built out, and more people use the area on a regular basis.

13.1.4 Wind tunnel studies to investigate effects of current and likely future surroundings were undertaken at RWDI's facility in Milton Keynes and were evaluated using the well-established Lawson LDDC criteria for acceptability of use for typical activities by pedestrians. This included investigation of the effects of current ideas for Master-plan landscaping and local mitigation around the development. These studies support the general conclusions above. This is described in more detail below.

13.2 Methodology and Scope

National Planning Policy

13.2.1 The **National Planning Policy Framework** (NPPF) came into force in March 2012. The NPPF does not contain any planning policies directly relating to wind microclimate issues. However, the benefits of a high quality built environment are emphasised in the NPPF. For example, paragraph 58 states development should use: "…streetscapes and buildings to create attractive and comfortable places to live, work and visit…" and paragraph 110 states "In preparing plans to meet development needs, the aim should be to minimise pollution and other adverse effects on the local and natural environment."

13.2.2 **The Guidance on Tall Buildings** (CABE and EH, 2007) sets out how the Commission for Architectural and Built Environment (CABE) and English Heritage (EH) evaluate proposals for tall buildings. Paragraph 4.4.9 under the criteria for evaluation states that applicants seeking planning permission should

ensure that the following criteria are addressed, "The effect on the local environment, including microclimate, overshadowing, night-time appearance, vehicle movement and the environment and amenity of those in the vicinity of the building…"

Local Planning Policy

13.2.3 There is no specific local planning policy related to wind for the Proposed Development.

Assessment Methodology

13.2.4 Wind tunnel testing was undertaken to quantify the effects of the proposed development on the local wind conditions at pedestrian level on and around the site. It is currently the most reliable method of assessing windiness in cases where strong winds may occur around wind exposed buildings, and enables rapid evaluation of the benefits of mitigation measures.

Wind Tunnel Testing

Overview

13.2.5 Two environmental wind tunnel workshops were organised by Arup and held at RWDI's wind tunnel in Milton Keynes on February 10 and March 24, 2016. Falconer Chester Hall (FCH) Architects provided massing information on the Proposed Development for the wind tunnel model and attended the workshop.

13.2.6 A 1:300 scale model of the Proposed Development and its surroundings was constructed and tested in the RWDI boundary layer wind tunnel. The model represented all surrounding buildings within approximately 350m of the Proposed Development, which is considered sufficient for the assessment of local wind effects in urban areas. A general view of the wind tunnel model with existing surroundings is shown in Figure 13.1.

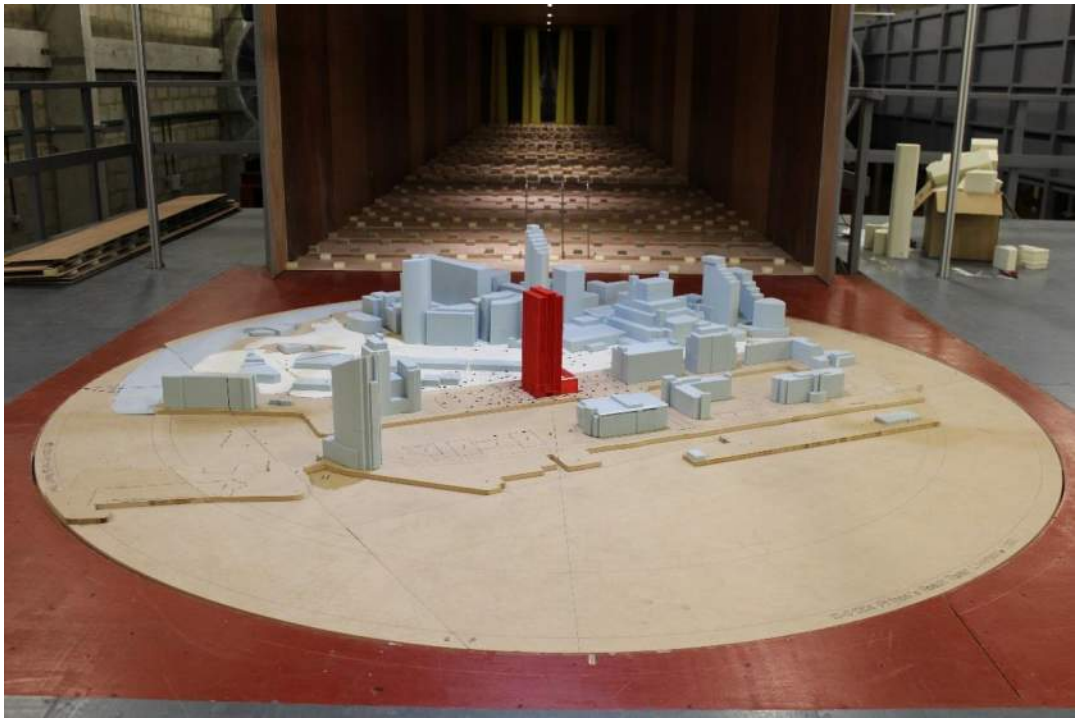

Figure 13.1: 1:300 scale model of the Proposed Development with existing surroundings (view from the west)

13.2.7 The wind tunnel workshops were used to investigate wind mitigation measures to improve wind conditions around the Proposed Development. The following scenario were tested.

- Baseline conditions (existing environment)
- Proposed Development with existing surroundings
- Proposed development with all the buildings of the Liverpool Waters Outline Consent (10O/2424). It should be noted that while outline planning normally provides limits to the building massing, the building forms are not fully developed and are likely to change.
- An emerging development scenario with buildings on plots A03, A05 and A07 of the Liverpool Waters Outline Consent. Note that the building modelled on plot A05 under this scenario differs from the outline consent due to emerging designs.

Simulation of atmospheric winds

13.2.8 The characteristics of the oncoming wind speed and turbulence are generated by using uniformly distributed roughness elements and spires upwind of the wind tunnel model (see Figure 13.2) to reproduce the natural wind behaviour.

Figure 13.2: Roughness element and spires used in the wind tunnel to generate the upstream wind profile

13.2.9 Wind profile predictions for the Site were obtained using the ESDU (Engineering Science Data Unit) model. This model is the basis for the wind profiles used in the UK National Annex to the Eurocode for Wind Loading, EN1991-1-4. The ESDU analysis of boundary profiles takes into account the variation in upwind terrain characteristics (e.g. effective surface roughness and fetch) for different directions. Different wind profiles were used in the testing for winds from the city and from the Mersey.

Measurement technique

13.2.10 Gust and mean wind speed ratios were measured using up to 161 Irwin probe anemometers placed around the site, depending on the test configuration. The probes measure wind speeds at an effective height of 1.5m above ground, which is the standard height used for assessing wind effects on pedestrians, compared to wind speeds above the Site at a height unaffected by buildings.

13.2.11 Measurements were taken at frequently used locations (e.g. entrances, walking zones) and in other areas expected to experience high wind speeds. For each test configuration, wind speeds were measured for sixteen equal angle increments to cover all wind directions.

13.2.12 The measured wind speed ratios were combined with the long-term wind statistics for Liverpool (see below) to calculate the windiness for each season of the year based on the Lawson ‘comfort’ and ‘distress’ criteria (described above)

Wind Climate

13.2.13 Historical wind data (wind speed and direction) recorded at Liverpool Airport during the years 2003 to 2015 were analysed and adjusted to site exposure using the ESDU method as described above.

13.2.14 Strength and directionality of the winds are fundamental aspects of the environmental wind assessment. While in the rest of the UK the most frequent and strongest winds are from the south-west, the most frequent winds in Liverpool are slightly shifted in the direction to the north-west and the strongest winds are from the west. Data from Blackpool is closer to normal UK wind directionality, but are less likely to be influenced by the likely real effect of the Welsh Mountains.

13.2.15 The annual wind rose shown in Figure 13.3 illustrates the directionality and strength of the prevailing winds at Liverpool Airport for all times of the day and seasons.

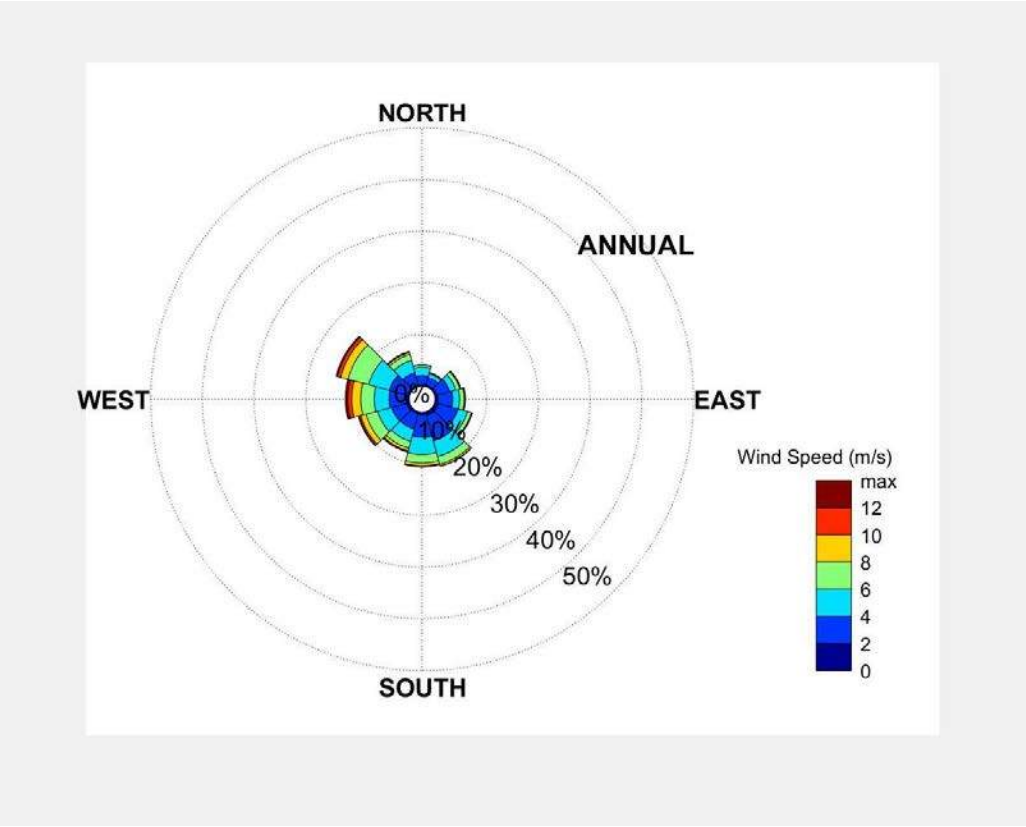

Figure 13.3: Annual wind rose obtained from the wind data recorded at Liverpool Airport (10m height) during the years 2003 to 2015

13.2.16 Other characteristics of the wind climate in Liverpool are summarized below.

- The north-west and west winds are the most frequent and strongest in Liverpool at all times of the year. These winds are relatively cold. Most cases of serious annoyance due to strong winds around buildings are caused by these winds.
- Northeast winds are less frequent than the south and west winds. They are often associated with cold, dry conditions. These winds can be more

unpleasant than their strength suggests due to the lower-than-average air temperature.

- Finally, southeast winds are generally warm and light and are rarely associated with problematic ground level winds.

LDDC Lawson Assessment Criteria

13.2.17 The acceptability of windiness is subjective and depends on a number of important factors, particularly the type of activity being performed.

13.2.18 Lawson's comfort criteria are used to describe frequent wind conditions, and specify tolerable limits for various every-day activities. For ideal conditions, it would be desirable to achieve a category better than the comfort categories described below.

13.2.19 The terms 'Sitting', 'Standing', 'Strolling' and business 'Walking' are used in the text to describe the comfort levels of windiness as described in Table 13.1. The coloured dots are used to indicate the windiness on the referenced figures, e.g. Figure 13.5, which also show the measurement locations.

Table 13.1: Lawson Comfort Criteria

Comfort Criteria		Description
Long Term 'Sitting'		Reading a newspaper, eating and drinking
'Standing' or short term 'Sitting'		Bus stops, window shopping and building entrances
Walking or 'Strolling'		General areas of walking and sightseeing
Business 'Walking'		Areas where people are not expected to linger

13.2.20 There are also distress (or safety) criteria used to describe less frequent levels of windiness, to be exceeded less often than once a year. These are described in Table .

13.2.21 The distress limit for 'General Public Access' corresponds to an equivalent mean speed of 15 m/s and gust speed of 28 m/s. Exceeding this limit signifies a safety hazard for less able-bodied members of the public (e.g. elderly and cyclists). In such instances, the wind tunnel results would display a single red ring around the outside of the coloured dot as shown in Table .

13.2.22 There is a further limiting distress criterion above which 'Able-bodied' individuals may find themselves in difficulties at times. This corresponds to a mean speed of 20 m/s and a gust speed of 37 m/s. Aerodynamic forces beyond this limit approach the body weight and it rapidly becomes impossible to remain

standing. If these conditions are exceeded, then the wind tunnel results would display a double red ring around the outside of the dot as shown in Table . Such winds may also affect safety of some road vehicles.

Table 13.2: Lawson Distress Criteria

Distress Criteria		Description
'General Public Access'		Above which the less able and cyclists may at times find conditions physically difficult
'Able Bodied Access'		Above which it may become impossible at times for an able bodied person to remain standing

Significance Criteria

13.2.23 The significance of windiness at a given location is assessed for the intended pedestrian activities at that location.

13.2.24 Lawson's comfort criteria (see Table 13.1 and Table 13.1) are used to evaluate the appropriateness of windiness for everyday use.

13.2.25 An effect may be described as:

- **Beneficial:** the likely windiness is lower than needed for the intended or existing-and-continued use;
- **Adverse:** the likely windiness is higher than needed for the intended or existing-and-continued use; or
- **Negligible:** any changes in windiness have a negligible effect on the intended or existing-and-continued use.

13.2.26 An effect is categorised according to the following table:

Table 13.3: Categorisation of effects

Magnitude of Effect	Criteria for Assessment	Lawson Description
Major adverse	Levels of windiness with expected effect on future wind 'safety', particularly in areas of frequent everyday use, such as main public access routes and main building entrances.	Exceedance of Lawson's distress criteria in areas used regularly by the Public Exceedance of 'Standing' conditions at major entrances
Moderate adverse	Levels of windiness, with expected moderate effect on wind 'comfort' and 'safety'. This includes any important adverse changes to existing usage categorisation.	Exceedance of acceptable conditions in areas of less critical use, which may affect usage at times
Minor adverse	Levels of windiness with minor effect on future usage, e.g. changes in areas that are normally used only in suitable weather conditions.	Marginal exceedance of acceptable conditions or exceedance in rarely used areas

Negligible	Levels of windiness that have a negligible effect on the future usage of the Development, and in the surrounding areas. This includes areas where appropriately described wind mitigation has been incorporated into the scheme.	Acceptable conditions
Minor beneficial	Levels of windiness that contribute to future usage of the Development and surrounding areas.	Conditions are at least one-category calmer than acceptable in areas of significant usage.
Moderate beneficial	Levels of windiness with expected benefit for both wind 'comfort' and 'safety' in areas of less critical use.	Conditions are calmer than acceptable limits in areas that previously exceeded the relevant Lawson 'comfort' and 'safety' criteria.
Major beneficial	Existing wind 'safety' exceedance in areas of everyday use, such as public access routes and major building entrances is improved to acceptable levels.	No longer any exceedance of Lawson's distress criteria in areas used regularly by the Public Conditions at major entrances are improved to the acceptable 'Standing' limit.

13.3 Limitations and assumptions

13.3.1 Information about future developments in the area is limited and not necessarily reliable. In particular testing using block-plans can be un-realistic since the overall obstruction to the wind is overestimated. Future developments in this area as part the masterplan or otherwise will affect the wind conditions around the proposed development.

13.4 Baseline Conditions

13.4.1 The baseline configuration for the Site with existing surroundings is shown in Figure 13.4. The Site is partially sheltered from the easterly winds by Liverpool City centre and the buildings along the eastern side of Bath Street. However, the Site is directly exposed to the westerly and north-westerly winds across the Mersey.

Figure 13.4: Baseline model of the Site with existing surroundings (view from the West)

13.4.2 The 'worst season' (normally winter) wind conditions around the Site (with existing surrounding) are shown in Figure 13.5a, and are summarised below:

- 'Business Walking' conditions and exceedance of the distress criterion for 'General Public Access' along the waterfront of Princes Parade. The west end of the bridge over the dock also exceeds the distress criterion for 'General Public Access'.
- 'Business Walking' conditions in the north-west corner of the existing car park and an exceedance of the distress conditions for 'General Public Access' on the east side.
- 'Business Walking' and exceedance of the distress conditions for 'General Public Access' near the Malmaison Hotel main entrance.
- Business 'Walking' conditions and exceedance of the distress criterion for 'General Public Access' at the north corner of No.1 Princes Dock near the main entrance.
- 'Strolling' and exceedance of the distress criterion for 'General Public Access' on the east side of King Edward Street, near Brook Street.
- 'Standing' to 'Strolling' at other measured locations within and around the site.

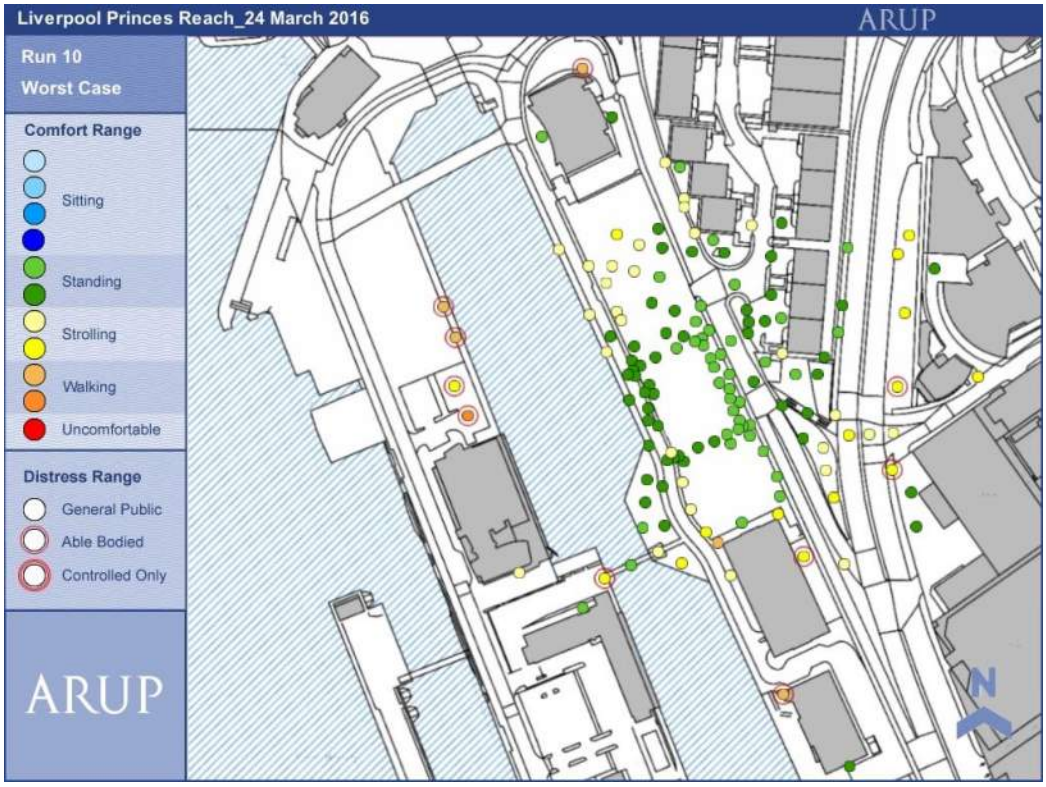

Figure 13.5a: Worst season wind conditions for the baseline configuration (Site with existing surroundings)

13.4.3 Summer conditions are on average perhaps half a comfort category better than in the worst season (winter). There are no reported exceedances of the distress criterion for 'General Public Access' except at No. 1 Princes Dock. The calmest areas are along the existing dock wall along Bath Street where comfort conditions are in the upper 'Sitting' range.

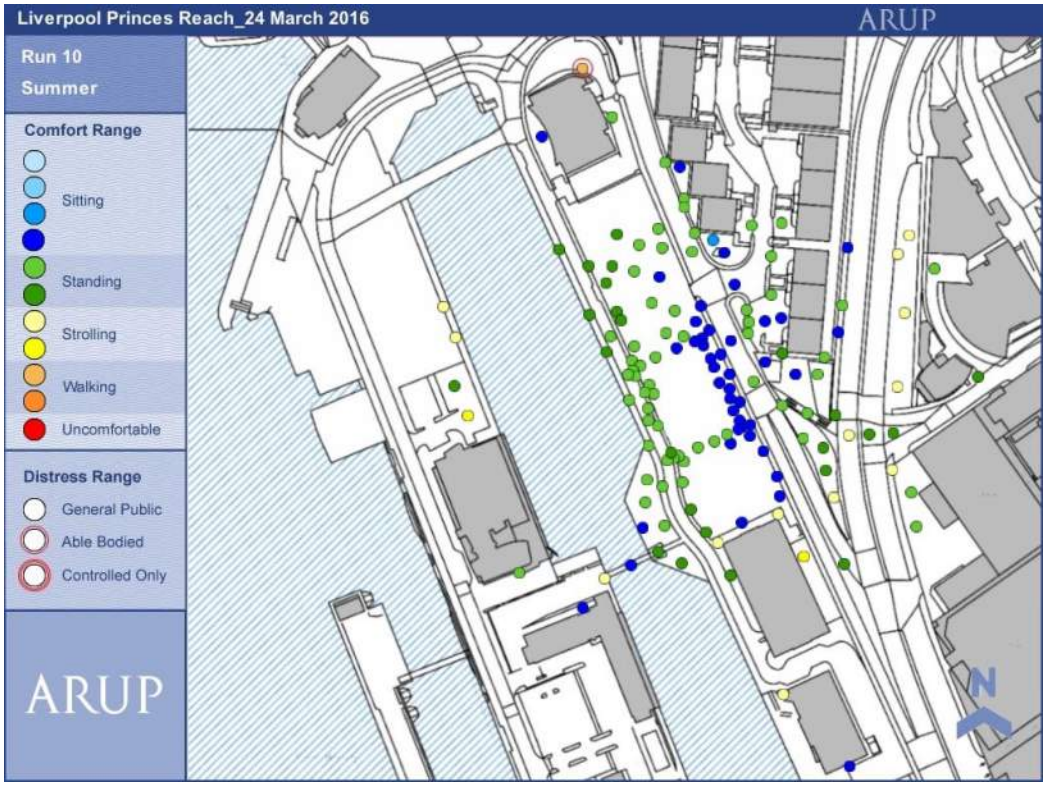

Figure 13.5b: Summer season wind conditions for the baseline configuration (Site with existing surroundings)

13.5 Assessment, Mitigation Measures and Cumulative Impacts

13.5.1 The studies below describe conditions once the building is complete and clad. Until cladding is attached, buildings are relatively porous and cause a lesser effect. Construction stage windiness is therefore normally less critical than when complete and is also temporary. Note however that delays to installing ground level mitigation after installation of cladding should be minimised where this affects areas likely to be used by the general public on a regular basis.

Proposed Development with Existing Surroundings – no mitigation

13.5.2 Figure 13.6 shows the wind tunnel model. The wind conditions in the worst season are shown in Figure 13.7.

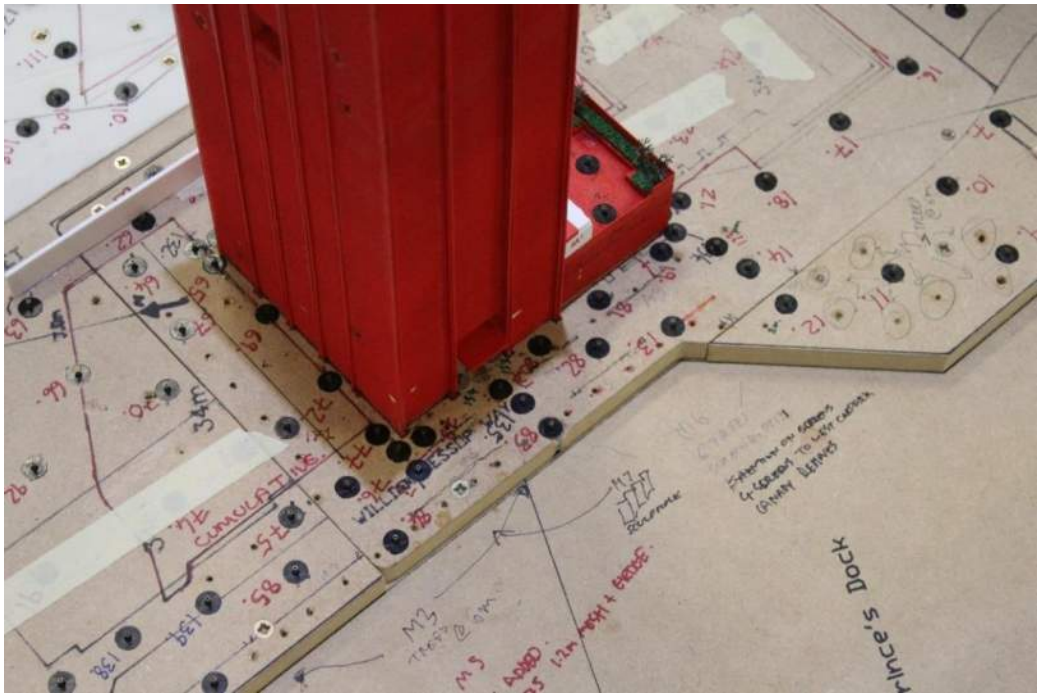

Figure 13.6: Proposed Development with Existing Surroundings

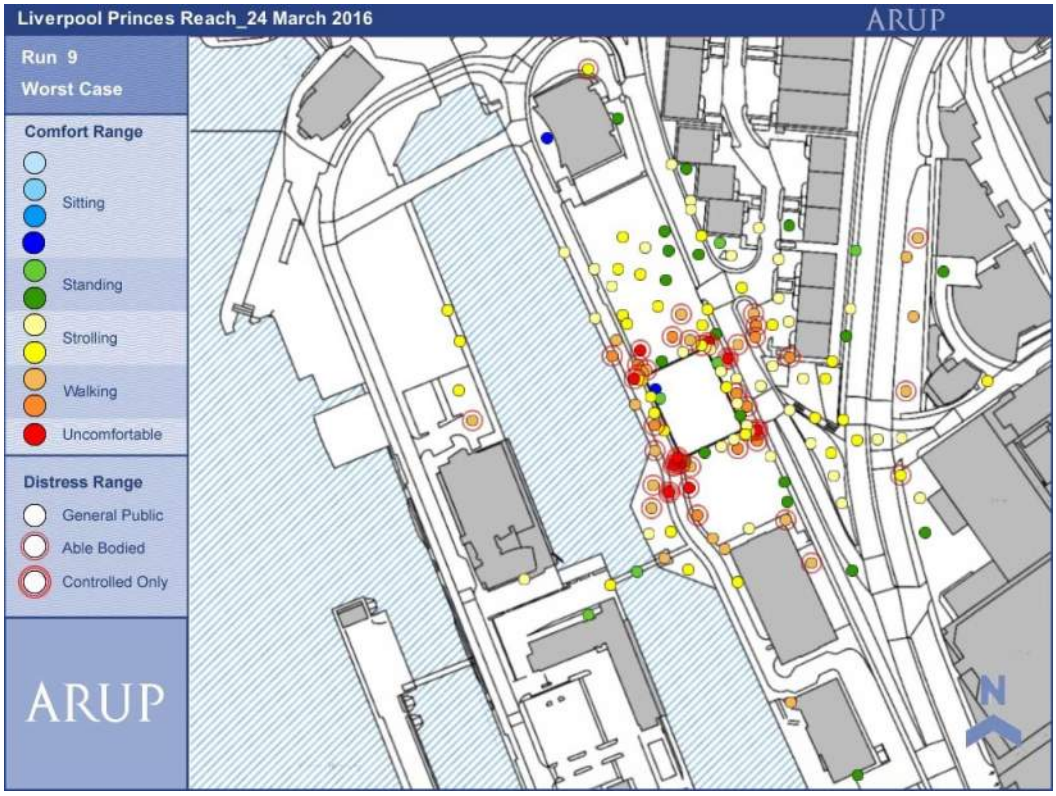

Figure 13.7: Worst season wind conditions for the Proposed Development with Existing Surroundings (without mitigation)

13.5.3 The results are assessed for the proposed pedestrian activities. Note that some of the conditions described improve when other developments are included in the surroundings as described later in this document.

13.5.4 The results show windiness increases significantly around the building compared with the baseline, exceeding normal comfort limits and the distress criteria for both 'Able-died' and 'General Public' access. Windiness also increases to Business 'Walking' with exceedance of the distress criterion for 'General public' access in streets to the east of the site.

13.5.5 There are no safe regular walking routes from the building to the Bath Street access door or along Princes Reach. Mitigation was therefore developed as described below.

Mitigation

13.5.6 Mitigation measures were developed through the wind tunnel testing. While there was some success it is not practical to mitigate all areas on this currently exposed site without considering the effect of likely future developments. The wind mitigation measures and their integration with the future development should be developed further during the detailed design phase, and with potentially better knowledge of the future surroundings. The wind conditions in the worst season with the mitigation as tested are shown in Figure 13.8.

13.5.7 The mitigations and their benefits are described in the sections following.

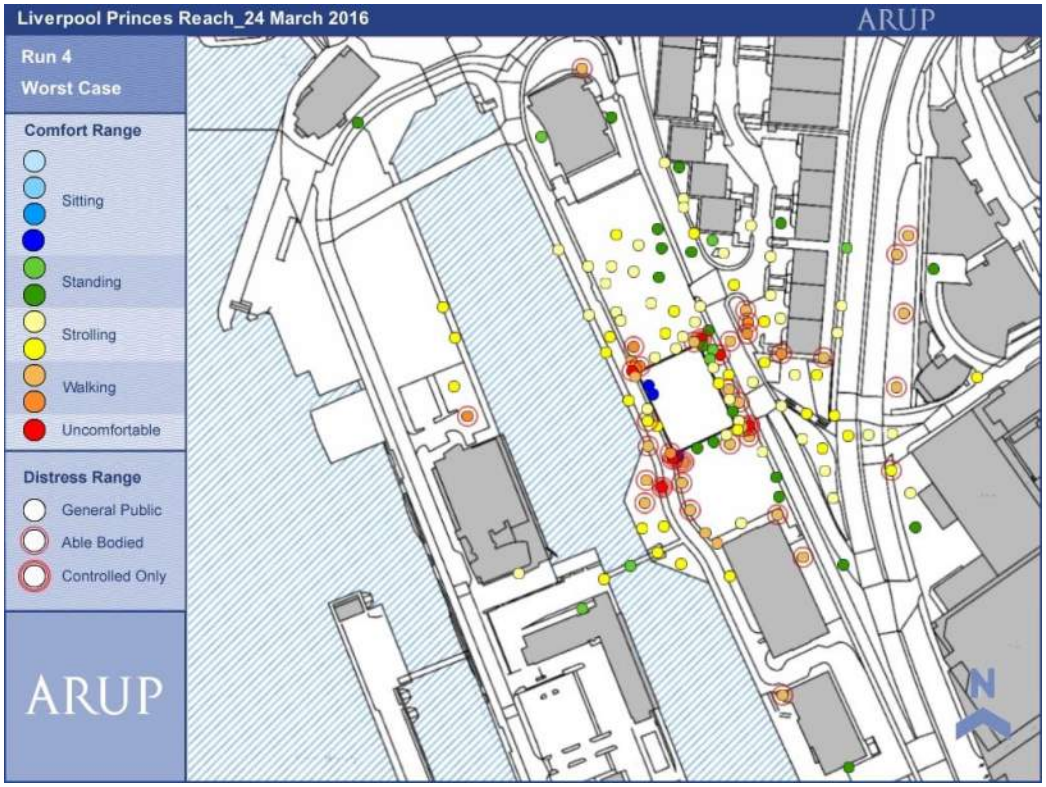

Figure 13.8: Worst season wind conditions for the Proposed Development with Existing Surroundings (with mitigation)

13.5.8 A number of proposed mitigations including 12 elevated vertical fins (6m tall, 2m wide, 50% porous) later described as 'flags' along the north and south sides of the Proposed Development, trees at the waterfront, screen around the Proposed Development (Figure 13.10 & 13.11) have been tested. Although the wind conditions are slightly improved around the building, there are still significant areas of 'Uncomfortable' and 'Business Walking' with exceedance of the distress criterion for 'General Public Access'.

13.5.9 The mitigation used is relatively small scale and has little off-site effect. Note that while some of the off-site areas appear worse with the mitigation in place, this is due to very marginal changes in the wind speed-up ratios.

13.5.10 With the tested mitigation there are still no protected routes suitable for everyday general public access around the building. Windiness is unlikely to affect car use but unloaded delivery vehicles may have problems on windy days.

13.5.11 The main entrance to the Proposed Development is sheltered by recessing and is technically better than the acceptable 'Standing' condition. A picture of the mitigation as tested is shown in Figure 13.9. Note that wind pressures in this location may cause significant infiltration with potential issues with door operation unless suitable revolving doors are used. Note that the vehicle drop-off location at the main entrance is in the 'Strolling' range which is windy but likely to be usable on most days although assistance may be useful at times.

Figure 13.9: Mitigation as tested for the drop-off area and main entrance for the Proposed Development with Existing Surroundings

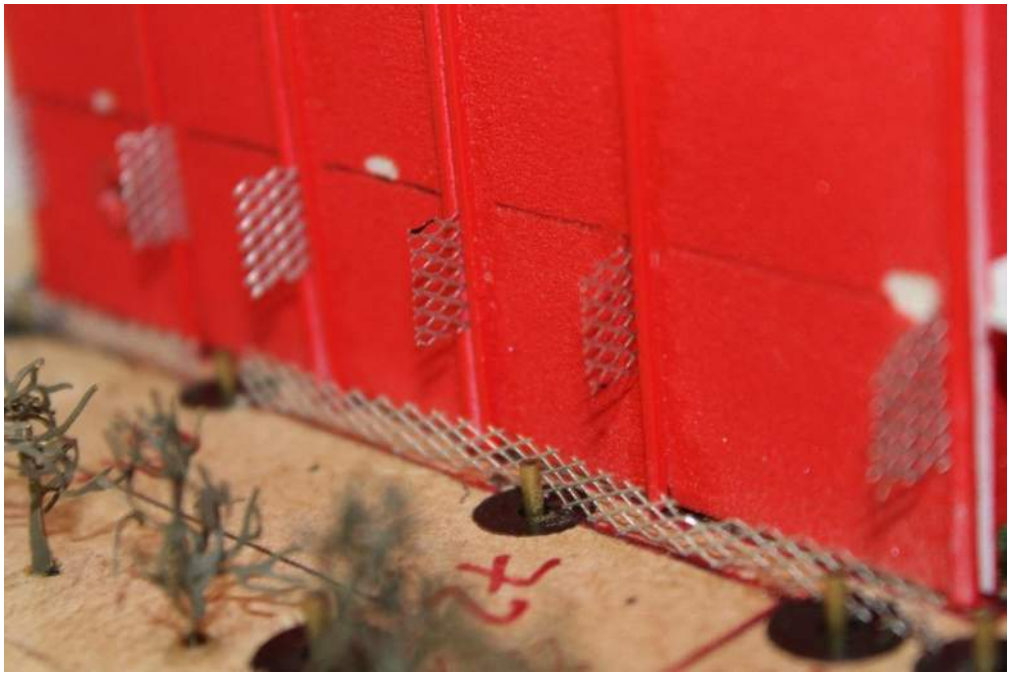

Figure 13.10: Mitigation ('flags') as tested for the passage to the north and south of the Proposed Development with Existing Surroundings

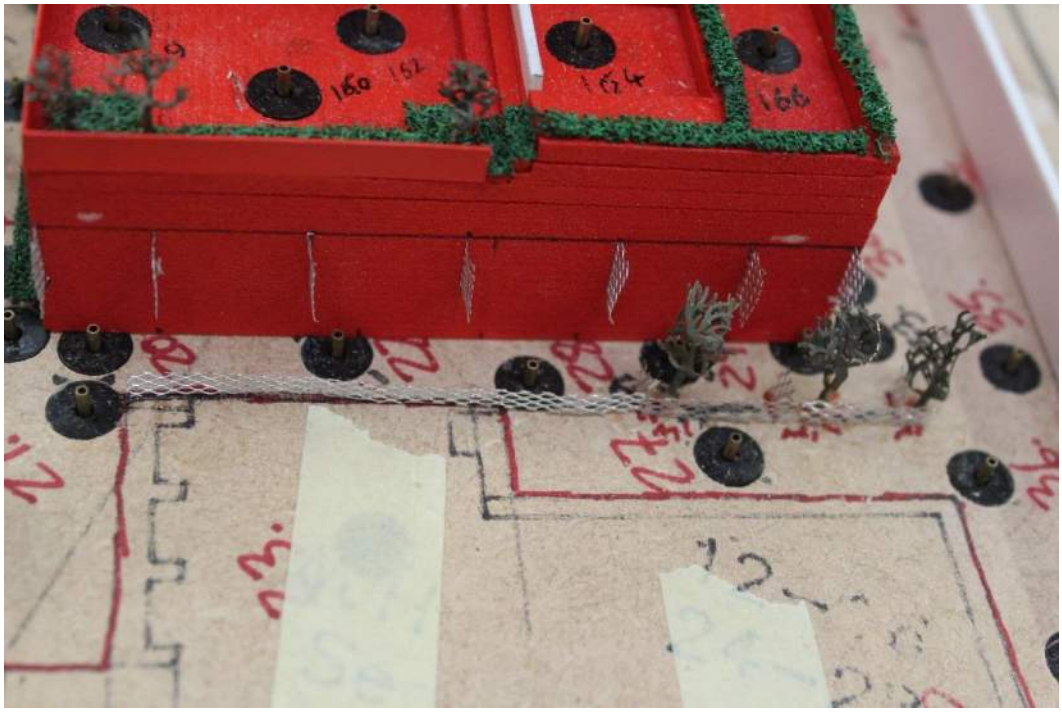

Figure 13.11: Mitigation ('flags', trees, and screen) as tested for the passage to the south of the Proposed Development with Existing Surroundings

13.5.12 Successful improvements to the terrace were made as shown in the figure below. Extending the canopy over the terrace to 5m and closing both ends, and adding the solid screen along the centre of terrace, resulted in terrace wind conditions that are acceptable for the anticipated regular use in many areas, especially in summer.

Figure 13.12: Mitigation as tested for the terrace of the Proposed Development with Existing Surroundings

Proposed Development with Future Surroundings

13.5.13 The Proposed Development with the Liverpool Waters outline consent surroundings completed is shown in Figure 13.13.

Figure 13.13: Proposed Development with Future surroundings

13.5.14 Figure 13.14 illustrates the wind conditions around the development for the worst season. Windiness around the development improves in the context of future surroundings as tested, noting that the improvement shown is almost certainly optimistic. This is partly because windiness around the cumulative buildings themselves remains well in excess of acceptable limits, indicating the need for improvements of the massing.

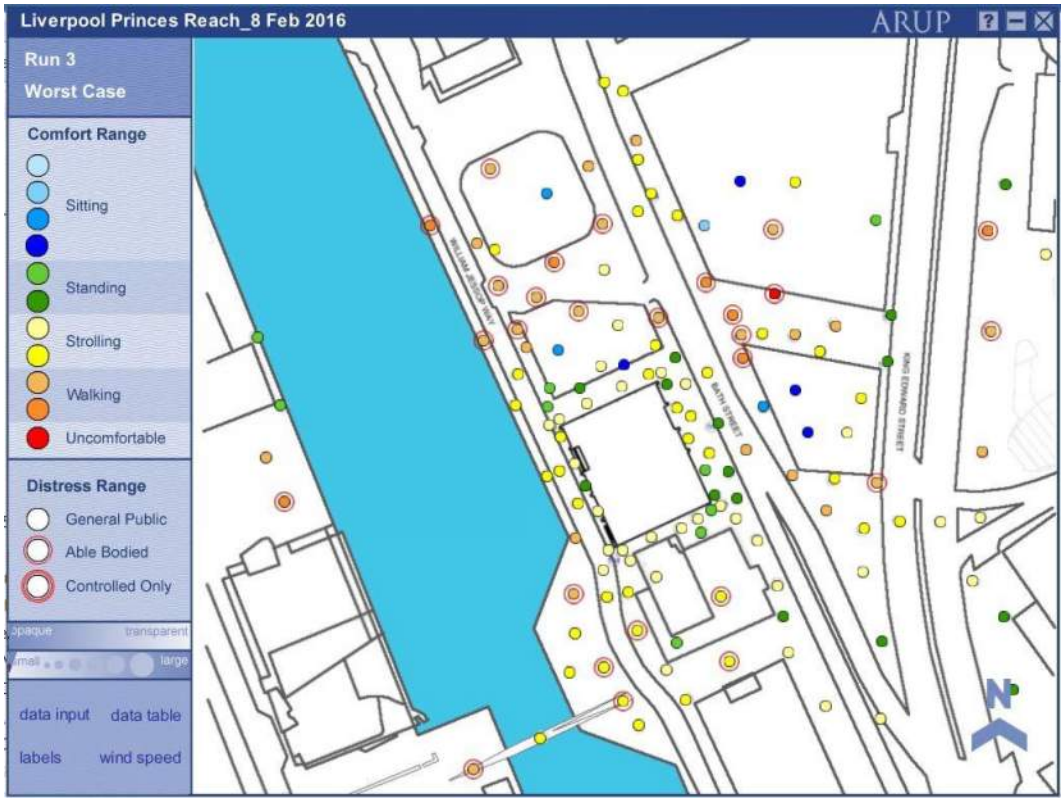

Figure 13.14: Worst season wind conditions for the Proposed Development with Future surroundings (without mitigation)

13.5.15 The "Strolling" at the main entrance to the Development, as shown above, is eliminated with recessing of entrance as shown in previous scenarios, but this was not modelling in this run.

Emerging development phase (with the A03, A05 & A07 buildings)

13.5.16 It is currently expected that the emerging developments will be built on a similar timescale to the Proposed Development. Plot A03 (William Jessop House) has already received full planning permission for an 8 storey building. Within this scenario, based on current understanding, plot A05 was modelled at an increased height compared to the parameters set by the Liverpool Waters outline consent, this version currently does not have planning permission. It is however important to show likely future outcomes of the neighbourhood within this study. Figure 13.15 shows the Proposed Development with A03, A05 & A07 and otherwise with existing surroundings.

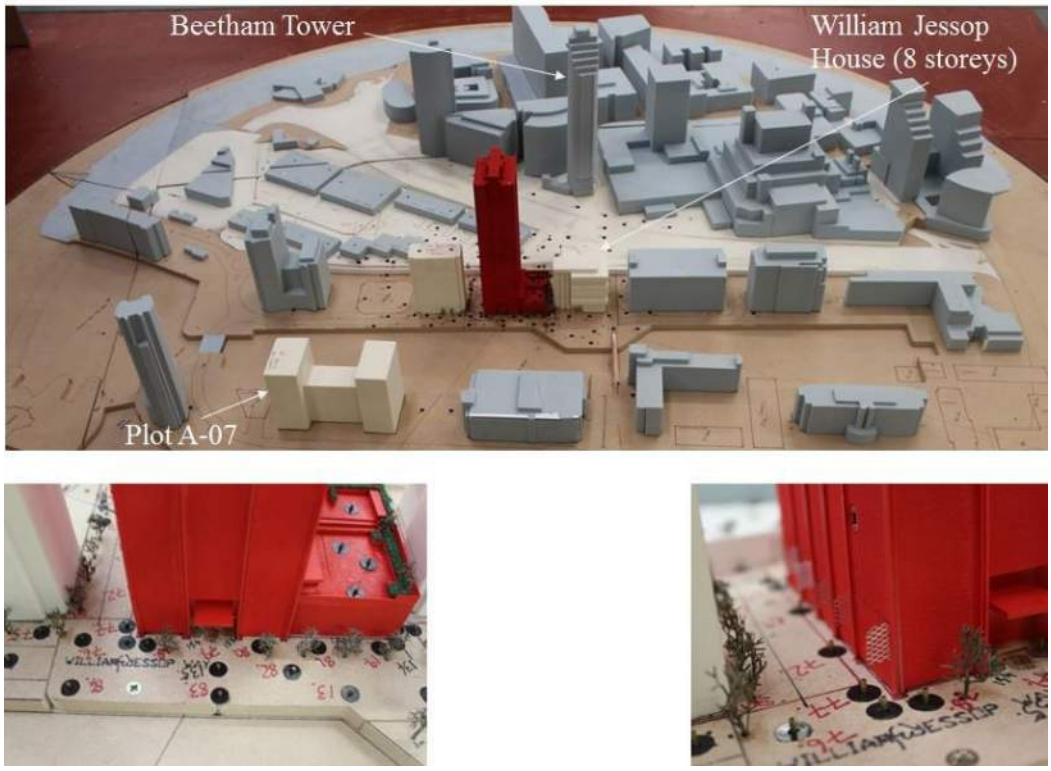

Figure 13.15: Proposed Development with Emerging Development Phase of surroundings (with the A03, A05 & A07 buildings)

13.5.17 Figures 13.16a and 13.16b illustrate the resulting wind conditions in the worst season and in summer with the mitigation described below. The results are assessed relative to the proposed pedestrian activities.

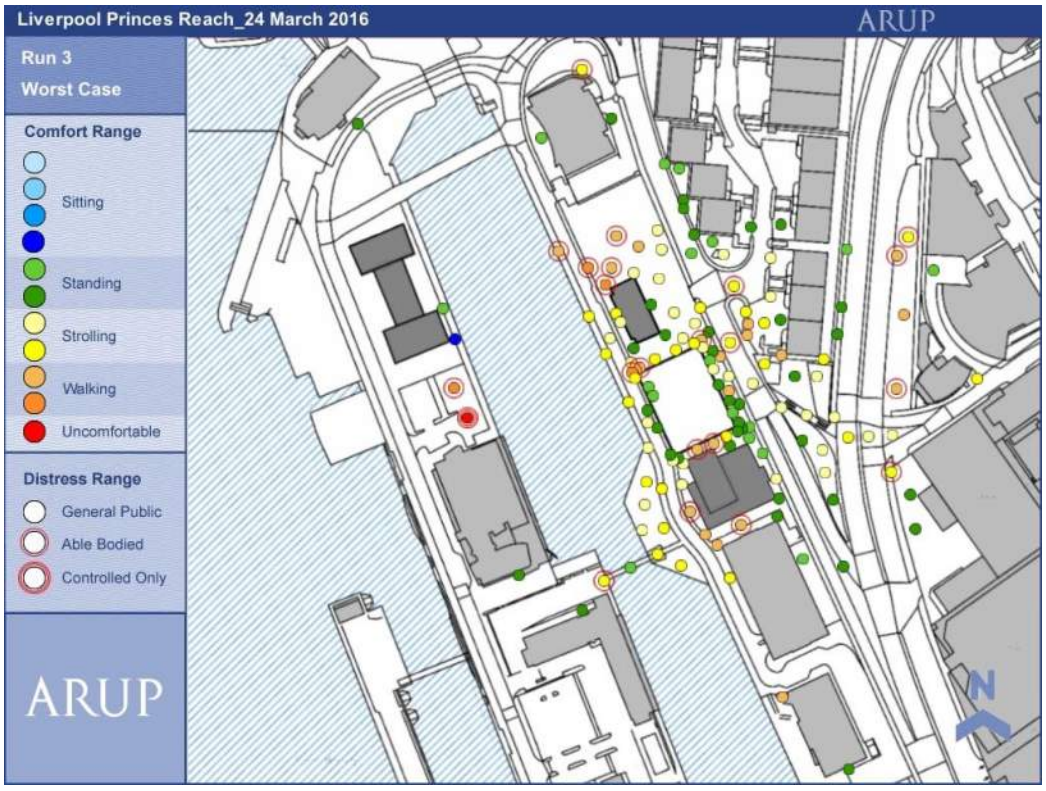

Figure 13.16a: Worst season wind conditions for the Proposed Development at Emerging Development Scenario (with mitigation)

13.5.18 The results presented are with full mitigation as shown for the existing surroundings (Figure 13.9-13.11). The Emerging Development surroundings result in significantly reduced windiness along the west front and east sides of the Development with only a few local areas of Business 'Walking' with local exceedence of the distress criterion for 'General Public Access'. The development of plot A07 on Princes Parade is especially important in achieving this.

13.5.19 While this does not fully meet the normal acceptability criteria, this shows that it is likely, in cooperation with other developers, to be able to achieve normally acceptable windiness conditions for access. However this will take more work.

13.5.20 Note that several offsite areas remain excessively windy for normally acceptable general public access, including areas of Bath Street and King Edward Street. These will also be significantly affected by the wider masterplan development.

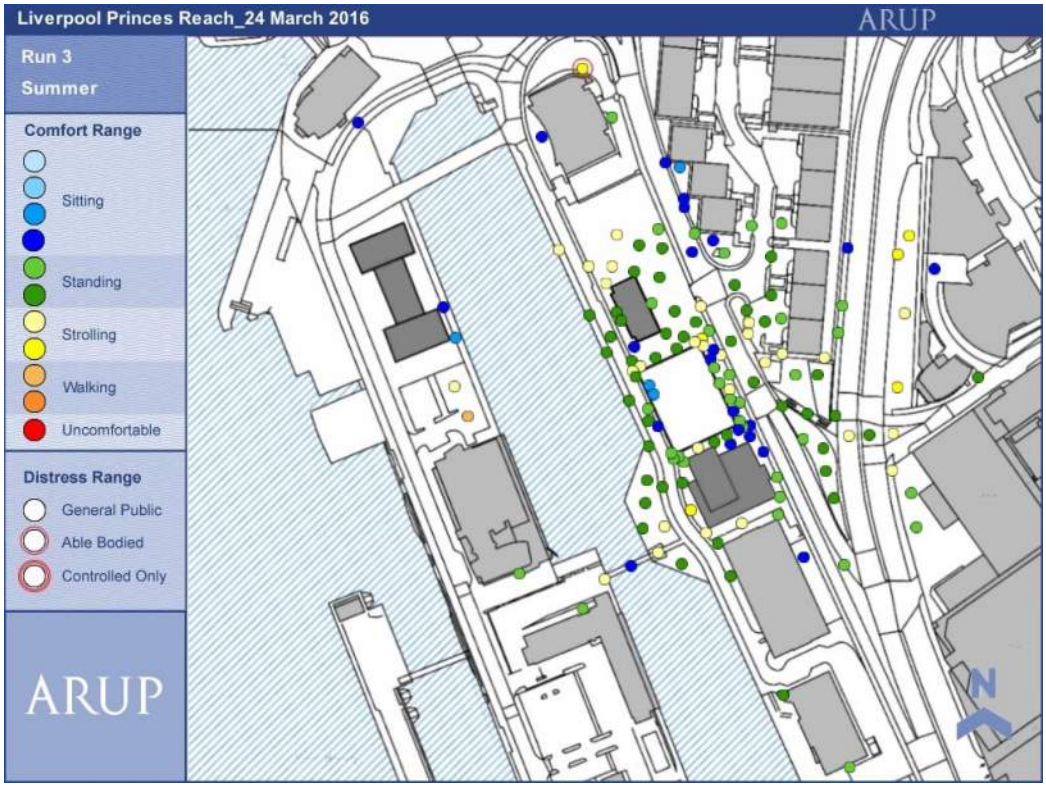

Figure 13.16b: Summer season wind conditions for the Proposed Development at Emerging Development Scenario (with mitigation)

Mitigation

13.5.21 It should be noted that wider master-plan planting around the buildings to north and south of the development is partial, including only the current master-plan landscaping in these areas. Note, further mitigation may be required to mitigate wind conditions around these buildings.

13.5.22 With the mitigation, an alternative safe access route from the car park to the door through to Bath Street is available.

13.6 Assessment Summary and Residual Effects

13.6.1 Table 13.4 below identifies the residual effects of the proposed development and the agreed mitigation of the pedestrian wind environment both on and off site. The significance for pedestrians is described using the terminology and criteria defined in Table 1.

Table 13.4: Summary of residual effects

Pedestrian Level Wind Condition	Pre-mitigation Significance	Possible Mitigation	Residual Significance
Proposed Development with Existing Surroundings			
High wind accelerations around all four corners of the Proposed Development and exceedance of the comfort and distress criteria.	**Major adverse effect**	Addition of numerous mitigations, including canopies, porous screens and 'flags' along the passage between A03 and A05. Conditions remain excessively windy.	**Major adverse effect** but improves with future development.
High wind accelerations at the drop-off area and the main entrance of the Proposed Development and exceedance of the comfort and distress criteria.	**Major adverse effect**	Recessing of the entrance is effective but mitigation of windiness at the drop-off is only partially effective. 'Strolling' conditions achieved.	**Minor adverse effect** but improves with future development.
'Standing and Strolling' at the terrace and exceedance of the comfort criteria on the terrace.	**Minor adverse effect**	Extending the canopy over the terrace to 5m and capping at both ends. Addition of a solid screen along the centre of terrace.	**Minor adverse effect** but improves with future development.
Exceedence of normal regular general public access requirements on Bath Street and the east side of King Edward Street	**Minor/Moderate adverse effect**	Mitigation likely to be needed but scope depends on future development of other areas of the masterplan	**Minor/Moderate adverse effect** depending on numbers of people expected to walk in these areas.
Proposed Development with the entire Liverpool Waters outline consent surroundings completed			
'Strolling' conditions at the corners of the Proposed Development.	**Negligible effect**	Additional trees along the waterfront of the Proposed Development.	**Negligible effect**
'Strolling' conditions at the drop-off area and the main entrance of the Proposed Development	**Minor adverse effect**	Additional trees along the waterfront of the Proposed Development.	**Negligible effect**
Exceedence of normal regular general public access requirements on Bath Street and the east side of King Edward Street and other areas of the masterplan.	**Major adverse effect**	This is only partially due to the development. Mitigation is needed depending on future development of other areas of the master-plan	**To be confirmed at the time of future development.**
Proposed Development with emerging development scenario (A03, A05 and A07)			
Local areas of 'Business Walking' and high wind accelerations around north-west corner of the Proposed Development and exceedence of the distress criterion for 'General Public Access'.	**Major adverse effect**	This was tested with full mitigation as above. It requires further development of mitigation as the adjacent developments are planned.	**Mitigation should be achievable in critical areas with cooperation between developers.**

13.7 Conclusions

13.7.1 Wind tunnel workshops were carried out in the presence of Falconer Chester Hall (FCH) Architects to investigate the feasibility of achieving normally acceptable wind conditions around the proposed development on the currently highly wind exposed site.

13.7.2 Tests were carried out in the atmospheric boundary layer wind tunnel at RWDI using a 1:300 reduced-scale model of the Proposed Development and surroundings within 350m. Lawson's Assessment Criteria were used to assess the wind conditions according to pedestrian activities and associated comfort and safety levels.

13.7.3 A number of mitigations were investigated over the course of the workshops, to cover three development scenarios, the Development with Existing Surroundings, the cumulative effects of committed development (Liverpool Waters Outline Consent) with maximum massing and an intermediate stage of development with two additional adjacent buildings along with Princes Reach and A-07 on Princes Parade, which are likely to be developed in the near future varying form the outline consent. This also represents a stage of development with representative numbers of people using Princes Reach. The baseline of existing surroundings was also tested.

13.7.4 As should be expected on the currently exposed site, it was not possible to mitigate windiness to normally acceptable levels around the isolated development. High wind accelerations were found around all four corners of the Proposed Development with exceedence of the distress criteria for both 'General Public' and 'Able-bodied' access. For everyday walking access, special temporary sheltered walking routes would be needed.

13.7.5 Conditions improve significantly in the intermediate stage of development and, with cooperation between developers, it is likely to be feasible to arrive at further developments of the tested mitigation to achieve normally acceptable conditions at least along key access routes. The presence of building A-07 is especially helpful. However, with mitigation that is less effective than tested, unacceptable conditions would also persist in this stage of development.

13.7.6 Further development is likely to create more of a cluster-effect and reduce the windiness further. It should be noted however that the building massing as tested in this case does not represent real building proposals and did not include any mitigation around these buildings. Excessive windiness was observed around many of the other buildings of the master-plan in this scenario.

13.7.7 Key mitigations identified include:

- Planting 40x6m tall and 2x8m tall deciduous trees within the site at key areas to help disperse high winds,
- Installing 12 number elevated, porous screens or 'flags' along north and south sides of the Proposed Development.
- Installing 3m wide solid canopies along the north, south and west elevations of the Proposed Development.

- Adding 3x6m trees and 3 screens (1.2mx1.5m with 50% porous) to the south east corner of the proposed development.
- Adding low planting in areas where this was practical.
- Extending the canopy over the terrace to 5m closed at both ends and adding a solid screen along the centre of terrace.

13.7.8 Based on the above, the following recommendations are made:

a) The mitigation as tested to date does not fully satisfy normally acceptable standards of windiness around buildings, but has not been fully developed pending understanding of the timing of concurrent developments. Further development of mitigation around the proposed Development is therefore recommended as the wider development plans become clearer.

b) If the building is constructed in advance of other development within Princes Dock then special temporary measures are likely to be needed, such creating a sheltered corridor to ensure that safe access for pedestrians can be achieved in all weather conditions. These would be developed as needed in the circumstances of the timing of the development and in conjunction with the City.

c) As more buildings are constructed, then the windiness and mitigation should be reviewed at each stage. A measure of cooperation between developers and the City in terms of planting, screening and fencing is likely to be needed to produce effective mitigation at all stages of the Master-plan development.

13.7.9 Based on the work carried out and the recommendations for mitigation above, the current massing proposal for the Development is acceptable for windiness in the context of the currently intended overall Liverpool Waters approved consent.

14 Conclusions

14.1 Introduction

14.1.1 This chapter provides the technical conclusions of the Princes Reach EIA. The overall aim of the ES is to provide an objective and systematic account of the significant environmental effects of the development and to assess the ability of the development site and the surrounding area to accept those impacts.

14.1.2 The assessments presented in this ES have considered the potential for significant environmental impacts to affect the baseline conditions as a direct/indirect result of the proposed development. The baseline conditions are defined as the existing state of the environment and how it may develop in the future in the absence of the proposals.

14.1.3 Assessments have been undertaken in accordance with best practice guidelines published by the relevant professional bodies. Each chapter's methodology section provides details of the assessment criteria and terminology in the context of that technical discipline.

14.1.4 The following provides a summary of each of the environmental disciplines assessed within this ES:

- Transport and Access
- Noise and Vibration
- Air Quality
- Archaeology and Cultural Heritage
- Daylight and Sunlight
- Ground Condition and Contamination
- Townscape and Visual Impact
- Wind

14.2 Transport and Access

14.2.1 The assessment of the likely significant effects of the proposal on Transport and Access are set out in Chapter 6 of the ES.

14.2.2 The impact and effects of the proposed scheme are deemed to be **Negligible**, subsequent to mitigation of construction phase impacts.

14.2.3 The development is located in a highly sustainable location, which is reflected in the low number of car parking spaces proposed. Subsequently there are **no transport-related impacts** identified.

14.3 Noise and Vibration

14.3.1 The assessment of the likely significant effects of the proposal on Noise and Vibration are set out in Chapter 7 of the ES.

14.3.2 Noise and vibration impacts from construction and operation of the proposed development do not cause significant effects at noise sensitive receptors. With the implementation of the identified mitigation measures (embedded or otherwise) and design to comply with noise criteria, the residual effects are assessed as being **not significant**.

14.4 Air Quality

14.4.1 The assessment of the likely significant effects of the proposal on Air Quality are set out in Chapter 8 of the ES.

14.4.2 The assessment of effects indicates that the proposed development will have a **negligible** effect on local air quality during both the construction and operation phases. Mitigation measures to limit the impact of dust soiling and exposure to PM10 should be implemented during the construction phase as the proposed development has been assessed to be a high risk for dust generation. The effect of traffic movements associated with the proposed development have been predicted to **negligible** for local air quality in the surrounding area. The effect of on-site combustion plant on local pollutant concentrations have been predicted to be **negligible** to slight adverse, at areas where members of the public might be present for time periods consistent with the objective.

14.4.3 The effect of the proposed development on local air quality is predicted to be not significant.

14.5 Archaeology and Cultural Heritage

14.5.1 The assessment of the likely significant effects of the proposal on Archaeology and Cultural Heritage are set out in Chapter 9 of the ES.

14.5.2 The study has identified 45 heritage assets in the vicinity of the development site. There will be no potential direct impacts on the majority of these assets, with the possible exception of below ground remains of Princes Dock wall and earlier sea walls, not yet fully identified. The assessment demonstrates that the overall impact on heritage assets will be broadly neutral.

14.5.3 With mitigation through design, overall safeguards, and mitigation as proposed, it is concluded that the potential for negative impact can be controlled satisfactorily, in accord with relevant policy standards. There will be minor adverse impacts during the Construction stage on the Princes Dock Gates (north), the Dock Gates (south), the Princes Dock boundary wall, the Dockside Railway and the Liver Building. There will **no adverse** impacts during the Operational stage.

14.5.4 The Heritage Impact Assessment identifies that any potential harm to heritage assets will be outweighed by the benefits offered.

14.5.5 Following implementation of the mitigation measures, the proposed development would **not result in any significant adverse effects** on heritage assets or features.

14.6 Daylight and Sunlight

14.6.1 The assessment of the likely significant effects of the proposal on Daylight and Sunlight are set out in Chapter 10 of the ES.

14.6.2 When assessing the proposal against the baseline conditions it can be concluded that the impact on all windows ranges from **negligible to slight**. Only one commercial property (04 Gibraltar Way) experiences a noticeable reduction in daylight availability, but this is only marginally lower than 80% of the baseline value. IT is also noted that the affected windows on the Passport Office, Metropolitan House and the Liverpool Echo offices typically experience lower than ideal levels of daylight and sunlight exposure in the baseline scenario.

14.6.3 When assessing the proposal against cumulative impacts including committed development proposals such as the Liverpool Waters outline consent the calculations have generally indicated that the impact on 623 of 1139 the windows assessed is **negligible**.

14.6.4 The commercial accommodation on Princes Parade experiences a **slight/negligible impact**.

14.6.5 It is predicted that the existing space is to experience only marginal changes in and the impact is therefore considered **negligible**.

14.6.6 Mitigation of the impacts would only be possible through adjustment to the massing of the proposed buildings. However, outline planning permission has already been given to the Liverpool Waters Masterplan and the Princes Reach proposal conforms with this outline consent.

14.7 Ground Condition and Contamination

14.7.1 The assessment of the likely significant effects of the proposal on Ground Conditions and Contamination are set out in Chapter 11 of the ES.

14.7.2 The most **significant impacts** of the proposed development are considered to be during the construction phase when development work will expose existing made ground. On the basis of available information, made ground does not appear to contain significantly elevated concentrations of contaminants and it is considered that the enhanced risks identified during the construction phase can be adequately addressed by commonly used control measures. Further ground investigation is proposed to provide additional data on ground contamination within the Site.

14.7.3 During the operational phase, most of the site will be covered by the floor slab of the building or by areas of adjacent hardstanding. As such, users/occupiers of the site will not be able to come into contact with any contaminants present in the made ground and risks to human health will therefore be negligible. Provision of clean cover in any limited areas of landscaping will address risks to human health associated with any contamination present in the un-paved areas of the site.

14.7.4 Overall, contamination in made ground at the Site is considered to represent only **Minor Adverse** environmental effects which can be reduced to **negligible** residual effects by the adoption of appropriate routine control measures.

14.8 Townscape and Visual Impact

14.8.1 The assessment of the likely significant effects of the proposal on Townscape and Visual Impact are set out in Chapter 12 of the ES.

14.8.2 When the cumulative impacts are taken in to consideration, then there are several **adverse impacts** on the townscape elements, including; Heritage Designations, Townscape Character, Building Heights and Environmental Designations and Public Open Space. This is due to the scale and height of the proposed Shanghai tower parameter and the scale and height of the parameter closest to the Royal Liver Buildings. The Princes Reach building does not contribute to the negative townscape effects. The proposals have been developed through an iterative process, and mitigation has been embedded into the design. As a result, the proposed development is predicted to result in mostly **'beneficial impacts'** to the townscape elements assessed, with the impact on Heritage Designations and Building Heights has been assessed as **'neutral'**.

14.8.3 The scale and massing of the proposed development, and its relationship with the nearby listed Royal Liver Building is also a key consideration. The height of the proposed development although higher than any existing buildings on Princes Dock, is consistent with that of the buildings that characterise this area of the city, and the commercial district behind. The building becomes part of an existing cluster of taller buildings. This relationship with the Pier Head and the Three Graces is largely **neutral**. It doesn't alter the townscape setting of these buildings.

14.8.4 A total of 18 principal viewpoints were identified and agreed with Liverpool City Council. Only one of the identified viewpoints is predicted to result in a **Slight Adverse** visual effect at the baseline assessment. This viewpoint (no. 7) is from the south west corner of the Albert Dock and is considered a highly sensitive view. The proposed building would slightly alter the silhouette of the Royal Liver Buildings against the skyline from this location.

14.8.5 When the cumulative assessment is included, several more views are assessed as having an **adverse** impact, these are views 2, 10, 12, 17 and view 18. This negative assessment is mainly due to the scale and height of the Shanghai tower parameter and the scale and height of the parameter adjacent to the Pier Head. The scale and proportion of both of these parameters are out of keeping with any existing buildings, and obscure views of the Royal Liver Buildings from the north and west and obscure views into Princes Dock from the Pier Head. These parameters do not improve the setting of the proposed Princes Reach building; in fact, they detract from the largely beneficial or neutral impacts of the building.

14.8.6 In conclusion this study provides a townscape and visual impact assessment of the proposed development at Princes Reach, Princes Dock. The building will have a **largely beneficial** effect on the townscape of the Princes Dock neighbourhood. The building although tall and highly visible can become a part of the cluster of tall buildings which already exist with Princes Dock and the central business district.

14.9 Wind

14.9.1 The assessment of the likely significant effects of the proposal on Wind are set out in Chapter 13 of the ES.

14.9.2 A number of mitigations were investigated over the course of the workshops, to cover three development scenarios, the Development with Existing Surroundings, the cumulative effects of committed development (Liverpool Waters Outline Consent) with maximum massing and an intermediate stage of development with two additional adjacent buildings along with Princes Reach and A-07 on Princes Parade, which are likely to be developed in the near future varying form the outline consent. This also represents a stage of development with representative numbers of people using Princes Reach. The baseline of existing surroundings was also tested.

14.9.3 As should be expected on the currently exposed site, it was not possible to mitigate windiness to normally acceptable levels around the isolated development. High wind accelerations were found around all four corners of the Proposed Development with exceedence of the distress criteria for both 'General Public' and 'Able-bodied' access. For everyday walking access, special temporary sheltered walking routes would be needed.

14.9.4 Conditions improve significantly in the intermediate stage of development and, with cooperation between developers, it is likely to be feasible to arrive at further developments of the tested mitigation to achieve normally acceptable conditions at least along key access routes. The presence of building A-07 is especially helpful. However, with mitigation that is less effective than tested, unacceptable conditions would also persist in this stage of development.

14.9.5 Further development is likely to create more of a cluster-effect and reduce the windiness further. It should be noted however that the building massing as tested in this case does not represent real building proposals and did not include any mitigation around these buildings. Excessive windiness was observed around many of the other buildings of the masterplan in this scenario.

14.9.6 Based on the above, the following recommendations are made:

a) The mitigation as tested to date does not fully satisfy normally acceptable standards of windiness around buildings, but has not been fully developed pending understanding of the timing of concurrent developments. Further development of mitigation around the proposed Development is therefore recommended as the wider development plans become clearer.

b) If the building is constructed in advance of other development within Princes Dock then special temporary measures are likely to be needed, such creating a sheltered corridor to ensure that safe access for pedestrians can be achieved in all weather conditions. These would be developed as needed in the circumstances of the timing of the development and in conjunction with the City.

c) As more buildings are constructed, then the windiness and mitigation should be reviewed at each stage. A measure of cooperation between developers and the City in terms of planting, screening and fencing is likely to be needed to produce effective mitigation at all stages of the Master-plan development.

14.9.7 Based on the work carried out and the recommendations for mitigation above, the current massing proposal for the Development is **acceptable** for windiness in the context of the currently intended overall Liverpool Waters approved consent.

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