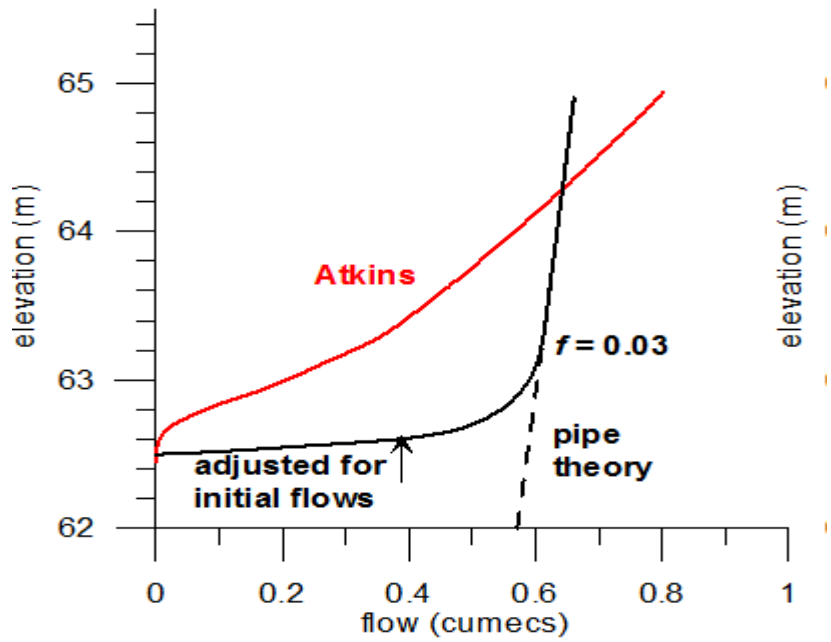
INDEPENDENT REVIEW OF HAMPSTEAD HEATH PONDS PROJECT

Data request to Atkins, 28/10/14 – Final status 26/11/2014, including other info

RFI No.	Description	Date requested	Comment / action	Date received (sent to AECOM)
N/A	- Planning Design & Access Statement (July 2014) submitted with planning application, for an initial general overview of the proposed development - Design Flood Assessment Report (March 2013) - Preferred Solution Report (June 2014) - Planning Drawings and Design Documents (July 2014) submitted with planning application - Previous studies by engineering firms (detailed below) *The documents not hyperlinked are available via the Council's website and via CD upon appointment.*		Provided with Scope of Independent Engineer Review - Supporting Information	Issued to Camden 11/09/2014
N/A	Panel Engineer presentation	N/A	Powerpoint presentation given at meeting with AECOM on 01/10/2014	CD sent to AECOM 8/10/2014
N/A	HHPP Hydrology presentation	N/A	Powerpoint presentation given at meeting with AECOM on 01/10/2014 by Margaretta Ayoung	Memory stick given to AECOM 01/10/2014
N/A	Design Flood Assessment Report rev4 (Atkins, March 2013)	01/10/14	Also available on Ponds Project website.	CD sent to AECOM 8/10/2014
N/A	Atkins response to LBC queries on objection from Brookfield Mansions.	20/10/14	Email sent from Atkins to Camden,	Email forwarded to AECOM

			who forwarded it to AECOM.	around 21/10/2014.
1	Atkins has updated the dam breach modelling and consequence assessment. A copy of the updated report to be forwarded to AECOM	01/10/14		Consequence assessment (Technical note with updated ASLL) received from Atkins 14/10/14. QRA Update summary sent by LBC (Jonathan Markwell) on 6/11/14.
2	Analysis of the critical storm duration indicated a much longer critical duration for the PMF event. Atkins will provide their explanatory note	01/10/14		Received 21/10/14
3	Atkins will prepare an explanatory note on the assessment of the impact of the scheme on the Thames Water network.	01/10/14		Received 15/10/14
4	Judicial review documents, redacted where necessary, to be forwarded to AECOM	01/10/14	Relevant parts sent to AECOM by City of London. Camden council have whole document.	Statement of grounds and witness statements received 15/10/14
5	Provide ASLL for each chain of reservoirs separately (possibly include in the updated consequence assessment)	01/10/14	This analysis of separate chains was not done as part of the QRA modelling.	Responded 20/10/14
6	Outline costs for the preferred schemes for each chain	07/10/14	CoL sent outline costs direct to AECOM.	Outline cost for whole scheme received 15/10/14
7	Pre (with and without breach) and post scheme outflow hydrographs for Highgate No.1 and Hampstead No.1 ponds for the PMF event, indicating the amount of each that enters the downstream drainage network, and the amount that flows overland. Hydrographs for lesser return period events would also be useful if available.	07/10/14	Available info sent 17th October. Atkins haven't modelled hydrographs for post-scheme PMF/other events with breaching, as	Received 17/10/14

			the second part of the QRA (for the preferred design scenario) has not been carried out yet.	
7a	Query regarding high flows post breach (RJM email 23/10/14).	23/10/14		Answered in email sent 3/11/2014.
8	Check critical duration for preferred scheme and report any change	07/10/14	Complete and critical duration does not change.	24/10/14
9	Derivation of the assumed time to final breach of 1.5 hours	07/10/14	Based on engineering judgement (Tony Bruggemann 22/10/14)	22/10/14
10	Confirmation that the works will include, where practicable, measures to address other defects or shortcomings (leakage/settlement, integrity and adequacy of outlet arrangements etc) as judged appropriate for reservoir safety and to future-proof the works	07/10/14	BJ to draft email confirmation of this, for AH to review.	15/10/14
11	Abstract the ASLL for each “branch” and for the common “stem” of the Y (inundation area) just from your current run, both for PMF and for PMF-plus-breach. We do not require any additional runs to be carried out.	24/10/14	No longer required – evidence found from previous Haycock report on proportion of ASLL for each chain	
12	Explanation of the Atkins rating curve for the outlet pipe at Highgate 1 in Professor Rushton’s paper.	28/10/14		Answered in email sent 11/11/2014 and follow-up query replied to 12/11/2014.


65
64
63
62
elevation (m)
Atkins
f = 0.03
pipe
theory
adjusted for
initial flows
0
0.2
0.4
0.6
0.8
1
flow (cumecs)
elevation (m)

HHPP RFI 1 Consequence Assessment

From: Jones, Ben
Sent: 14 October 2014 13:14
To: 'Hay-Smith, Debbie'
Cc: Hughes, Andy; Wanner, Tom; Woolgar, Mike J; Farrar, Joanne; Mann, Robert J; Downs, Chris
Subject: HHPP Consequence Assessment
Attachments: TN Basement Flat Survey ASLL Draft 300914 issued.pdf

Debbie
For request No.1 in your table. The updated interim QRA report will follow shortly.
Regards
Ben

Water & Environment
ATKINS
75 years of design, engineering and project management excellence

Epsom Gateway, 2 Ashley Avenue, Epsom, Surrey, KT18 5AL | Web: http://www.atkinsglobal.com |

Memo

To:	Jonathan Markwell, London Borough of Camden		
From:	Joanne Farrar	**Email:**	joanne.farrar@atkinsglobal.com
Phone:	02032148889	**Date:**	5 Nov 2014
Ref:	5117039	**cc:**	
Subject:	Hampstead Heath Ponds Project QRA Update		

Update to Interim QRA

An interim Quantitative Risk Assessment (QRA) was originally carried out in August 2013 at the request of the Stakeholders to understand the scale of the risks associated with the failure of the ponds within both chains in their current condition. It was prepared prior to the finalisation of the design and any planning approval and conditions and before work has been started on site. A QRA is typically applied to compare the risk associated with various options to allow for risk-based decision-making and should not be used as the basis of design. The final QRA will be undertaken to demonstrate the 'as-built' risk once the project has been implemented. The Dams will have been excavated and remodelled, and some of the currently known defects will have been improved. It is not considered appropriate to provide a further update to this interim version at this stage, however this note summarises the key issues.

In the current situation the two cascades of ponds are in the "unacceptable" range (Figure 1) due to the estimated likely loss of life in accordance with the QRA methodology. The estimated likely loss of life depends on the type of failure modes, probability of the failure modes occurring, the volume and rate of the water released on collapse of the ponds, the effect of the water released in terms of velocity and depth of flow and the number of people in the downstream area who could be affected.

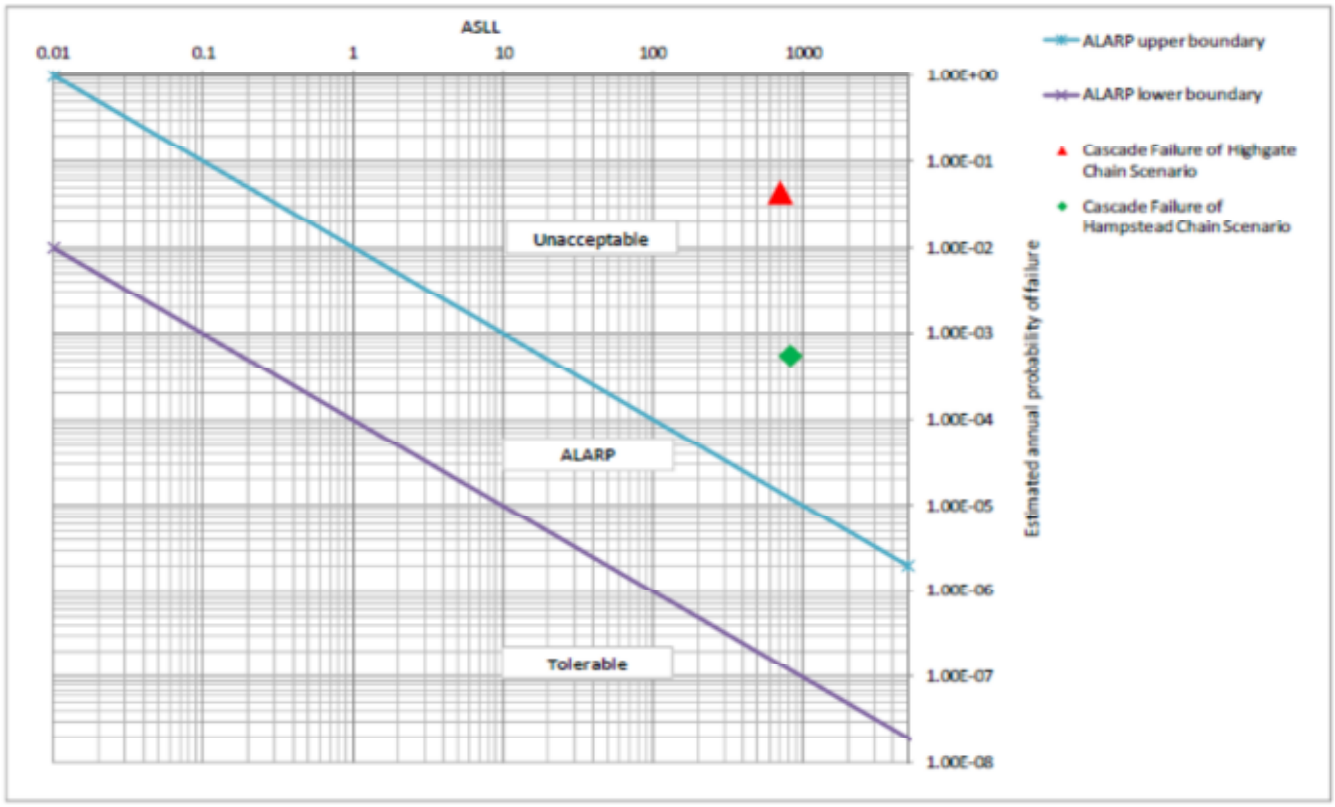


Figure 1: Assessment of Risk Tolerability (Existing)

Memo

The failure modes for this type of earth dam are: overtopping leading to erosion; internal erosion (piping) due to water finding a way through the dam and eroding a path through the earth leading to a collapse of the crest and release of water; and a slope failure leading to a drop in the crest and release of water. The assessment under QRA shows that the dominant (most likely) failure mode is overtopping leading to erosion. The other failure modes have relatively insignificant probabilities. The designs we have prepared are principally to virtually eliminate the probability of failure by ensuring that the dams will not overtop and hence will not erode even in the most extreme case we can consider: the PMF. When the probability of the overtopping failure mode (the dominant mode) is reduced to 0 the probabilities of the other 2 modes remain extremely small (and could be further reduced due to the works we will be doing to raise, stabilise or restore crests). This moves the cascades from “unacceptable” (Figure 1) to “acceptable” (Figure 2) as we would anticipate. Once the designs have been approved it will be possible to do a final assessment: the probability of overtopping failure will remain zero and the other failure modes can be reviewed based on the new materials added and the new shapes of the dams. We will not be doing anything which will not improve the stability or internal erosion risk so the outcome will be more favourable.

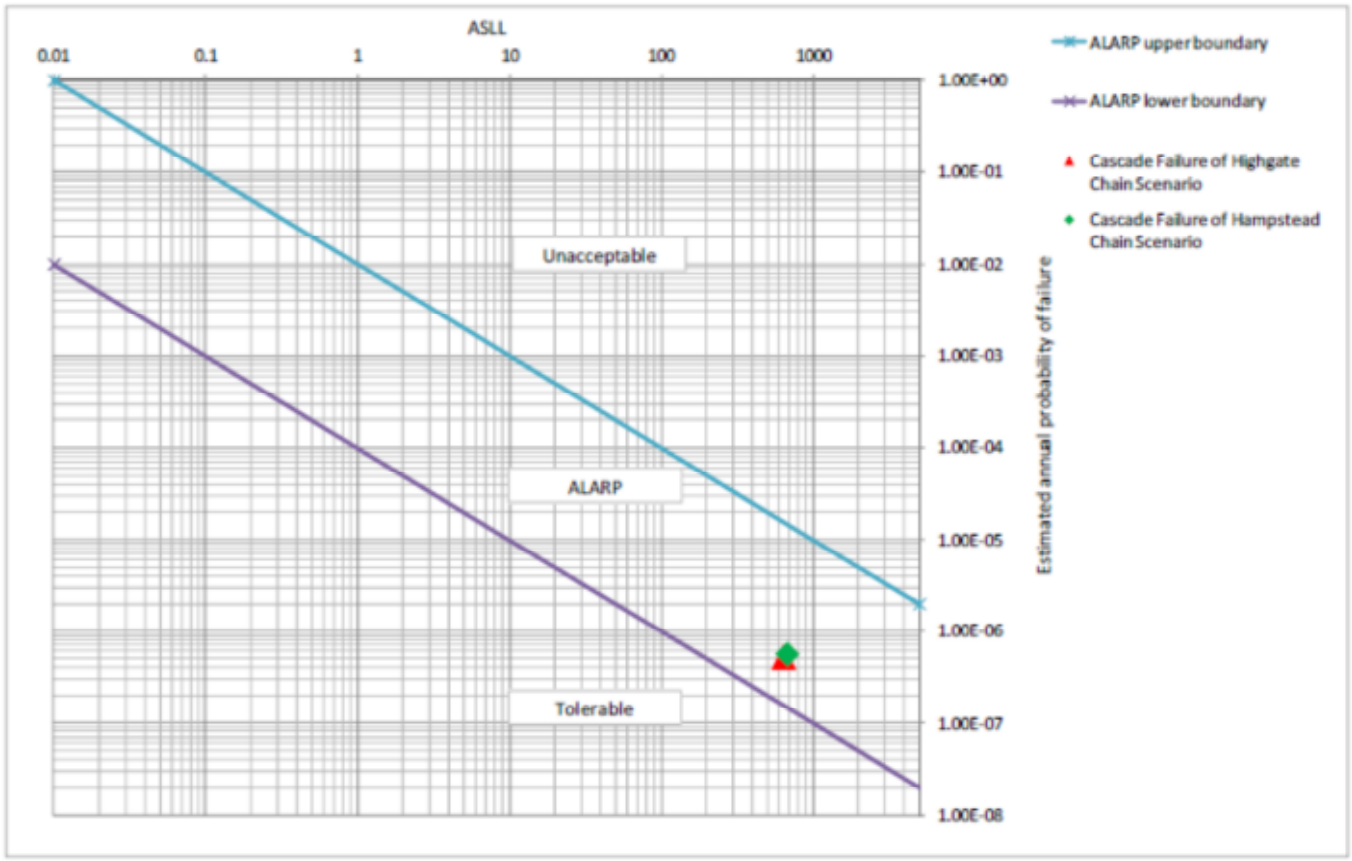


Figure 2: Assessment of Risk Probability (Proposed Design)

CITY OF LONDON

Consequence Analysis Technical Note

DRAFT

Notice

This document and its contents have been prepared and are intended solely for The City of London Corporation's information and use in relation to the Hampstead Heath Flood and Water Quality Management works.

Atkins' Planning assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

This document has 13 pages including the cover.

Document history

Job number: 511			Document ref:			
Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
1.0	Draft for comment	NW	AMC	MJV	MJW	30/09/14

Client signoff

Client	The City of London Corporation
Project	Hampstead Heath Flood and Water Quality Management Works
Document title	Consequence Analysis Technical Note
Job no.	5117039
Copy no.	
Document reference	

Table of contents

List of Tables

List of Figures

1. Introduction

Aims and Objectives

1.1 This Technical Note outlines the Average Societal Life Loss (ASLL) assessment completed to estimate the potential impact of breach and overtopping scenarios of Hampstead Heath ponds.

1.2 The original ASLL assessment, completed in September 2013, highlighted the number of residential properties and flats in the "at risk" area, and how the assumptions relating to the number of basement flats could impact on the ASLL value. There are 6,937 flats, out of a total of 9,034 residential properties, in the "at risk" area. As this property type dominates the residential total, the assumptions applied to flats are most likely to have an impact on the ASLL totals. In the absence of a site survey the September 2013 assessment tested sensitivity on the assumptions made regarding basement flats and the impact on the ASLL totals. This indicated that assumptions relating to basement flats could have a large impact on the ASLL total.

1.3 The National Receptor Data Base (NRD) indicates which flats are ground floor and which are upper floor, but does not indicate which are basement flats. Site visits and existing knowledge of the "at risk" area suggested that there may be a large number of basement flats in this area of London. The level of flood risk for a basement flat is greater than that of ground and above ground floor flats, and so a more detailed evaluation has been made.

1.4 This Technical Note outlines the methodology used for updating the NRD to give a more accurate account of the number of basement flats in the "at risk" area, and thus improve the confidence in the ASLL assessment.

2. Hydrological and Hydraulic Modelling Methodology

2.1 Hydraulic modelling used in this study is based on that reported in "Dam Breach Assessment Technical Note", July 2013 and "Assessment of Design Flood", March 2013; the sections below summarise the results.

2.2 It should be noted that the flood outlines contained in this report are those issued in April 2014, and differ from those used to undertake the original ASLL assessment in September 2013. The flood outlines applied in this assessment are slightly less extensive than those applied in the September 2013 assessment. The principle cause of the difference in flood outlines is the removal of the A400 road bridge from the Digital Terrain Model which, in the September 2013 model had prevented flood flows from travelling south-eastwards in the railway cutting towards St Pancras station. The Digital Terrain Model is based on LiDAR data which had taken the ground level as the A400 road, rather than the railway cutting beneath it. Removal of this bridge in the hydraulic model resulted in more flood flows travelling within the railway cutting, and reduced flood extents and depths in the Kentish Town area. Figure 2-1 shows the location of the removed A400 road bridge.

Overtopping Assessment

2.3 The hydraulic model was run with the PMF event with no breach of dams/embankments to assess the impact of overtopping in isolation, and for comparison against the breach scenario. The difference in ASLL can be used to gauge

the residual risks posed by the dams breaching during the Probable Maximum Flood (PMF).

2.4 The following figure illustrates the flood outline used to assess the overtopping scenario ASLL for the PMF.

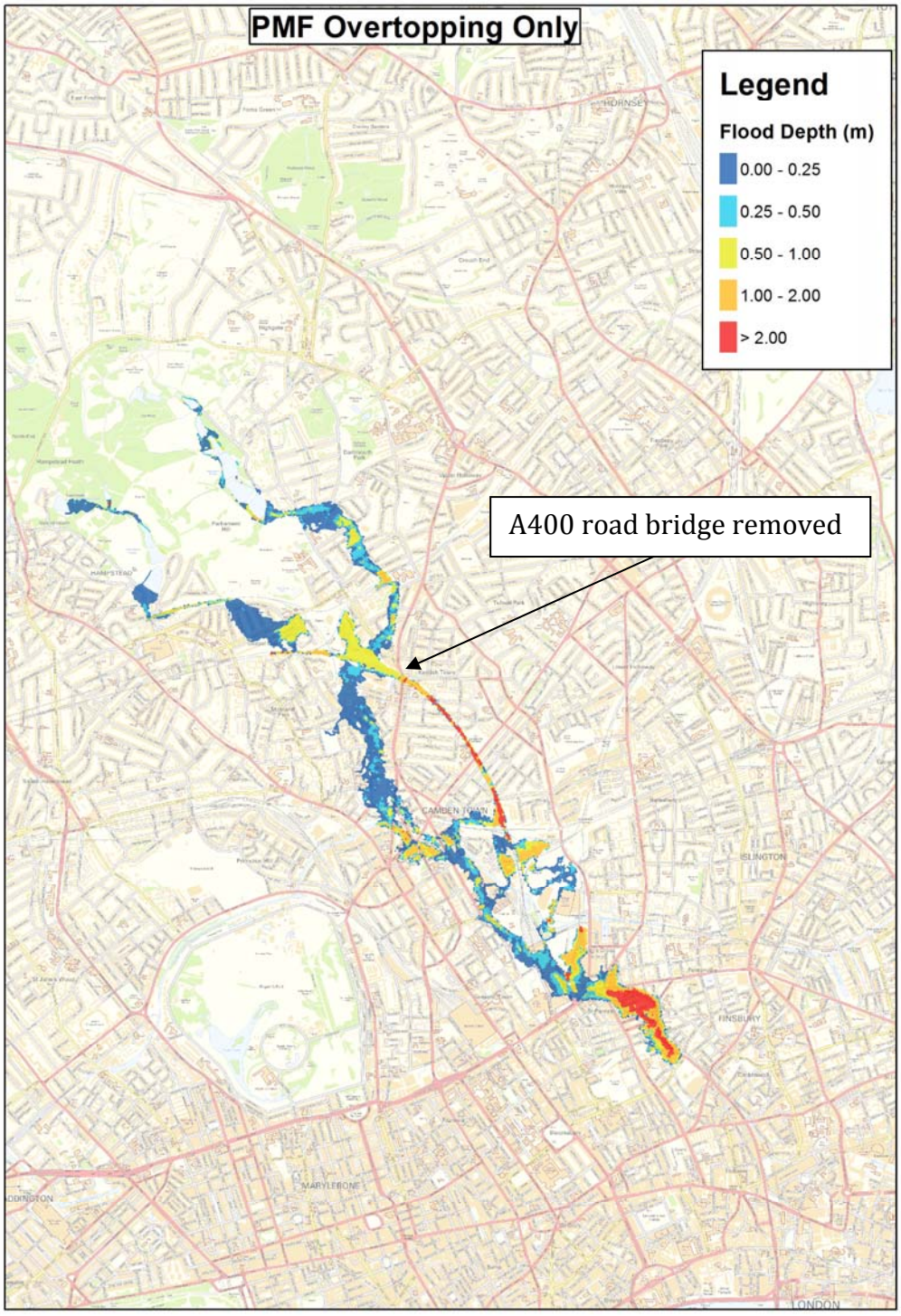


Figure 2-1: Overtopping Assessment Flood Depths

Breach Assessment

2.5 The breach assessment is based on a worst case scenario in which all the dams/embankments breach. Breach parameters were estimated using the Froehlich assessment methodology (Froehlich, D. C. 1995. Peak outflow from breached embankment dam. ASCE Journal of Water Resources Planning and Management 121(1), 90-97) to calculate breach width. All other parameters were based on guidance from the Lead Engineer and included: the assumption that the breach starts 1 hour after the start of overtopping; the time to final breach is 1.5 hours after the start of breaching and the height of the breach is the full height of the dam. The key breach parameters for each pond are displayed in the following table.

Table 2.1: Summary breach parameters

Pond Name	Pond Element						
	Dam length (m)	Dam elevation (mAOD)	Storage Volume (m^3)	Dam height (m)	Breach base level (mAOD)	Breach start time (hrs)	Time to final breach (hrs)
Highgate Chain							
Stock	59.65	81.65	6400	4.5	77.15	3:30	1.5
Ladies Bathing	23.39	76.87	14200	3.73	73.14	5:05	1.5
Bird Sanctuary	60.46	72.57	13000	2.1	70.47	5:10	1.5
Model Boating	73.02	71.87	46000	5.3	66.57	5:40	1.5
Men's Bathing	122.16	68.16	55000	4.7	63.46	5:55	1.5
Highgate No 1	129.98	63.77	42800	3.81	59.96	6:10	1.5
Hampstead Chain							
Vale of Health	129.83	105.44	17800	5.7	99.74	5:50	1.5
Viaduct	65.40	89.97	5000	4.27	85.70	6:00	1.5
Mixed Bathing	69.98	75.46	11900	4.4	71.06	6:00	1.5
Hampstead No 2	104.71	74.91	25400	5.19	69.72	6:00	1.5
Hampstead No 1	120.74	70.91	50600	4.44	66.47	6:40	1.5

2.6 Figure 2-2 illustrates the flood outline used to assess the PMF breach scenario ASLL.

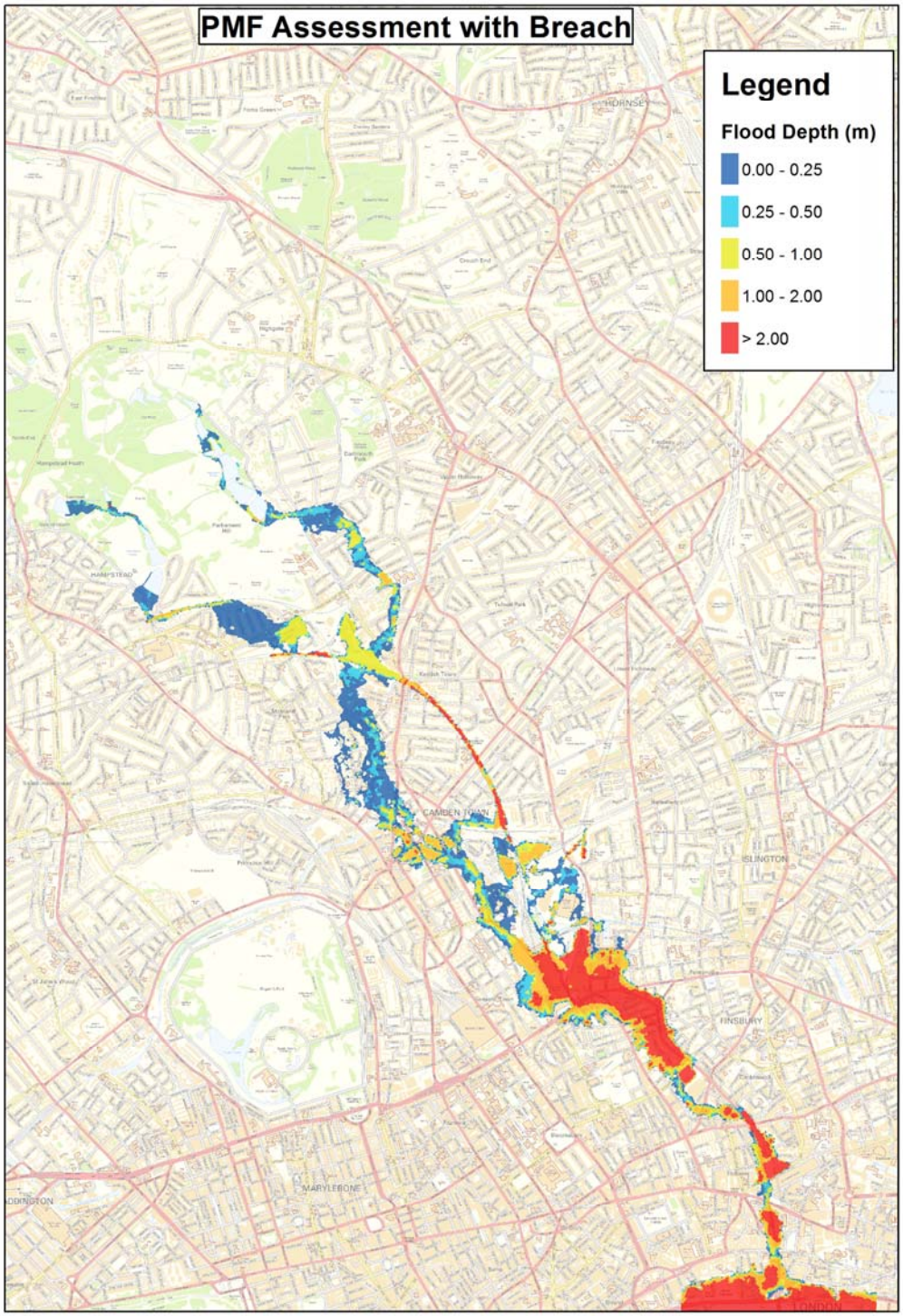


Figure 2-2: Breach Assessment Flood Depths

3. Basement Flat Identification Methodology

3.1 This section outlines the methodology followed to identify the basement flats and undertake the ASLL assessment.

3.2 The existing NRD dataset contains information pertaining to building use and type. This information is limited in its use for ASLL assessments as those properties categorised as subterranean developments, better known as and hereafter referred to as basements, are more vulnerable to inundation and therefore the associated loss of life. The methodology can be split into three stages, as outlined below:

- Stage 1: Screening the existing NRD, firstly using the 'OS_Class' field to limit the data to 'dwellings' to identify residential properties. Further screening using the field 'housetype' was then carried out to leave just residential properties that contain flats. The generated maximum flood outline was extended by 10 metres to ensure the coverage of properties considered was comprehensive. The buffered maximum flood outline was then used to clip the screened NRD. The resulting data set contained 11,119 properties that could contain basement flats in the "at risk" zone;

  Stage 2: The 11,119 properties were added to a QGIS workspace and a virtual walkover survey was carried out for each property using the plug in 'go2streetview'. A field 'Surveyed' was added to the attribute table and properties were recorded as either 'No Access', 'No Basement Flats' or 'Basement Flat'. For the properties identified as having a basement flat, only one basement flat was recorded at each property (unless more were clearly identifiable);

- Stage 3: For the properties identified as 'No Access' during the 'go2streetview' survey, a site walk over survey was carried out on 24 September 2014. This site walkover also allowed validation of the areas where basement flats had been identified.

3.3 For the purpose of this investigation basement flats were defined as any property partly or entirely below ground level without access to above properties, and for whose occupants the only means of access or egress was through a point below ground level. As detailed above, only one basement flat was recorded at each property as the definition of a basement flat used in this assessment and the limitations of a 'go2streetview' survey mean that variations in internal property layout cannot be accounted for.

4. Average Societal Loss of Life Assessment Methodology

4.1 The approach to calculating the ASLL is in line with that stated in the "Guide to risk assessment for reservoir safety management Volume 2: Methodology and supporting information" produced by the Environment Agency in March 2013.

4.2 The methodology can be split into two stages, as outlined below:

- Stage 1: Population At Risk (PAR): the flood outlines were extracted from the InfoWorks 1D-2D model and overlain on the National Receptors Database (NRD). For each residential property the PAR is 2.35 multiplied by the number of residential properties, but then reduced to account for assumed occupancy rate (80%) during an event. For each Non-Residential Property (NRP), the number of people affected is linked to the floor area of the property (one person per 40m²).

This number is then reduced based on an assumed occupancy rate of 25%. This approach is set out in Table 9.2 of the guidance. This provides the number of people at risk per property, which is then combined with the fatality rate in the next stage to estimate the loss of life.

- Stage 2: ASLL: the maximum depth (D) and velocity (V) values from the InfoWorks 1D-2D model were extracted and applied to the properties within the flood outline. For each property the Q/W value was calculated based on 0.67*(D*V); the relationship between DV and Q/W is specified in Table 9.2 of the guidance. The fatality rate based on the Q/W value was then assessed using the No-Warning curve in Figure 9.1 of the guidance (as shown in Figure 4.1). For each property the PAR was then combined with the fatality rate to estimate the ASLL.

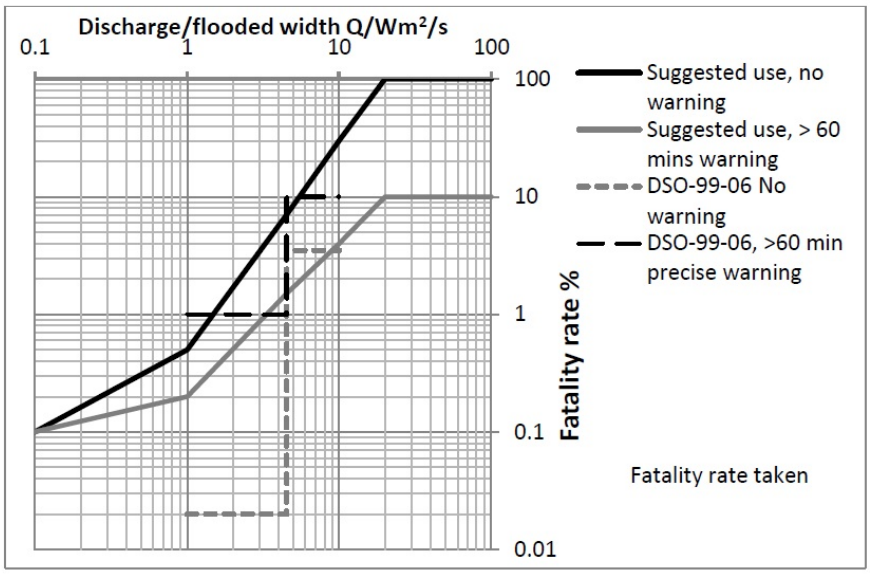


Figure 4-1: Figure 9-1 from the guidance (suggested relationship of fatality rate to force of water)

4.3 The following property types were removed from the assessment: electricity sub-stations, moorings, ponds, public telephone, play areas, post boxes and shelters.

4.4 It should be noted that this ASLL does not include potential life loss related to transport infrastructure. These losses could be considerable given the number of 'A' roads, underground and mainline links, and stations, notably Kings Cross and St Pancras stations, within the "at risk" area.

4.5 It was not considered appropriate to include all of the 6,937 flats in the assessment as the above ground floor dwellings may not be directly impacted by flood waters. Therefore, flats recorded as being above ground level have been excluded.

4.6 The baseline case includes all properties (i.e. houses, terraces, Non-residential properties) plus all flats specified as being on the ground floor: these are the base elements of all the sensitivity tests. For this baseline case no basement flats have been defined and all ground floor are treated as ground floor flats for the purposes of the hazard assessment even though a percentage of them are technically basement flats.

4.7 The following sensitivity tests were completed:

- Baseline case plus 100% fatality rate applied where DV is greater than 7. Table 9.2 of the guidance states that where DV>7 a building is completely destroyed. It was therefore considered appropriate to apply a 100% fatality rate where buildings are completely destroyed;

- Baseline case plus all basement flats with a 20% fatality rate applied (an increased fatality rate when compared to the baseline case), this assumes that a proportion of residents in basement flats would be unable to exit their property;
- Baseline case plus all basement flats with a 100% fatality rate applied (an increased fatality rate when compared to the baseline case), this assumes that all occupants in basement flats would be unable to exit their property.

4.8 No sensitivity tests were considered necessary for the assumptions relating to Non-Residential Properties.

5. Results

Street View Survey Results

5.1 Initial screening of the NRD produced a total of 11,119 residential properties recorded as being an apartment or flat, some of which could have potentially been basement dwellings. This data was then extracted from the original NRD and investigated using the QGIS plug in 'go2streetview'. Of the 11,119 flats in the buffered at risk area, 3,702 were defined as ground floor properties. This is different to the number of flats at risk in the 2013 assessment due to the change in floodplain extents. 328 properties were positively identified using 'go2streetview' as basement flats.

5.2 Following the site walkover the total number of basement flats in the at risk area was reduced to 267 as they were observed as either being part of the upper floor dwellings, or were in fact at ground level and not at basement level.

5.3 The number of basement flats was lower than expected. This was primarily due to the fact that where basements existed they were often part of the upper level properties and were not true basement flats.

Average Societal Loss of Life Assessment Results

5.4 The following tables summarise the results from the ASLL assessment. Table 5.1 compares the number and type of properties in the at risk area between the overtopping and breach scenarios.

Table 5.1: Property types in the at risk area

Property Type	Number in at risk area – PMF Overtopping	Number in at risk area - PMF Breach
Non-residential properties	683	1447
Residential Properties	5563	9034
Total Flats	4410	6937
Flats (ground floor only)	1535	2308
Flats (basement)	145	193
Total Properties	**6246**	**10481**

5.5 The table below compares the ASLL under the PMF overtopping scenario, including the sensitivity tests relating to the assumed fatality rates for basement flats and properties incurring DV>7. This indicates an ASLL of 4 people during the PMF overtopping event.

Table 5.2: Overtopping ASLL for each sensitivity test

No.	Scenario	Maximum Population At Risk	Population At Risk (including occupancy factor)	Average Societal Loss of Life
1	Baseline Case (including flats specified as ground floor or basement)	10476	6279	4
2	Baseline Case (plus 100% fatality where DV>7)			4
3	Baseline Case (including basement flats with 20% fatality rate)			58
4	Baseline Case (including basement flats with 100% fatality rate)			276

5.6 The following table compares the ASLL under the PMF breach scenario, including the sensitivity tests relating to the assumed fatality rates for basement flats and properties incurring DV>7. This indicates an ASLL of 17 people during a PMF breach scenario.

Table 5.3: Breach ASLL for each sensitivity test

No.	Scenario	Maximum Population At Risk	Population At Risk (including occupancy factor)	Average Societal Loss of Life
1	Baseline Case (including flats specified as ground floor or basement)	18758	10632	17
2	Baseline Case (plus 100% fatality where DV>7)			35
3	Baseline Case (including basement flats with 20% fatality rate)			89
4	Baseline Case (including basement flats with 100% fatality rate)			380

Comparison with September 2013 assessment

5.7 The differences from the September 2013 assessment for the Baseline Case are summarised in Table 5.4, and show that there is a proportional reduction in the PAR and ASLL under both the overtopping and breach scenarios from the September 2013 assessment. The reduction in PAR and ASLL is expected since the updated flood outlines are less extensive than those used in the September 2013 assessment. The total number of properties at risk from the PMF breach scenario in the 2013 assessment is 12,619, compared with 10,481 in this assessment.

Table 5.4: Breach and overtopping ASLL compared to September 2013 assessment (baseline case only)

	September 2013 Assessment	September 2014 Assessment	Difference
Overtopping			
Maximum Population At Risk	14333	10476	-3857
Population At Risk (including occupancy factor)	8960	6279	-2681
Average Societal Loss of Life	5	4	-1
Breach			
Maximum Population At Risk	20139	18758	-1381
Population At Risk (including occupancy factor)	12074	10632	-1442
Average Societal Loss of Life	19	17	-2

Comparison with alternative methods

5.8 The Brown and Graham method for assessing Likely Loss of Life (LLoL) was also applied to compare results with the ASLL approach. The differences for the breach scenario are summarised in Table 5.5, and show that the LLoL method produces significantly higher figures, with the exception of the scenario where a 100% fatality rate is assumed for all basement flats.

Table 5.5: RAR assessment method compared with Brown and Graham method (breach scenario)

No.	Scenario	LLoL (Brown and Graham)	ASLL (RARS)	Difference
1	Baseline Case (including flats specified as ground floor or basement)	343	17	-326
2	Baseline Case (plus 100% fatality where DV>7)	343	35	-308
3	Baseline Case (including basement flats with 20% fatality rate)	343	89	-254
4	Baseline Case (including basement flats with 100% fatality rate)	343	380	+37

6. Summary

6.1 This ASLL assessment has indicated that:

- Under the PMF overtopping scenario a minimum of 6,279 people are at risk, with a minimum Average Societal Loss of Life of 4. This represents 0.06% of people in the "at risk" area. Depending on the assumptions applied relating to impacts on

basement flats and DV values, the Average Societal Loss of Life could rise to 276 (or 4.4% of people in the “at risk” area);

- Under the PMF breach scenario a minimum of 10,632 people are at risk, with a minimum Average Societal Loss of Life of 17 for the baseline case. This represents 0.16% of people in the “at risk” area. Depending on the assumptions applied relating to impacts on basement flats and DV values, the Average Societal Loss of Life could rise to 380 (or 3.6% of people in the “at risk” area) for the 100% fatality rate for basement flats;
- Comparison with the September 2013 assessment shows a reduction in the numbers of people at risk based on the updated flood outlines, and a proportional reduction in the Average Societal Loss of Life value;
- Comparison with the LLoL assessment using the Brown and Graham approach indicates that the RAR method results in significantly lower LLoL figures, unless a 100% fatality rate is assumed for all basement flats in the “at risk” area.
- The 2013 assessment assumed 25% of ground floor flats were basement flats, which gave a total of 744 flats defined as basement dwellings (for the PMF breach scenario), and an Average Societal Loss of Life of 1,414 (assuming 100% fatality for occupants of basement flats). This study has demonstrated that 193 basement flats are within the PMF breach “at risk” area, giving an Average Societal Loss of Life of 380 (assuming 100% fatality for occupants of basement flats). This new number of basement flats is 8% of ground floor flats demonstrating the refinement of this recent study.

Default rainfall

PMF Duration	Storm Depth	CWI	PR	Peak flow	IS Check
1.5	166.88	153.523	73.48	17.442	✓
2.5	187.925	151.238	74.427	17.958	✓
3.5	199.732	150.47	75.056	18.11	✓
4.5	208.548	149.728	75.472	18.21	✓
5.5	215.584	149.282	75.834	18.297	✓
6.5	221.438	148.904	76.128	18.368	✓
7.5	226.451	148.485	76.354	18.422	✓
8.5	230.835	148.038	76.529	18.464	✓
9.5	234.729	147.574	76.666	18.497	✓
10.5	238.231	146.476	76.618	18.485	✓
11.5	241.414	145.397	76.553	18.469	✓
12.5	244.33	144.401	76.49	18.454	✓

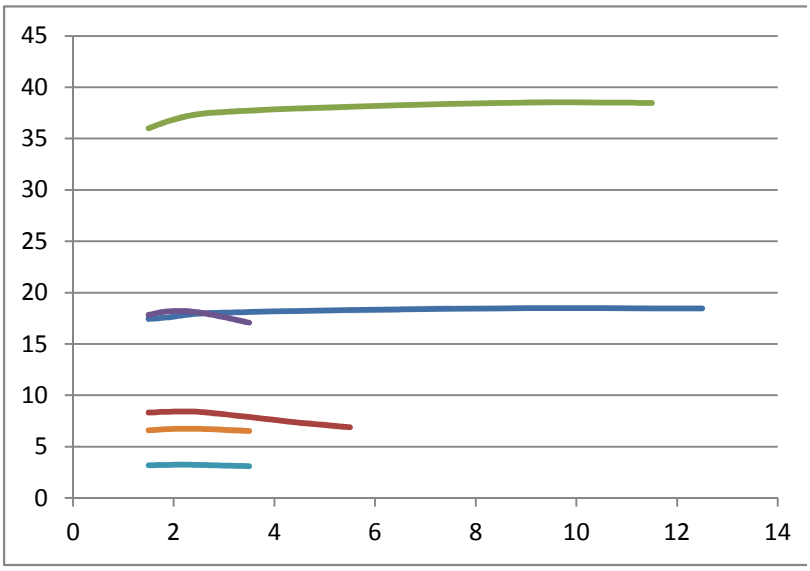
SPR 53%

PMP Duration	ham pmf	ham 10K	ham 100	high pmf	high 10K
1.5	17.442	8.318	3.184	36.007	17.833
1.9	*17.6*	*8.4*	3.232	*36.7*	18.183
2.5	17.958	8.385	3.224	37.385	18.074
3.5	18.11	7.884	3.099	37.719	17.072
4.5	18.21	7.332		37.929	
5.5	18.297	6.884		38.111	
6.5	18.368			38.26	
7.5	18.422			38.374	
8.5	18.464			38.462	
9.5	18.497			38.53	
10.5	18.485			38.506	
11.5	18.469			38.473	
12.5	18.454				

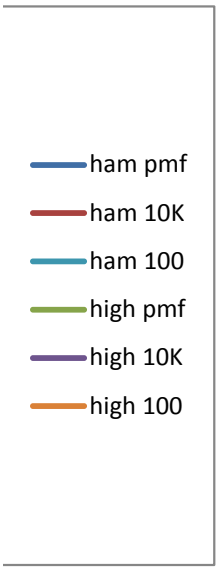
Peak flow	Default rainfall	10,000 year Duration	Storm Depth	CWI	PR	Peak flow	IS Check
17		1.5	135.263	98.78	58.352	8.318	✓
18		2.5	150.249	98.78	59.437	8.385	✓
18		3.5	158.205	98.78	59.995	7.884	✓
18		4.5	163.689	98.78	60.373	7.332	✓
18		5.5	168.914	98.78	60.729	6.884	✓
18							
18							
18							
18							
18							
18							
18							

high 100

6.589
6.712
6.737
6.532



Peak flow	Default rainfall	100-year Duration	Storm Depth	CWI	PR	Peak flow	IS Check	Peak flow
8		1.5	59.005	98.78	51.534	3.184	✓	3
8		1.9	62.103	98.78	51.898	3.232	✓	3
8		2.5	65.887	98.78	52.322	3.224	✓	3
7		3.5	70.816	98.78	52.847	3.099	✓	3
7								



	PMF					IS Check
Default rainfall	Duration	Storm Depth	CWI	PR	Peak flow	
	1.5	165.248	153.738	73.417	36.007	✓
	2.5	186.421	151.451	74.374	37.385	✓
	3.5	198.33	150.669	75.009	37.719	✓
	4.5	207.22	149.914	75.428	37.929	✓
	5.5	214.314	149.457	75.729	38.111	✓
	6.5	220.216	149.068	76.088	38.26	✓
	7.5	225.269	148.639	76.315	38.374	✓
	8.5	229.687	148.184	76.491	38.462	✓
	9.5	233.61	147.712	76.628	38.53	✓
	10.5	237.139	146.609	76.581	38.506	✓
	11.5	240.346	145.526	76.516	38.473	✓

SPR 53%

EXAMPLE ONLY

PMP

Duration	**5D**	**"EMa"**	**"0.5^(D/24)"**	**CWI**
0.5	2.5	83.8	0.99	207.60
1.5	7.5	72.3	0.96	194.23
8.5	42.5	50.2	0.78	164.27

Peak flow	Default rainfall	10,000 year Duration	Storm Depth	CWI	PR	Peak flow	IS Check
36		1.5	133.941	100.22	58.761	17.833	✓
37		1.9	141.281	100.22	59.292	18.183	✓
38		2.5	149.046	100.22	59.842	18.074	✓
38		3.5	157.094	100.22	60.399	17.072	✓
38							
38							
38							
38							
39							
39							
38							

Peak flow	Default rainfall	100-year Duration	Storm Depth	CWI	PR	Peak flow	IS Check	Peak flow
18		1.5	58.539	100.22	52.091	6.589	✓	7
18		1.9	61.607	100.22	52.448	6.712	✓	7
18		2.5	65.347	100.22	52.864	6.737	✓	7
17		3.5	70.211	100.22	53.377	6.532	✓	7

HHPP FW PMF Duration question - RFI No2

From: Jones, Ben
Sent: 21 October 2014 09:57
To: 'Hay-Smith, Debbie'; Downs, Chris; Mann, Robert J; 'dylan.huws'
Cc: Hughes, Andy; Farrar, Joanne; Ayoung, Margaretta; 'Paul.Monaghan'; 'Thomas.Creed
Subject: HHPP FW: PMF Duration question - RFI No9
Attachments: HH Duration investigation_IS check.xlsx; RFI 071014 _initial response 21-10-2014.docx

Debbie et al
Please see below, in relation to the item number 3 on the list of RFI's.

I've attached an updated checklist of the 10 RFI's, there are 2 remaining which should both be tied up this week.

Regards
Ben

From: Ayoung, Margaretta
Sent: 14 October 2014 17:54
To: Jones, Ben
Cc: Farrar, Joanne; Hughes, Andy; Grout, Clare L; Sivyer, Ian
Subject: FW: PMF Duration question

Ben,

Please see email below which is CEH's response to the question regarding the CD of the PMF being much longer than the T-year events.

Regards,
Margaretta

From: Stewart, Lisa
Sent: 14 February 2014 15:21
To: Ayoung, Margaretta
Subject: RE: PMF Duration question

Dear Margaretta,

I have spoken to my colleague Helen Houghton-Carr, who wrote Vol. 4 of the FEH, and she makes the following comments:

1)
We are not comparing like with like. The rainfall-runoff model used for T-year floods is slightly different to that used for PMFs - for a PMF, the Tp of the unit hydrograph is shorter. Also the percentage runoff is greater for a PMF as this depends on the design event CWI and Summer/Winter PMP rainfall (and possibly snowmelt), both of which are significantly greater for a PMF than a T-year flood. Hence, the critical storm duration will be different – how different will vary between catchments.
It is also important to remember that it is a model – we have no idea what the true magnitude of the 100-year, 10,000-year flood or the PMF is, so the errors in applying a national estimation to an individual catchment are unquantifiable – so the amount of attention that should be paid to differences in decimal places is questionable. Indeed, curves of flood magnitude against storm duration are generally relatively flat, as in this case (example on HAM sheet), so the choice of storm duration is not usually critical.

2)
T-year flood CWI remains constant because it is derived from SAAR which doesn't change – and it is less than 125 (around 100mm) because SAAR is around 700mm.
PMF CWI starts at 125mm and is a function of SMD and API. For PMPs, SMD is assumed to be zero. API represents the wetting-up of the catchment over an antecedent period of 2D duration prior to the PMP storm event, so will change with duration. API is a function of the estimated maximum antecedent rainfall EMa, itself calculated as half of the 5D duration rainfall minus the D duration rainfall (the D duration rainfall being the PMP storm event itself) – to give the 2D duration rainfall. See example in green on HIGH sheet - as duration increases, EMa decreases. The EMa is assumed to occur instantaneously halfway through the 2D antecedent period so is adjusted by a factor of 0.5^(D/24). As duration increases, the adjustment factor decreases. Hence, as duration increases, API decreases, so CWI decreases.

So the decrease in CWI with duration in the PMF case is what we would expect and is caused by the structure of the PMF model. The main point about the critical duration being longer in the PMF case again seems to be related to the form of the model which was developed in a fairly arbitrary way. Hardly any research has been carried out on the PMF model since the period following the publication of the FSR in the late 1970s, so I think it is a good candidate for revision, or at least reappraisal.

I realise that this is difficult to justify to your clients. All I would say is that the PMF procedure has been designed to estimate the worst possible case and that, although the critical duration is considerably longer than in the T-year case, this is to be expected given the model parameters (SAAR, PMP etc.). Whilst the FSR/FEH rainfall-runoff method can be interpreted as a conceptual model of the catchment in the T-year case, this interpretation cannot be extended to the PMF case because of the complexity of the underlying assumptions.

I think that's the best I can come up with!

Regards,
Lisa

Lisa Stewart
Hydrological Modelling and Risk Group
CEH Wallingford
Wallingford
Oxon.
OX10 8BB

INDEPENDENT REVIEW OF HAMPSTEAD HEATH PONDS PROJECT

Data request to Atkins, 7/10/14 – Atkins update, 21st October

A number of pieces of information were requested during the workshop, held on 1st October 2014. These are included in the table below along with further data that we would like in order to complete our review.

No.	Description	Date requested	Atkins comment / action	Date received (sent to AECOM)
1	Atkins has updated the dam breach modelling and consequence assessment. A copy of the updated report to be forwarded to AECOM	01/10/14	Consequence assessment sent 14th October. CoL have instructed that the other parts of the latest version of the QRA should not be forwarded yet.	14/10/14
2	Analysis of the critical storm duration indicated a much longer critical duration for the PMF event. Atkins will provide their explanatory note	01/10/14	See contemporary emails between Margaretta Ayoung (Atkins lead hydrologist) and CEH Wallingford, forwarded 21st October.	21/10/14
3	Atkins will prepare an explanatory note on the assessment of the impact of the scheme on the Thames Water network.	01/10/14	Email explaining this sent 15th October.	15/10/14
4	Judicial review documents, redacted where necessary, to be forwarded to AECOM	01/10/14	The City of London have forwarded the relevant sections of the JR to AECOM.	15/10/14
5	Provide ASLL for each chain of reservoirs separately (possibly include in the updated consequence assessment)	01/10/14	This analysis of separate chains was not done as part of the QRA modelling. CoL to give instruction as to whether this work should be done.	Part response 20/10/14
6	Outline costs for the preferred schemes for each chain	07/10/14	CoL have sent an outline cost for the whole scheme. The project has not been costed as two chains.	14/10/14

7	Pre (with and without breach) and post scheme outflow hydrographs for Highgate No.1 and Hampstead No.1 ponds for the PMF event, indicating the amount of each that enters the downstream drainage network, and the amount that flows overland. Hydrographs for lesser return period events would also be useful if available.	07/10/14	All available hydrographs sent 17th October. We haven't modelled hydrographs for post-scheme PMF/other events with breaching, as the second part of the QRA (for the preferred design scenario) has not been carried out yet.	Sent 17/10/14
8	Check critical duration for preferred scheme and report any change	07/10/14	This has not yet been done, to be modelled by 24th October.	
9	Derivation of the assumed time to final breach of 1.5 hours	07/10/14	BJ to find and send.	
10	Confirmation that the works will include, where practicable, measures to address other defects or shortcomings (leakage/settlement, integrity and adequacy of outlet arrangements etc) as judged appropriate for reservoir safety and to future-proof the works	07/10/14	Email sent 15th October.	15/10/14

3 HHPP Review - re RFI item 3 - effect on Thames Water

From: Jones, Ben
Sent: 15 October 2014 12:56
To: 'Hay-Smith, Debbie'; Mann, Robert J; Downs, Chris
Cc: Hughes, Andy; Farrar, Joanne; Paul Monaghan (paul.monaghan; Creed, Thomas; 'Sumner, Esther'; Ayoung, Margaretta
Subject: HHPP Review - re RFI item 3 - effect on Thames Water

Debbie
Regarding item No.3 on your list, “Atkins will prepare an explanatory note on the assessment of the impact of the scheme on the Thames Water network”, I can provide an explanation as follows:

One of the key objectives of the project was to ensure that the frequency and volume of floodwater passing downstream of the ponds was not increased by the proposed works. This was first checked for the design flood (the PMF) once a design arrangement had been established that ensured no overtopping of any of the dams where overtopping would not be tolerable. Then, for the purposes of the Flood Risk Assessment, the 1:100, 1:1,000 and 1:10,000 events were checked to compare the volumes of floodwater overtopping the existing dam (in the existing case) against the volumes discharging through the proposed spillways. We also checked the volumes of floodwater passing through the overflow pipes into the surface water drainage system from Hampstead No.1 and Highgate No.1 Ponds, again in the existing and design scenarios. In all the three return period events mentioned above and the PMF, the discharge rates and volumes passing through the pipes were found to be less in the proposed scenario.

At a meeting with Thames Water on 30th July, it was requested that Atkins check that the proposed works also did not affect the lower return periods (1:5, 1:20 and 1:50), since Thames Water are only obliged to deal with floods up to a return period of 1:30 years. They were not concerned with larger floods of the kind that would be evaluated in a dam safety context, since in very large floods all the surface water systems would be full. We therefore ran the hydraulic model, which included the preferred design option, for the lower return period events, and found that the outflows in the preferred option were again either the same or lower in the proposed scenario. Thames Water were satisfied with these results and have stated that they have no objection to the proposed scheme.
It is important to note that with the proposed works in place, the overall total volume of water being discharged into the combined surface water / sewage system would be the same. In the existing case, floodwater in large events would overtop the last dams and flow overland but would not reach the River Thames, so would reach the SW system via many properties in residential areas.
By temporarily storing more floodwater behind raised dams, the proposed works would allow a slower, safer and more controlled release of water into the SW system. While there would still be a large volume of water discharging through the spillways and flowing overland, this floodwater is less than what would be overtopping the dams in the existing scenario for the same size flood event.

I trust that this answers your question. I will provide more information related to the overflow pipes in our response to your item No.7 about pre and post scheme hydrographs.

Regards
Ben

Water & Environment
ATKINS
75 years of design, engineering and project management excellence

From: Jones, Ben
Sent: 14 October 2014 17:32
To: 'Hay-Smith, Debbie'; Mann, Robert J; Downs, Chris
Cc: Hughes, Andy; Paul Monaghan
Farrar, Joanne; Woolgar, Mike J; 'Sumner, Esther';
'Peter.Snowdon
Subject: FW: Independent review - RFI - permissions
Attachments: RFI 071014 _initial response 14-10-2014.docx

Debbie
Please see below response from the City of London regarding items number 1, 4 and 6 on your list.
We will continue to supply you with the other items where these are available, and the text that you require for items 3 and 10.
Regards
Ben

From: Creed, Thomas
Sent: 14 October 2014 17:25
To: Jones, Ben; Monaghan, Paul
Cc: Hughes, Andy; Farrar, Joanne; Wanner, Tom; Woolgar, Mike J; Sumner, Esther; Snowdon, Peter
Subject: Re: Independent review - RFI - permissions

Ben,

As discussed, I do not see why AECOM are concerned with the JR documents in any way as it does not form part of their brief. Therefore please do not send them this information unless there is a justification to do so.

Regarding costs, the public cost of the scheme is £15.2million +or- 15% at Q4 2010. Again, if there is a reason for them to have any further information for them to comment on the planning application then let us know but otherwise, I hope this will suffice.

Furthermore, please do not release any further drafts of the QRA until we have time to discuss it further internally. This document should still be considered a draft.

Regards,

Tom

From: Jones, Ben
Sent: Tuesday, October 14, 2014 12:01 PM
To: Monaghan, Paul
Cc: Hughes, Andy; Farrar, Joanne ; Wanner, Tom
; Woolgar, Mike J Creed, Thomas
Subject: FW: Independent review - RFI - permissions

Paul
We are working through the attached request for information from AECOM but we need your assistance / permission on a couple of items:

No.4 “Judicial Review documents, redacted where necessary” : we have these in hard copy form so we are scanning them so that we can send them in a CD to AECOM. Please can you give your permission for us to do this, and advise on anything that needs redacting (if any)?

No.6 – “Outline costs for the preferred schemes for each chain”: Outline costs were estimated by Capita last August and revised this April following the issue of outline design drawings by us around the 4th April. These costs have been kept confidential (between yourselves and Capita) so if you wish to maintain that confidentiality, please could you forward the cost estimates directly to AECOM?

Regards
Ben

Water & Environment
ATKINS
75 years of design, engineering and project management excellence

Epsom Gateway, 2 Ashley Avenue, Epsom, Surrey, KT18 5AL
| Web: http://www.atkinsglobal.com |

From: Hay-Smith, Debbie
Sent: 07 October 2014 11:06
To: Hughes, Andy; Jones, Ben; Ayoung, Margaretta
Cc: Markwell, Jonathan; Downs, Chris; Mann, Robert J
Subject: Independent review of Hampstead Heath ponds project

Dear all

Please find attached our request for some further information and clarification to help us complete our review.
Kind regards
Debbie Hay-Smith
Principal Engineer
Water Business Line

AECOM
1 Tanfield
Edinburgh
EH3 5DA
www.aecom.com

7 HHPP Hydrograph info - RFI Item 7

From: Jones, Ben
Sent: 17 October 2014 18:09
To: 'Hay-Smith, Debbie'; Downs, Chris; Mann, Robert J; 'dylan.huws'
Cc: 'Paul.Monaghan; Farrar, Joanne; Hughes, Andy; Ribeiro Correia, Joao; 'Thomas.Creed'
Subject: HHPP Hydrograph info - RFI Item 7
Attachments: PMF and breaching Hydrographs.xlsx; RESERVOIR ROUTING_HAMPSTEAD No1 -PMF_ 1_100_1000_10000.zip; HH Pref Option May 14 Results - Highgate 1 only.xlsx; Hydrograph RFI checklist.xlsx; Modelled Hamp1 HG1 Pipe Flows for TW Oct 14.xlsx

Debbie et al
Please see attached hydrograph info for pre and post scheme, with and without dam breach for the PMF, and without breach for all other return periods, all for Hampstead No.1 pond and Highgate No.1 Pond.

There is some overlap between the sets of data, since the PMF flows with and without dam breach were first calculated in 2013, and then the PMF without dam breach was rerun in May of this year for the purposes of the Flood Risk Assessment for the planning application.
I have included the low return period hydrographs created for the assessment of effects on the Thames Water system, as emailed yesterday, just for completeness.

I have created a table which shows which hydrographs have been calculated, when they were created and for which purpose.

Please feel free to ask us any questions about the attached.

Regards
Ben

Water & Environment
ATKINS
75 years of design, engineering and project management excellence

Epsom Gateway, 2 Ashley Avenue, Epsom, Surrey, KT18 5AL
| Web: http://www.atkinsglobal.com |

From: Jones, Ben
Sent: 03 November 2014 12:42
To: 'Hay-Smith, Debbie'; Downs, Chris; 'dylan.huws'
Cc: Hughes, Andy; Farrar, Joanne; Cox, Andrew
Subject: Re: HHPP Hydrograph info - RFI Item 7

Robert, Debbie et al
Please see below response from our modellers about the flat-lining observed in some of the model runs:

After the QRA modelling was completed in 2013, it was noted that the model was flat-lining flows over spills. This phenomenon was noted on other modelling studies being undertaken at the time as well. Atkins contacted Innovyze Support who informed us that the flat lining is caused when, over the duration of one timestep, the flow out is not sufficient to reduce water levels in the reservoir unit. The level in the reservoir gets stuck because the flow out is never big enough to reduce levels. At the time the peak was captured and the model demonstrated peak probable maximum flood water levels in the ponds. Since the release of the QRA Innovyze suggested a few of solutions to solve this oddity. We tested the solutions for the design modelling, and found the most effective was increasing the timestep. However, for the QRA modelling completed in 2014 changing the model timesteps would not allow the model to run, as a result the flatlining issue remains for the QRA modelling.

Regards
Ben

From: Mann, Robert J
Sent: 23 October 2014 17:17
To: Jones, Ben
Cc: Hay-Smith, Debbie
Subject: RE: HHPP Hydrograph info - RFI Item 7

Ben,
I've a query on the PMF and breaching hydrographs.xlx spreadsheet.
I've produced from your spreadsheet tabulations a graph for the Hampstead and Highgate hydrographs, in each case showing both PMF and PMF-plus-breach, reproduced below:

I'm trying to do a reality check to see if the difference in hydrograph volumes relates to the escaped volume from each chain.
In both cases the breach hydrograph shows a peak after the PMF peak, but the flow reduces only part way down from the peak and remains at a high rate for 24 hours or more after the breach. I'd expect it to continue to reduce to close to the PMF flow.
I calculate that release of the brim-full capacity of the whole chain would account for the difference in hydrograph volumes up to about hour 0900 for Hampstead and about 0950 for Highgate. So this observation poses no reason to doubt the assessed peaks of the PMF and the dam breach. Even so, I wonder if this continuing high flow shown has arisen spuriously or been added artificially for some reason – can you comment?

I note that at Highgate the peak flow from breach is less than the peak PMF flow. On the face of it this could call into question the designation as flood Category A, but other matters come to bear that are likely nevertheless to result in the Risk Assessment upholding justification of Category A.

Kind regards
Robert

From: Jones, Ben
Sent: 17 October 2014 18:09
To: Hay-Smith, Debbie; Downs, Chris; Mann, Robert J; Huws, Dylan
Cc: 'Paul.Monaghan; Farrar, Joanne; Hughes, Andy; Ribeiro Correia, Joao; 'Thomas.Creed
Subject: HHPP Hydrograph info - RFI Item 7

Debbie et al
Please see attached hydrograph info for pre and post scheme, with and without dam breach for the PMF, and without breach for all other return periods, all for Hampstead No.1 pond and Highgate No.1 Pond.

There is some overlap between the sets of data, since the PMF flows with and without dam breach were first calculated in 2013, and then the PMF without dam breach was rerun in May of this year for the purposes of the Flood Risk Assessment for the planning application.
I have included the low return period hydrographs created for the assessment of effects on the Thames Water system, as emailed yesterday, just for completeness.

I have created a table which shows which hydrographs have been calculated, when they were created and for which purpose.

Please feel free to ask us any questions about the attached.

Regards
Ben

Water & Environment
ATKINS
75 years of design, engineering and project management excellence

Epsom Gateway, 2 Ashley Avenue, Epsom, Surrey, KT18 5AL |
| Web: http://www.atkinsglobal.com |

http://www.atkinsglobal.com/site-services/group-company-registration-details

8FW HH Proposed Option - Critical Duration Tests - RFI No.8

From: Jones, Ben
Sent: 24 October 2014 19:59
To: 'Hay-Smith, Debbie'; Mann, Robert J; Downs, Chris
Cc: Grout, Clare L; Hughes, Andy; Farrar, Joanne
Subject: FW: HH Proposed Option - Critical Duration Tests - RFI No.8

Debbie
Please see below from our hydrologist / hydraulic modeller.
Having modelled the effects of different storm durations for the PMF event, it appears that there is no significant difference for other storm durations when compared with the levels obtained using the critical storm duration found using the existing scenario model. We are therefore not intending to repeat this process with the smaller flood events.

Regards
Ben

From: Grout, Clare L
Sent: 24 October 2014 17:56
To: Jones, Ben
Cc: Sivyer, Ian
Subject: HH Proposed Option - Critical Duration Tests

Ben,

To confirm the critical duration findings….

Using the proposed option models, we have tested two additional storm durations for the PMF event:
* 7.5 hours (2 hours shorter than the existing critical duration of 9.5 hours); and
* 11.5 hours (2 hours longer than the existing critical duration of 9.5 hours)
These storm durations are consistent with those which were previously tested in the model set up to represent the existing situation.
The model results were extracted. The peak pond water levels modelled using the alternative PMF storm durations were compared with the peak water levels previously obtained for the 9.5 hour duration event (as reported in the FRA).
Compared with the 9.5 hour duration results:
* Using the shorter duration storm (7.5 hours) gave peak water levels which were the same or slightly lower; and
* Using the longer duration storm (11.5 hours) gave peak water levels which were the same.
This was true for all ponds in both the Highgate and the Hampstead chains.

I trust this answers the AECOM query.

Kind Regards,

Clare

Clare Grout
Hydrologist, Water and Environment
ATKINS
Thought leadership in a complex world – www.atkinsglobal.com/angles

From: Bruggemann, Tony
Sent: 23 October 2014 15:03
To: Mann, Robert J; Jones, Ben
Cc: Wanner, Tom
Subject: RE: AECOM review - RFI No 5 re separate ASLLs on QRA

Robert,

Your understanding is correct. The breach is fully formed 2.5hrs after overtopping starts.

Regards,

Tony

Tony Bruggemann
Technical Manager, Dams & Reservoirs
Atkins
Epsom Gateway
Ashley Avenue, Epsom, Surrey, KT18 5AL

Web: www.atkinsglobal.com

From: Mann, Robert J
Sent: 23 October 2014 14:55
To: Jones, Ben
Cc: Bruggemann, Tony
Subject: RE: AECOM review - RFI No 5 re separate ASLLs on QRA

Ben, Tony,
Am I right in understanding that the breach develops fully 1.5 hours after the breach starts (therefore 2.5 hours after overtopping starts)?
Kind regards
Robert

From: Jones, Ben
Sent: 22 October 2014 18:31
To: Mann, Robert J; Hay-Smith, Debbie; Downs, Chris; Huws, Dylan
Cc: Hughes, Andy; Farrar, Joanne; Bruggemann, Tony
Subject: FW: AECOM review - RFI No 5 re separate ASLLs on QRA

Robert,

Please see below explanation of the breach parameters for the existing situation.

Regards
Ben

From: Bruggemann, Tony
Sent: 22 October 2014 18:26
To: Jones, Ben
Subject: RE: AECOM review - RFI No 5 re separate ASLLs on QRA

Ben,

The breach parameters were based on engineering judgement. It was assumed that that breaching commenced after 1 hour of overtopping and then 1.5 hours for the breach to develop fully.

Regards,

Tony

Tony Bruggemann
Technical Manager, Dams & Reservoirs
Atkins
Epsom Gateway
Ashley Avenue, Epsom, Surrey, KT18 5AL

Web: www.atkinsglobal.com

From: Mann, Robert J
Sent: 22 October 2014 18:16
To: Jones, Ben; Hay-Smith, Debbie; Downs, Chris; Huws, Dylan
Cc: Wanner, Tom; 'Thomas.Creed@cityoflondon.gov.uk'; Hughes, Andy; Farrar, Joanne
Subject: RE: AECOM review - RFI No 5 re separate ASLLs on QRA

Ben,
Can I suggest you first address our query on the time for breach of the dams – until that's done I think this could be a more fundamental issue as regards the risk assessment.
Kind regards
Robert

From: Jones, Ben
Sent: 20 October 2014 17:14
To: Hay-Smith, Debbie; Downs, Chris; Mann, Robert J; Huws, Dylan
Cc: Wanner, Tom; 'Thomas.Creed; Hughes, Andy; Farrar, Joanne
Subject: FW: AECOM review - RFI No 5 re separate ASLLs on QRA

Debbie et al

Just to let you know, I've asked the City to give us an instruction on whether they want us to do this extra task of reanalysing the breach scenario in two halves, see below, since it has not been done before. (We only considered both pond chains failing at the same time in the breach scenario.)

Regards
Ben

From: Jones, Ben
Sent: 17 October 2014 10:37
To: 'Thomas.Creed
Cc: Hughes, Andy; Farrar, Joanne; Wanner, Tom; Tolsma, Sjouke; 'Paul.Monaghan
Subject: AECOM review - RFI No 5 re separate ASLLs on QRA

9 RE AECOM review - RFI No 9 re time to breach

Tom,

Item No.5 on AECOM's RFI list was "Provide ASLL for each chain of reservoirs separately (possibly include in the updated consequence assessment)".

We haven't treated the pond chains separately in the QRA, so we don't have this information.
Andy argued at the meeting with AECOM on the 1st that it wasn't necessary. It is possible, but it would take some more work to split and re-run the model and then analyse the 2 new sets of results.
Please can you confirm whether you would like us to do this work, or whether it would be satisfactory at this stage to say that we haven't got the results?

Regards
Ben

Water & Environment
ATKINS
75 years of design, engineering and project management excellence

Epsom Gateway, 2 Ashley Avenue, Epsom, Surrey, KT18 5AL | Web: http://www.atkinsglobal.com |

_____
The IS team in Atkins has scanned this email and any attachments for viruses and other threats; however no technology can be guaranteed to detect all threats. Always exercise caution before acting on the content of an email and before opening attachments or following links contained within the email.

10 HHPP Review - re RFI No.10 - works to address defects

From: Jones, Ben
Sent: 15 October 2014 12:40
To: 'Hay-Smith, Debbie'
Cc: Hughes, Andy; Farrar, Joanne; Creed, Thomas; Paul Monaghan ; 'Sumner, Esther'; Tolsma, Sjouke
Subject: HHPP Review - re RFI No.10 - works to address defects

Debbie
In response to your RFI number 10 (“Confirmation that the works will include, where practicable, measures to address other defects or shortcomings (leakage/settlement, integrity and adequacy of outlet arrangements etc) as judged appropriate for reservoir safety and to future-proof the works”), we can confirm that this is the case.

For example, leakage observed at the Men’s Bathing Pond is being addressed with a sheet pile design which also provides the raising height required. The settlement seen at many of the dams is being addressed by crest restoration works (where the settled parts of the crest are to be raised by between 0.1m and 0.5m) at Bird Sanctuary Pond, Vale of Health Pond, Viaduct Pond, Hampstead No.2 Pond, Stock Pond and Ladies Pond, and by raising works at Men’s Pond, Highgate No.1 Pond and Model Boating Pond (by 1.0, 1.25 and 2.5m respectively).

Existing overflow works will be either augmented by new pipes or box culverts (at Vale of Health, Viaduct Pond and Ladies Bathing Pond, Hampstead No.1 and No.2 Ponds) or, in the case of Stock Pond, replaced by a new culvert. The proposed scheme will include works to unblock scour pipes where this is the case (eg at Stock Pond).

Please feel free to ask us about any aspect of the proposed design.
Regards
Ben

Water & Environment
ATKINS
75 years of design, engineering and project management excellence
Epsom Gateway, 2 Ashley Avenue, Epsom, Surrey, KT18 5AL || Web: http://www.atkinsglobal.com |

11 RE Independent review of Hampstead Heath ponds project - RFI

From: Hay-Smith, Debbie
Sent: 03 November 2014 09:32
To: Jones, Ben
Cc: 'Markwell, Jonathan'; Downs, Chris; Mann, Robert J; Wanner, Tom; Ayoung, Margaretta; Hughes, Andy; Farrar, Joanne
Subject: RE: Independent review of Hampstead Heath ponds project - RFI
Attachments: Information request status 031114.doc

Ben

We have found evidence in a previous report by Haycock that allows us to infer the proportion of the total ASLL that is attributable to each chain, so we no longer require you to address RFI no 11. RFI 7a and 12 are now the only outstanding requests.

Kind regards
Debbie Hay-Smith
Principal Engineer
Water Business Line

AECOM
1 Tanfield
Edinburgh
EH3 5DA

www.aecom.com

From: Hay-Smith, Debbie
Sent: 28 October 2014 11:22
To: 'Jones, Ben'
Cc: 'Markwell, Jonathan'; Downs, Chris; Mann, Robert J; Wanner, Tom; Ayoung, Margaretta; Hughes, Andy; Farrar, Joanne
Subject: RE: Independent review of Hampstead Heath ponds project - RFI

Ben

We have been asked to include in our review, comments received from Brookfield Mansions Ltd, which includes a paper from Professor Rushton regarding the overflow from Highgate No 1. The comments do include a number of misinterpretations which are adequately dealt with in Joanne's email to Jonathan Markwell of 21st October. However, I do have a query regarding Professor Rushton's paper. In it, he presents a graph showing the Atkins rating curve for the Highgate outlet pipe (in red below)

Where is this data from? It does not match the rating curve you sent me (below left) which does match quite well with Prof Rushton's rating curve (below right)?

I have included this in the latest version of the RFI table attached. There are two other outstanding pieces of information we are waiting for:

* 7a – Query regarding high flows that remain post breach
* 11 - Separate out the ASLL figures for each "branch" and "common stem" of the inundation area.

Just to be clear, we don't need you to carry out any additional modelling, just use the existing runs for PMF and PMF plus breach.

Kind regards
Debbie Hay-Smith
Principal Engineer
Water Business Line

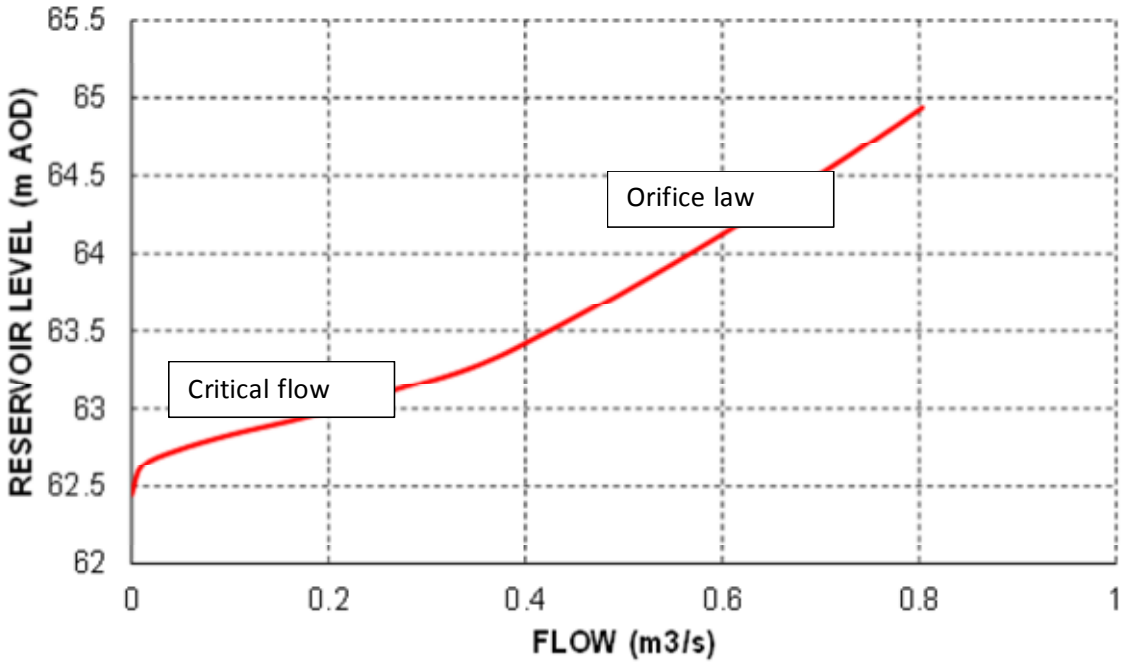
AECOM
1 Tanfield
Edinburgh
EH3 5DA

www.aecom.com

RE: Independent review - RFI 12 re Outflow pipe rating curves follow-up query

Debbie,
In general, because most of the overflow pipes have supercritical slopes, the rating curve was calculated considering upstream control until the pressurized flow occurs along the entire pipe.

Thus, for the upstream control at the inlet cross section, and while the inlet is not submerged, it was assumed that the flow will occur in critical conditions up until the corresponding head reaches around 1.5 x the pipe diameter. After that point, it was assumed that the flow will be discharged according to a law similar to an orifice.



In the Atkins rating curve for the overflow pipe at Highgate No.1 Pond it was assumed that the fully pressured flow on the pipe would not occur.

Regards
Ben

From: Hay-Smith, Debbie **Sent:** 11 November 2014 11:48
To: Jones, Ben; Downs, Chris; Mann, Robert J
Cc: Hughes, Andy; Farrar, Joanne; Monaghan, Paul; Wanner, Tom; Ayoung, Margaretta; 'Markwell, Jonathan'
Subject: RE: Independent review - RFI 12 re Outflow pipe rating curves

Ben

Can you confirm that the rating curves were calculated using orifice theory rather than pipe theory? I've also done a quick check and that looks to be the case. Not that it will make any difference at all to the design but we need to respond to this in our report.

Kind regards

Debbie Hay-Smith
Principal Engineer
Water Business Line

AECOM
1 Tanfield
Edinburgh
EH3 5DA

From: Jones, Ben
Sent: 11 November 2014 10:01
To: Hay-Smith, Debbie; Downs, Chris; Mann, Robert J
Cc: Hughes, Andy; Farrar, Joanne; Monaghan, Paul; Wanner, Tom; Ayoung, Margaretta; 'Markwell, Jonathan'
Subject: RE: Independent review - RFI 12 re Outflow pipe rating curves

Debbie
The rating curve data used by Professor Rushton was taken from a workbook of answers to questions asked by one of the stakeholders who lives at Brookfield Mansions immediately downstream of Highgate No.1 Pond. (See attached file). We believe that Professor Rushton is assisting this particular resident.

The blue line in your graph which uses our hydrograph data for the pipe at HG1 Pond is mostly the same as the red line in the graphs created by Professor Rushton except the table in the hydrograph data stops when the water level in HG1 Pond reaches 64.44m. This is a leftover from the model of the existing scenario where the maximum water level in the PMF case reached 64.45m. It was decided at the time (October 2013) that the extra part of the pipe rating curve table, for water levels rising above 64.44m up to 64.94m, would be omitted from revisions of the model to ensure consistency between existing and proposed scenarios for comparison purposes. This would have led to a slight underestimate of the flow through the overflow pipe of around 0.12 cumecs for the few hours in the PMF event where water reaches higher levels in HG1 Pond, because of the proposed raising of the dam crest with a wall from 63.77m up to 65.02m. However, when compared to the flow over the spillway of around 30 cumecs this is relatively minor, and an underestimate of pipe flow would mean that the modelling of the proposed spillway is slightly on the conservative side for a short period of the PMF event when the spillway at HG1 Pond is discharging, and similarly a very short time during the 1:10,000 year event.

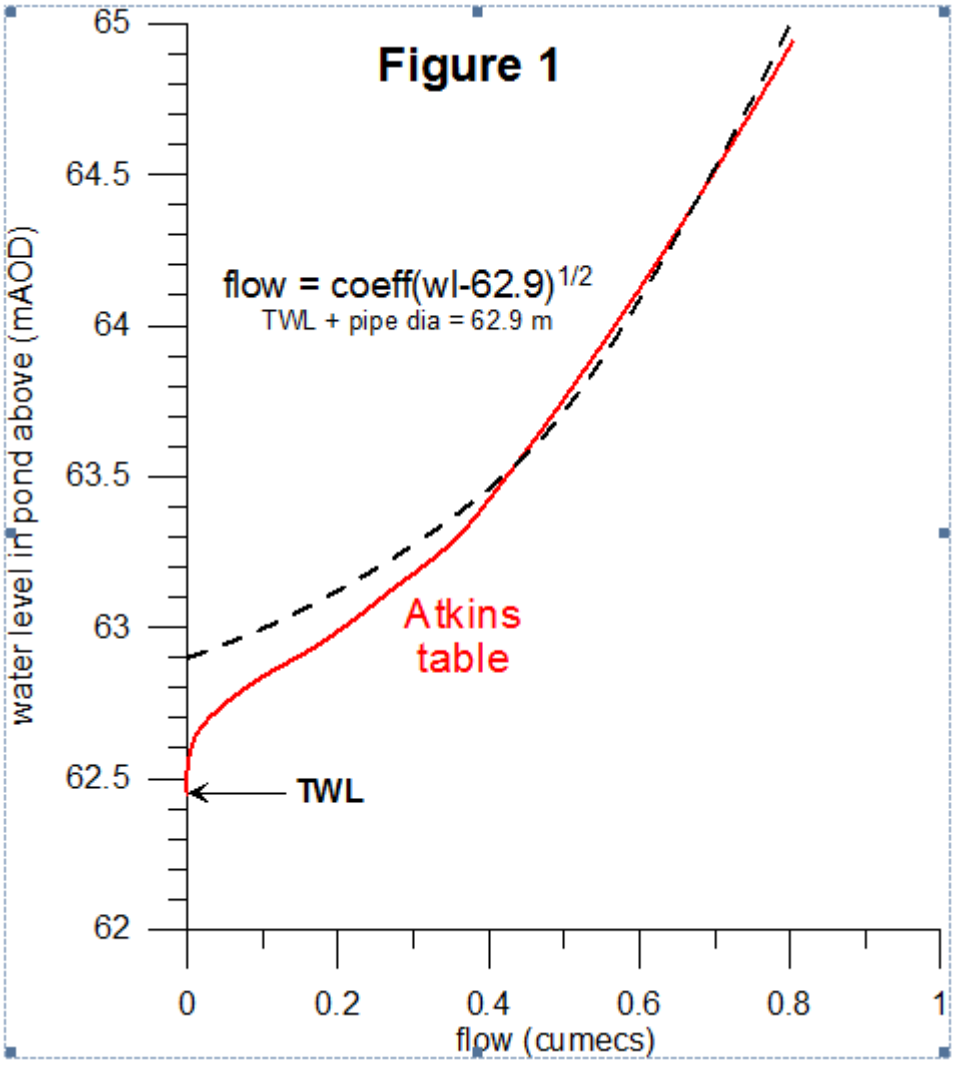
This decision wouldn't affect flows in the pipes in floods of return periods of 1:1,000 or anything less, since the water level in the 1:1,000 event only reaches 30mm above the proposed spillway weir (which is at 64.45m), and the water levels in HG1 Pond in all smaller floods do not reach 64.44m.

Regards
Ben

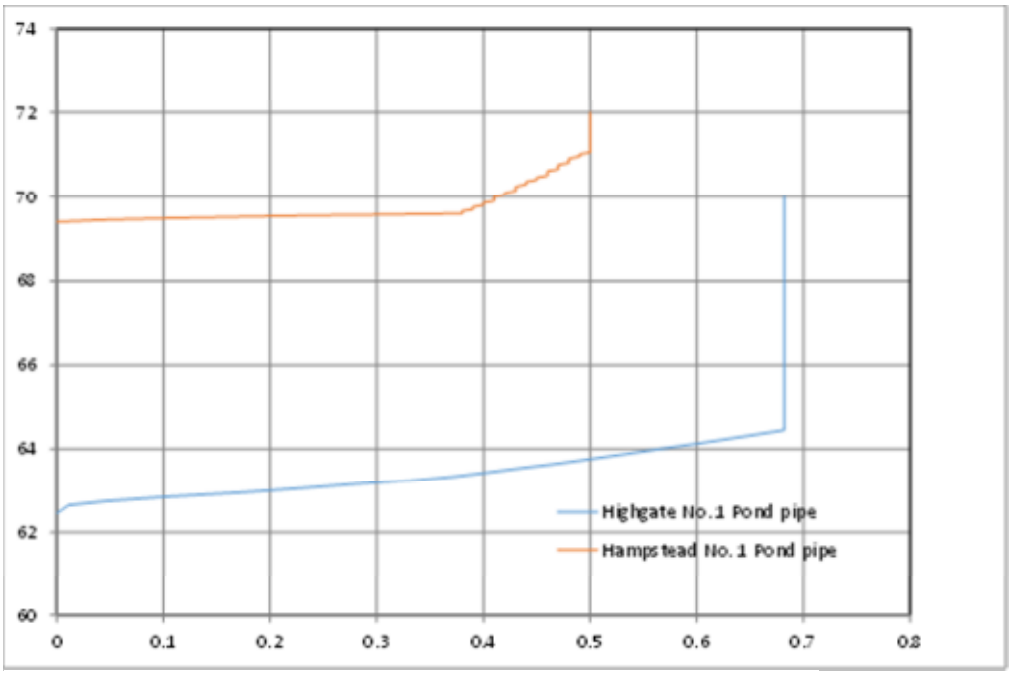
From: Hay-Smith, Debbie
Sent: 28 October 2014 11:22
To: Jones, Ben
Cc: 'Markwell, Jonathan'; Downs, Chris; Mann, Robert J; Wanner, Tom; Ayoung, Margaretta; Hughes, Andy; Farrar, Joanne
Subject: RE: Independent review of Hampstead Heath ponds project - RFI

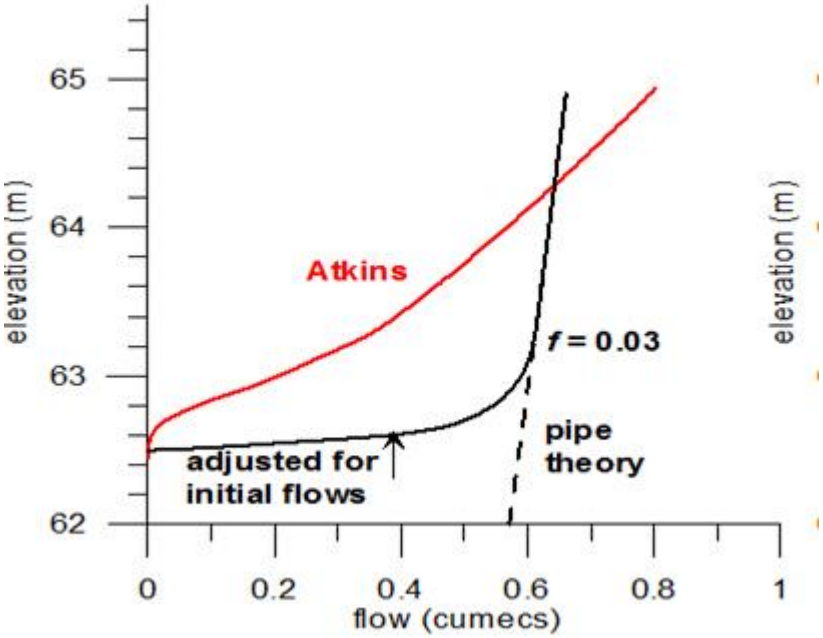
Ben

We have been asked to include in our review, comments received from Brookfield Mansions Ltd, which includes a paper from Professor Rushton regarding the overflow from Highgate No 1. The comments do include a number of misinterpretations which are adequately dealt with in Joanne's email to Jonathan Markwell of 21st October. However, I do have a query regarding Professor Rushton's paper. In it, he presents a graph showing the Atkins rating curve for the Highgate outlet pipe (in red below)



Where is this data from? It does not match the rating curve you sent me (below left) which does match quite well with Prof Rushton's rating curve (below right)?





I have included this in the latest version of the RFI table attached. There are two other outstanding pieces of information we are waiting for:

- 7a – Query regarding high flows that remain post breach
- 11 - Separate out the ASLL figures for each “branch“ and “common stem” of the inundation area. Just to be clear, we don’t need you to carry out any additional modelling, just use the existing runs for PMF and PMF plus breach.

Kind regards

Debbie Hay-Smith
Principal Engineer

Water Business Line

AECOM
1 Tanfield
Edinburgh
EH3 5DA

Highgate chain

HG1		EXISTING	OPTION 4	OPTION 6	REVISED OPTION 6	Atkins Comments
		from DFA	(2m raising at Model Boating Pond)	(2.5m raising at Model Boating Pond)	Men Pond Spillway spill elevation was slighly lowered	
TWL	m AOD	62.45	62.45	62.45	62.45	
PWL (peak water level PMF)	m AOD	64.12	64.92	64.92	64.91	Typo amended in Revised Option 6 column.
Min crest level	m AOD	63.77	64.45	64.45	64.45	Note min crest level on existing dam is 63.77m AOD following review of topo survey. Min crest level in Options 4 and 6 would be the spillway crest level.
Proposed crest level (min crest level + 1.25m)	m	na	65.02	65.02	65.02	
Spillway level (proposed crest level -0.57m)	m	na	64.45	64.45	64.45	Note proposed spillway level is higher than existing minimum ground level on the dam crest.
Peak (PMF) overtopping discharge	m3/s	39.10	32.70	30.90	30.83	Option 4 and 6 overtopping discharges are the same as the 'PMF output' figures in the options flowcharts, and would only be over the spillway.
Pond surface area (TWL)	m2	13,660	13,660	13,660	13,660	13,660m^2 was at TWL. Modellers to calculate surface area of floodwater at Peak WL of 64.92m which is reached in both Option 4 and 6.
Pond surface area (PMF)	m2	15,500	19,700	19,700	19,700	
available storage above TWL	m3	18,549	43,356	43,356	43,356	Note existing storage above TWL is now considered as slightly higher than in the DFA report due to revision of minimum EGL on crest up to 63.77mAOD. For the old value of 63.5, the volume was 14,343m^3.
PMF volume flowing into HG1, in m^3 **(0 - 14 hours)**	m^3	275972	215,687	207,193	206,172	Note these volumes are for the first 14 hours of a storm, which is why they vary (the total outflow would eventually be the same). This also explains why the PMF volume into HG1 is less, because more is stored for several days in upstream ponds, slowly draining away through overflow pipes.
Cumulative % of ~~peak~~ inflow that can be stored in HG1 Pond.	%	7%	20%	21%	21%	The 5% figure for the existing scenario in the DFA report was the available storage above TWL (the old value of 14,343m^3) as a percentage of the total PMF volume 'in' (275,972m^3). (Note this was not peak inflow but total inflow.)
spillway overtopping	m AOD	N/A - overtops existing crest at min 63.77m	64.45	64.45	64.45	Note this is the same as the spillway level.
TOTAL CHAIN CAPACITY		42,518	180,492	179,353	179,925	

Overflow

Peak discharge capacity	m3/s	The overflow pipe discharge varies with the water level in the pond, see table below as provided in answer to Query 123.

Scour pipe

Maximum discharge capacity	m3/s	This would vary with water level in pond, but be limited to about 1.0 m^3/s.

Questions

Is TWL top water level (DFA) or typical water level (preferred options)?

TWL means Top Water Level, this is the invert level of the overflow pipe at a pond.

Is TWL the same as the invert level of the overflow pipe?

See above.

Is peak flow the same as peak inflow?

Table 4-7 in the DFA report provides peak flows. These are in relation to the hydrological inflows to the ponds. They are therefore not the same as the total inflow to the pond, as the latter also takes into account flow from the upstream pond (either over the dam crest, spillway or round the side / on the floodplain).

Is overflow 310mm dia or 457mm dia (as shown on TWA plan)

The overflow pipe is 457mm (18 inches).

What is the total pmf volume for the Highgate chain?

See above data for item **9.**

Calculated discharge rates through overflow pipe

Flow m^3/s	Stage (water level) mAOD
0	62.45
0.011	62.64
0.046	62.74
0.102	62.84
0.172	62.94
0.228	63.04
0.279	63.14
0.332	63.24
0.373	63.34
0.405	63.44
0.436	63.54
0.466	63.64
0.495	63.74
0.523	63.84
0.551	63.94
0.578	64.04
0.605	64.14
0.631	64.24
0.657	64.34
0.682	64.44
0.707	64.54
0.732	64.64
0.756	64.74
0.78	64.84
0.803	64.94

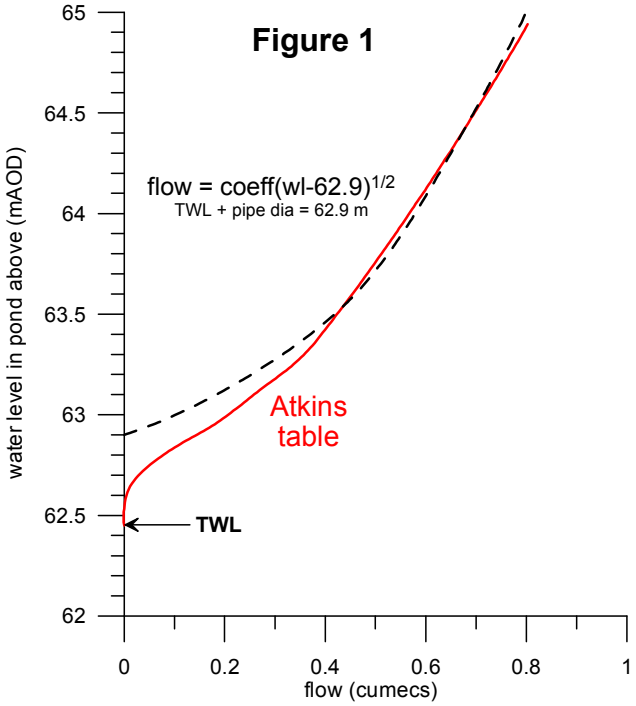
	Available storage (m^3) above TWL existing (from Table 5-7)	4	6
Stock Pond	2,597		
Ladies Bathing	6,026		
Bird Sanctuary	4,770		
Model Boating	4,379		
Men's Bathing	10,403		
Highgate No 1	14,343		

42,518 Total existing flood storage capacity

Overflow from Highgate No 1

Comments on 03/10/2014 by Professor K R Rushton, PhD, DSc, CEng, MICE, MCIWEM.

I Atkins Approach



The full line in the above graph is a plot of the flow through the overflow pipe from HG1 according to Atkins' calculation. The broken black line is my attempt to match part of the curve using an equation of the form head difference raised to the power 0.5. Apart from the early stages, the curves are not very different although the head for zero flow is 62.9 m rather than TWL of 62.5 m in Atkins' values. Nevertheless, it appears that Atkins have used some form of orifice equation where the flow equals the square root of the head difference between the water level in HG1 and the elevation of the inlet to the overflow, but with some adjustment for lower head differences. The general form of the orifice equation is

$$Q = A_O C_d \sqrt{2g(\Delta h)}$$

where Q = flow, A_O is the cross sectional area of the orifice, C_d is the coefficient of discharge and Δh is the total difference in energy head across the orifice.

The orifice approach ignores the reality that the flow through the overflow pipe should be based on hydraulic pipe theory, not just the conditions at the inflow to the pipe.

II Estimate of Flows through the Overflow Pipe based on Pipe Theory

The following analysis is based on conventional pipe theory; assumptions have been made about the parameter values used in calculating representative flows. However, the results are of the correct order of magnitude.

Flow inside the overflow pipe can be analysed using the Darcy-Weisbach formula; for circular pipes (Daugherty et al. 1989) the frictional head loss

$$h_f = \frac{flu^2}{2gd}$$

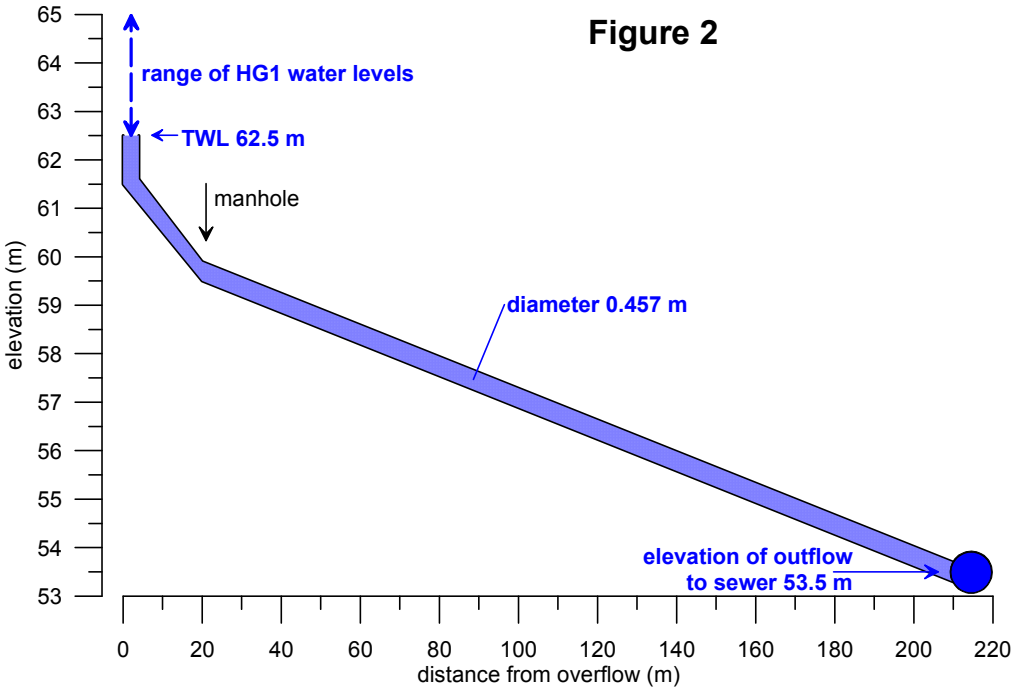
where f is the friction factor, l is the pipe length, u is the average velocity and d is the pipe diameter.

Writing this equation in terms of the total flow Q and substituting for g,

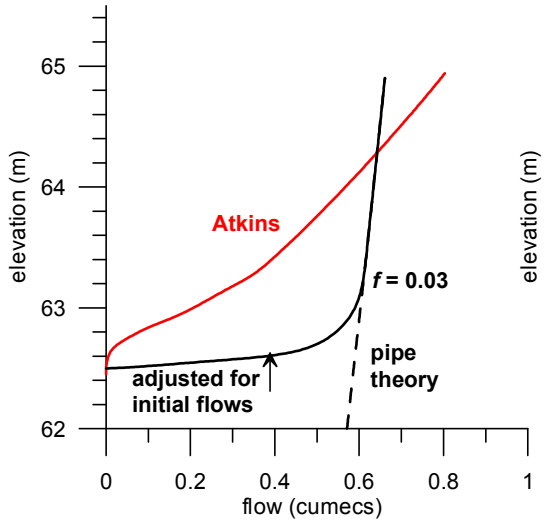
$$h_f = \frac{flQ^2}{12.1d^5} \qquad \text{or} \qquad Q = \sqrt{\frac{12.1\,h_f\,d^5}{f\,l}}$$

This means that the discharge Q is a function of the square root of the head difference from inflow to outflow.

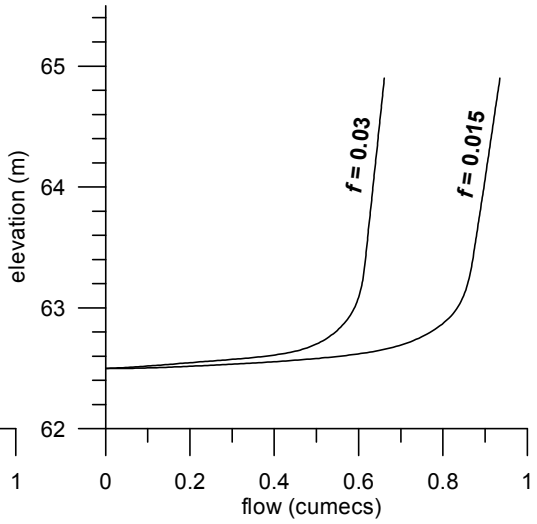
Figure 2



(a) schemtic vertical cross section of overflow pipe (elevations and distances are estimates)



(b) comparisons of Atkins with pipe theory



(c) different pipe friction coefficients

Figure 2(a) illustrates the probable layout of the overflow pipe (elevations and lengths need to be confirmed). Inflow occurs from HG1, outflow occurs to a sewer; for the initial calculations the sewer is assumed to be running half full. The difference in elevation between the water level in HG1 and the outflow to the sewer determines the flow through the overflow pipe.

Assuming d = 457 mm, f = 0.01 to 0.07 try 0.03, l = 210 m, outflow head = 53.5 m

head when inflow starts = 62.5 m so h_f = 62.5 – 53.5 = 9.0 m, $Q = (0.345)^{1/2}$ = 0.59 cumecs

when head = 64.9 m, h_f = 64.9 – 53.5 = 11.4 m hence $Q = (0.437)^{1/2}$ = 0.65 cumec

These and intermediate results are plotted in Fig. 2(b) as a broken line, the broken line is also extended a short distance below TWL. The reason for this downwards extension of the line is that the pipe flow calculation is based on the difference in elevation between HG1 water level and the outflow to the sewer. Consequently hypothetical flows can be calculated for water levels below the TWL. In practice, when the water level in HG1 just exceeds the TWL, water does flow into the overflow pipe but it will not fill the pipe and pipe theory does not apply. It is assumed that it is not until the pond water level is more than 0.5 m above the TWL that pipe flow is fully established. Consequently an empirical relationship has been devised to represent pond water levels between 62.5 and 63.0 m. If field evidence is obtained for outflows for this range of water levels, the curve in Fig. 2(b) can be refined.

Figure 2(b) also contains a plot of the relationship calculated by Atkins. The curves exhibit significant differences, although the maximum flows are of similar magnitude. Of special significance is the relatively small difference in discharge for pipe flow over the range of water levels in HG1 (apart from the initial 0.5 m when the pipe is not flowing full of water).

Parameter values used in these calculations are only preliminary. Distance and heights can be checked but there will always be some uncertainty about the friction factor although, if information about the pipe material is provided, more reliable estimates can be made. When there are uncertainties, sensitivity analyses should be performed. Similar calculations to those described above have been made for f = 0.015; the results are plotted in Fig. 2(c).

III Conditions when substantial floods occur

When the water level in HG1 reaches the peak water level of 64.9 m, flooding is also likely to occur in the vicinity of the outflow sewer causing a rise in water levels. Therefore the hydraulic head differences between inflow and outflow will be less than those used in the above calculations; this will result in a lower outflow.

The suggestion of an orifice plate in the overflow pipe is unacceptable because this would effectively increase the pipe friction and reduce flows through the overflow pipe for all surface water levels in HG1; making conditions worse than the current conditions. A consequence would be that the spillway would overtop earlier than previously calculated.

IV Concluding remarks

This note has shown that hydraulic pipe theory should be used to estimate the flows in the overflow pipe from Highgate No 1 pond. Further field information is required to refine the calculated flows.

This methodology is similar to that adopted in a study of flow in a horizontal well (Rushton and Brassington 2013).

References:

Daugherty, R.L., Franzini, J.B., Finnemore, E.J., 1989. Fluid Mechanics with Engineering Applications, McGraw-Hill, New York.

Rushton, K.R., Brassington, F.C. 2013. Significance of hydraulic head gradients within horizontal wells in unconfined aquifers of limited saturated thickness. J. Hydrol **492**;281-289.

From:	Farrar, Joanne	Sent:	Tue 21/10/2014 15:49
To:	'Markwell, Jonathan'		
Cc:			
Subject:	RE: Hampstead Heath Ponds Project (2014/4332/P)		

Jonathan

If you wish AECOM to look at this then please just forward on my email.

Kind regards
Joanne

From: Markwell, Jonathan
Sent: 21 October 2014 13:16
To: Farrar, Joanne
Subject: RE: Hampstead Heath Ponds Project (2014/4332/P)

Dear Ms Farrar,

Thank you for your email, which I have discussed with colleagues internally.

We feel that the issues raised by the Brookfield Mansions party are required to be addressed/ responded to, particularly given that the concept of a flow restriction was initially raised by the City.

As such, officers request that this forms part of the independent review. With your comments in mind, you are advised that it may be helpful for AECOM for you to set out a note explaining the context / your responses to the various points raised by Professor Rushton and Mrs King (presumably an adapted form of the correspondence below?) to help inform AECOMs subsequent comments.

Once I receive these from you, I will advise AECOM of this and the Thames Water reply. As an alternative, you may simply prefer for the email correspondence below to be sent onto AECOM?

Please note that I am out of the office beyond Thursday 23rd October, returning on 3rd November. As such, please reply prior to 12 noon on Thursday 23rd October.

Yours sincerely,

Jonathan Markwell
Principal Planning Officer

Telephone:

intended recipient you are expressly notified that any copying or dissemination of this message without our permission is prohibited. You must not copy, distribute or take any action in reliance on it. Unless stated to the contrary, any opinions or comments are personal to the writer and do not represent the official view of the Council.
From: Farrar, Joanne
Sent: 21 October 2014 09:57
To: Markwell, Jonathan
Cc: Sumner, Esther; Creed, Thomas
Subject: RE: Hampstead Heath Ponds Project (2014/4332/P)

Apologies for the delay in responding Jonathan

We would like to request that the comments by Professor Rushton in their present form should not be sent to AECOM as a lot of them refer to a suggestion to fit an orifice plate to the inlet of the overflow pipe at Highgate No.1 Pond. This orifice plate was never part of our proposed design, or included in any of our hydraulic modelling.

The flow control device (such as an orifice plate, which would limit the size of the opening of the pipe) was suggested by Paul Monaghan of the City of London in response to comments made by certain stakeholders who thought that Thames Water would require some flow control in the overflow pipes, should the proposed works increase the flow through the pipes. However, following our modelling of the low return periods (e.g 1:5 and 1:20) we have shown to Thames Water that our proposed works on the dams would not increase the flow through the pipes in the kind of storms that they are obliged to cater for. Thames Water have since reiterated their position, which is that they have no objection to the proposed works, and they have not asked for any flow control devices.

We have also commented on some inaccuracies in Mrs King's email below (in blue.)

Kind regards
Joanne

Thames Water clarified their statutory duties; we understand that they have been asked to comment on the proposals. Thames Water told us that it is a material consideration under the Town and Country Planning Act that they do not agree to any works which may be to the detriment of residential areas downstream from the Ponds. Although the buildings that make up Brookfield lie downstream of the ponds, they are upstream of the junction of TWA's sewers with the overflow and scour pipes from the Highgate chain. Brookfield includes the most vulnerable properties directly below the Highgate chain. Several properties are more low lying, as shown on our flood extent maps issued last week.

We are concerned about the proposed reduction in the size of the overflow pipe; this would increase the flows over the spillway of Highgate No1 and potentially into Brookfield.
This is not being proposed.
In addition, the overflow will be positioned in the spillway (at present it is in the dam) where it could easily become blocked.
This implies that we are moving the overflow, but we are not proposing any works to the overflow inlet. None of our proposed works would increase the likelihood of the inlet being blocked. The inlet will be maintained and kept clear by the Heath staff as is done currently.

In the existing situation in an extreme event, some water would flood areas adjacent to the higher ponds. As proposed, all excess water, that is water not held in the ponds or discharged down the overflow, will be discharged down the spillway of Highgate No 1. Atkins clarified that the overflow reaches peak capacity in a 1:20 storm. We have not said this. We have explained on a number of occasions that the discharge through the overflow pipe increases as water level in Highgate No.1 Pond rises in a flood, but the peak capacity is not reached even in a PMF event.

Thames Water had visited the Heath and looked at the toe of Highgate No 1 and were sympathetic to the

consideration of a bund (say 1m high) to the south of Brookfield. They also stated that in an extreme storm, any increase in flow down the pipe would be insignificant, particularly in view of the fact as there would be a delay (appoximately 6 hours) from the start of the storm to the maximum discharge of water through the overflow.
The increase in flow down the pipe is not significant compared to the flow over the spillway (in the proposed case) or over the top of the dam (in the existing case). Any works beyond the dam at Highgate No.1 Pond are beyond the scope of the City of London in their role as responsible undertakers of the dams.

We have also proposed that an additional overflow at top water level would in fact increase our protection significantly in extreme events and we believe this would not have a significant effect on flooding downstream.
We are already increasing the protection significantly by raising most of the dam by 1.25m and filling in low spots elsewhere (since the spillway level is around 500 – 600mm above the low spots). This, combined with the storage capacity works at upstream ponds, would increase the standard of protection (the return period of overtopping / spilling) from around 1:100 in the existing situation to over 1:1,000 in the proposed scenario. This should be compared to typical Environment Agency flood alleviation schemes, which generally aim for a design standard of protection of around 1:75 to 1:100. It should also be noted that this is not a flood alleviation scheme and the increase in storage capacity is intended to reduce the impact of dam safety works downstream. However, residents downstream will benefit from reduced flooding during large (greater than 1:1000) events, as shown in our flood extent maps for the 1:10,000 event.

I've attached a comment that has been prepared by Professor Rushton. We haven't been told what the proposed orifice reduction would be. There doesn't need to be one.

From: Markwell, Jonathan
Sent: 20 October 2014 14:29
To: Farrar, Joanne
Subject: RE: Hampstead Heath Ponds Project (2014/4332/P)

Dear Ms Farrar,

Further to my email below, I would appreciate a response as soon as possible from you in respect of the Thames Water/Brookfield Mansions point? As detailed below, I would like to progress this without delay with AECOM for the benefit of all parties.

Yours sincerely,

Jonathan Markwell
Principal Planning Officer

Telephone:

From: Markwell, Jonathan
Sent: 16 October 2014 12:12
To: Farrar, Joanne
Subject: Hampstead Heath Ponds Project (2014/4332/P)

Dear Ms Farrar,

Further to recent emails, I would like to clarify/confirm that I consider that all supporting information which AECOM are presently considering as part of their

review should be formally submitted to the local planning authority, and duly added to the list of drawings / documents included on any future planning application decision notice. This is as such documents are those which will have been considered in coming to a decision on the application. I realise that there is some overlap between information/documents already submitted, but there would appear to also be a significant number of documents which haven't been formally submitted which AECOM are considering. On this basis, I would be grateful if you could please provide a list of documents being considered (including for example those sent by your colleague Ben Jones earlier in the week) and email me (or provide a direct weblink to the CoL/HHPP website so I can download them) those which don't currently form part of the submission? These will then be uploaded to the Council's website.

In addition, I refer back to our correspondence on 11/09/14 about the QRA (attached for your convenience). I would be grateful for an update as to when this will be formally submitted?

I can also update you that earlier in the week I received a further consultation response from Thames Water, and a further technical response from Brookfield Mansions Freehold Limited. Both are in the process of being uploaded to the Council's website, but I attach them here for your information as soon as possible. I intend to feed in both to AECOM as part of the independent review. I intend to inform AECOM that the Thames Water response should be used for their information in informing question 4 of the scope. Meanwhile, the Brookfield Mansions Freehold Limited response (in particular that from Professor K R Rushton, PhD, DSc, CEng, MICE, MCIWEM) will be sought to be incorporated within question 5 of the scope. Please advise me if you have any comments on this intended approach? I will ask AECOM whether this will have any implications for their fee requirements, and look to agree this with you if that is the case. I would be grateful if you could please detail your thoughts on this as soon as possible, as obviously the sooner AECOM has this information the better.

I therefore look forward to hearing from you.

Yours sincerely,

Jonathan Markwell
Principal Planning Officer
Regeneration and Planning
Culture and Environment
London Borough of Camden

Telephone:
Web: camden.gov.uk
2nd Floor
5 Pancras Square
London N1C 4AG

consideration of this matter by the Development Management Section or to the Council's formal decision. This e-mail is intended solely for the person to whom it is addressed. It may contain confidential or privileged information. If you receive this message but are not the intended recipient you are expressly notified that any copying or dissemination of this message without our permission is prohibited. You must not copy, distribute or take any action in reliance on it. Unless stated to the contrary, any opinions or comments are personal to the writer and do not represent the official view of the Council.

This e-mail may contain information which is confidential, legally privileged and/or copyright protected. This e- mail is intended for the addressee only. If you receive this in error, please contact the sender and delete the material from your computer.

The IS team in Atkins has scanned this email and any attachments for viruses and other threats; however no technology can be guaranteed to detect all threats. Always exercise caution before acting on the content of an email and before opening attachments or following links contained within the email.