Technical Appendix C: Water Balance

1 Introduction

The purpose of this Technical Appendix is to summarise the methodology, results, assumptions and potential limitations of the Water Balance calculations that have been undertaken for the IWMP study area.

The objective of the Water Balance calculations is to broadly characterise and quantify the water cycle flows anticipated from the proposed growth across the study area. In order to achieve this, each of the six growth zones have been considered as a separate system boundary and changes to the water cycle built up from anticipated development in each zone.

The data on anticipated housing growth made available for the IWMP by LBTH for the years 2016 – 2031 comprises specific sites, however for growth anticipated for the years 2031-2041, the quantum of growth is taken from the maximum growth scenario set out in the IoDSP OAPF rather than specific sites identified by LBTH. As a result, it should be noted that the Water Balance for each zone covers the period up to 2031; whereas the Water Balance for the whole study area covers the period up to 2041.

Flows have been estimated on both a daily and an annual scale to consider the area–wide balance between input and output of water. The two predominant inflows to the urban cycle are:

- The natural hydrological flows, which originate as rainfall and exit the system through groundwater infiltration, evapotranspiration and urban runoff.
- The centralised water supply, which is imported from outside the area boundary, and consumed or discharged through the wastewater system.

Each of the flows described in Table 1-1 have been estimated for each of the zones and the whole study area in the pre-development and post-development state. These estimates have been developed based on the best information available; however, it should be noted that they are based on assumptions and should not be regarded as assured. An overview of the assumptions and overall methodology is presented in Section 2.

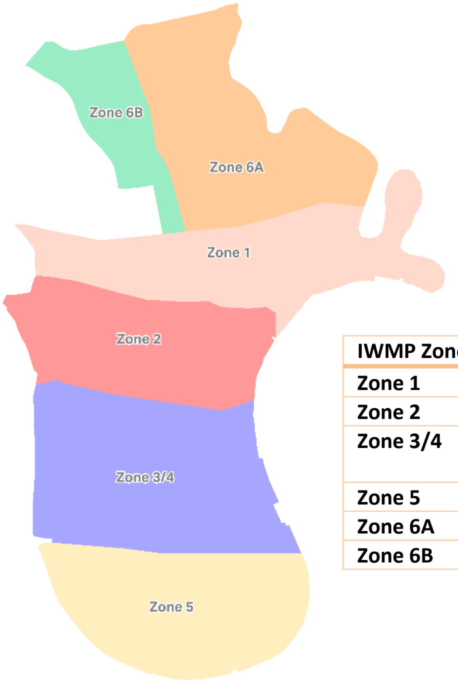
Table 1-1 Urban Water Cycle Flows

Flow	Definition
Rainfall	The volume of natural precipitation falling over the Opportunity Areas over an average year.
Roof water	The quantity of rainwater which falls directly on rooftops within the Opportunity Areas. This has been split from storm water due to the differing water quality characteristics.
Stormwater	Runoff from the urban environment generated during rainfall events. This consists predominately of runoff from impervious areas. This flow has been split from roof water above; however, within the current system, both roof water and storm water are combined and enter the drainage system.
Losses	Losses of water from the water balance, including evapotranspiration (water which is returned to the atmosphere through the processes of evaporation and transpiration of vegetation) and infiltration (the proportion of rainwater which infiltrates through the soil).
Potable water	High quality water supplied for uses within the home, including water used for drinking and use in the kitchen and bathroom. Within this analysis, potable water has been assumed as necessary for all household uses except toilet flushing.
Non-Potable Water	Water which is utilised for low-contact uses including irrigation and toilet flushing. In general, this water is not required to be of the same quality as that used for potable uses. Under the current (baseline) scenario, water for all uses is supplied from the centralised, potable system.
Grey Water	Wastewater generated from use in hand basins, baths and showers. Grey water generally excludes water used in toilets, the kitchen or for cleaning use, which has a greater concentration of contaminants.
Black Water	Wastewater generated from toilets, kitchen and laundry use. This has a higher concentration of contaminants than grey water. Under the current scenario both black water and grey water are combined and disposed to the drainage system.

2 Methodology and Key Assumptions

2.1 Study Area

The study area for the IWMP has been divided into 6 zones as shown in Figure 2-1. These are based broadly on Zones 1-5 of the IoDSP Opportunity Area; the 'Core Area' of the LBTH East of the Borough Area Action Plan (AAP Area); and, a section of the 'Wider Area' of the LBTH East of the Borough AAP. Two of the OAPF Zones (Zones 3 and 3) have been combined into one zone for the purpose of the IWMP.



IWMP Zone Name	Description
Zone 1	OAPF Zone 1 South Poplar
Zone 2	OAPF Zone 2 Canary Wharf
Zone 3/4	OAPF Zone 3 South Quay and Zone 4 Crossharbour
Zone 5	OAPF Zone 5 Island Gardens
Zone 6A	East of Borough AAP Core Area
Zone 6B	East of Borough AAP Wider Area

Figure 2-1 IWMP Water Balance Zones

2.2 Baseline Conditions

Ordnance Survey Master Map (OSMM) data has been analysed to determine the current site conditions for each growth zone. Proportional land coverage and surface permeability has been established based on the following categories:

- Buildings;
- Land (assumed to comprise 50% permeable space and 50% impermeable space);
- Water;
- Land for rail (assumed to comprise 50% permeable space and 50% impermeable space);
- Roads, tracks and paths (assumed to be wholly impermeable):
- Structures (assumed to be wholly impermeable).

Baseline water consumption has been estimated by considering the modelled demand information supplied by Thames Water. The data included daily demands for each District Metered Areas (DMAs) within the Isle of Dogs Demand Zone where these were provided[1]. Both the daily and annual demand in each growth zone were estimated proportionally by assuming an even spatial distribution of demand across the area occupied by each DMA within the growth areas.

[1] Data for DMA ZFINSB79 was not available for use in the study

For the annual water balance, household demands were assumed to apply every day of the year, while non-household demands were assumed to apply over 253 days of the year. The split between potable and non-potable use has been assumed based on standard fittings consumption.

Overall wastewater discharge was estimated using the water demands and the split of grey water to black water assumed based on equivalent fittings consumption. No system loss or leakage has been included in the calculations at this stage.

2.3 Precipitation, Runoff and assumed losses

Long term precipitation data for the local area has been provided by the Environment Agency. This was used to generate an average annual rainfall of 637.48 mm/year, based on a 10-year period of rainfall data (2009-2018), and applied over the area to estimate total annual precipitation.

Estimates for Stormwater and Roofwater were estimated using the land use (and permeability) assumptions detailed in Section 2.2, with the following assumed annual volumetric runoff coefficients:

- Rooftop areas - 0.9
- Grass / Pervious Surface – 0.2
- Hardstanding / impervious surfaces - 0.7

A total assumed loss, which includes losses associated with evapotranspiration and infiltration, was used to complete the mass balance.

No allowance has currently been included for climate change as part of this assessment.

2.4 Growth Assumptions

Development Maximum Scenario

The post-development parameters have been developed based on forecast growth data, as provided by LBTH Council, including:

- Housing and employment projections.
- High level development layout and form based on information within the Managing Development Document.
- Phasing assumptions.

Table 2-1 and Table 2-2 provide a summary of the development maximum scenario for housing and commercial development by zone. LBTH have provided specific sites to account for the housing growth up to 2031, however for the growth anticipated from 2031 to 2041, the quantum of growth is taken from the maximum growth scenario set out in the IoDSP OAPF rather than specific sites identified by LBTH. For the commercial development, this is provided only until 2031.

It has been assumed that all housing and commercial figures are additional to existing.

Table 2-1 Housing Development Phasing by Zone

	Zone 1 ***(OAPF Zone 1)***	**Zone 2** ***(OAPF Zone 2)***	**Zone 3/4** ***(OAPF Zone 3 & 4)***	**Zone 5** ***(OAPF Zone 5)***	**Zone 6A** ***(EoB AAP Core Area)***	**Zone 6B** ***(EoB AAP Wider Area)***	**Total**
Total Housing development up to 2031 (LBTH Capacity and Phasing Analysis)	8,340	8,842	14,225	199	4,399	1,911	37,916
Total Housing development up to 2041 (in accordance with the maximum growth scenario in the OAPF)	9,347	11,107	27744	799	5,568	2,037	56,602

Table 2-2 Commercial Development Phasing by Zone

	Zone 1 ***(OAPF Zone 1)***	**Zone 2** ***(OAPF Zone 2)***	**Zone 3/4** ***(OAPF Zone 3 & 4)***	**Zone 5** ***(OAPF Zone 5)***	**Zone 6A** ***(EoB AAP Core Area)***	**Zone 6B** ***(EoB AAP Wider Area)***	**Total**
Commercial Development Floorspace (m^2) to 2031	77,284	407,547	80,347	2,448	19,205	5,155	591,986

Development layout

Across each development site, assumptions have been made about the development layout and land cover, which are summarised below:

- Developable housing and employment area have been assumed to cover 80% of the total site area, and of this developable area:
    - 60% is assumed to be covered by built footprint,
    - The remaining 40% covered by landscaping, hardstanding and parking with an assumption of 50% permeable and 50% impermeable.
- Transport infrastructure is assumed to account for 4% of overall site area and is assumed to be totally impermeable.
- Social and hard infrastructure accounts for 12% of overall area and is also assumed to be totally impermeable.
- Public realm (outside the developable area) is assumed to account for 4% of overall area, comprised of 50% permeable and 50% impermeable surfaces.

2.5 Post Development Conditions

The post development site conditions have assumed a net increase of population and employment and associated water demand and wastewater discharge based on the analysis of the planning described in Section 2.4.

Water Demand

Domestic water demands were estimated using the BR 2010 Part G[2]. Non-domestic demand was calculated using British Standard 8524:2001[3]. For both these methodologies, the total water demand is based on assumptions on the use of sanitary fittings.

It is assumed that all new buildings will be constructed to the high efficiency Optional Performance criteria specified in BR 2010 Part G, corresponding to end use water efficiency targets specified in the London Plan. The resultant water use assumptions for domestic and non-domestic properties are summarised in Table 2-3 and Table 2-4.

Table 2-3 Domestic Water Use

Domestic Sanitary Ware	**Water Demand (litres/person/day)**
Potable	97.80
Bathroom taps	9.48
Bath	18.70
Shower	34.96
Kitchen taps	13.00
Dishwasher	4.50
Non-Potable	13.54
WC full flush	5.84
WC part flush	7.696
Washing machine	17.16
Total domestic water demand	111.33

Table 2-4 Non-Domestic Water Use

Non-Domestic Sanitary Ware	**Water Demand (litres/person/day)**
Potable	17.65
Hand basins	5.00
Showers	1.34
Kitchenette	3.58
Dishwasher	0.60
Kitchen Canteen	7.13
Non-Potable	18.00
WC male (4.5 litre)	9.00
WC female (4.5 litre)	9.00
Total non-domestic water demand	35.65

[2] Building Regulations 2010 (BR 2010) Part G (2015 Edition) Water Efficiency Calculator for New Dwellings.

[3] British Standard 8524:2001 Calculating domestic water consumption in non-domestic buildings.

Annual water use was calculated assuming a 253 day operating year for commercial and industrial properties and 365 day occupation for residential properties.

2.6 Wastewater Generation

Wastewater generation was calculated using the same fittings consumption values. Grey water was taken to be water generated from bath, shower and hand basin. Black water was taken as water generated from the kitchen, toilets and laundry. No system loss has been applied to the wastewater estimates at this stage.

The resultant wastewater assumptions are summarised in Table 2-5 and Table 2-6.

Table 2-5 Domestic Wastewater Generation

Domestic Sanitary Ware	Wastewater Generation (litres/person/day)
Grey	63.14
Bathroom taps	9.48
Bath	18.70
Shower	34.96
Black	48.19
Kitchen taps	13.00
Dishwasher	4.50
Washing machine	17.16
WC full flush	5.84
WC part flush	7.70
Total domestic wastewater generation	111.33

Table 2-6 Non-Domestic Wastewater Generation

Non-Domestic Sanitary Ware	Wastewater Generation (litres/person/day)
Grey	6.34
Hand basins	5.00
Showers	1.34
Black	29.31
Dishwasher (1.25 litres/place setting/cycle)	0.60
Kitchenette (8 L/second)	3.58
Kitchen Canteen - Fixed Use	7.13
WC male	9.00
WC female	9.00
Total non-domestic wastewater generation	35.65

2.7 Methodology Limitations

In considering these calculations, it should be noted that the masterplanning for the study area is still at an early stage, and therefore only limited resolution is currently available regarding the anticipated residential and commercial development. Additionally, only limited information on the current land use is available. Therefore, whilst the model calculations provide a good indication of the relative magnitude of various flows, they are based on several assumptions and simplifications in order to facilitate strategic-level analysis and planning and should not be regarded as assured volumes. More detailed analysis will be required at a later stage in each growth area in order to determine the exact volumes, and detailed design of the required infrastructure undertaken.

3 Annual Water Balance Results

3.1 Overview

This Section presents the results of the pre-development and post-development Water Balance calculations for:

- the whole study area up to 2041 (Section 3.2);
- the 6 separate study area zones, up to 2031 (Section 3.3).

3.2 Whole Study Area Results

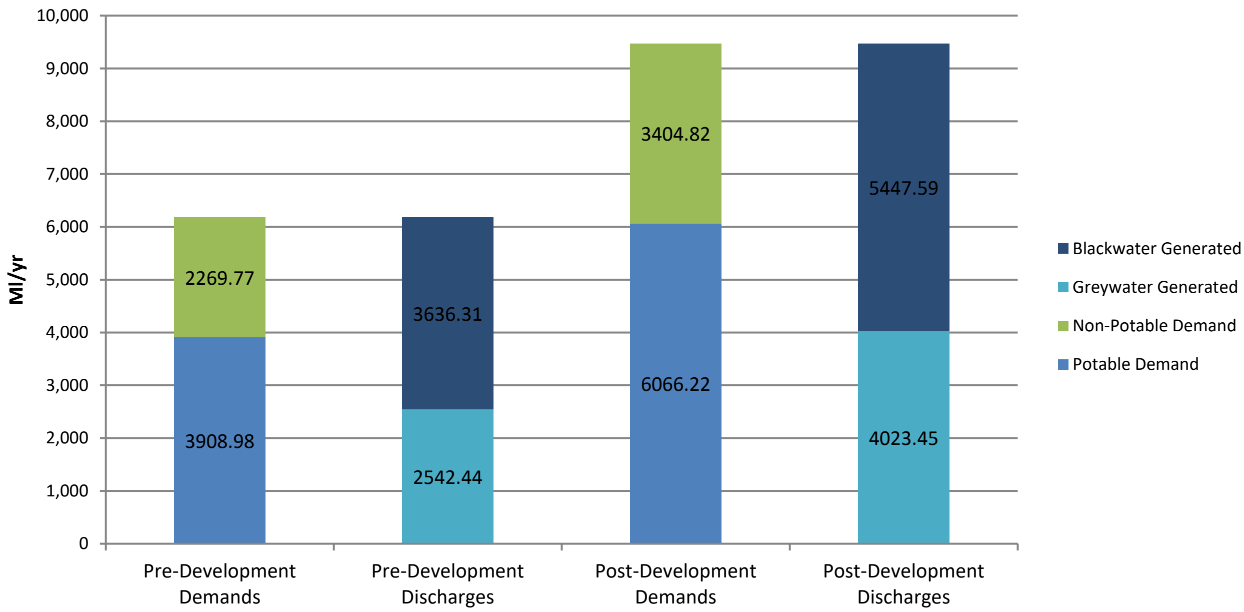
Comparing the results, it can be seen that the proposed development across the zones will lead to a substantial increase in the demand for water and subsequent generation of wastewater. There is also an increase in the proportion of rainfall falling on rooftops and contributing to urban storm water, through an increase in anticipated impervious surfaces.

As these figures illustrate, without intervention, the proposed development across the Isle of Dogs and South Poplar Opportunity Area will significantly increase demand on the regional water supply and wastewater assets.

Analysis of the post-development figures shows that the greywater generated post-development (4023.45 Ml) would be sufficient to meet the demand for non-potable water (3404.82 Ml).

Table 3-1 Whole Study Area Annual Water Balance Results

	Rainfall (Ml)	Potable Water (Ml)	Non Potable (Ml)	Greywater (Ml)	Blackwater (Ml)	Roofwater (Ml)	Stormwater (Ml)	Assumed Losses (Ml)
Baseline	3969.39	3908.98	2269.77	2542.44	3636.31	794.87	1610.09	1564.44
Post development	3969.39	6066.22	3404.82	4023.45	5447.59	835.48	1587.02	1546.89



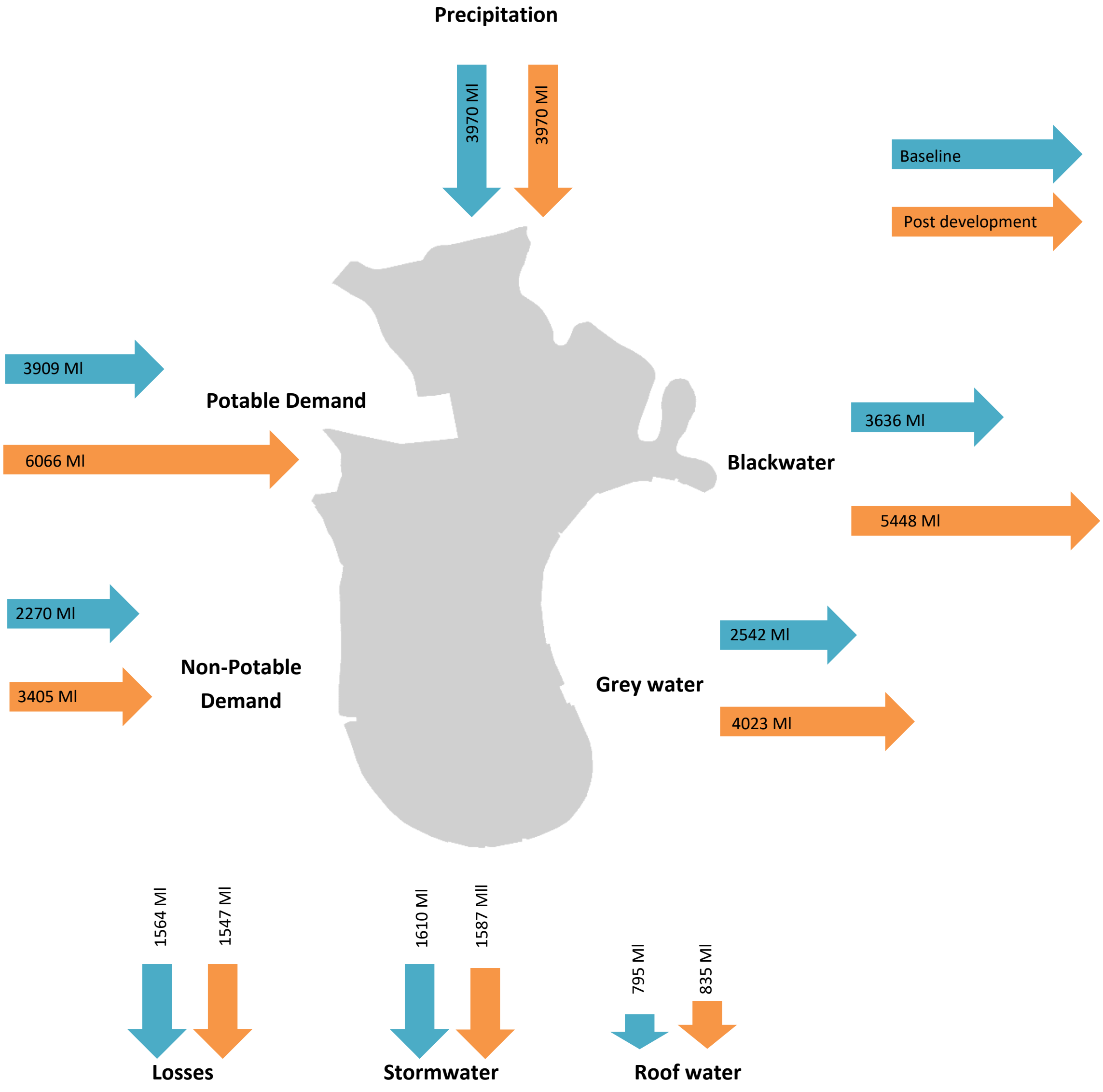


Figure 3-1 Annual Water Balance for the whole Study Area Pre and Post Development (2041)

3.4 Zone Level Results

Zone 1 South Poplar

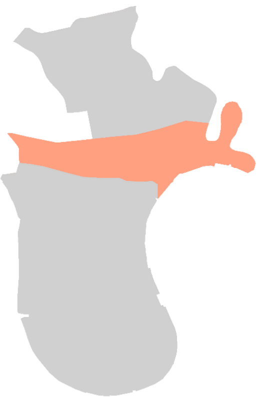
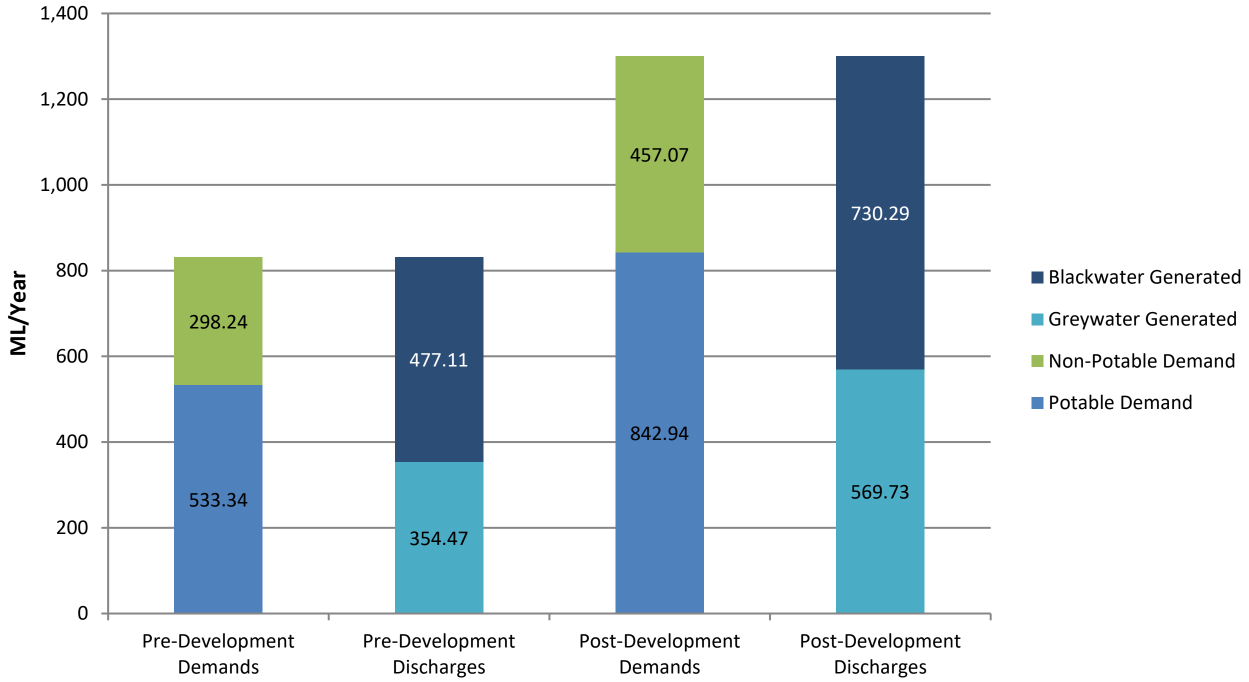


Table 3-2 Zone 1 South Poplar Annual Water Balance Results

	Rainfall (Ml)	Potable Water (Ml)	Non Potable (Ml)	Greywater (Ml)	Black-water (Ml)	Roofwater (Ml)	Stormwater (Ml)	Assumed Losses (Ml)
Baseline	709.52	533.34	298.24	354.47	477.11	121.71	323.04	264.76
Post development	709.52	842.94	457.07	569.73	730.29	183.82	279.81	245.89



Zone 2 Canary Wharf

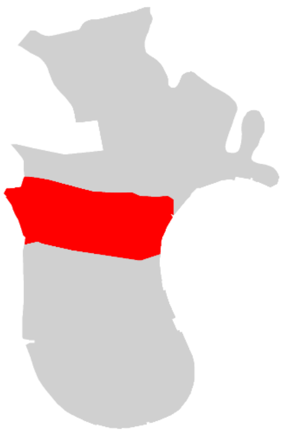
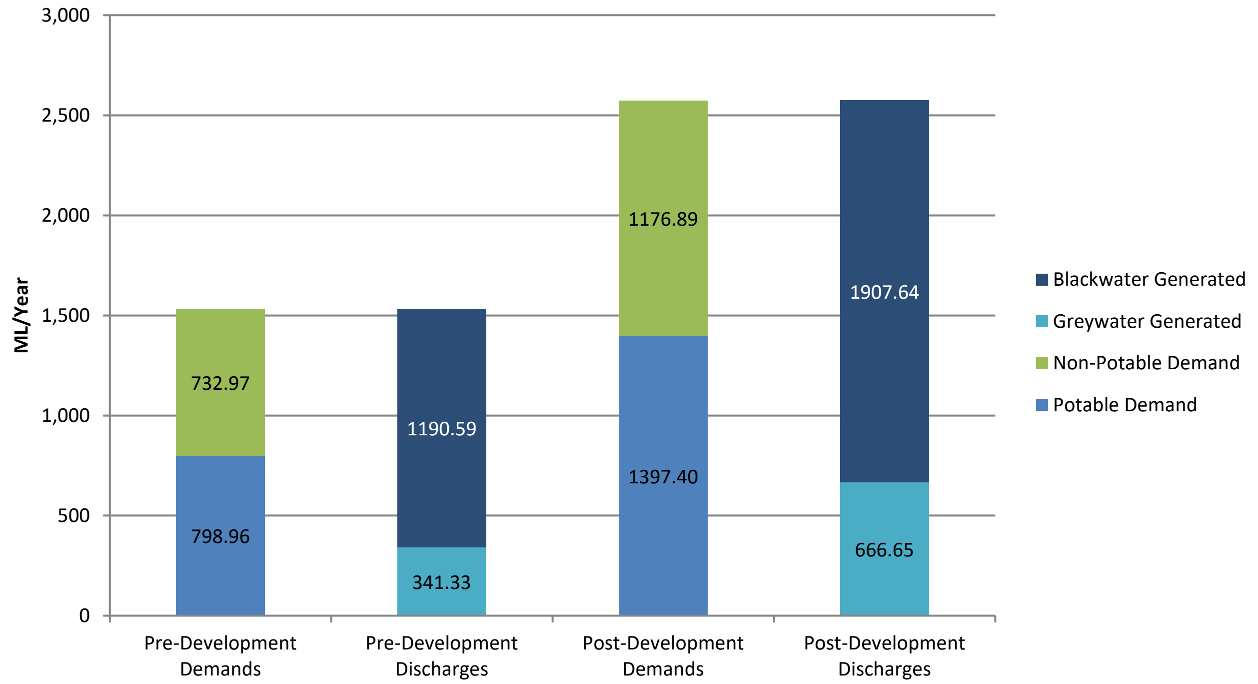


Table 3-3 Zone 2 Canary Wharf Annual Water Balance Results

	Rainfall (Ml)	Potable Water (Ml)	Non Potable (Ml)	Greywater (Ml)	Black-water (Ml)	Roofwater (Ml)	Stormwater (Ml)	Assumed Losses (Ml)
Baseline	630.34	798.96	732.97	341.33	1190.59	143.93	218.77	267.65
Post development	630.34	1397.40	1176.89	666.65	1907.64	177.41	206.75	246.18



Zone 3/4 South Quay Crossharbour

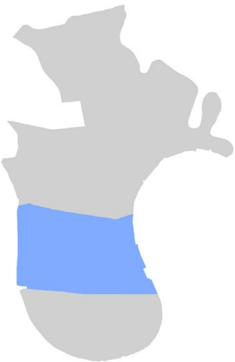
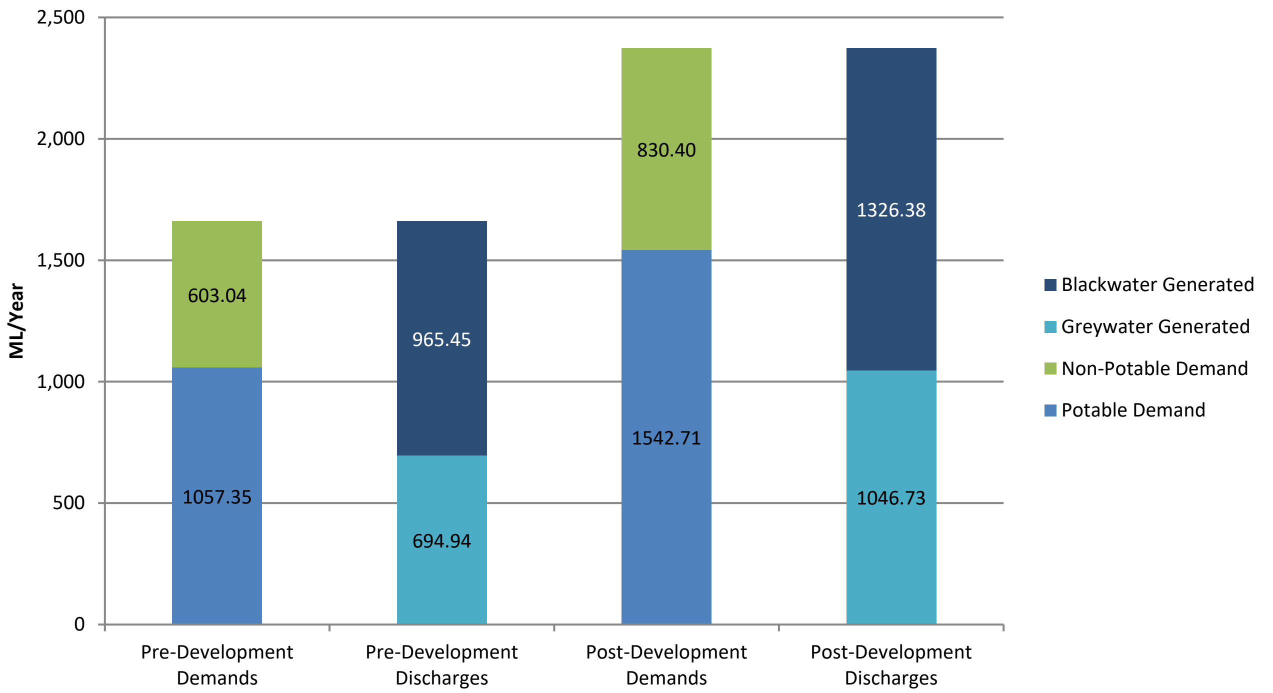


Table 3-4 Zone 3/4 South Quay and Crossharbour Annual Water Balance Results

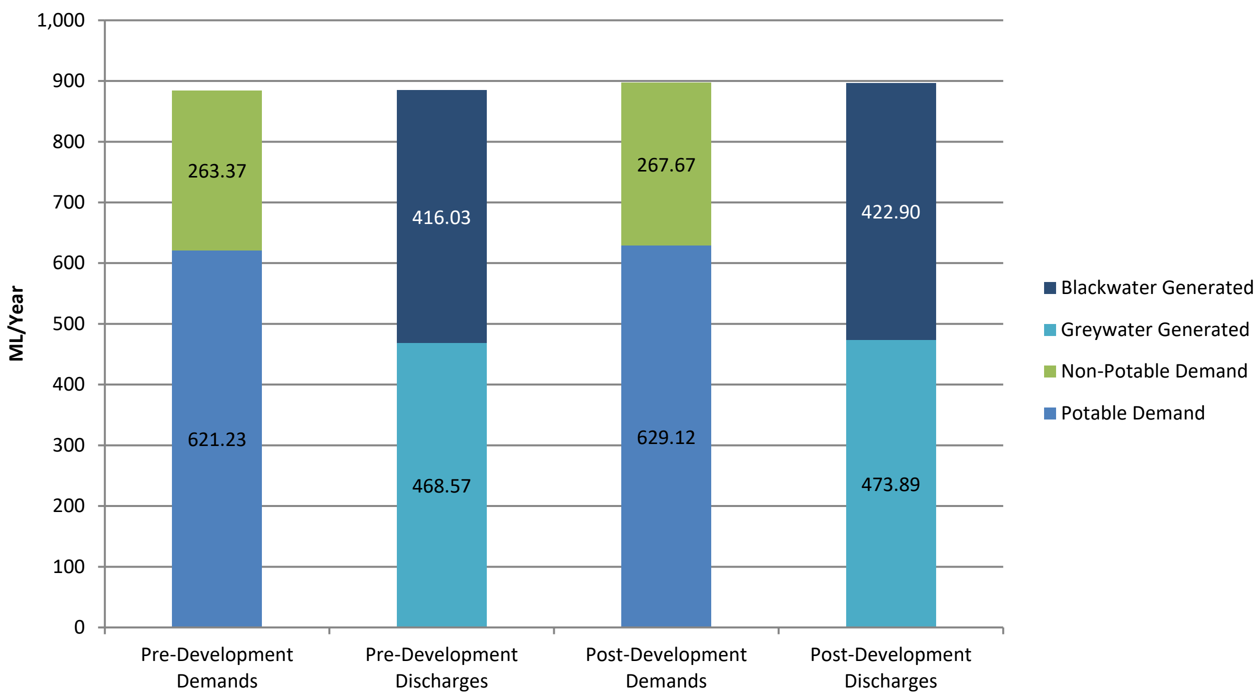
	Rainfall (Ml)	Potable Water (Ml)	Non Potable (Ml)	Greywater (Ml)	Black-water (Ml)	Roofwater (Ml)	Stormwater (Ml)	Assumed Losses (Ml)
Baseline	894.38	1057.35	603.04	694.94	965.45	189.16	330.52	374.70
Post development	894.38	1542.71	830.40	1046.73	1326.38	253.12	302.81	338.46



Zone 5 Island Gardens

Table 3-5 Zone 5 Island Gardens Annual Water Balance Results

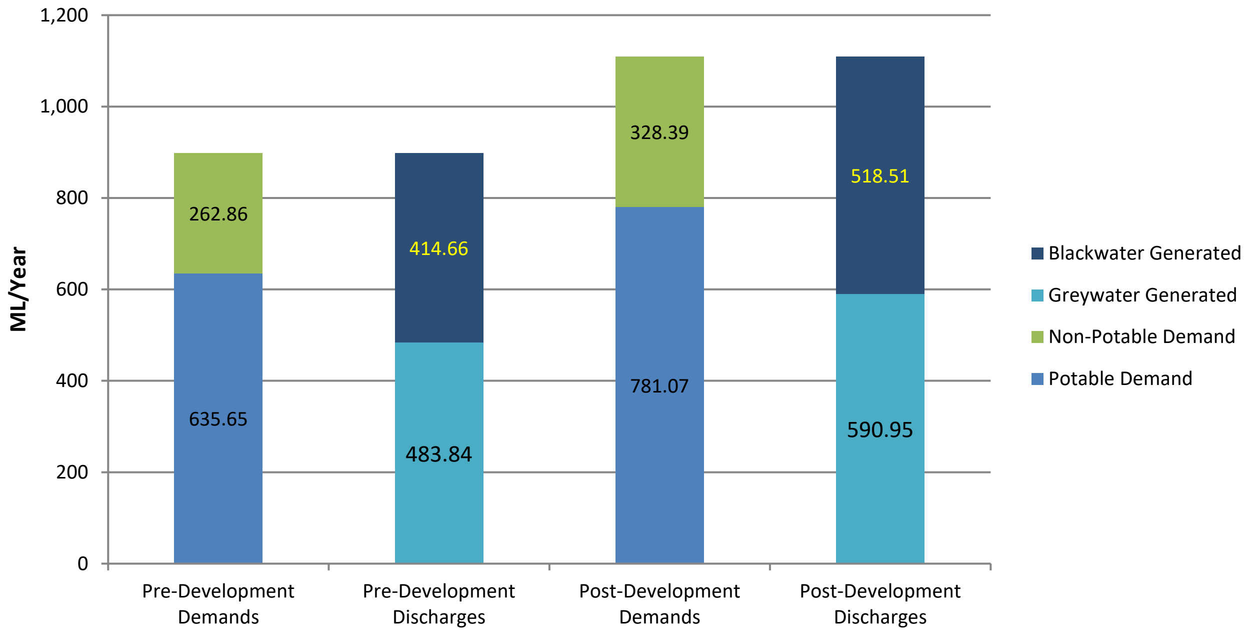
	Rainfall (Ml)	Potable Water (Ml)	Non Potable (Ml)	Greywater (Ml)	Black-water (Ml)	Roofwater (Ml)	Stormwater (Ml)	Assumed Losses (Ml)
Baseline	687.84	621.23	263.37	468.57	416.03	125.05	295.22	267.57
Post development	687.84	629.12	267.67	473.89	422.90	127.47	293.72	266.65



Zone 6A AAP Core Area

Table 3-6 Zone 6A AAP Core Area Annual Water Balance Results

	Rainfall (Ml)	Potable Water (Ml)	Non Potable (Ml)	Greywater (Ml)	Black-water (Ml)	Roofwater (Ml)	Stormwater (Ml)	Assumed Losses (Ml)
Baseline	750.31	635.65	262.86	483.84	414.66	151.94	324.29	274.09
Post development	750.31	781.07	328.39	590.95	518.51	206.78	286.48	257.05



Zone 6B AAP Wider Area

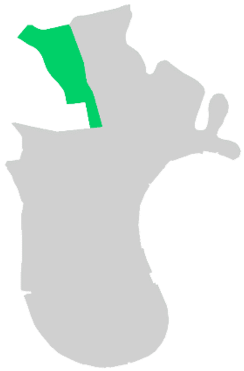
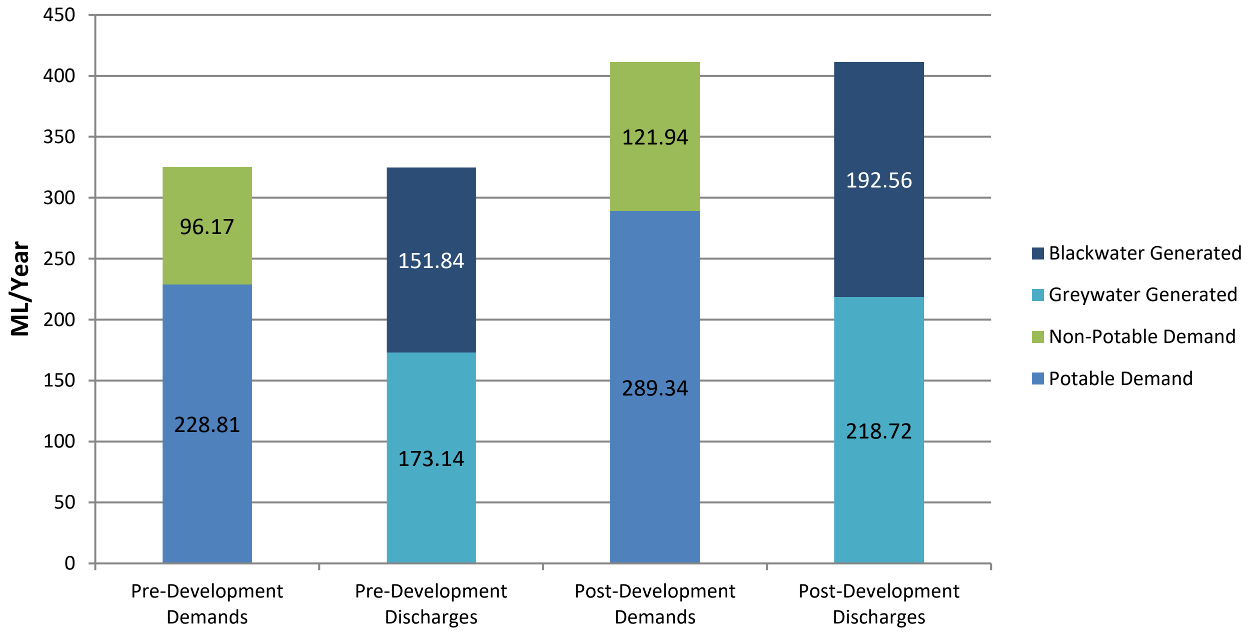


Table 3-7 Zone 6B AAP Wider Area Annual Water Balance Results

	Rainfall (Ml)	Potable Water (Ml)	Non Potable (Ml)	Greywater (Ml)	Black-water (Ml)	Roofwater (Ml)	Stormwater (Ml)	Assumed Losses (Ml)
Baseline	281.12	228.81	96.17	173.14	151.84	66.52	115.52	99.09
Post development	281.12	289.34	121.94	218.72	192.56	78.98	106.78	95.36



4 Peak Sewage flows

The distribution of the flows as described in the water balance are in reality not uniform, fluctuating significantly across different days and seasons. Variability in rainfall intensity and subsequent runoff rates of surface water during heavy rainfall events is a key feature determining capacity in the sewer system. In addition, peak wastewater flow from site occupation is also a key factor for sewer capacity in dry weather conditions.

Demand for water varies seasonally with the weather. In hot, dry weather, customer usage may increase, whilst in cold weather leakage may rise due to an increased number of burst pipes. Water demand also varies diurnally, with the greatest demands occurring in the morning and evening, before and after standard office hours. Using information provided by Thames Water for other London based IWMS, modelling standards indicate that a peak factor of 2.12 times the average flow should be used to represent peak residential sewage flows, and 3 used for commercial flows (excluding infiltration). Considering the water balance presented above, the estimated pre and post-development peak sewage flow for the growth zones is indicated in Table 4-1.

Table 4-1 Estimated increase in peak instantaneous foul sewer discharge (excluding infiltration)

	Pre-Development Estimated Peak Water Use (l/s)			**Post development Estimated Peak Water Use (l/s)**			**Total percentage change**
	Domestic	Non-Domestic	Total	Domestic	Non-Domestic	Total	
Zone 1	35.67	41.31	76.98	58.45	59.08	117.54	53%
Zone 2	5.14	152.91	158.05	36.03	279.75	315.78	100%
Zone 3&4	69.00	87.00	156.01	107.86	105.48	213.35	37%
Zone 5	53.75	11.68	65.42	54.29	12.24	66.53	2%
Zone 6A	55.96	9.07	65.03	67.98	13.49	81.46	25%
Zone 6B	19.92	3.94	23.86	25.14	5.12	30.26	27%

5 Attenuation vs. Non-potable Demand Analysis

5.1 Attenuation Analysis

Calculations have been undertaken to determine how the volume of rainwater attenuated from rooftop runoff compares to the non-potable demand in each zone. This information is useful for the IWMP to inform the feasibility of using rainwater harvesting approaches to deliver benefits for the area. As part of the analysis, calculations have been undertaken to determine the number of days the attenuated rooftop runoff could (1) meet demand; (2) partially meet demand and (3) not meet any demand.

The following assumptions have been made as part of this analysis:

- A single area of attenuation storage has been used for each growth zone, similar to a reservoir storage model. The attenuation has an infinite size such that its storage capacity is not exceeded by any rainfall event in the rainfall record available.
- Stored water not used to meet non-potable demand would be carried over to support next day demand.
- All rainwater falling on post-development rooftop area has been assumed to drain to the attenuation storage, including existing buildings. It is therefore assumed that rooftop attenuation is retrofitted on existing buildings.
- The attenuation feature has a dual purpose, to hold sufficient water to control surface water runoff rates to greenfield rates and to provide a source for non-potable supply via local package treatment. The purpose of a single storage unit is to determine at a conceptual level if usable rainfall volumes are likely to be sufficient to supply non-potable demand.
- The calculations are based on daily rainfall over a 10-year period (2009-2018).

5.2 Results

This Section presents the results of the analysis for:

- the whole study area (for the period to 2041);
- the 6 separate study area zones, (for the period to 2031).

The following details are recorded:

- Maximum attenuation calculated over a 10-year period;
- Non-potable demand;
- The number of days the demand is met, partially met or not met.

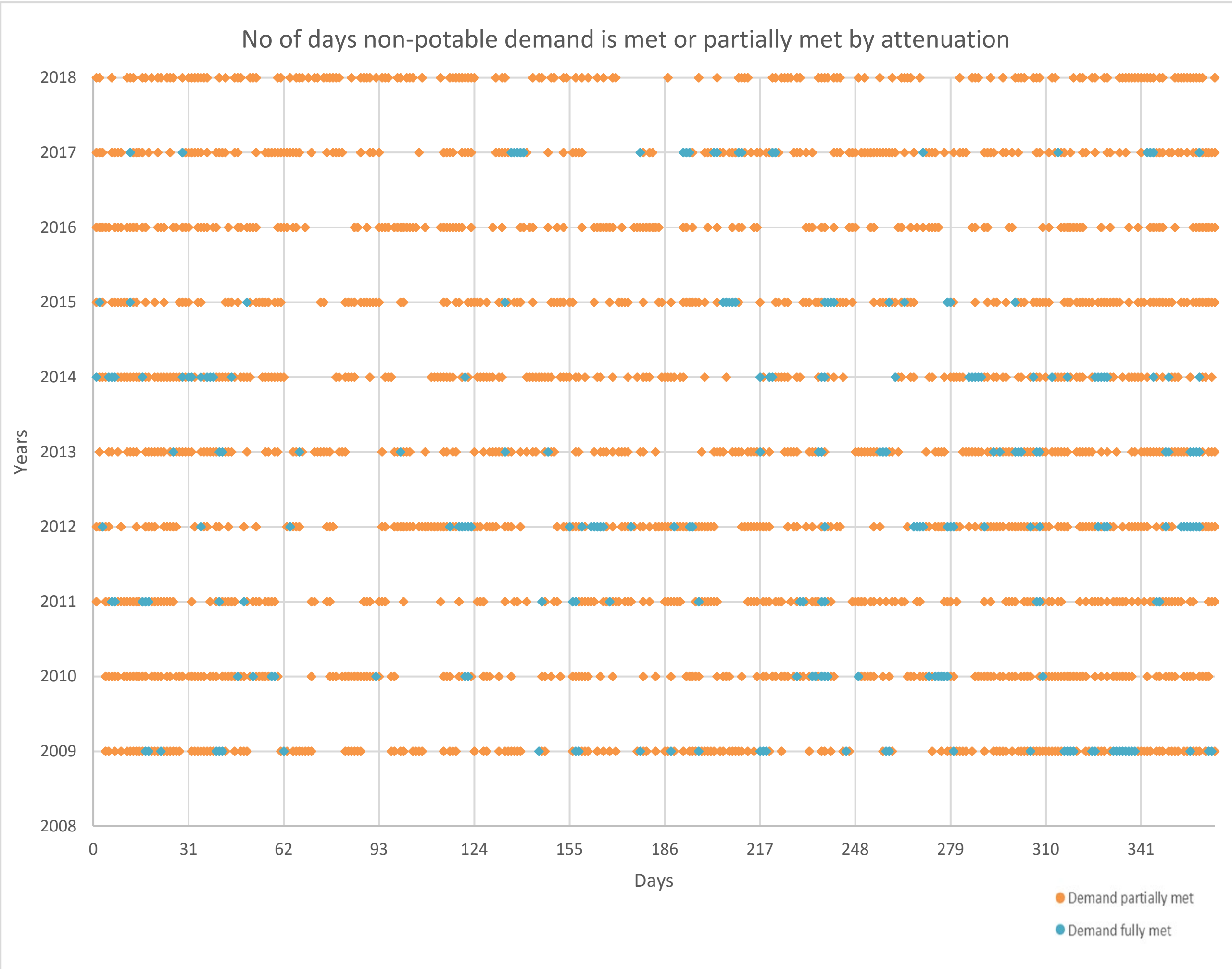
Findings from the analysis for the whole study area in Table 6-1 show that over a 10 year period, the demand for non-potable water is only met by the available rainfall 6% of the time, and during 43% of the time, the demand for non-potable water is not met by the available rainfall. This has significant implications for the viability of rainwater harvesting approaches on their own to meet non-potable demand in the study area.

When reviewing the results across the 6 zones, Table 6-2 shows that there is some variation in where rainwater harvesting systems may prove more viable. In Zone 6A and 6B, the non-potable demand is met 42-43% of the time, whereas in Zone 2 Canary Wharf it is only 1% of the time, and in Zones 1, 3/4, and 5 only 18%, 10% and 28% of the time respectively. As a result, rainwater harvesting systems may be more viable in the northern part of the IWMP study area.

Whole Study Area Results

Table 5-1 Study Area Wide Attenuation vs. Demand Results

	No. of days demand is met	% time demand is met	No. of days demand is partially met	% time demand is partially met	No. of days demand is not met	% time demand is not met
2009	38	10%	170	47%	157	43%
2010	21	6%	187	51%	157	43%
2011	20	5%	169	46%	176	48%
2012	42	12%	178	49%	0	0%
2013	27	7%	184	50%	154	42%
2014	36	10%	168	46%	161	44%
2015	18	5%	172	47%	175	48%
2016	0	0%	159	44%	206	56%
2017	23	6%	162	44%	180	49%
2018	0	0%	165	45%	200	55%
Average % over 10 years		**6%**		**47%**		**47%**
Max. Attenuation over 10 year period: 36,387.96 m^3						
Non potable demand: 11,449.00 m^3/day						



Zone Level Results

Table 5-2 Summary of the average % of time (over 10 years) that attenuation meets non-potable demand

Zone	Average % of time (over 10 years) that the Demand is met.	Average % of time (over 10 years) that the Demand is not met.
Zone 1 South Poplar	18	41
Zone 2 Canary Wharf	1	43
Zone 3/4 South Quay Crossharbour	10	42
Zone 5 Island Gardens	28	39
Zone 6A AAP Core Area	43	35
Zone 6B AAP Wider Area	44	35

Table 5-3 Zone 1 South Poplar Attenuation vs. Demand Results

	No. of days demand met	No. of days demand partially met	No. of days no demand met	% time demand is met	% time demand is not met
2009	94	132	139	26	38
2010	63	163	139	17	38
2011	66	133	166	18	45
2012	111	121	0	30	0
2013	87	138	140	24	38
2014	102	119	144	28	39
2015	61	145	159	17	44
2016	0	129	236	0	65
2017	70	132	163	19	45
2018	0	140	225	0	62
		Average % over 10 years		18	41
Max. Attenuation over 10 year period: 10,734.94 m^3					
Non potable demand: 1,515.87 m^3/day					

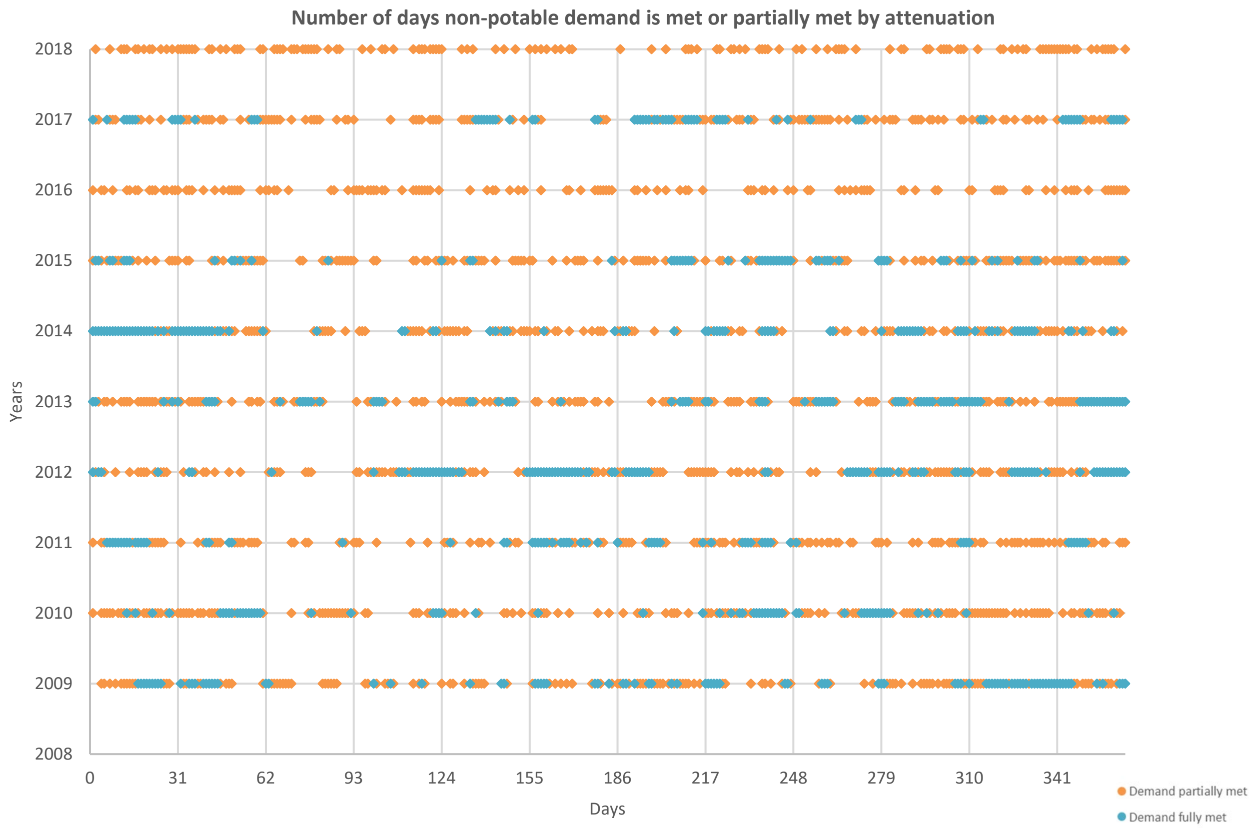


Table 5-4 Zone 2 Canary Wharf Attenuation vs. Demand Results

	No. of days demand met	No. of days demand partially met	No. of days no demand met	% time demand is met	% time demand is not met
2009	6	197	162	2	44
2010	4	201	160	1	44
2011	5	181	179	1	49
2012	6	210	0	2	0
2013	7	198	160	2	44
2014	7	190	168	2	46
2015	5	184	176	1	48
2016	0	175	190	0	52
2017	6	174	185	2	51
2018	0	180	185	0	51
		Average % over 10 years		1	43
Max. Attenuation over 10 year period: 5,685.36 m^3					
Non potable demand: 4,472.56 m^3/day					

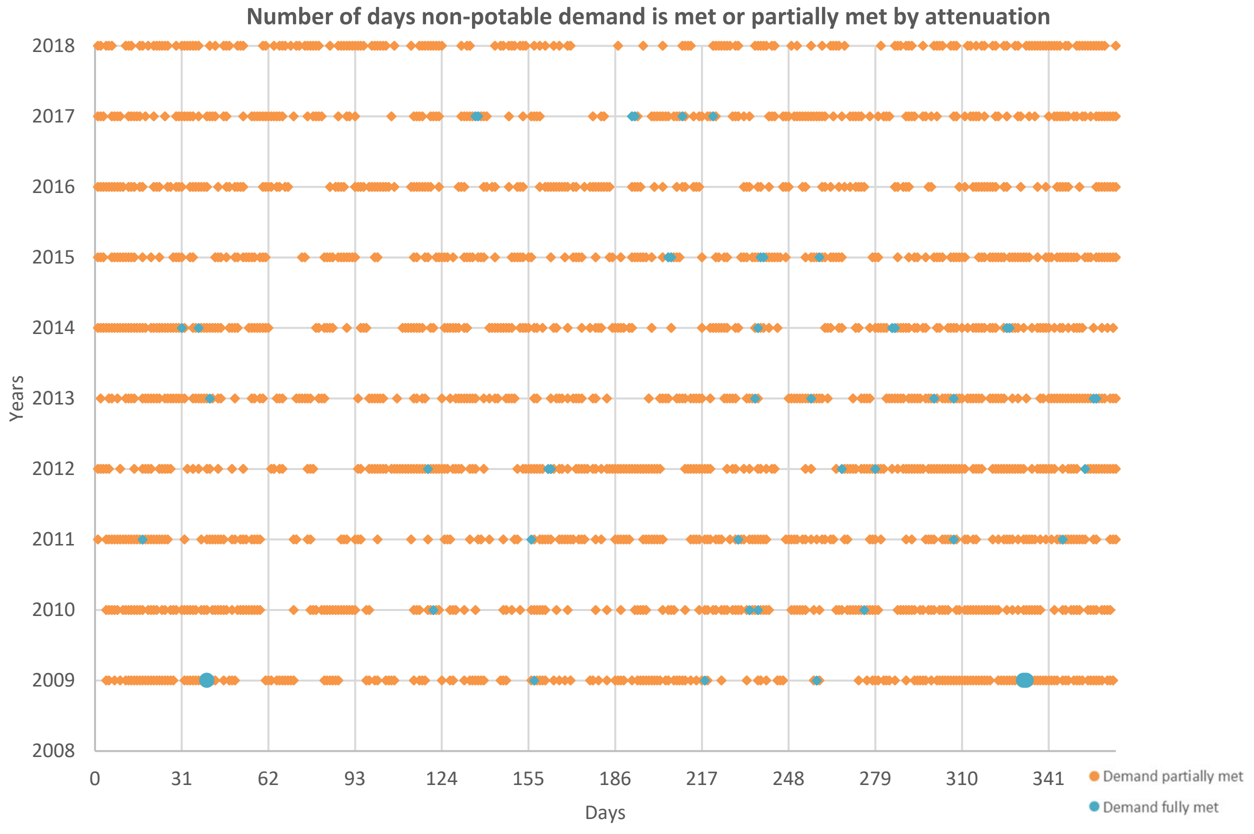


Table 5-5 Zone 3/4 South Quay Crossharbour Attenuation vs. Demand Results

	No. of days demand met	No. of days demand partially met	No. of days no demand met	% time demand is met	% time demand is not met
2009	61	154	150	17	41
2010	37	178	150	10	41
2011	33	160	172	9	47
2012	62	160	0	17	0
2013	49	167	149	13	41
2014	60	149	156	16	43
2015	34	161	170	9	47
2016	0	151	214	0	59
2017	40	149	176	11	48
2018	0	156	209	0	57
		Average % over 10 years		10	42
Max. Attenuation over 10 year period: 12,376.37 m^3					
Non potable demand: 2,745.71 m^3/day					

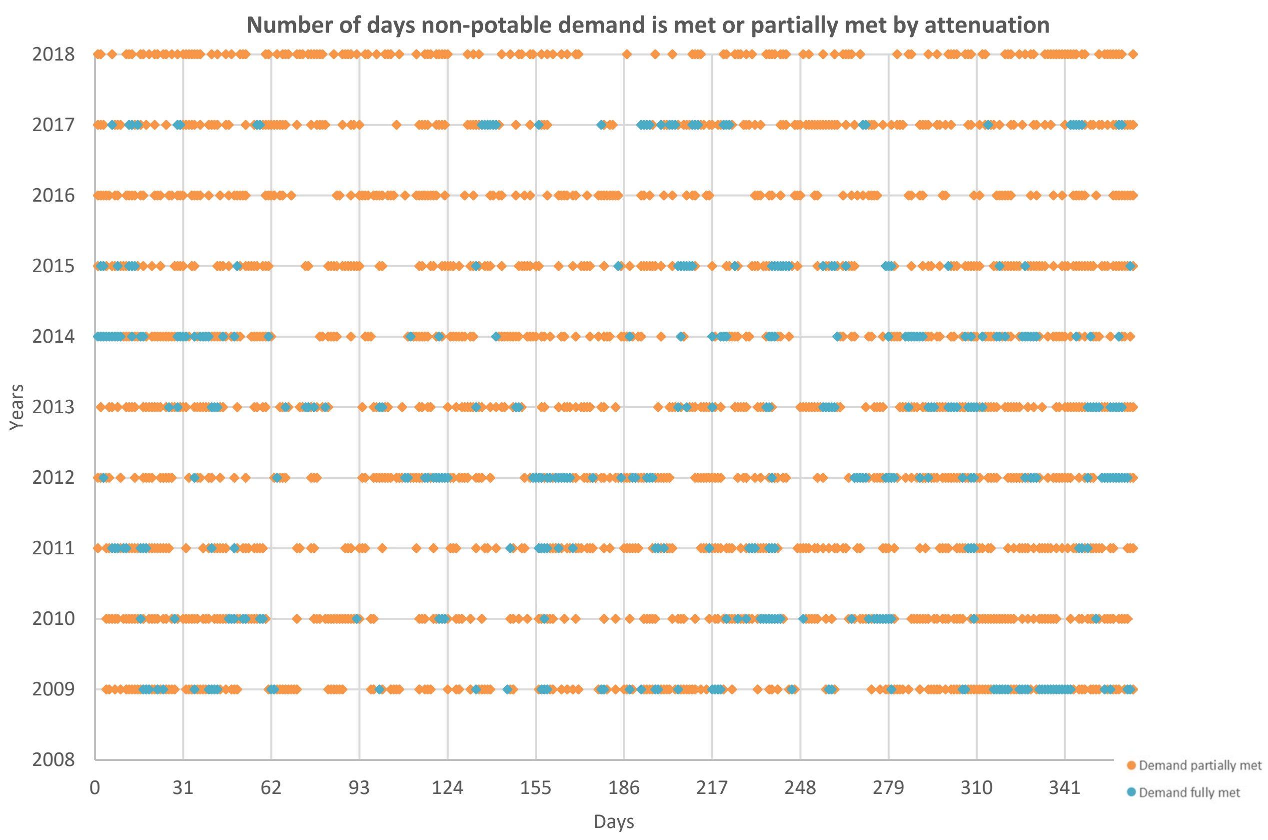


Table 5-6 Zone 5 Island Gardens Attenuation vs. Demand Results

	No. of days demand met	No. of days demand partially met	No. of days no demand met	% time demand is met	% time demand is not met
2009	143	98	124	39	34
2010	105	141	119	29	33
2011	104	106	155	28	42
2012	171	79	0	47	0
2013	131	116	118	36	32
2014	167	82	116	46	32
2015	99	127	139	27	38
2016	0	104	261	0	72
2017	114	104	147	31	40
2018	0	111	254	0	70
		Average % over 10 years		28	39
Max. Attenuation over 10 year period: 16,448.21 m³					
Non potable demand: 787.96 m³/day					

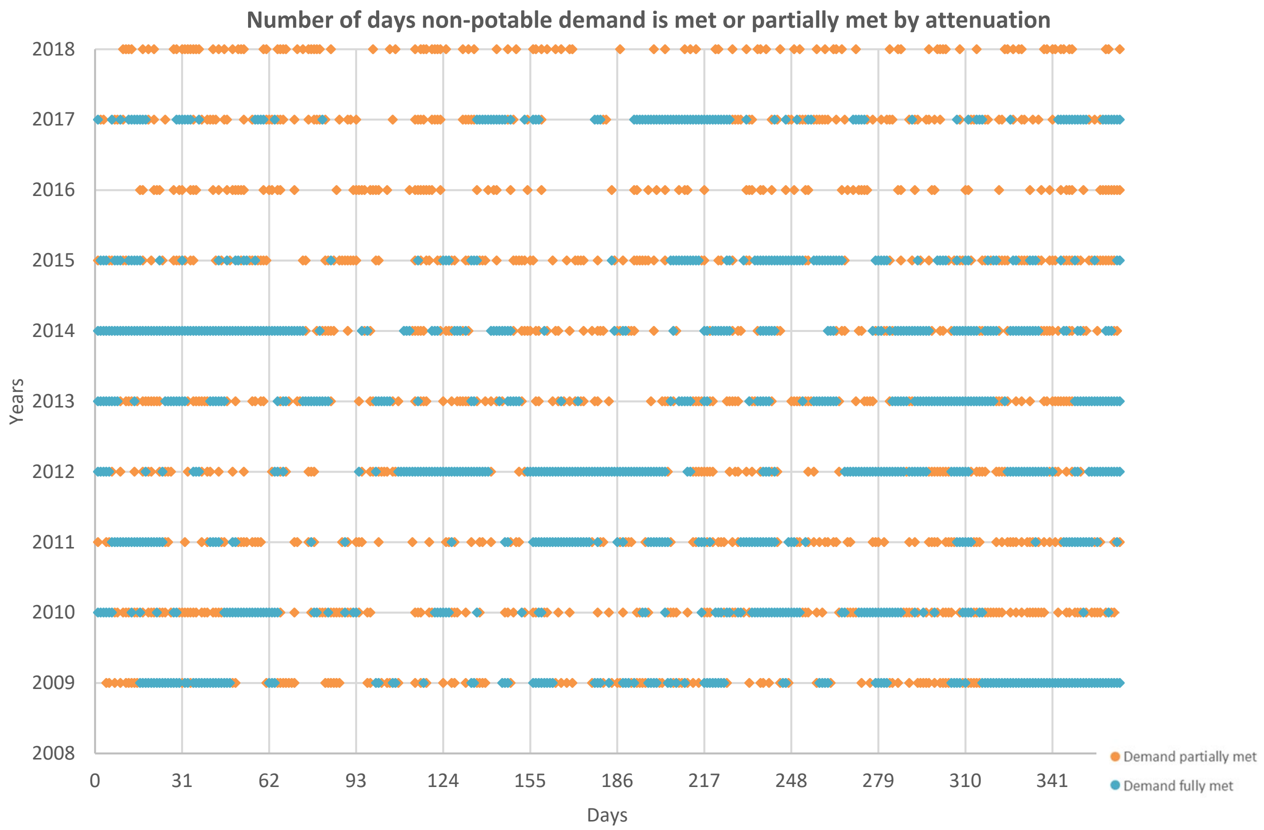


Table 5-7 Zone 6A AAP Core Area Attenuation vs. Demand Results

	No. of days demand met	No. of days demand partially met	No. of days no demand met	% time demand is met	% time demand is not met
2009	197	71	97	54	27
2010	185	83	97	51	27
2011	153	83	129	42	35
2012	238	47	0	65	0
2013	190	84	91	52	25
2014	262	35	68	72	19
2015	160	94	111	44	30
2016	0	80	285	0	78
2017	168	74	123	46	34
2018	0	81	284	0	78
		Average % over 10 years		43	35
Max. Attenuation over 10 year period: 45,714.28 m^3					
Non potable demand: 959.89 m^3/day					

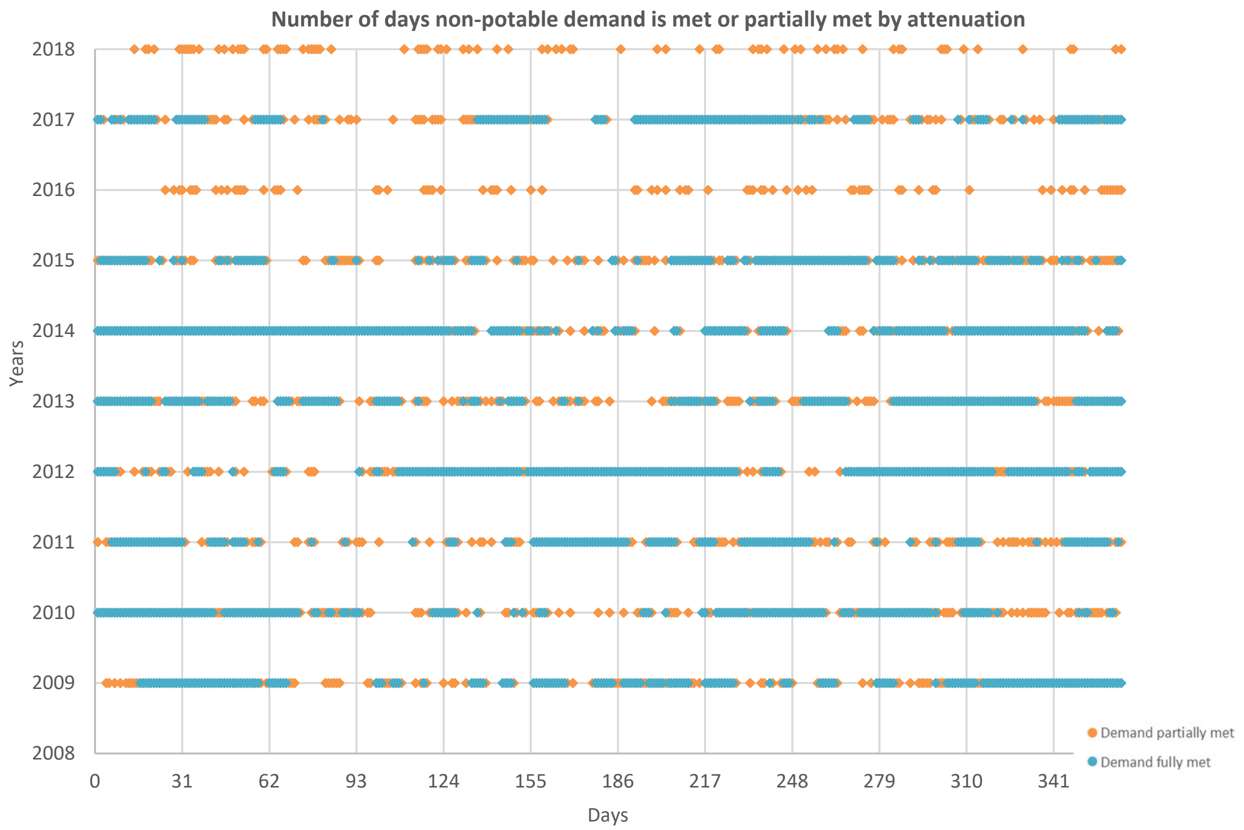
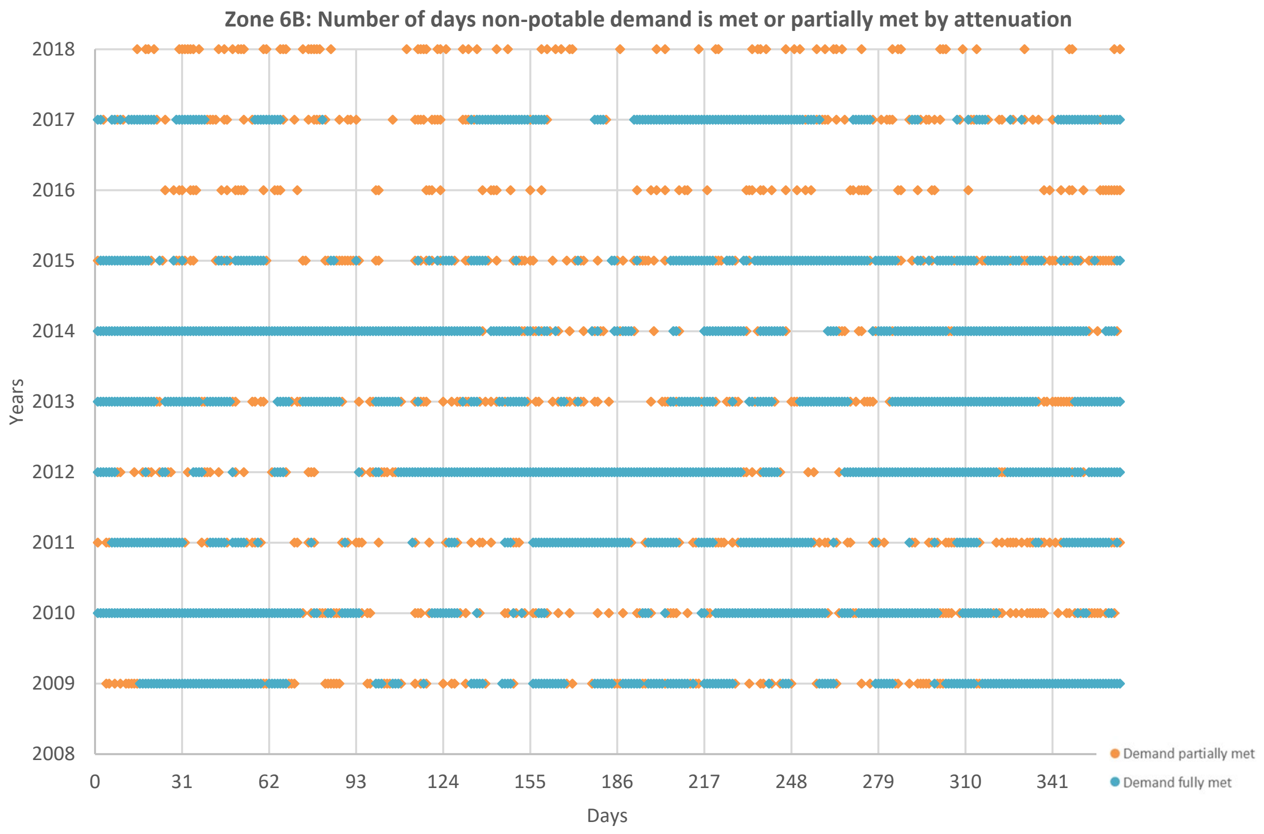


Table 5-8 Zone 6B AAP Wider Area Attenuation vs. Demand Results

	No. of days demand met	No. of days demand partially met	No. of days no demand met	% time demand is met	% time demand is not met
2009	199	71	95	55	26
2010	196	76	93	54	25
2011	158	81	126	43	35
2012	245	42	0	67	0
2013	199	80	86	55	24
2014	269	33	63	74	17
2015	166	93	106	45	29
2016	0	76	289	0	79
2017	172	70	123	47	34
2018	0	80	285	0	78
		Average % over 10 years		44	35
Max. Attenuation over 10 year period: 18,061.94 m³					
Non potable demand: 356.94 m³/day					



6 Summary

This Technical Appendix summarises the methodology, results, assumptions and potential limitations of the Water Balance calculations that have been undertaken for the IWMP study area.

Each of the six growth zones in the IWMP study area have been considered as a separate system boundary and changes to the water cycle built up from anticipated development in each zone.

The data on anticipated housing growth made available for the IWMP by LBTH for the years 2016 – 2031 comprises specific sites, however for growth anticipated for the years 2031-2041, the quantum of growth is taken from the maximum growth scenario set out in the IoDSP OAPF rather than specific sites identified by LBTH. As a result, the Water Balance for each zone covers the period up to 2031; whereas the Water Balance for the whole study area covers the period up to 2041.

Comparing the results, it can be seen that the proposed development across the zones will lead to a substantial increase in the demand for water and subsequent generation of wastewater. There is also an increase in the proportion of rainfall falling on rooftops and contributing to urban storm water, through an increase in anticipated impervious surfaces.

As these figures illustrate, without intervention, the proposed development across the Isle of Dogs and South Poplar Opportunity Area will significantly increase demand on the regional water supply and wastewater assets.

Calculations have been undertaken to determine how the volume of rainwater attenuated from rooftop runoff compares to the non-potable demand in each zone. This information is useful for the IWMP to inform the feasibility of using rainwater harvesting approaches to deliver benefits for the area. As part of the analysis, calculations have been undertaken to determine the number of days the attenuated rooftop runoff could (1) meet demand; (2) partially meet demand and (3) not meet any demand.

Findings from the analysis for the whole study area in Table 6-1 show that over a 10 year period, the demand for non-potable water is only met by the available rainfall 6% of the time, and during 43% of the time, the demand for non-potable water is not met by the available rainfall. This has significant implications for the viability of rainwater harvesting approaches on their own to meet non-potable demand in the study area.

When reviewing the results across the 6 zones, Table 5-2 shows that there is some variation in where rainwater harvesting systems may prove more viable. In Zone 6A and 6B, the non-potable demand is met 42-43% of the time, whereas in Zone 2 Canary Wharf it is only 1% of the time, and in Zones 1, 3/4, and 5 only 18%, 10% and 28% of the time respectively. As a result, rainwater harvesting systems may be more viable in the northern part of the IWMP study area.

Analysis of the post-development figures shows that the greywater generated post-development (4023.45 Ml) would be sufficient to meet the demand for non-potable water (3404.82 Ml). Greywater re-use is therefore considered a more viable option for future development within the study area and it presents a more reliable source of water to meet the increasing demand.