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ENVIRONMENT

London Borough of Merton
Wimbledon Park Lake

Flood Study: Summary Note

July 2019

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1. INTRODUCTION

1.1 Wimbledon Park Lake (WPL) is located within Wimbledon Park, in the London Bourgh of Merton. A location plan is included within **Figure 1.1**.

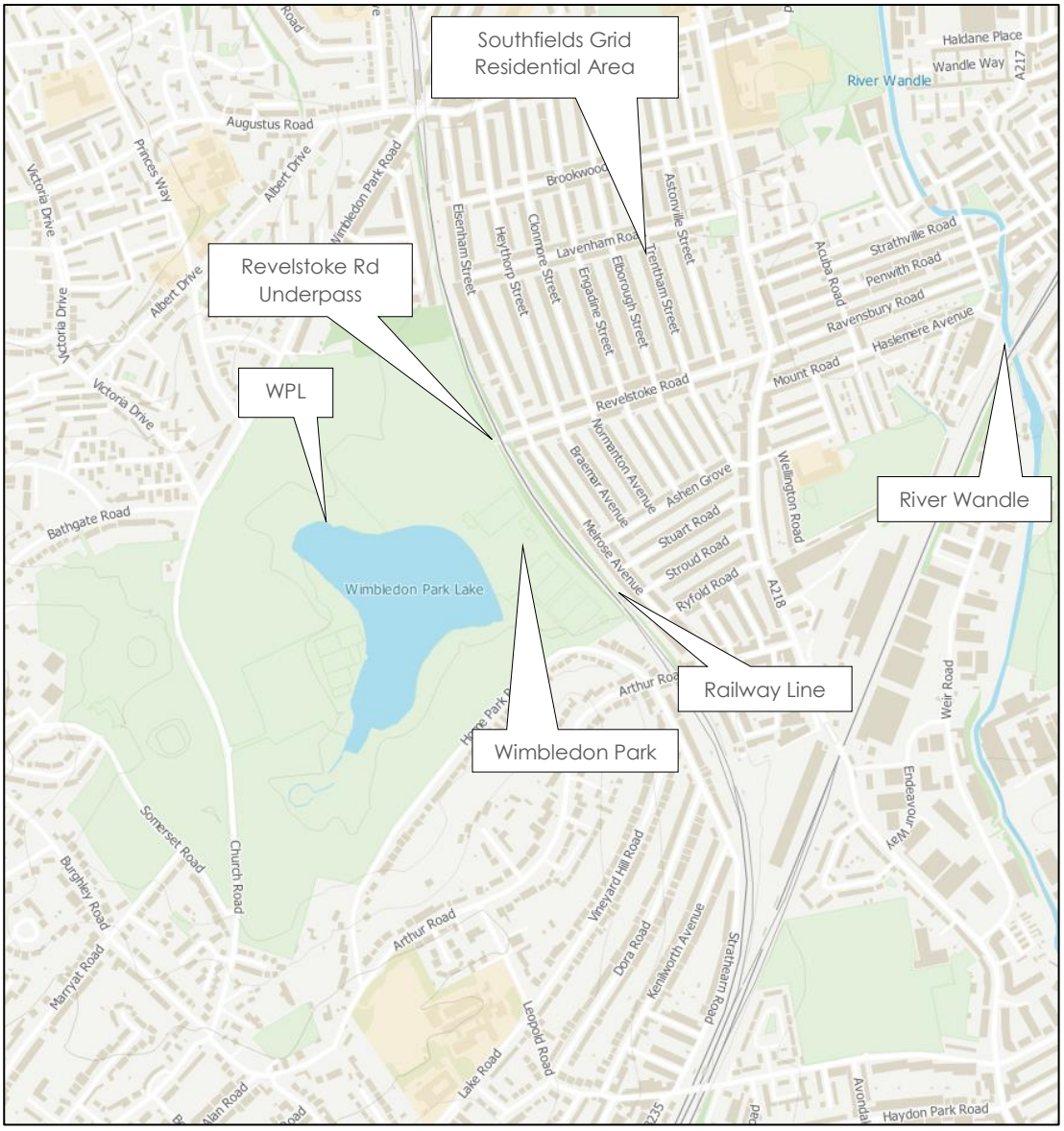

Figure 1.1: WPL Location Plan 1

1.2 The lake was created in 1765 and is designated as Grade II in Historic England's Register of Parks and Gardens of Special Historic Interest. The lake is used for a variety of recreation and amenity uses.

1.3 WPL is retained by an earth-fill dam approximately 320m long and 4m high. The lake has a surface area of approximately 9.6 hectares and a potential capacity of around 160,000m³, although a large proportion of this capacity is currently lost to accumulated silt.

1.4 Main inflows into the lake are by two 900mm diameter Thames Water surface water sewers, in addition to a number of smaller private drainage pipes. These serve an upstream catchment of approximately 2.54km².

1.5 Two small diameter outlet pipes are present through the dam. One feeds an ornamental 'Waterfall Garden' which is set into the downstream face of the dam. The second provides a drawdown facility for the lake and so is typically not operational.

1.6 A small stepped concrete channel arrangement is located on the southern end of the dam to provide an overflow facility (see **Figure 1.2**). The outlet pipes do not have enough capacity to pass the everyday flow on the lake by themselves, and therefore the overflow operates under normal conditions, thereby determining normal water levels in the lake.

Figure 1.2: Overflow Weir Structure from Wimbledon Park Lake

1.7 The outlet pipes and overflow facility discharge to a downstream watercourse which flows through Wimbledon Park and enters pipe beneath the London Underground District Line before joining the Thames Water surface water sewer system.

1.8 The crest (top) of the dam is only a short height above normal water level, and consequently waves and flood water are regularly observed to flow over the dam leading to shallow flooding of the downstream park.

1.9 The potential for a failure (or breach) of a dam is worsened by flood water and waves flowing over a dam structure leading to erosion of the downstream face and toe, compromising its structural integrity.

1.10 A breach of the WPL dam would entirely flood the downstream park, and also pose a risk to approximately 460 buildings within the downstream residential area. If a breach of the dam were to coincide with a large storm event in the upstream catchment, then the number of buildings potentially at risk of flooding could increase to approximately 1690. The potential flood envelope of a worst-case breach of the WPL dam is illustrated within **Figure 1.3**.

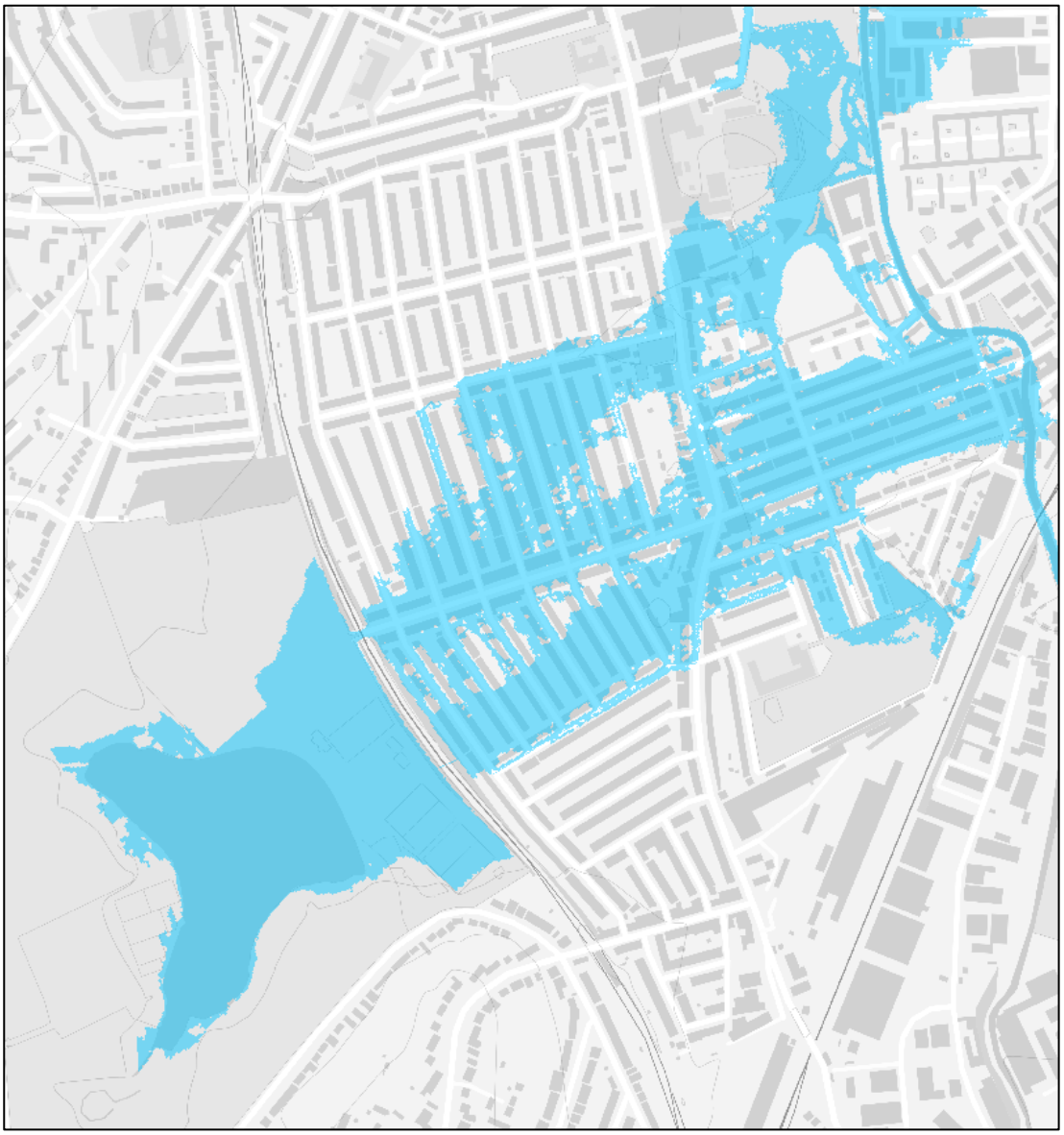

Figure 1.3: Breach Floodplain Extent (Wet Day)

1.11 The Reservoirs Act 1975 Act provides the legal framework to ensure the safety of British reservoirs that hold at least 25,000 cubic metres of water impounded above natural ground level; reservoirs such as WPL.

1.12 An All Panel Reservoirs (ARP) Engineer's statutory April 2014 inspection report made recommends for the preparation of Flood Study of WPL to be taken in the interest of safety under Section 10 (6) of the Reservoirs Act 1975.

1.13 This report provides a summary of the Flood Study which was undertaken across two stages:

- Stage 1 of the flood study included a hydrological assessment of WPL's catchment, and a hydraulic assessment of the current dam and overflow.
- Stage 2 of the study outlined indicative options that could be undertaken to improve the dam to meet the safety standards as recommended by the Institute of Civil Engineers (ICE) on behalf of the Department for Environment, Food and rural Affairs (DEFRA).

2. RESERVOIR SAFETY STANDARDS

2.1 It is required to consider of a combination of extreme flood events with wind interactions to ensure that the probability of the dam being overtopped in an uncontrolled manner by flood water or wave run up is very low.

2.2 Floods and Reservoir Safety guidance prepared by the ICE identifies the categories of dams and the degree of security required. WPL has been classified as a 'Category A' reservoir by the Environment Agency (EA). This is a dam whose failure would affect a community of 10 people or over.

2.3 The flood events considered under the legislation for a Category A reservoir far exceed those that would normally be assessed for a 'standard' flood study for a river or coastal environment:

- **Design flood conditions**: 0.01% Annual Exceedance Probability (AEP) flood combined with mean annual maximum wind speed.
- **Safety check flood conditions**: Probable Maximum Flood (PMF) and mean annual maximum wind speed.

2.4 To meet the required safety standards, essentially no overtopping of the dam should occur during the design flood or safety check flood conditions, and the crest of the dam should be a minimum of 0.6m above the design flood level.

3. HYDRAULIC REVIEW OF WIMBLEDON PARK LAKE

3.1 To identify WPL current performance against the minimum safety standards, a hydraulic computer model was produced. This included hydrological inflows from the upstream catchment, and hydraulic representations of the lake, the overflow structure, the dam crest, the downstream Thames Water sewer and the floodplain between the lake and the River Wandle, including the Southfields Grid residential area.

3.2 Whilst the reservoir safety standards are mainly concerned with the design flood and safety check flood conditions, a range of smaller 'standard' flood events, more typically associated with the flood risk from watercourses, were also assessed to identify the downstream floodplain extent and properties/businesses potentially at risk.

3.3 Within these 'standard' flood events the latest climate change allowance(s) for river flows were applied (+35% and +70%) to represent the potential future conditions.

3.4 The hydraulic assessment confirmed that the dam crest is overtopped in all events investigated: from the 20% AEP event through to the design flood (0.01% AEP) and the safety check flood events (the PMF). The reservoir safety standards require no overtopping of the dam in these events.

3.5 As the flood surcharge water level for all return period events exceeds the height of the dam, it can be concluded that wave overtopping also occurs at rates in excess of the reservoir safety standards.

3.6 Therefore, WPL does not currently meet the safety standards required of Category A dam.

4. FLOOD RISK REVIEW

4.1 Once flood water has overtopped the dam it is directed towards the culverted system beneath the railway line, and the Thames Water sewers beyond. The culvert has a limited capacity which causes flood water to build within the park behind the railway line.

4.2 In all magnitude events up until the 1.0% AEP flood event with a 35% allowance for climate change, flood water is contained within the park, and drains slowly over time to the River Wandle via the railway culvert and Thames Water sewer network.

4.3 At larger events, flood water in the park builds to such a level that it can flow through the Revelstoke Road underpass, into the Southfields Grid residential area, and into the River Wandle beyond. The number of buildings within the Southfields Grid potentially affected by overtopping flows from WPL are provided within **Table 4.1.**

Table 4.1: Number of Building Potentially Affected in Southfields Grid

Annual Exceedance Probability	20%	5.0%	1.0%	0.67 %	0.50 %	1.0% +35%	1.0% +70%	0.10 %	0.01 %	PMF
Number of Buildings Affected	0	0	0	0	0	0	848	1090	1428	1795

5. OUTLINE OPTIONS APPRAISAL

5.1 The primary objective of the appraisal was to outline indicative options to satisfy the required safety standards for a Category A dam and reduce the risk of a failure. Specifically, to allow the safe passage of the design flood and safety check flood, and reduce wave overtopping to acceptable levels.

5.2 This objective could be met using a combination of the following:

- Construction of a new overflow with a greater capacity.
- Construction of a new auxiliary overflow offering an alternative flow route over the dam.
- Raising of the dam height, or provision of a wall or similar, to prevent overtopping of the dam by waves and flood surcharge.

5.3 A 'long list' of eleven options was prepared, each outlining variation of the three parameters identified above.

5.4 Following stakeholder consultations four of the options were shortlisted and brought forward for an outline appraisal. This included conceptual design, indicative costs, and hydraulic modelling to assess potential downstream impacts.

5.5 A summary of the four options is presented within **Table 5.1**.

5.6 All four options result in a reduction in precited flood levels within Wimbledon Park due to an increase in the flood attenuation offered by the reservoir.

5.7 A degree of flood relief is also predicted within the Southfield Grid residential area, and an example of the numbers of buildings potentially removed from flood risk for each option is presented within **Table 5.1**.

5.8 While the short-listed options would address the reservoir safety requirements, they could also impact the appearance and use of the lake. Following stakeholder engagement, a list of possible pros and cons for each option are also presented within **Table 5.2**.

Table 5.1: Summary of Indicative Short-Listed Options

Short Listed Option	Summary	Relative Costs		Flood Risk within the Southfields Grid	
		Construction	Annual Maintenance	Return Period Event	Buildings potentially removed from risk
1	Existing overflow retained. Reinforce the dam crest by rebuilding the footpath. Reinforce the downstream face of the dam through the installation of erosion protection across most of the embankment. Thereby allowing the dam to act as an auxiliary overflow to safely convey the design and safety check flood events, and wave overtopping. Dam crest raised circa 0.25m.	Medium-Low	Highest	**1 in 100+70%**	304
				1 in 1,000	274
				1 in 10,000	191
2	Existing overflow widened to 14m and lowered 0.35m An auxiliary spillway constructed to convey flood surcharge events up to the design and safety check events. Where the footpaths rise to the top of the embankment and access needs to be preserved, the downstream dam face will be protected. A wall will be added to raise the dam crest, by circa 1.10m. This will prevent overtopping in flood surcharge conditions and will also control wave overtopping.	Lowest	Lowest	**1 in 100+70%**	299
				1 in 1,000	275
				1 in 10,000	189

Short Listed Option	Summary	Relative Costs		Flood Risk within the Southfields Grid	
		Construction	Annual Maintenance	Return Period Event	Buildings potentially removed from risk
3	Existing overflow widened to 14m and lowered 0.35m An auxiliary spillway will be constructed to convey flood surcharge events up to the design and safety check events. Similar to Option 2. Instead of a wall, the embankment crest would be raised 1.10m so that the footpath is effectively elevated above its current position, which will prevent overtopping in flood surcharge conditions and will also control wave overtopping. Level access for boating amenity would be provided along a new auxiliary overflow.	Highest	Medium-High	**1 in 100+70%**	300
				1 in 1,000	276
				1 in 10,000	202
4	Existing overflow widened to 14m and lowered 0.35m An auxiliary spillway will be constructed to convey flood surcharge events up to the design and safety check events. Similar to Option 3, but this option sees the crest of the dam increasing circa 1.10m, through relocating the footpath circa 3m further into the lake, and an additional embankment constructed in the footpath's current location. i.e.: this option requires a decrease in reservoir footprint through the construction of a new sheet pile bank approximately 3m away from the existing bank. Behind the new sheet pile would be back filled using suitable material to effectively widen the existing footpath.	Medium-High	Medium-Low	**1 in 100+70%**	300
				1 in 1,000	276
				1 in 10,000	202

Table 5.2: Indicative Shorted Options Pros & Cons

Shortlisted Option	Pros	Cons
1	• Addresses reservoir safety requirements • Minimises alterations to WPL • Access to the lake largely unchanged • Offers some downstream flood relief • Normal water level potentially unaltered	• May require tree removal, subject to the installation of erosion matting • Slight increase in dam crest height required to install improved surfacing • Overtopping flows and waves still present across the full length of the dam
2	• Addresses reservoir safety requirements • Offers some downstream flood relief • Overtopping flows and waves occur at designated locations	• Requires existing dam to be of sound structural integrity • Wall foundations could encroach upon tree roots and utilities • The wall cannot provide a full liner defence if access routes are to be preserved • Normal water level lowered marginally, which could trigger the need for de-silting to preserve amenity use. • Angling Club building may need to be relocated to accommodate the new overflow structure
3	• Addresses reservoir safety requirements • Offers some downstream flood relief • Overtopping flows and waves occur at designated locations • Replaces degraded lake frontage as part of option	• Requires dam to be of sound structural integrity • Requires removal of trees on the dam crest • Potentially affects access to the lake – limited to auxiliary overflow • Normal water level lowered marginally, which could trigger the need for de-silting to preserve amenity use • Potentially requires the import of material (but may be found in the wider park) • Raising of the dam crest may not be in keeping with the heritage asset • Angling Club building may need to be relocated to accommodate the new overflow structure
4	• Addresses reservoir safety requirements • Offers some downstream flood relief • Overtopping flows and waves occur at designated locations • Replaces degraded lake frontage as part of option • Preserves level access to the lake	• Results in the marginal loss of some of the lake • Requires removal of trees on the dam crest • Normal water level lowered marginally, which could trigger the need for de-silting to preserve amenity use • Potentially requires the import of material (but may be found in the wider park) • Raising of the dam crest/ loss of lake are may not be in keeping with the heritage asset • Angling Club building may need to be relocated to accommodate the new overflow structure

6. WIDER CONSIDERATIONS

6.1 While this assessment has focused upon addressing the reservoir safety requirements, the exercise has identified other associated opportunities that could be considered during future phases of the project that may offer additional benefits.

Outlet Structure

6.2 The outlet pipe next to the existing overflow may need to be replaced in any option which amends the overflow due to its proximity.

Angling Club Relocation

6.3 If a new overflow is constructed it may be necessary to remove the existing angling club building and relocate it.

Stilling Pond

6.4 It may be beneficial to implement erosion control measures at the existing stilling pond to promote its longevity and reduce maintenance requirements.

Downstream Watercourse

6.5 It has been observed that the existing watercourse through Wimbledon Park, between the stilling pond and the railway line, has limited capacity which is exacerbated by restrictive culverts. The watercourse is reported to require regular maintenance and has been the cause of historic flooding of the park.

6.6 The watercourse through the park could be improved to increase hydraulic capacity, thereby reducing the probability of localised flooding. This could be done in a manner which also re-naturalises the channel, thereby helping any future scheme to deliver a biodiversity net gain.

Lake Frontage

6.7 The sheet piling which currently forms the lake frontage is in a visually poor condition in places. It is understood that this is not a structural element of the dam but is a cosmetic measure which forms an edge to the footpath. Nevertheless, if works to the dam are being undertaken it may prove to be cost effective and less disruptive to the public in the long term if the sheet piling was addressed at the same time.

Local Sewers/Drainage

6.8 The reservoir is fed from multiple upstream sewer networks. There is an opportunity to 'day-light' a stretch of these immediately upstream of the reservoir. This would help re-naturalise the appearance of the lake. It could also facilitate the formation of reed beds on the sewer outlets. The reed beds would help to remove silts upstream of the lake, potentially slowing the accumulation of sediments in the lake itself.

6.9 While this would not directly affect the reservoir safety requirements it would help any future scheme deliver a biodiversity net gain.

6.10 The provision of Sustainable Drainage Systems (SuDS) in the upstream catchment could also help remove sediments and pollutants from surface water runoff before they reach the reservoir.

Wider Stakeholder Land Ownership

6.11 This flood study has limited its appraisal to land within the London Borough of Merton's ownership. However, if wider land around the reservoir were available then the potential impacts of the reservoir safety works could potentially be better offset.

6.12 For example, any loss in the lake's areas due to increasing the dam height could be offset by increasing the lake area upstream. Providing an overall gain in lake area could also potentially offer additional flood storage and downstream flood risk benefits.

6.13 Additionally, the existing waterfront access could be relocated away from the dam, around the side of the reservoir, thereby resolving some of the potential access issues.

Reservoir De-silting

6.14 There is significant silt build up within the reservoir which anecdotally causes issues for the sailing and fishing on the reservoir and the depth of water/silt also has some impact on the potential for algae blooms and water quality.

6.15 While there is no direct requirement as part of the reservoir safety works to desilt the reservoir, lowering normal water level to potentially accommodate a new overflow structure could necessitate silt removal to preserve amenity use in the reservoir.

Revelstoke Road Flood Defence

6.16 While the indicative options all provide a reduction to downstream flood risk, there remains a flood route from the park to the downstream residential area via the Revelstoke Road underpass at extreme flood events.

6.17 Further flood relief could be offered to the residential area through reprofiling of ground levels in the park upstream of the underpass, as to create an elevated landform between the floodplain and the road.

7. SUMMARY

7.1 BWB Consulting have been instructed by the London Borough of Merton to undertake a Flood Study of the Category A large raised reservoir known as Wimbledon Park Lake (WPL), located within Wimbledon Park, Merton.

7.2 The Stage 1 hydraulic assessment identified that the existing configuration of the dam and overflow do not meet the required safety standards. This is because the dam crest is subject to uncontrolled overtopping during flood surcharge and wave run up events.

7.3 The Stage 2 option appraisals outlines potential options to meet the required safety standards. Indicative design, cost estimates costs and hydraulic modelling of the options has been completed.

7.4 All of the shortlisted options offer flood relief to the downstream catchment and residential area.

7.5 Whilst the principles of what has been described in this report are sound, it may be found that during future phases that there are additional constraints have not been considered and the Options Appraisal should be reconsidered.

7.6 The hydraulic modelling results and costs are of indicative options, are subject to change during detailed design.