Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Tackling London's Sewer Overflows

Doc Ref: **8.2.5**

Solutions Working Group Report: Volume 2

APFP Regulations 2009: Regulation **5(2)(q)**

Hard copy available in

Box **60** Folder **A**
January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

This page is intentionally blank

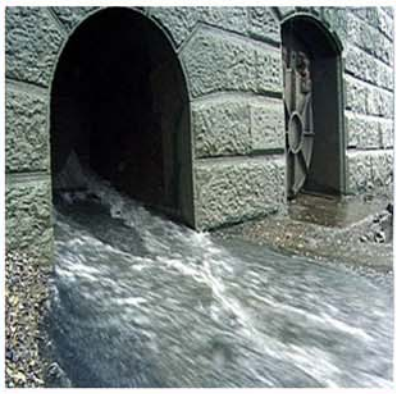
Tackling London's Sewer Overflows

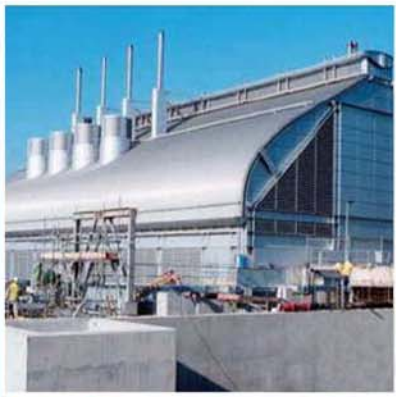
Thames Tideway Tunnel and Treatment - Option Development

Solutions Working Group Report,

Volume 2 - Treatment

Thames Tideway





December 2006

Thames Water

CONTENTS

1 INTRODUCTION

1.1 INTRODUCTION

The Executive Summary and main introduction to the Solutions Working Group report is covered in Volume I.

Volume II specifically covers proposals for treatment of tunnel pump-out flows and a rebalancing of treatment requirements across the Tideway STWs.

Following the request to review selected options for the tideway tunnel, it was agreed at an early stage of the development work that collected wastewater from the tunnel should receive secondary treatment to Tideway Operating Agreement standards. The location of treatment was determined taking various factors into account and confirmed as part of this development work.

The option development has taken account of the planned upgrades of Tideway STWs that have already been approved. Options have been reviewed to re-balance treatment capacity to meet the needs of the tunnel and environmental objectives. This has formed part of an integrated solution for the Tideway that best meets the requirements of the UWWTD.

2 TREATMENT STRATEGY FOR THAMES TIDEWAY

2.1 OBJECTIVES FOR RIVER

There are three main objectives for the Thames Tideway Strategy. These are to protect the ecology of the Thames Tideway by improving dissolved oxygen levels, reducing the quantity of sewage derived solids and protecting the health of recreational water users. The improvements required at the sewage treatment works (STWs) will contribute towards the first of these objectives, namely improvements to dissolved oxygen levels.

The dissolved oxygen objectives are discussed in detail in the Objectives & Compliance Working Group Report. The objectives are defined as allowable return periods for dissolved oxygen levels to fall below target levels.

These are:

Table 2.1 - Dissolved Oxygen Standards

Threshold	Dissolved Oxygen Concentration (mg/l)	Duration (tides)	Allowable Return Period (years)	Allowable number of failures (over 14 years of event data)
1	4	29	1	14
2	3	3	3	5
3	2	1	5	3
4	1.5	1	10	1

Note: A tide is a single ebb or flood.

2.2 TIDEWAY STW UPGRADE SOLUTION ASSUMED AT FINAL DETERMINATION

The Tideway STW Upgrade proposals assumed at Final Determination were based on providing a satisfactory solution for meeting target river quality standards in conjunction with the tunnel. Further modelling and review of previous assumptions has resulted in changes as outlined in follwing sections.

Table 2.2 - Consents Assumed at Final Determination – 2 December 2004

STW	DWF (Ml/d) (1)	FTFT (Ml/d) (2)	xDWF (3)	Consent (mg/l) (4)	
				BOD (5)	AmmN (6)
Mogden	559	1075	2.5	11	1
Beckton	1344	1800	1.7	5	1
Crossness	597	1485	3.6	5	1
Long Reach	186	311	1.8	15	15
Riverside	103	216	2.6	7	7

Notes

(1) Dry weather flow, DWF = PG + I + E. Where P = 2021 population, G = per capita water consumption, I = Infiltration and E = industrial flow
(2) Flow to full treatment, FTFT
(3) Multiple of dry weather flow using formula XDWF = XPG + I + XE
(4) Consent is based on Tideway median or 50%ile
(5) Biochemical oxygen demand, BOD
(6) Ammoniacal Nitrogen concentration, AmmN

2.3 Combined Tunnel and STW Upgrade Solution

In order to meet the three main objectives identified above, a combined solution of a tunnel or tunnels and treatment works capacity increases is required. This study has investigated a number of tunnel proposals combined with a number of STW improvements. This volume of the report deals only with the STW proposals.

2.4 Optimised Solution

A number of potential solutions with varying treated flows and discharge consents were considered and modelled to determine whether the dissolved oxygen objectives would be met. As a part of this work, improvements made to the sewer catchment and water quality mathematical models since the Thames Tideway Strategic Study was published in February 2005 allowed for a better balance of treatment upgrade to be considered for improvements to the Tideway STWs at Beckton, Crossness, Mogden, Longreach and Riverside. In particular the modelling work considered increased treatment at Longreach and Riverside, balanced by a more realistic increase in capacity at Crossness.

The STW improvements have been optimised in terms of proposed consented flow to full treatment and discharge quality parameters for Tunnel Option 1a, which is the full length 7.2m diameter storage tunnel. The following tables identify the treatment capacities assessed at each of the works for each of the different Tunnel options:

Table 2.3 Option 1a – 7.2 m diameter tunnel with tunnel treatment at Beckton

STW	DWF (Ml/d) (1)	FTFT (Ml/d) (2)	xDWF (3)	Consent (mg/l) (4)	
				BOD (5)	AmmN (6)
Mogden	559	1064	2.5	11	1
Beckton	1344	2336	N/A (7)	8	1
Crossness	597	1118	2.5	8	1
Long Reach	186	338	2.0	10	3
Riverside	103	206	2.5	8	1

Notes

(1) Dry weather flow, DWF = PG + I + E. Where P = 2021 population, G = per capita water consumption, I = Infiltration and E = industrial flow
(2) Flow to full treatment, FTFT
(3) Multiple of dry weather flow using formula XDWF = XPG + I + XE
(4) Consent is based on Tideway median or 50%ile
(5) Biochemical oxygen demand, BOD
(6) Ammoniacal Nitrogen concentration, AmmN
(7) The treatment upgrade for Beckton allows for treatment of tunnel pump-out flows

Table 2.4 Option 1b – 6.0 m diameter tunnel with tunnel treatment at Beckton

STW	DWF (Ml/d) (1)	FTFT (Ml/d) (2)	xDWF (3)	Consent (mg/l) (4)	
				BOD (5)	AmmN (6)
Mogden	559	1064	2.5	11	1
Beckton	1344	2105	N/A (7)	8	1
Crossness	597	1118	2.5	8	1
Long Reach	186	338	2.0	10	3
Riverside	103	206	2.5	8	1

Notes – See Option 1a

Table 2.5 Option 1c – 7.2 m diameter tunnel with direct tunnel from Abbey Mills to Beckton and tunnel treatment at Beckton

STW	DWF (Ml/d) (1)	FTFT (Ml/d) (2)	xDWF (3)	Consent (mg/l) (4)	
				BOD (5)	AmmN (6)
Mogden	559	1064	2.5	11	1
Beckton	1344	2336	N/A (7)	8	1
Crossness	597	1118	2.5	8	1
Long Reach	186	338	2.0	10	3
Riverside	103	206	2.5	8	1

Notes – See Option 1a

Table 2.6 Option 2a – West Tunnel 7.6 m diameter & East Tunnel 13 m diameter

STW	DWF (Ml/d) (1)	FTFT (Ml/d) (2)	xDWF (3)	Consent (mg/l) (4)	
				BOD (5)	AmmN (6)
Mogden	559	1064	2.5	11	1
Beckton	1344	1998	N/A (7)	8	1
Crossness	597	1118	2.5	8	1
Long Reach	186	338	2.0	10	3
Riverside	103	206	2.5	8	1

Notes – See Option 1a

Table 2.7 Option 2b - West Tunnel 7.6 m diameter & East Tunnel 10 m diameter with additional treatment capacity

STW	DWF (Ml/d) (1)	FTFT (Ml/d) (2)	xDWF (3)	Consent (mg/l) (4)	
				BOD (5)	AmmN (6)
Mogden	559	1064	2.5	11	1
Beckton	1344	2700	N/A (7)	8	1
Crossness	597	1118	2.5	8	1
Long Reach	186	338	2.0	10	3
Riverside	103	206	2.5	8	1

Notes – See Option 1a

Option 2b has a lower volume in the East tunnel as compared to Option 2a and in consequence requires tunnel pump out to commence as the tunnel fills, to limit the spill frequency. It requires an increased treatment capacity at Beckton of 2700 Ml/d.

Table 2.8 Option 2c - West Tunnel 7.6 m diameter & East Tunnel 10 m diameter via Charlton

STW	DWF (Ml/d) (1)	FTFT (Ml/d) (2)	xDWF (3)	Consent (mg/l) (4)	
				BOD (5)	AmmN (6)
Mogden	559	1064	2.5	11	1
Beckton	1344	1998	N/A (7)	8	1
Crossness	597	1118	2.5	8	1
Long Reach	186	338	2.0	10	3
Riverside	103	206	2.5	8	1

Notes – See Option 1a

Examination of Tables 2.3 to 2.8 above shows that the consents proposed at Mogden, Crossness, Longreach and Riverside remain the same whichever Tunnel option is considered. However, the FTFT at Beckton, where Tunnel pump out flows are to be treated, varies depending upon the Tunnel option considered.

The proposed consent at Long Reach is set at the tightest that can be achieved on land currently owned by Thames Water. This explains the lower multiple of dry weather flow and the less stringent quality standards proposed at this works.

It should be noted that the performance of each of the above options against the dissolved oxygen quality objectives is not the same. Options 1a and 1b pass all objectives even when the impact of climate change to 2020 is assessed. However, Options 2a, 2b and 2c fail to meet some of the dissolved oxygen objectives when the impact of climate change to 2020 is assessed. Option 2a, 2b and 2c could be made to meet these objectives but would require further tightening of the consents at each of four east London STWs. This in turn would require additional improvements at each of the four east London STWs. Mogden would not require further improvements, as the reaches of the Tideway upstream of London Bridge pass the dissolved oxygen objectives with the inclusion of climate change impact to 2020.

Additional options have been considered which allow for the Tunnel to continue to Crossness and Tunnel treatment capacity to be provided there. This would require the design flow to full treatment to rise to 1507 Ml/d, with quality consent parameters remaining the same.

Table 2.9 Consents Assumed at Final Determination – 2 December 2004

STW	DWF (Ml/d) (1)	FTFT (Ml/d) (2)	xDWF (3)	Consent (mg/l) (4)	
				BOD (5)	AmmN (6)
Mogden	559	1075	2.5	11	1
Beckton	1344	1800	1.7	5	1
Crossness	597	1485	3.6	5	1
Long Reach	186	311	1.8	15	15
Riverside	103	216	2.6	7	7

Notes – See Option 1a

Table 2.10 Consents for STW extensions now proposed

STW	DWF (Ml/d) (1)	FTFT (Ml/d) (2)	xDWF (3)	Consent (mg/l) (4)	
				BOD (5)	AmmN (6)
Mogden	559	1064	2.5	11	1
Beckton	*	*	*	8	1
Crossness	597	1118	2.5	8	1
Long Reach	186	338	2.0	10	3
Riverside	103	206	2.5	8	1

* depends on tunnel option - see above

Notes – See Option 1a

Examination of the above two Tables shows that additional works at Longreach and Riverside are now proposed when compared to the Final Determination proposals and that these are offset by a reduction in works now proposed at Beckton and Crossness.

2.5 OTHER ISSUES

There is a possibility that there will be a future discharge consent imposed on level of total nitrogen and phosphorus to prevent eutrophication in the Thames Estuary. This would require additional treatment facilities to be constructed to enable the works to achieve nutrient

removal. The layouts proposed at each of the works have made allowance for this potential requirement.

An assessment was made as to the performance of the proposals with Crossness FTFT reduced to 2.0 DWF (945 Ml/d) from the proposed 2.5 DWF (1118 Ml/d). This was shown to have little impact on water quality in the Tideway. However, FTFT at Crossness remains proposed at 2.5 DWF as it was considered that benefits associated with less frequent Storm Tanks spills at Crossness were not fully represented by the modelling. It should also be noted that reducing the FTFT at Crossness does not have a directly proportional impact on the scale of the works required as a significant extension is required simply to treat the average load to the new quality standards. A project due under the AMP4 programme will deliver Storm Tanks cleaning and access improvements at Crossness which will result in an improvement to the quality of the spills from these Tanks. This improvement has been taken into account in the proposals.

Climate change impacts have been estimated to horizons of 2020 and 2080. This has demonstrated that further improvements may be required to discharge qualities after 2020. The next step in improvements would be to reduce the effluent quality standards further perhaps by introducing tertiary treatment at the works. It is unlikely that increases in FTFT alone would have any significant benefit as has been demonstrated by the 2.0 and 2.5 DWF comparisons at Crossness.

All current proposals are designed to a population horizon of 2021. Funding was granted in the Final Determination (FD) in December 2004 for projects design to an horizon of 2016. Designs have therefore been established for a 2016 design horizon so that the costs associated with the supply / demand increase (growth) can be established.

A number of strategic alternatives were considered for the East London works. These included options for extending the tunnel to Crossness and providing the tunnel treatment capacity at Crossness. This option further distorts the balance of treatment between Beckton and Crossness apart from having a higher cost with the additional length of tunnel required to reach Crosness. Other reasons for providing treatment at Beckton rather than Crossness are covered elsewhere in the report.

3 PROPOSALS FOR UPGRADING TIDEWAY STWS

3.1 INTRODUCTION

This section of the report provides details of the existing treatment facilities on each of the Tideway STW sites. It sets out details of the extensions proposed to allow each works to comply with the new AMP4/5 consents and the changes required as a consequence of the modelling undertaken to optimise treatment requirements to cater for the proposed Tideway Tunnel. Details of the existing and proposed consents are tabulated below.

Table 3.1 – Existing and Proposed Tideway Operating Agreement Period Consents

Treatment Works	Current			AMP4/5			Revised AMP4/5		
	Flow (Mld))	BOD (mg/l)	Amm (mg/l)	Flow (Mld))	BOD (mg/l)	Amm (mg/l)	Flow (Mld))	BOD (mg/l)	Amm (mg/l)
Beckton	1,420	6	1	1,800	5	1	Note 1.	8	1
Crossness	982	10	7	1,485	5	1	1,118	8	1
Mogden	810	11	1	1,075	11	1	1,064	11	1
Longreach	311	20	25	311	15	15	328	10	3
Riverside	200	15	20	216	7	7	206	8	1

Note 1. The revised flow to treatment at Beckton depends on the Tunnel Option adopted.

In conjunction with the changes to design flows to treatment and Tideway Operating Period consents tabulated above, it is also proposed to change the design horizons for the new works from 2016 to 2021.

3.2 BECKTON

3.2.1 Existing Works

The existing treatment works at Beckton was originally designed to treat a flow of up to 1420,000 m^3/d to a discharge consent not exceeding 22 mg/l BOD and 6 mg/l Ammonia (as 95%iles). During periods when the Tideway Operating Agreement is in operation, the consent reduces to 6 mg/l BOD and 1 mg/l Ammonia (as 50%iles).

The existing works includes the following effluent treatment stages between the five incoming Northern Outfall Sewers (NOS) and the outfall to the River Thames: Coarse screening (50 mm bar spacing); Grit separation in Constant Velocity Channels; Storm flow separation and storm screens (6mm in two directions); Fine screens (6mm slotted); Primary sedimentation tanks; Aeration (Using fine bubble diffused aeration); Final settlement tanks; Flow measurement.

Sludge treatment is currently provided by thickening of primary sludge in picket fence thickeners and thickening of surplus activated sludge (SAS) using belt thickeners. Following thickening, these sludges are blended before being pumped to the Sludge Powered Generator. Blended sludge delivered to the Sludge Powered Generator is first dewatered in plate presses before being incinerated.

3.2.2 Proposed New Works

The initial design for the AMP4/5 solution for Beckton was prepared against a requirement to treat flows of up to 1,800,000 m^3/d to a discharge consent not exceeding 22 mg/l BOD and 6 mg/l Ammonia (as 95%iles). During periods when the Tideway Operating Agreement was in

operation, the consent would reduce to 5 mg/l BOD and 1 mg/l Ammonia (as 50%iles). The extended works catered for population growth to 2016.

The existing Beckton plant has sufficient grit removal, fine screening and primary settlement tank capacity to cater for this additional flow. Further secondary treatment capacity was required to enable treatment to be provided for this increased flow to treatment. Therefore, it was proposed to construct a new treatment stream. This required a new pumping station to feed settled sewage (from downstream of the Primary settlement tanks) to a new Aeration plant (using diffused air) and its associated Final settlement tanks. In addition the existing primary settlement tanks and secondary treatment streams were to be optimised and uprated.

During periods when the Tideway Operating agreement was in operation, to achieve the proposed consent, approximately 50% of all flows from the existing works and the works extension would require tertiary treatment in deep bed down flow type sand filters. Whether or not the tertiary treatment plant was in operation, effluent flows from the existing works and the works extension were to be combined upstream of the existing final effluent flow meter and discharged via the existing outfall structure. This scope was very similar to that included in the PR04 submission.

In addition, a new sludge thickening plant (using mechanical thickening) to cater for approx. 37% of the sludge make was required for the increased sludge volume and to allow the existing Picket fence thickeners to be maintained. Surplus activated sludge will be thickened in the existing SAS belt thickeners, which have adequate spare capacity. Following thickening the raw and SAS sludges will be blended for disposal in the Sludge Powered Generator

As a consequence of the conclusions of the Tideway water quality modelling work and a desire to balance treatment capacities at each Tideway STW, it was agreed that the design criteria for the AMP4/5 extensions at Beckton should be revised. The revised proposals include for extension of the treatment capacity at Beckton to allow the works to treat an increased flow of 1,972,000 m^3/d, equivalent to 2 Dry Weather Flow (DWF), to a discharge consent not exceeding 22 mg/l BOD and 6 mg/l Ammonia (as 95%iles). During periods when the Tideway Operating Agreement is in operation, the consent reduces to 8 mg/l BOD and 1 mg/l Ammonia (as 50%iles).

The process extensions required to treat this additional flow are similar but generally slightly larger than the new treatment plant originally proposed above, with the exception that tertiary treatment is not required.

To enable the extensions to the works to operate without increasing the odour profile of the works, odour control measures will be included in the design of the raw sludge thickening plant. See also Section 4. It is proposed that tunnel treatment should be at Beckton. Therefore, if approved, the extensions will be in accordance that those discussed in Section 4.7.

3.3 CROSSNESS

3.3.1 Existing Works

The existing treatment works at Crossness was originally designed to treat a flow of 982,000 m^3/d to a discharge consent not exceeding 25 mg/l BOD and 16 mg/l Ammonia (as 95%iles). During periods when the Tideway Operating Agreement is in operation, the consent reduces to 10 mg/l BOD and 7 mg/l Ammonia (as 50%iles). Due to hydraulic limitations in the performance of the final settlement tanks, the consented discharge has recently been reduced to 777,600 m^3/d.

The existing works includes the following effluent treatment stages between the three inlet sewers and the outfall to the River Thames: Coarse screening (25 mm); Inlet pumping; Fine screens (6mm in two dimensions); Grit separation in Constant Velocity Channels; Primary sedimentation tanks; Aeration (Using surface aeration); Final settlement tanks; Flow measurement.

Sludge treatment is currently provided by thickening of raw sludges in picket fence thickeners and thickening of surplus activated sludge (SAS) using belt thickeners. Following thickening, the sludges are blended before being pumped to either the Sludge Powered Generator or the Lime Treatment Plant. Blended sludge delivered to the Sludge Powered Generator is first dewatered in plate presses before being incinerated. Blended sludge pumped to the Lime Treatment Plant is chemically dosed before dewatering in centrifuges.

3.3.2 Proposed New Works

The initial design for the AMP4/5 solution for Crossness was prepared against a requirement to treat flows of up to 1,485,000 m^3/d to a discharge consent not exceeding 25 mg/l BOD and 16 mg/l Ammonia (as 95%iles). During periods when the Tideway Operating Agreement was in operation, the consent reduced to 5 mg/l BOD and 1 mg/l Ammonia (as 50%iles).

To enable treatment to be provided for this increased volume of flow, it was proposed to construct a new treatment stream. This would abstract raw sewage downstream of the existing coarse screens and included the following effluent treatment stages: Second inlet pumping station, Fine screens (6mm in two dimensions); Grit separation in Constant Velocity Channels; Primary sedimentation tanks; Aeration (Using diffused air); Final settlement tanks. During periods when the Tideway Operating agreement was in operation, to achieve the proposed consent, all flows from the existing works and the works extension would require tertiary treatment in deep bed down flow type sand filters. Whether or not the tertiary treatment plant was in operation, effluent flows from the existing works and the works extension were to be combined upstream of the existing final effluent flow meter and discharged via the existing outfall structure. This scope was almost identical to that included in the PR04 submission.

As a consequence of the conclusions of the Tideway water quality modelling work and a desire to rationalise the peaking factors on dry weather flows adopted each work, it was agreed that the design criteria for the AMP4/5 extensions at Crossness should be revised. The revised proposals include for extension of the treatment capacity at Crossness to allow the works to treat an increased flow of 1,117,900 m^3/d to a discharge consent not exceeding 25 mg/l BOD and 16 mg/l Ammonia (as 95%iles). During periods when the Tideway Operating Agreement is in operation, the consent reduces to 8 mg/l BOD and 1 mg/l Ammonia (as 50%iles).

To enable treatment to be provided for this increased volume of flow, it is proposed to construct a new treatment stream. This will abstract raw sewage downstream of the existing coarse screens and include the following effluent treatment stages: Second inlet pumping station, Fine screens (6mm in two dimensions); Grit separation in Constant Velocity Channels; Primary sedimentation tanks; Aeration (Using diffused air); Final settlement tanks. Flows will be combined with flows from the existing works immediately upstream of the existing final effluent flow meter and discharge via the existing outfall structure.

Raw sludge from the new works will be thickened in belt thickeners. Surplus activated sludge will be thickened in the existing SAS belt thickeners, which have adequate spare capacity. Following thickening the raw and SAS sludges will be blended for disposal in the Sludge Powered Generator and the Lime Treatment Plant, which have adequate spare capacity to treat the increased volume of sludge generated by the proposed works extension.

To enable the extensions to the works to operate without increasing the odour profile of the works, odour control measures will be included in the design of the inlet pumping station, inlet works, primary sedimentation tanks and raw sludge thickening plant.

3.3.3 Linked Projects

A project is currently underway under an AMP4 obligation for storm tank cleaning which will improve the quality of all storm tank discharges to the Tideway. This project will clean the existing storm tanks and add facilities to make cleaning simpler in future.

3.4 MOGDEN

3.4.1 Existing Works

The existing works at Mogden STW was designed for a flow to full treatment of 810,000 m^3/d with a discharge consent not exceeding of 23 mg/l BOD and 7 mg/l Ammonia (95%ile). During periods when the Tideway Operating Agreement (TOA) is in operation, the consent reduces to 11 mg/l BOD and 1 mg/l Ammonia as a 50%ile. Due to the poor performance of the final tanks and thereby to minimise the amount of solids discharged to the River Thames, the works currently has a reduced consent flow of 690,000 m^3/d.

The current works has a high level sewer from which the West side inlet works receives its flow. The low level sewers have their flows lifted up to the East inlet works along with excess flows from the high level sewer not drawn off by the West side works. The effluent culvert collects flow from all the works final tanks and discharges into the River Thames at Isleworth Ait.

The West side works has fine screens (6mm in two dimensions), then grit removal in two detritors. A screw pumping station then lifts flow to two sets of primary tanks, two sets of aeration tanks (diffused air) and final settlement tanks.

The East side works consists of fine screens (6mm in two dimensions); grit removal by constant velocity channels; two stage primary sedimentation tanks; aeration tanks (diffused air) and final tanks. Flow measurement is in the final effluent culvert is upstream of the storm tank discharge.

Sludge treatment is provided by thickening of raw sludge using drum thickeners and thickening of surplus activated sludge (SAS) using picket fence thickeners for pre-thickening then centrifuges. The two sludges are blended and fed to eight pasteurisation units before feeding to anaerobic digesters. The gas generated from digestion powers 2 No. dual fuel engines generating 3MVA. Digested sludge is pumped via a pipeline to Iver South Sludge Disposal Works (SDW) where it is dewatered and transferred to land as cake.

3.4.2 Proposed New Works

The initial design for the AMP4/5 solution for Mogden STW was prepared against a requirement to treat flows of up to 1,075,000 m^3/d to a discharge consent not exceeding 23 mg/l BOD and 7 mg/l Ammonia (as 95%iles). During periods when the Tideway Operating Agreement is in operation, the consent will remain at 11 mg/l BOD and 1 mg/l Ammonia (as 50%iles).

To enable treatment to be provided for this increased volume of flow, it was proposed to up-rate the East side works and construct a new treatment stream on the West side of the works. The East side works upgrade will convert the first stage primary sedimentation tanks to final tanks, thereby increasing the hydraulic capacity of the East works. The new treatment stream would abstract raw sewage downstream of the existing west inlet and included the following effluent treatment stages: Fine screens (6mm in two dimensions); Grit separation in two detritors; Existing extended primary sedimentation tanks; New aeration lanes (using diffused air) and Final settlement tanks. Effluent flows from the existing works and the works extension were to be combined upstream of the existing final effluent flow meter and discharged via the existing outfall structure. During the up-rating of the East side works, the converted final tanks would discharge to the effluent culvert via a new outfall with effluent monitoring and flow measurement. This scope is smaller to that included in the PR04 submission.

As a consequence of the conclusions of the Tideway water quality modelling work and a desire to rationalise the peak flows treated by each works, it has been agreed that the design criteria for the AMP 4/5 extensions at Mogden STW should be revised. The revised proposals include for extension of the treatment capacity at Mogden STW to allow the works to treat a maximum flow of 1,063,600 m^3/d to reflect a flow of 2.5 DWF at the design horizon.

To enable the extensions to the works to operate without increasing the odour profile of the works, odour control measures will be included in the design of the new inlet works, primary sedimentation tanks and sludge stream extensions.

3.5 LONGREACH

3.5.1 Existing Works

The Longreach STW receives an average flow of 165,000 m3/day and is designed to treat to a discharge consent not exceeding 50 mg/l BOD and 53 mg/l Ammonia (as 95%iles). During periods when the Tideway Operating Agreement is in operation, the consent reduces to 20 mg/l BOD and 25 mg/l Ammonia (as 50%iles). Hydraulic limitations of the incoming sewer limit the maximum flow that Longreach can accommodate. Flows above this are discharged to the River Thames via storm tanks located at Creek Works. Longreach does have on site storm tanks for flows above the maximum permissible treated flows.

The existing works includes the following effluent treatment stages between the inlet sewers and the outfall to the River Thames: Coarse screening (25 mm); Fine screens (6mm in two dimensions); Grit separation in Constant Velocity Channels; Primary sedimentation tanks; Interstage pumping; Aeration (using diffused air); Final settlement tanks; Flow measurement.

Sludge treatment is currently provided by thickening of raw sludges in picket fence thickeners and thickening of surplus activated sludge (SAS) using belt thickeners. Following thickening, sludge is blended before being pumped to primary digesters, where it is kept for 12 days at 35°C. Digested sludge is pumped to secondary digesters for a further 8 days before being dewatered. The dewatered cake is recycled to agricultural land.

3.5.2 Proposed New Works

The initial design for the AMP4 solution for Longreach was prepared against a requirement to treat flows of up to 2DWF (dry weather flow) to a discharge consent not exceeding 50 mg/l BOD and 53 mg/l Ammonia (as 95%iles). During periods when the Tideway Operating Agreement is in operation, the consent will reduce to 15 mg/l BOD and 15 mg/l Ammonia (as 50%iles). The solution proposed in the AMP4 Strategic Business Plan was to optimise aspects of the existing process and run the works at higher loading rates to meet the new consent.

As a consequence of the conclusions of the Tideway water quality modelling work it is proposed that the design criteria for the AMP 4 extensions at Longreach should be revised. The revised proposals include for extension of the treatment capacity at Longreach to allow the works to treat 2DWF to a discharge consent of 10 mg/l BOD and 3 mg/l Ammonia (as 50%iles) during periods when the Tideway Operating Agreement is in operation.

To enable treatment to be provided for this tighter consent, it is proposed to extend the existing treatment stream. This will comprise extending the existing aeration lanes by adding new lanes (using diffused air); reconfiguring the flow split across all the lanes; additional blower capacity; additional final settlement tanks; uprating the return activated sludge across the plant and providing new surplus activated sludge facilities. Flows will be combined with flows from the existing works immediately upstream of the existing final effluent flow meter and discharge via the existing outfall structure.

The existing sludge stream will be extended to take into account the additional sludge production. This will be achieved by providing additional picket fence thickeners and additional primary digesters. Extra SAS thickening belts and digested sludge dewatering plant will be provided.

3.6 RIVERSIDE

3.6.1 Existing Works

Riverside STW, with a population equivalent of 415,500, is located on the North side of River Thames in Rainham / Dagenham, Essex. The works' effluent outfalls into Rainham Creek, which joins the tidal River Thames. The existing treatment works at Riverside was originally designed to treat to a discharge consent during the Tideway Operating Agreement to a standard of 15 mg/l BOD and 20 mg/l Ammonia (50%iles). The consent outside the Tideway Operating Agreement is 45 mg/l Suspended Solids, 20 mg/l BOD and 10 mg/l Ammonia (95%iles).

The Riverside catchment has 4 main sewers arriving at the works inlet pumping station. Bretons Farm sewer and Ingrebourne valley sewer are the two 'high level' sewers whereas Barking sewer and Wennington sewers are the 'low level' sewers in the catchment. Additionally, trade flows enter the works into a dedicated trade pumping station sump and this flow is diverted to the upstream side of high-level inlet screens to mix with domestic flows.

The existing works includes the following effluent treatment stages between the inlet sewers and the final effluent outfall: Inlet pumping; Fine screens (6mm in two dimensions); Grit separation in Detroiters; Primary sedimentation tanks; Aeration (Using diffused air); Final settlement tanks; Flow measurement.

Blended raw and surplus activated sludges are pumped to Beckton. The sludge is discharged into the inlet works where it is then co-settled in the Beckton primary tanks, prior to passing to the Beckton incineration sludge process.

3.6.2 Proposed New Works:

The initial design for the AMP4 solution for Riverside was prepared against a requirement to treat flows of up to 2DWF (dry weather flow) to a discharge consent of 45/20/10 SS/BOD/NH_3 (as 95%iles). During periods when the Tideway Operating Agreement is in operation, the consent will reduce to 7 mg/l BOD and 7 mg/l Ammonia (as 50%iles).

In order to meet the requirements of the TOA, the works would require extensions to provide additional 2No. FSTs including all associated flow distribution chambers, pipelines/channels and Electrical / ICA scope of work.

As a consequence of the conclusions of the Tideway water quality modelling work it was agreed that the design criteria for the AMP 4 extensions at Riverside should be revised. The revised proposals include for extension of the treatment capacity at Riverside to allow the works to treat 2DWF to a discharge consent of 8 mg/l BOD and 1 mg/l Ammonia (as 50%iles) during periods when the TOA is in operation. The consent outside the TOA remaining unaltered.

In order to meet the requirements of the TOA, the works will require extensions to provide additional 5No. Aeration Lanes, Blower House, 2No. FSTs including all associated flow distribution chambers, pipelines/channels and Electrical / ICA scope of work. This will allow the Works to be run as two parallel streams each treating 50% of the design flow.

3.7 COSTS

Costs for the combined proposed works all sites are in line with approved AMP4/5 budgets exclusive of the additional costs of allowing for revision of the design horizons from 2016 to 2021.

3.8 REVISED PROGRAMMES

Subject to agreement of the revised proposals, dates for completion of the proposed works at each site will be as follows.

Activity	Beckton	Crossness	Mogden	Longreach	Riverside
Original Programme	March 2012	March 2014	March 2012	March 2010	March 2010
Revised Programme (1)	2012/2014 (2)	March 2014	March 2012	March 2012	March 2012

Notes:

1. Subject to review and sign-off of revised proposals. Due to the request to undertake the review, the original programme has been delayed and therefore dates may be put back but the impact will be minimised.
2. Depends on tunnel option adopted.

4 TREATMENT PROPOSALS WITH TIDEWAY TUNNEL

4.1 OPTIONS AT BECKTON AND CROSSNESS

4.1.1 Introduction

In February 2005 the final report on the Tideway Tunnel Strategic Study (TTSS) concluded by recommending that a storm storage and transfer tunnel be constructed between Hammersmith and Crossness Sewage Treatment Works. Storm sewage collected in the tunnel was to be pumped out for treatment in a dedicated storm water treatment facility at Crossness STW before being discharged to the tideway, but facilities were also proposed to allow the alternative of pump-out and treatment at Beckton STW. Proposed dedicated treatment facilities at Crossness included Preliminary Treatment followed by Deep Bed Filtration. Pump-out at Beckton was to be to the main treatment works whenever spare treatment capacity was available. The tunnel pump-out rate was assumed to be approximately $10m^3/s$ (with pumping capacity of this amount provided at both Crossness and Beckton).

As discussed in Section 2 of this report, the proposed Tideway Tunnel project is only one element of the works required to enable water quality in the Tideway to meet the desired objectives. The other elements include major upgrades to the treatment capacity provided at Beckton, Crossness, Mogden, Long Reach and Riverside works, which are being implemented during AMP4 and AMP5. These improvements will both increase the amount of flow to be treated at each works and augment the existing treatment process to enable the treated effluent discharged to meet tighter consents.

Contrary to the assumptions made at the time of completion of the TTSS final report, it is now evident that all flows pumped from the tunnel will require secondary treatment and therefore meet the same effluent quality criteria as are set out in the proposed new consents for each works. Hence an increased area of land would be required at Crossness to that area previously reserved for construction of dedicated facilities for treatment of tunnel flows.

This section of the report reviews the changes to the TTSS decision for the tunnel treatment facilities at Crossness and evaluates the benefits of moving the tunnel treatment facilities to Beckton.

4.1.2 Planning Issues at Crossness

At Crossness the land owned by Thames Water includes:

- The current Operational Site, inclusive of the conservation area which surrounds the historic Beam Engine House,
- The Crossness Nature Reserve, which occupies land to the east of the Operational Site and was designated as a nature reserve in response to a S.106 planning condition relating to construction of the Crossness Sludge Powered Generator (SPG),
- The Crossness Southern Marshes, which separate the A2016 road from the proposed East Thamesmead Business Park.

Except for the developed area of the existing works, these areas are all designated as Metropolitan Open Land and Areas of Metropolitan Importance for Nature Conservation.

Discussions with key stakeholders during development of designs for the AMP4/5 extensions at Crossness have indicated that there will be strong opposition to any proposals for extension of the STW on any land outside the boundary of the current Operational Site.

4.1.3 Planning Issues at Beckton

At Beckton the land owned by Thames Water and associated companies includes:

- The existing Operational Site which is designated as Metropolitan Open Land (MOL),

- The Western Triangle, which is not currently part of the Operational Site and is designated as MOL,
- The Becton Rectangle which is designated as a Major Opportunity Zone (MOZ),

Immediately adjacent to the site there are two areas of SNCI covering the River Thames to the south and Barking Creek to the east.

London Thames Gateway Development Corporation also have aspirations for regeneration of the area around Beckton STW and the treatment works itself.

4.1.4 Hydraulic Design Capacity

While the TTSS report proposed construction of dedicated facilities to treat tunnel drain-down flows, the new requirement for treated effluent from the tunnel to achieve the same consent as the main works militates against construction of a dedicated works. Instead, it is now proposed that the tunnel flows be treated in an extension of the proposed extended works.

In the design of the extended works including facilities to treat flows pumped from the tunnel, it is proposed that the extended works be sized to provide the capacity required to treat the average annual dry weather flow to the works plus the peak tunnel pump-out flow. This requires a treatment capacity that is greater than the normal peak design flow to treatment for works of these sizes.

Comparative figures for treatment at Beckton and Crossness are tabulated below for the proposed average maximum tunnel pump-out rate of 9.36 m^3/s (Options 1a and 1c).

Table 4.1 – Flows to Treatment (in MLD)

Works	Average DWF 2021	Tunnel Pump-out	Combined Hydraulic Design 2021	2.5 DWF in 2021
Beckton	1,526.9	808.7	2,335.6	2,286.7
Crossness	698.1	808.7	1,506.8	1,117.9

4.1.5 Consideration of Alternatives

As a part of the Tideway Tunnel Development Project, an evaluation exercise has been undertaken into the relative merits of treating pump-out flows from the tunnel at Beckton as an alternative to treatment of tunnel flows at Crossness. As discussed above, Becton STW is also the subject of a planned AMP4/5 upgrade to meet the same consent criteria as apply at Crossness. This evaluation has considered the following issues:

4.1.5.1 Processes Designed on Hydraulic Design Parameters

As indicated in the above table, the tunnel flow is 53% of the average flow to Beckton but is 116% of the average flow to Crossness. Similarly, construction of works to treat the combined average DWF plus pump-out flow would be 102% of the capacity required to treat 2.5 DWF at Beckton but 135% of the capacity required to treat 2.5 DWF at Crossness. Hence the construction of facilities to accept the tunnel pump-out at Crossness would require construction of a higher percentage of additional treatment capacity than would be required at Beckton. This capacity will be in excess of that required during times when there is no pump-out from the tunnel. As a consequence, those process stages that are sized on hydraulic parameters (Primary Sedimentation Tanks and Final Settlement Tanks) will be under utilised during periods of normal flow. This illustrates that treatment capacity with tunnel flow to Beckton is the better balanced treatment option.

4.1.5.2 Design Considerations in Aeration

A more detailed examination of the process designs indicates that, if the aeration plants were designed to have a hydraulic retention of 4 - 4.5 hours at maximum flow rates, at Beckton this would provide about 7 hours retention at average flow, whereas at Crossness the corresponding figure would be about 9 hours. This must be compared with a more normal value of about 6 hours for a typical design. Hence, for both options the aeration capacity will be larger than normal. The disadvantages that arise from this will be:

- Excessive retention periods could degenerate sludge settleability (Mixed Liquor) making FST performance less reliable and risking solids loss in the initial phases of high flow events.
- The additional retention results from having larger aeration lanes, thus the aeration plant will be holding more sludge mass than normal. This additional sludge must be supplied with air to satisfy its respiration, irrespective of the oxygen demand of the incoming settled sewage. Typically 20% of the air supplied for aeration supports the sludge mass. If Beckton has 16.5% more sludge mass than typical (7 hours instead of 6) arguably it will be necessary to supply an additional 16.5% of this 20% of the total air, say 3% every day. Hence, 3% more power will be used at Beckton for aeration than in a typical design. Similar analysis of figures for Crossness shows that it will require 50% more aeration capacity than typical, so an additional 10% energy will be used than in a typical design. Thus, there is a greater energy penalty involved in the Crossness solution, making treatment at Beckton a more sustainable solution.

4.1.5.3 Final Settlement Tank Performance

Final Settlement Tanks (FSTs) are designed based on maximum flow to treatment. At Beckton the average flow is 65% of the peak design flow whereas at Crossness it would be 46%. In this situation, comparatively, the MLSS would have a longer retention at average flows at Crossness than it would at Beckton unless RAS pumping rates were unnecessarily high. This situation would give an increased risk of poorer sludge settleability at Crossness and an increased risk of denitrification at Crossness, which could lead to floating sludge on the Final Settlement Tanks.

4.1.5.4 Primary Sedimentation Tanks Performance

For Primary Sedimentation Tanks (PSTs) it could be argued that the relatively high PST retention periods at average/low flows would result in a weaker settled sewage, as more load will be removed. This could lead to periods of under loading and high D.O. in the aeration plant, both of which could adversely affect the sludge settleability. Obviously this effect would be greater with the Crossness solution than the Beckton solution.

4.1.6 Conclusions

From a technical point of view treatment capacity for tunnel pump-out is better located at Beckton. It allows a better balance of treatment capability between Beckton and Crossness taking account of the upgrades required at both works to meet river quality objectives.

Additionally, if tunnel pump-out was provided at Crossness the proportional increase in hydraulic load would be significantly greater, raising concerns on the impact on treatment during pump-out events.

It should also be noted that the majority of CSO flow is from the Beckton catchment, with half of the total flow coming from Abbey Mills, which is the terminal pumping station for Beckton STW. Optimum use of the existing infrastructure would also be compromised (e.g. use of the existing Northern Outfall Sewer), if treatment was at Crossness.

As compared to a tunnel which terminated at Crossness, construction of facilities for tunnel drain-down and treatment at Beckton will save the considerable costs associated with approximately 4.1 km of 7.2 m diameter tunnel and a shaft at Crossness, plus the cost of the 1.35 km of 3 m diameter branch tunnel required to connect Beckton STW to the main tunnel.

Construction of treatment facilities at Beckton aligns with the minimum tunnel solution for early phased implementation.

The tunnel falls at a constant gradient and hence there will be a slightly higher energy cost associated with a drain-down pumping facility at Crossness as compared to Beckton.

4.2 PROPOSED TREATMENT SOLUTIONS

4.2.1 Introduction

Treatment solutions are based on Process Design Reports as described in Section 6. Where existing process capacity exists this has been utilised. For all tunnel options, the treatment solutions require extensions that are larger in scale than those required for the AMP4/5 Upgrade alone. In all cases the process designs are based on the rationalised Tideway Operating Agreement consent adopted for AMP4/5 Upgrades at Beckton and Crossness, namely 8 mg/l BOD and 1 mg/l Ammonia (as 50%iles).

All tunnel treatment options require drain-down at Beckton and therefore significant extensions. However, the partial tunnel options (2a to 2c) require 2.3m^3/s from the Eastern tunnel to be pumped out into the southern low-level interceptor sewers at Heathwall for treatment at Crossness STW, where only limited additional extensions are required beyond those required for the Amp4/5 Upgrade.

The treatment solutions required for the various tunnel options are summarised below.

4.2.2 Tunnel Treatment Proposals at Beckton and Crossness

The new treatment proposals at Beckton for the range of tunnel options are described in the Table 4.2 below.

Typically the extensions include supplementary grit channels, primary settlement tanks and new primary sludge thickening facilities. A new secondary treatment stream is required comprising aeration tanks and associated Blower House, and final settlements tanks. Each of the process options requires a proportionate provision of supporting infrastructure including, odour control facilities, buildings and kiosks, power supplies and distribution, control and instrumentation, roads, lighting, drainage and washwater.

Table 4.2 – Tunnel Treatment Proposals

Process Scope	**Tunnel Option**						
	1a	**1b**	**1c**	**2a**	**2b**	**2c**	**AMP4/5 Upgrade only**
Beckton							
FTFT (MLD)	2,336	2,105	2,336	1,972	2,700	1,972	1,889 (2DWF in 2016)
New grit channels	✓	✓	✓		✓		
New Primary Settlement Tanks	✓	✓	✓		✓		
New secondary treatment flow split (% **new**/ existing)	**27**/73	**24**/76	**27**/73	**18**/82	**31**/69	**18**/82	**9**/91

New Aeration plant	✓	✓	✓	✓	✓	✓	✓
New Final Settlement tanks	✓	✓	✓	✓	✓	✓	✓
Crossness (additional scope beyond Amp4/5 scope)							
Increased inlet PS and preliminary treatment capacity				✓			
New Primary Sedimentation Tanks				✓	✓	✓	
New Final Settlement tanks				✓	✓	✓	
Primary Sludge thickening				✓	✓	✓	

4.3 ALTERNATIVE LAYOUTS

4.3.1 Beckton Proposals

The original AMP4/5 Upgrade proposals were to be constructed on the area east of Jenkins Lane (aka the Western Triangle). Due to the scale of the larger extensions required for tunnel treatment, the optimum site for the extensions is the area west of Jenkins Lane (aka Beckton Rectangle). This site has sufficient area for the plant to be laid out in a logical fashion and to provide space for future growth and /or tightened consent.

The layouts, which are preliminary are based on conventional activated sludge technology, which is considered the most appropriate for the specific consent and application. Realistic design parameters have been adopted in line with Thames Water's current design best practice.

During the next stage of development it is intended to consult with a range of stakeholders including London Borough of Newham and London Thames Gateway Development Corporation to consider further optimisation of the layout in the context of the wider aspirations for the local area and regeneration of the wider area.

4.3.2 Crossness Proposals

As discussed tunnel options 1a, 1b and 1c do not require any increases in treatment capacity at Crossness. Tunnel options 2a, 2b, and 2c require only limited increases in provision beyond that required for the rationalised Amp4/5 upgrade proposals as outlined in Table 4.2 above. The additional process requirements do not significantly affect the overall AMP4/5 Upgrade plant layout at Crossness.

4.4 OTHER BECKTON SPECIFIC ISSUES

The proposals for extensions to Beckton STW to treat tunnel drain down include development on land designated as Metropolitan Open land (MOL) and land currently owned by a Kennet Properties Ltd (a wholly owned subsidiary company of Thames Water) and designated as Major Opportunity Zone (MOZ).

In addition Transport for London's (TFL) preferred route for the East London Transit Route runs north to south through the site on the eastern side of Jenkins Lane. This route, if implemented, would restrict access to the new extended plant and would affect operational activities detrimentally. In light of Thames Water's concerns TFL are reviewing alternative options.

Part of the site proposed for development (the southern area of the Beckton Rectangle) has previously been used for storage of sewage sludge in both lagoons and on the ground and for

disposal of sewage screenings and arisings from digester cleaning operations. Previous site investigations indicate the presence of significant quantities of contaminated soil. The full extent of contamination is not known at present and further investigations are planned. The remainder of the proposed site has been investigated and found to be only moderately contaminated, such that the majority of the contaminated soil can be reused on site.

A site investigation exercise has also been undertaken to collect information on geotechnical conditions on site, with the exception of the southern Beckton Rectangle area for which further investigations are planned. A piling risk assessment has been carried out for the proposed plant with due regard to protection of the underlying ground water and deeper chalk aquifer.

The proposed plant layout requires crossing of major services including high-pressure gas mains, and TW owned cast iron pumping mains. Construction work will require work close to and potentially under 132kV EDF overhead power cables. The diversion of one section of overhead cable is also likely to be necessary.

The existing 6.6kV site power supply is insufficient to cater for the tunnel pump-out and treatment requirements and therefore new feed arrangements at 132kV are planned.

4.5 Programme Impacts

As a consequence of the decision to treat flows from the tunnel at Beckton, the proposed design of the AMP4/5 works extensions require significant amendment. This change has already introduced delays in preparation and submission of the Planning Application, and construction of the enlarged works will now require longer that originally programmed. In consequence the completion of construction of the works will now be delayed such that commissioning is unlikely to be achieved before end 2014. Should an early phase of the tunnel be approved, earlier completion could be achieved if a shorter planning period can be agreed.

5 SLUDGE TREATMENT

5.1 BECKTON

Since 1997 the disposal route for sludge produced at Beckton has been incineration. Prior to this the sludge was disposed of to sea, which legislation brought to an end in 1998.

The maximum historic performance of the incinerators at Beckton is 200 tonnes dry solids per day (tds/d). The current sludge production is larger than this; the solids not processed through the incinerators are lost either in the storm discharge or within the final effluent.

Beckton currently complies with its flow and effluent quality consent. However, on commissioning of the proposed works extension in 2011, the tighter effluent quality standards and the higher flow to full treatment will mean that the solids currently lost within the effluent and the storm discharge will be captured within the treatment works resulting in a significant sludge disposal capacity deficit.

The impact of the Tideway tunnel has been estimated from the results of sewerage modelling (described elsewhere). The sewerage modelling provides a volume of storm water to be pumped out of the tunnel and treated through the Beckton works. Coupling this with the solids concentration assumed for the storm water gives the additional mass of sludge

Growth in the catchment between 2007 to 2021 also provides additional sludge. Table 5.1 summarises the breakdown in the overall deficit against the different drivers

Table 5.1: Sludge deficit at Beckton – contribution of the various drivers

Driver	Year	Disposal deficit (tds/d)	Percentage of total deficit
AMP4/5 Upgrade	2011	106	74%
Growth	2007 – 2021	28	19%
Tideway Tunnel	2020[1]	10	7%
	Total	**144**	**100%**

The proposals for Beckton therefore include only a proportion (7%) of the costs for further sludge treatment and disposal.

6 DESIGN CONSIDERATIONS

6.1 DESIGN CRITERIA

For each treatment works a spreadsheet is maintained to record information relevant to a Strategic Overview of Long term Assets and Resources (SOLAR Forms). Each SOLAR form records estimates of the current domestic residential population equivalent (PE), the non-residential PE, the cess PE, and trade PE, which are totalled to give on overall PE. Using information published in local plans, estimates are then made on how the domestic and commercial PE figures may vary in 5-year increments for a 20 year period. The SOLAR forms also include information on anticipated per capita flows to sewers, infiltration volumes and sewage strengths. Periodically, the information contained on the SOLAR forms is review by undertaking a flow and load analysis for the works, allowing figures for the current year and projections for future years to be adjusted.

The design maximum flows have been taken from 'Tideway Summary Strategy Draft 6.doc' and 'Tideway Strategy West East Tunnels Options Summary Draft 2.doc'. Flow and loads have been taken from 'Tideway STW Flows and Storm Tanks Draft 2 – DMFv2.xls. These tables have been prepared by extracting relevant information from current SOLAR forms for each works.

A 2021 design horizon is proposed for the new works. Hence the year 2021 population equivalent values have been used for design with no additional allowance for uncertainty included. In principle the treatment plant design allows for a situation where the whole catchment load arrives at the STW.

6.2 PROCESS DESIGN

Primary sedimentation tank design is based on standard surface loading/retention criteria with performance based on existing plant performance values.

For non tunnel solutions a design F:M of 0.12 has been used in design of aeration plants. For solutions including tunnel pump out flows, a lower design F:M loading has been used. The F:M used depends on the ratio of the maximum flow (including tunnel pump out) to the average daily flow. For situations where this ratio is up to 135% an F:M of 0.11 has been used and for ratios greater than 135% an F:M of 0.10 has been used.

The reduced design F:M has been used to allow for two factors that cannot be strictly quantified. Firstly, for period when the tunnel pump out is occurring, the maximum flow to treatment will persist for much longer than for a normal STW flow distribution, and additional capacity needs to be added back in to maintain the necessary nitrification capacity. Since the duration and frequency of pump out events is a variable, a reduced F:M is used a means of adding back this capacity without requiring a precise knowledge of the frequency and duration of pump outs. Secondly, some storm events will transfer a small amount of load between combined catchments via the tunnel. These transferred loads will be variable and depend on rainfall intensity and distribution. The reduced design F:M is used as a means of allowing for this transferred load without requiring a detailed knowledge of the frequency and distribution of rainfall.

Where required, outline designs for nitrogen/nutrient removal will be produced using design criteria used for nitrogen removal designs for existing AMP4/5 projects.

Final sedimentation tank design uses standard Mass Flux Theory design principles with existing tank performance modified to reflect the results of modelling work carried out for existing AMP4/5 projects.

Theoretical sludge productions have been assumed for all solutions based on design catchment PE values and standard per capita solids production values. This approach is being adopted for existing AMP4/5.

For tunnel solutions a short term peaking factor has been applied to the sludge production to allow for having to process the tunnel contents over a relatively short period as far as sludge thickening. An estimate of the sludge mass contained in the tunnel contents has been made and it has been assumed that this mass will be processed over 4 days to give a daily additional mass of sludge. This additional mass is added to the theoretical average sludge mass to give pump out maximum sludge production.

It has been assumed that the tunnel will be progressively flushed as it empties, to avoid large slugs of high solids material being produced at the end of the tunnel pump out. No special allowance has been included for treating the sewage solids that will arise from any tunnel flushing exercise.

6.3 ODOUR

In design of extensions at all sites, careful consideration will be given to the impacts of any increase in odour emissions consequent upon construction of the new works. This will be undertaken by a combination of review of odour complaint records, identification of sensitive receptors around each site, odour survey work to quantify emissions on each site, and modelling of how these emissions may be dispersed under various wind conditions.

The rationalised AMP4/5 Upgrade proposals for Beckton require a relatively small extension of the secondary treatment plant and provision of further sludge thickening plant, which will be odour controlled. The small increase in odour associated with this extension is effectively offset by reductions in odour associated with the required refurbishment of the existing primary sedimentation tanks, which is required to handled the increased flow to treatment. Therefore an 'odour neutral' situation would be maintained.

The tunnel treatment proposals, however, require larger extensions to the existing works, including extensions to the inlet works and primary treatment, which will tend to increase the odour footprint of the site. In recognition of this allowance has been made to provide odour control for the new plant to engineer an 'odour neutral' solution. Further odour modelling and consideration of the most cost effective mitigation measures will be required during detailed development of the proposals.

6.4 RENEWABLE ENERGY

In development of power supply requirements for each site, allowance has been made for the current GLA requirement that a percentage of the average energy demand is met from renewable sources. Currently this percentage is 10% but it is anticipated that it will shortly rise to 20%.

Renewable energy requirements for Beckton, Crossness and Mogden have been the subject of a renewable energy study undertaken by Arup. This has examined the additional power requirements of the AMP 4/5 projects for each site and evaluated the suitability of a variety of alternative technologies.

Current proposals for each site are based on the following sources of renewable energy:

Site	Proposed Renewable Power Source
Beckton – Treatment Works	Wind turbines
Beckton – Tunnel Pumping Station	Diesel generator powered from bio-diesel fuel
Crossness	Wind turbines
Mogden	Increased percentage of power generation from CHP engines
Longreach	Yet to be determined
Riverside	Yet to be determined

6.5 PLANNING AND ENVIRONMENTAL

The scale of works proposed at a number of the Tideway sites is such as to require Planning Applications and associated Environmental Statements to be prepared. Specialist consultants have been appointed to undertake work on the larger sites as follows:

Beckton AMP 4/5 Upgrade	Scott Wilson
Crossness AMP 4/5 Upgrade	Scott Wilson
Mogden AMP 4/5 Upgrade	Arup

Work completed to date for each site has involved ecological surveys, identification and evaluation of significant environmental impacts, consultation with both the Local Authority and local residents groups, plus preparation of draft chapters of the Environmental Statements.

Consultants have yet to be appointed to cover Planning and Environmental aspects of work at Longreach and Riverside.

Consultants have also been appointed to provide advice on Planning and Environmental matters on the current stage of work on development of the Tideway Tunnel. A preliminary consultation meeting was held with a number of stakeholders at a meeting in GLA offices on 17 November 2007. Attendees were requested to complete preliminary feedback forms which are discussed elsewhere. The conclusions of this work on Planning and Environmental issues are reported in the report prepared by a separate working group.

This page is intentionally blank

Thames Water Utilities Limited
Clearwater Court, Vastern Road, Reading RG1 8DB

DCO-DT-000-ZZZZZ-080205