

# **Project Transform**

## **Residual Waste Treatment Procurement**

Reference Project Technical Modelling  
Assumptions – Final Report

September 2008

Entec UK Limited



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**Report for**

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## Document Revisions

No.	Details	Date
1	Final Report	Sept 08

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# Executive Summary

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## Purpose of this Report

This report has been produced for the purpose of supporting the Project Transform Outline Business Case (OBC) application to DEFRA for Public Finance Initiative (PFI) credits. The report details the major assumptions made within the Waste PFI Reference Project Waste Flow Model, and provides a brief over-view of the model itself.

The model provides projections for all sources of municipal solid waste up until 2039/40 (the anticipated final contract year). Waste growth rates and compositions are applied to all municipal waste streams. Recycling and composting schemes conducted by the authorities are modelled to identify the tonnages of material requiring processing in the various treatment facilities. Assumptions around increased materials capture rate of kerbside collections are detailed, as are projected improvements in diversion of material at the Household Waste Recycling Centres (HWRCs).

This report provides an assessment of the capital and operational expenditure values for the reference project. The costs summarised in this report are based upon the functional unit costs for each process or facility. Where current operational costs were not available costs are based on generic cost curves/functional unit estimates derived from market information.

The base data used for all future waste projections has been derived from the existing datasets from the Project Transform partners, namely Coventry City Council (CCC), Solihull Metropolitan Borough Council (SMBC) and Warwickshire County Council (WCC). The data used is from the year 2006/07, which is the most recent complete and audited data available.



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# 1. Introduction

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## 1.1 Background to Project Transform

Project Transform is a partnership of the following Waste Disposal Authorities (WDAs):

1. Coventry City Council;
2. Solihull Metropolitan Borough Council;
3. Warwickshire County Council.

Project Transform aims to procure waste infrastructure for the treatment of residual municipal waste arising within the partnership area. Each constituent Waste Collection Authority within the partnership will continue to independently manage all kerbside and commercial collections.

In 2006/07, the partners collectively managed over 600,000 tonnes of municipal solid waste.

## 1.2 The Project

In support of Project Transform's Expression of Interest (EoI) and subsequent Outline Business Case (OBC), Entec has assisted with a detailed appraisal of waste treatment solutions capable of delivering the project's strategic objectives.

Details of the full Options Appraisal can be found in a separate report 'Long Term Residual Waste Treatment Procurement – Scenarios Evaluation Paper'. The purpose of the Options Appraisal is to identify a suitable 'Reference Project' for the OBC. The options appraisal tests various assumptions to ensure that the reference project selected is robust, deliverable and appropriate.

This report details the key technical assumptions underpinning the Reference Project.

## 1.3 The 'Reference Project'

Key features of the Project Transform reference project are detailed below:

- Household waste has been modelled to increase broadly in line with the anticipated growth in household numbers within the partnership area;
- Combined recycling and composting targets of 50% will be achieved;
- New food and recycle collections will be started to meet the recycling targets;
- Food waste collections will be rolled out across the partners;
- A new Energy from Waste (EfW) facility, with a capacity of circa 300,000 tonnes per annum will be procured to treat the waste that is left over after recyclable and compostable material is removed (i.e. the 'residual waste');

- The EfW facility will export heat as a Combined Heat and Power (CHP) facility.

## 2. Waste Arisings and Growth Profiles

### 2.1 Waste Arisings

The base data used for all future waste projections has been derived from the existing datasets of each of the partners.

The base data used is from the financial year 2006/07, which is the most recent complete and audited data available. Table 2.1 presents the breakdown of arisings for each partner.

**Table 2.1 Partnership Municipal Solid Waste Arisings 2006/07**

<b>Household Waste</b>	<b>CCC</b>	<b>SMBC</b>	<b>WCC</b>	<b>Total</b>
Kerbside Refuse Collection	89,090	54,277	164,640	308,007
Kerbside Dry Recyclables	11,966	7,358	26,472	45,796
Organic (garden + Kitchen) waste collection	14,536	9,169	41,353	65,058
Hospital Collection	188	44	91	322
Upstream Household Recycling	0	0	143	144
Other Dry Recyclables (Bring)	5,093	5,226	4,756	15,076
Commercial	27,690	0	11,245	38,935
Open Space Maintenance	243	0	0	243
Offices, Shops, Traders Etc.	27,447	0	11,245	38,692
Street Cleaning / Litter Bins	1,460	6,663	7,304	15,428
Street Cleaning	444	0	0	441
HWRC	23,529	21,198	55,134	99,861
Fly Tipped Council Land	301	0	22	323
Fridge / Freezer Collections	1,018	0	111	1,129
Highway Maintenance	6,680	0	0	6,680
Property Maintenance	0	0	5,574	5,574
Household Bulky Collection	442	0	0	442
Cement / Asbestos Collections	218	0	100.58	319
<b>Total Household Waste</b>	<b>144,960</b>	<b>101,514</b>	<b>300,007</b>	<b>546,481</b>
<b>Total Municipal Waste</b>	<b>182,651</b>	<b>103,935</b>	<b>316,948</b>	<b>603,535</b>

## 2.2 Housing Growth

There are specific housing growth plans for each constituent Authority. Table 2.2 presents the anticipated number of households in each district for the years 2011, 2016, 2021 and 2026.

This data has been provided by each Authority.

For the modelling exercise a profile up to 2040 was required. The housing profile was based on existing housing growth plans, then kept static from the end of current projects.

**Table 2.2 Housing Stock Growth Projections (2011 to 2026)**

	2011	2016	2021	2026
Coventry	137,218	151,499	167,268	167,268
Solihull	86,825	91,254	95,909	100,801
Warwickshire *	235,516	249,980	273,292	287,233
Total	459,559	492,733	536,469	555,302

Note: An error in the Warwickshire housing numbers has been observed. The numbers used overstates the residual waste arisings by approximately 3000 tonnes (less than 1%). The housing numbers will be corrected in the next version of the waste flow model.

## 2.3 Housing Groups

A single housing group was used for modelling in each WDA. This approach was selected due to the limited quantity of specific composition data for each housing type, and because of the strategic aim of the partnership, which will quickly roll out all waste collection schemes to the entire county.

This approach simplifies part of the model, however improves the calibration of the overall model through closer correlation between modelled scheme performance, and the actual waste collection figures.

## 2.4 Waste Growth Profiles

### 2.4.1 Relationship between Waste Growth and Household Growth

The growth profile forms a fundamental assumption of any mass flow model. Whilst authorities often wish to reflect the impact of waste minimisation initiatives within growth profiles, there also needs to be recognition of the growth in household numbers. The Entec model multiplies arisings at the household level by the number of households. Therefore if the number of households increases, so in turn do waste arisings. The model also includes a separate waste growth profile applied at the household level to account for waste minimisation activities and actual growth in waste arisings per household. This ensures waste minimisation is reflected at the household level, with the rate of increase slowing over time. Therefore, all household waste

streams have an underlying growth rate in-line with the anticipated growth in housing stock (housing growth is presented in Section 2.3).

#### 2.4.2 WDA Household Waste Growth

Waste arising data for the last 6 years was analysed for each of the WDAs. In order to analyse waste arisings data at the household level (i.e. to exclude the influence of growth in housing numbers), historical waste arising data has been converted into arisings per household by dividing the total arisings by the number of households in each WCA for the relevant year. Figure 2.3 presents waste arisings, in tonnes per household per year for each of the WCA's for the period 2001/02 to 2006/07.

**Table 2.3 WDA Waste Arisings 2003/4 to 2006/07 (tonnes/household/year)**

	Coventry		Solihull		Warwickshire	
	Total	% change	Total	% change	Total	% change
2006/07	179807	-1.08%	103,848	-2.40%	316,399	0.84%
2005/06	181775	-4.28%	101,411	-2.57%	313,694	-0.47%
2004/05	189899		104,090		315,166	6.18%
2003/04					296,814	

The above data demonstrates that the waste growth is still fluctuating on an annual basis. This is accepted by the partner authorities, who have adopted a waste minimisation strategy to ensure that waste growth is minimised.

#### 2.4.3 Other Household Waste

It has been assumed that non-kerbside household waste streams such as charity collections, fridge and freezers collections, bulky household waste and street sweepings will not increase at the household level, but will increase in line with housing stock growth.

#### 2.4.4 Non- Household Increases

In discussions with LCC it was agreed that the modelling should assume no growth in non-household waste arisings. LCC does not envisage significant increases in trade waste collections from the WCAs. The Authority will work with the Environment Agency to reduce the incidents of fly-tipping. However it was considered pragmatic to keep arisings at their current level.

### 2.5 Total WDA Waste Growth Profile

The total WDA waste growth profile has been developed by combining the anticipated waste growth at the household level for each individual WDA and the underlying growth in housing

stock. This is further developed by assuming that the waste minimisation proposals are successfully implemented, which will reduce the annual waste growth profile to 0.75%.

Table 2.4 presents the projected waste arisings and annual waste growth for the Reference Project.

**Table 2.4 Reference Project Waste Arisings (2007/8 to 2039/40)**

	<b>Kerbside Refuse Collection</b>	<b>Trade Waste</b>	<b>HWRC</b>	<b>Other</b>	<b>Total Househol d Waste</b>	<b>Total MSW</b>	<b>% change</b>
2006	432137	38935	99861	30335	544215	601268	
2007	437975	39324	101241	30638	551571	609179	1.32%
2008	443456	39678	102540	30914	557985	616588	1.22%
2009	448564	39995	103753	31161	564009	623474	1.12%
2010	453352	40295	104889	31395	569631	629931	1.04%
2011	457872	40597	105958	31630	574914	636057	0.97%
2012	462114	40902	106956	31868	579851	641840	0.91%
2013	466070	41209	107882	32107	584570	647267	0.85%
2014	469731	41518	108732	32347	588943	652328	0.78%
2015	473254	41829	109548	32590	593358	657221	0.75%
2016	476803	42143	110369	32834	597808	662150	0.75%
2017	480379	42459	111197	33081	602292	667116	0.75%
2018	483982	42777	112031	33329	606809	672119	0.75%
2019	487612	43098	112871	33579	611360	677160	0.75%
2020	491269	43421	113718	33831	615945	682239	0.75%
2021	494954	43747	114571	34084	620565	687356	0.75%
2022	498666	44075	115430	34340	625219	692511	0.75%
2023	502406	44406	116296	34597	629908	697705	0.75%
2024	506174	44739	117168	34857	634632	702938	0.75%
2025	509970	45074	118047	35118	639392	708210	0.75%
2026	513795	45412	118932	35382	644188	713521	0.75%
2027	517648	45753	119824	35647	649019	718873	0.75%
2028	521531	46096	120723	35914	653887	724264	0.75%
2029	525442	46442	121628	36184	658791	729696	0.75%
2030	529383	46790	122540	36455	663732	735169	0.75%
2031	533353	47141	123460	36729	668710	740683	0.75%
2032	537353	47495	124385	37004	673725	746238	0.75%
2033	541384	47851	125318	37282	678778	751834	0.75%
2034	545444	48210	126258	37561	683869	757473	0.75%
2035	549535	48571	127205	37843	688998	763154	0.75%
2036	553656	48936	128159	38127	694165	768878	0.75%
2037	557809	49303	129120	38413	699372	774644	0.75%
2038	561992	49672	130089	38701	704617	780454	0.75%
2039	566207	50045	131065	38991	709901	786308	0.75%
2040	570454	50420	132047	39284	715226	792205	0.75%

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## 3. Waste Composition

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### 3.1 Kerbside Composition

The reference model considers the specific waste composition, and looks to the most recently available data to determine waste composition.

#### 3.1.1 Coventry Waste Composition Data

Composition data was available from Coventry. The study completed by MEL on behalf of Coventry City Council reported detailed compositions for ACORN categories 3, 4 and 5. Acorn categories 1 and 2 were not sampled due to the small proportion of the population which they represented. In total 85.7% of the population were represented by the ACORN categories sampled. The compositions for the 3 samples were blended proportionally to the percentage of the total sample which they constituted. The categories used in the composition were not exactly the same as those needed for the model therefore some manipulation was needed e.g. the different material types of plastic bottle were not needed so these were combined into the 'Plastic Bottle' category.

Bring site composition taken from WDF 2006/07 data provided by council.

Non-kerbside category 27 – street cleaning - is actually parks and gardens waste of which 100% has been sent to windrow. The composition has been set at 100% garden waste.

#### 3.1.2 Warwickshire Waste Composition Data

Composition data was available for Warwickshire. The study completed by AEA Technology on behalf of Warwickshire County Council reported detailed compositions by district. This study was not completed according to ACORN sampling. Instead each district was requested to provide details of an area of approximately 40 households which could be used to represent the district as a whole. For the purpose of this modelling the compositions from each district sample were blended in proportion to the percentage of the total households in the county which the district represented.

#### 3.1.3 Solihull Waste Composition Data

There was limited composition data for Solihull. The model uses a similar composition to Warwickshire's.

### 3.1.4 Limitations of the Data

These studies proved an indication of the composition, it is limited in that it represents a single snap shot in time and does not portray realistic picture of the 'annual' waste composition for collected household waste within the partnership region. The discrepancies between the snapshot waste composition assays and the actual waste collection performance are used to calibrate the waste flow model, and developing composition, capture rate, and collection scheme participation rates for the specific communities served.

The three modelled waste compositions used are shown in Table 3.1.

**Table 3.1 Waste Composition**

Primary Category	Secondary Category	CCC Weighted Composition	SMBC Weighted Composition	WCC Weighted Composition
Paper	Newspapers	11.55%	13.00%	12.37%
	Magazines	0.00%	3.50%	0.00%
	Other Recyclable Paper	4.56%	4.00%	2.75%
	Paper Packaging	0.00%	0.00%	0.00%
Card	Non-recyclable Paper	4.16%	2.80%	3.02%
	Liquid Cartons	0.30%	0.00%	0.00%
	Board Packaging	1.90%	1.00%	1.15%
	Card Packaging	2.57%	2.38%	2.86%
Dense Plastic	Other Card	0.89%	0.00%	0.00%
	Plastic Bottles	2.26%	1.75%	1.99%
	Dense Plastic Packaging	2.04%	1.75%	2.22%
Plastic Film	Other Dense Plastic	2.40%	1.27%	1.27%
	Other plastic film	1.29%	1.58%	1.58%
Textiles	Packaging film	1.50%	1.50%	1.80%
	Textiles	2.72%	1.25%	1.37%
Glass	Shoes	0.60%	0.48%	0.48%
	Glass Bottles	5.06%	5.00%	6.42%
	Glass Jars	0.00%	0.00%	0.00%
Miscellaneous Combustibles	Other Glass	0.25%	0.39%	0.39%
	Treated Wood	0.83%	0.75%	0.75%
	Untreated Wood	0.00%	0.00%	0.00%
	Furniture	0.00%	0.00%	0.00%
Miscellaneous Non-combustibles	Disposable Nappies	2.66%	2.00%	2.70%
	Other Misc. Combustibles	1.05%	1.45%	2.70%
	Carpet and Underlay	1.32%	0.50%	0.62%
Ferrous Metal	Construction and Demolition	1.68%	0.65%	0.73%
	Other Misc Non-combustibles	0.72%	1.00%	1.00%
	Ferrous food	1.68%	1.40%	1.60%
Non-ferrous metal	Ferrous beverage cans	0.00%	0.00%	0.00%
	other ferrous metal	1.02%	0.88%	0.88%
WEEE	Non-ferrous food	0.38%	0.00%	0.00%
	Non-ferrous beverage cans	0.00%	0.22%	0.22%
	Other non ferrous metal	0.30%	0.39%	0.39%
	white goods	0.00%	0.00%	0.00%
Hazardous	Large electronic goods	0.00%	0.12%	0.12%
	TV's and monitors	0.00%	0.00%	0.00%
	Other WEEE	1.02%	0.54%	0.54%
	Household Batteries	0.00%	0.00%	0.00%
Organic non-catering	Car Batteries	0.00%	0.00%	0.00%
	Engine Oil	0.00%	0.00%	0.00%
	Other potentially hazardous	0.34%	0.06%	0.06%
Organic catering	Identifiable clinical waste	0.00%	0.07%	0.07%
	Garden Waste	13.17%	33.00%	22.00%
	Soil	0.00%	0.00%	0.00%
Fines	Other Organic	2.39%	1.75%	2.77%
	Home comp Food Waste	13.12%	8.00%	11.33%
Fines	Non-home comp Food Waste	11.98%	4.00%	10.00%
	Fines	2.28%	1.50%	1.86%

## 3.2 HWRC Waste Composition

The composition of HWRC waste has been calculated by applying the expected NACAS CA waste composition. The tonnages were then adjusted slightly to match the reported level of recycling and composting from the HWRC sites. Table 3.2 presents the modelled HWRC waste composition.

**Table 3.2 HWRC Waste Composition**

<b>Material Stream</b>	<b>2006/7 Composition</b>
Green waste	25.6%
Inert	16.5%
Bagged waste	20.8%
Paper & card	4.8%
Timber	7.8%
Furniture	2.3%
Carpets	3.3%
Metal	7.7%
Electrical	3.7%
Glass	1.9%
Plastics	2.3%
Textiles	1.5%
Hazardous	0.5%
DIY & fittings	0.0%
Miscellaneous	1..%

## 4. Collection Schemes

### 4.1 Dry Recycling and Organic Collection Schemes

Each of the individual waste collection services is currently tailored to their specific characteristics. In order to model forward projections of waste management solutions, a thorough understanding of the current situation is necessary. Tables 4.1, 4.2 and 4.3 present a summary of the existing kerbside collection schemes in each of the partnership areas.

**Table 4.1 Summary of Coventry Kerbside Collection Schemes**

Scheme	Material	Start	HH (start)	HH (end)	Participation
C1	Paper	2006	128,274	100% coverage (2006)	81%
C2	Card	2006	128,274	100% coverage (2010)	60%
C3	Plastic Bottles	2008	21,000	100% coverage (2009)	63%
C4	Glass	2009	40,000	100% coverage (2009)	63%
C5	Cans	2009	21,000	100% coverage (2009)	72%
C6	Garden waste	2009	129,303	100% coverage (2009)	96%
C7	Textiles & Shoes	2010	139,962	100% coverage (2010)	60%
C8	Kitchen Waste	2011	142,761	100% coverage (2011)	82%

**Table 4.2 Summary of Solihull Kerbside Collection Schemes**

Scheme	Material	Start	HH (start)	HH (end)	Participation
S1	Paper	2006	70,000	100% coverage (2009)	87%
S2	Garden waste	2006	50,400	100% coverage (2008)	73%
S3	Glass	2008	42,000	100% coverage (2009)	80%
S4	Plastic Bottles	2009	42,000	100% coverage (2010)	80%
S5	Cans	2009	42,000	100% coverage (2010)	80%
S6	Card	2009	42,000	100% coverage (2010)	80%

**Table 4.3 Summary of Warwickshire Kerbside Collection Schemes**

Scheme	Material	Start	HH (start)	HH (end)	Participation
W1	Paper	2006	212,525	100% coverage (2010)	70%
W2	Card	2007	101,811	100% coverage (2016)	80%
W3	Plastic Bottles	2007	101,811	100% coverage (2015)	80%
W4	Glass	2006	212,525	100% coverage (2009)	66%
W5	Cans	2006	212,525	100% coverage (2013)	73%
W6	Garden waste	2006	210,321	100% coverage (2012)	92%
W7	Textiles & Shoes	2006	212,525	100% coverage (2010)	30%
W8	Dense Plastic	2007	49,500	49,500 (no further roll-out)	80%
W9	Hazardous (Batteries, engine oil)	2006	212,525	100% coverage (2015)	100%
W10	Paper Packaging	2006	90,194	90,194 (no further roll-out)	80%
W11	Kitchen Waste	2006	52,381	117,000 (from 2009)	80%

## 4.2 Kerbside Collection Scheme Capture Rates

The quantity of a specific material captured for recycling on a particular scheme is a result of a number of variables, namely:

1. Scheme coverage (i.e. the number of households offered the scheme);
2. Waste composition (how much of the materials present in the waste);
3. Scheme participation rate (the number of households that use the recycling scheme as a percentage of the scheme coverage); and
4. Material recognition rate (how well each participating household ‘recognises’ and captures each targeted material).

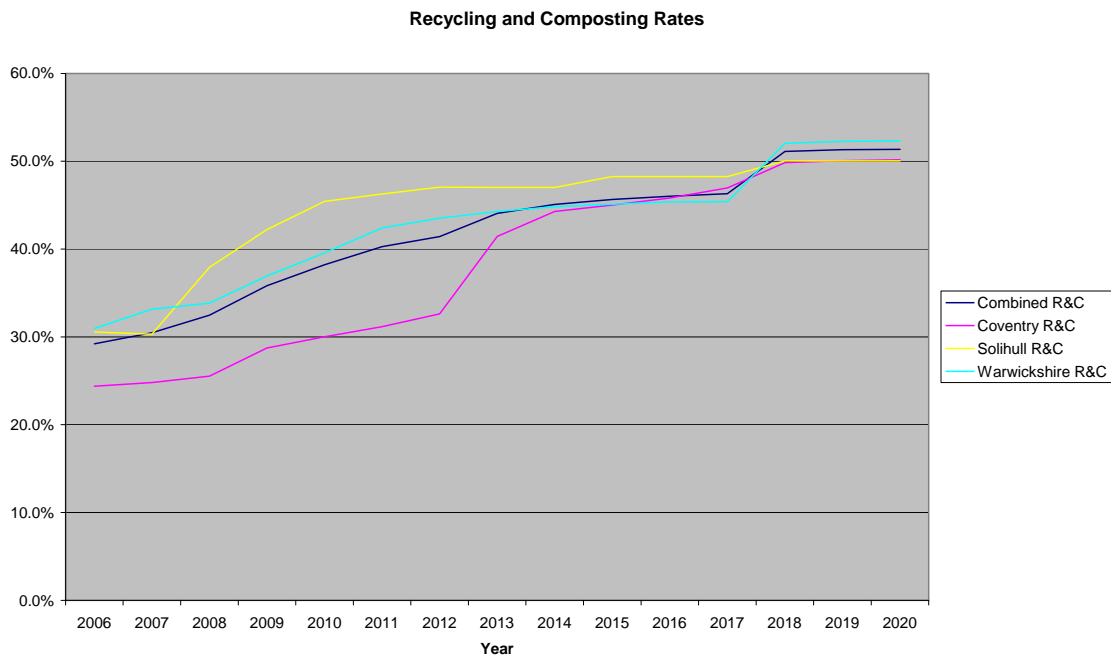
The four variables are interrelated and any assumptions made about one variable will have an impact on the other variables. The Entec mass flow model is ‘calibrated’ for the base year (in this case 2006/7), meaning that the four variables referenced above are tuned so that the models base year reflects the reality of actual data. The variables are benchmarked against best practice data gathered from schemes across the country to validate any assumptions made. The model enables future scenarios to be modelled by adjusting any of the variables over time, whether this is increasing the coverage of a particular scheme as more households have access to it, or increasing participation or recognition rates due to an increase in publicity or education. Recognition rates have been “pushed” from 2018 to reflect ongoing commitments to public education regarding correct use of the recycling and collection schemes, and assume

continuation of national programs such as the “Recycle Now” campaign, research by WRAP and ROTATE.

### 4.3 Recycling and Composting Performance

Figure 4.1 presents the projected recycling and composting rates for each of the Project Transform partners up to 2020. The recycling and composting rates reflect current and planned future scheme initiatives.

Figure 4.1 Individual WCA Recycling and Composting Rates





## 5. Residual Waste Treatment (PFI)

### 5.1 Facility Sizing

One of Project Transform's key strategic objectives is to minimise the amount of waste disposed of in landfill. This means that some element of the waste will require treatment to avoid landfill.

The Reference Project facility is sized to limit the residual quantity of waste requiring landfill.

Table 5.1 presents the waste streams that have been assumed will be treated in each facility type.

**Table 5.1 Waste Stream Process Modelling Assumptions**

	Direct to Landfill	Residual Treatment Facility	Windrow / IVC / AD	Bulking / MRF
Kerbside Refuse Collection		100%		
Kerbside Collected Dry Recyclables*				100%
Kerbside Collected Organic Waste*			100%	
Household Bulky Collection	100%			
Hospital Collection	100%			
Other Dry Recyclables (Bring)				100%
Parks and Gardens			100%	
Fridge / Freezer Collections				100%
Street Cleaning / Litter Bins	100%			
Collected Trade Residual		100%		
Commercial Recycling				100%
Fly Tipped Council Land	100%			
Cement / Asbestos Collections	100%			
HWRC Trade Wood			61%	39%
HWRC Trade Residual	25%	75%		
HWRC Household Residual	25%	75%		
HWRC Dry Recyclables				100%
HWRC Green			100%	
HWRC Inert	100%			
MRF / Windrow / IVC / AD Rejects	100%			

## 5.2 EfW Plant Assumption

The Reference Project facility is sized to ensure adequate capacity to process the residual waste arising, which requires a facility with an operating capacity of 305,000 tonnes of waste per annum.

The EfW is assumed to be operational in October 2015.

The material going through the EfW is fully diverted for the purposes of BMW diversion calculations and from operation start, the solution fully meets Project Transform's LATS requirements.

The output bottom ash is assumed to be approximately 23% by weight of the input tonnage. The modelling assumes that the bottom ash is sent for reprocessing for aggregate. It is anticipated that ferrous metal will be recovered from the bottom ash. Air pollution control residues (APC) are 3% of the input mass and are assumed to be sent to specialist hazardous landfill sites.

Facility assumptions are presented in Table 5.2.

**Table 5.2 Facility Assumptions**

Item	Assumption
Bottom Ash	23% of input mass (excluding recovered metals)
Recovered metals from bottom ash	2% of input mass
Air Pollution Control (APC) residue	3% of input mass
CV of Waste	10 MJ/kg
Tonnage Rating	40.3 tonnes per hour
Thermal Capacity	104 MW(th) @ 85% Load Factor
Electrical Output	23 MW(e) @ 22% Net Electrical Efficiency
Electrical Output	170,695 MW.h per year = 569 kWh(e) per tonne of waste

## 6. Financial Cost Information

### 6.1 Costing Methodology

#### 6.1.1 Basis of Costing

The costs summarised in this report are based upon the functional unit costs for each process or facility. Where current operational costs were not available costs are based on generic cost curves/functional unit estimates derived from market information.

The initial baseline cost estimates have been defined as 'Class E: Order of Magnitude Estimates'. Class E estimates have an accuracy of +/-30 to 50% (it should be noted that additional work has been undertaken to increase the level of accuracy for these cost estimates – details of this work can be found in Section 6.2.4).

Class E estimates are generally obtained very early in a project lifecycle with limited knowledge of the Project other than the general scope. Process flow sheets, plant layouts or equipment lists will not have been produced and instead capacity yardsticks or unit prices will be used. Other potential variables include site acquisition costs, site specific requirements, detailed process design and operability requirements.

**Table 6.1 Class E Estimates - Accuracy and Information Requirements**

Heading	Parameter
Accuracy	+/- 30 to 50%
Typical Information needed	Process assumptions Product or plant output (approx.) Assumption on main plant Approximate size of structure or facility Geographical location
Estimating Methods	Factoring of known similar plants form databases Cost curves (if applicable) TR61, BCIS Elemental Analyses Professional Experience Indexation

More accurate costings can be developed as a procurement project progresses and further project specific information becomes available. In particular the following issues will potentially impact on final out-turn costs:

- Precise process specifications;

- 
- detailed site characteristics (ground conditions, existing features, ground contamination, topography);
  - planning and environmental requirements (appearance, architectural enhancement, odour emissions, specific planning conditions imposed); and
  - infrastructure requirements (service connections, access roads, highways requirements etc.).

Other key assumptions at the strategic level which will also affect the costings relate to the waste flow model, which determine the waste characteristics, tonnages etc:

- Risk on future capture and segregation rates/ assumptions (joint risk between authority and contractor); and
- variable plant throughput due to underlying waste growth assumptions. The sizing of the initial plant may not match the final throughput or may be dependant on external sources/markets.

### **6.1.2 General Assumptions / Notes**

It is assumed that works will be procured through a competitive procurement approach.

Functional unit costs are based on the Advisors own database. There are other sources of “quoted” cost data for waste projects but there is no industry standard format (such as BCIS for example) and process manufactures are understandably reluctant to divulge sensitive information.

It has been assumed that the suitable plot has service and transport links at the boundary. Costs also include contractors’ design and supervision fees.

### **6.1.3 Base Data**

Capital and operating costs are based at quarter 1 2008.

### **6.1.4 Key Exclusions**

The following elements have been excluded from the costs estimates:

- VAT;
- Insurance;
- NNDR;
- Finance/funding;
- PFI bid costs, SPV set up costs;
- Potential Site Abnormals (poor ground, contamination etc based on more detailed survey work); and
- Termination of existing contracts/plants/equipment/TUPE etc.

The costs presented in the report are related to the treatment and disposal of municipal waste.

All capital and operating costs are best estimates at this time based on knowledge of similar schemes throughout the UK and Europe.

Baseline costs have not been adjusted to consider the effects of future inflation or interest rates. Actual costs will vary according to the method of procurement, market conditions and risk profile adopted. Movement in foreign exchange rates can also significantly affect actual costs, depending on the country of origin for major capital items.

## 6.2 Indicative EfW Capital Costs

### 6.2.1 Indicative Capital Costs

Table 6.2 presents the indicative capital costs used in the model. The prices are drawn from in-house cost estimates derived from market intelligence. The costs are presented as total capital costs (in £m). At this stage in the project, a potential site has been identified. Preliminary site investigations comprising walk over surveys have been conducted, however detailed ground investigations, topographical surveys and contamination surveys have not been undertaken. Therefore, the cost estimates presented in Table 6.2 assume neutral conditions and the estimate is sufficient to deliver the facility assuming there are no unforeseen circumstances.

**Table 6.2 Facility Capital Cost Breakdown**

<b>Estimated Baseline EFW EPC Capex</b>	<b>Capital Cost Element</b>
Thermal Element	£45.0
Tonnage Element	£67.0
CHP Element	£5.0
<b>Total EFW EPC Cost Estimate</b>	<b>£117.0</b>
Additional Costs to Baseline EFW Costs	
Grid Connection	£1.9
SPC Project Management Costs	£6.7
Licensing Costs	£1.5
"Other General", including allowances for minor architectural enhancements, basic visitors centre, offices and amenities block, basic site infrastructure.	£10.0
<b>Total Additional Cost Estimate</b>	<b>£20.2</b>
<b>Total EfW Capital Cost</b>	<b>£137.2</b>

### 6.2.2 Additions to basic Capital Costs

A baseline EfW cost of £117.0 has been estimated for the plant and machinery elements of the facility. It is anticipated that an additional £20.2m is required to deliver the facility. These additional capital costs are assumed to be incurred for site preparations, enabling works, grid connections and supporting infrastructure. The site preparations include for remediation of any minor or moderate site contamination, for clearance of existing buildings and simple ground works to prepare the site for construction.

An additional cost driver relates to the architectural features of a plant. Depending on the site circumstances, for planning reasons, an EfW plant may require sophisticated design features in the buildings – recent examples of this approach include the projects in development and construction in Hampshire and Nottinghamshire. The additional design, engineering and construction costs of sophisticated structural features can increase the capital costs by up to 10% compared with a more industrial ‘box’ design. Therefore, given the proposed Reference Project site location, an allowance of £10m is included for architectural enhancement and architectural aesthetics. Architectural enhancement is a provision necessary to accommodate design requirements resulting from planning requirements as part of the planning approval. It can also relate to a requirement or desire to improve the visual appearance of a facility.

### 6.2.3 CHP Infrastructure Capital Costs

The reference case technology for the PFI Outline Business Case is an EfW facility with CHP. The additional capital cost of the principal steam/hot water pipe work or ring-main connection to the existing heat pumping station has been included in the capital cost estimate. Any additional network of pipes necessary to deliver the heating into residential homes or to an industrial user is not included and for this exercise does not form part of the capital costs.

### 6.2.4 Three Point Capital Cost Risk Estimates

The capital cost estimates presented in Table 6.2 assume neutral conditions. A review of available data, including historic site investigation reports, has enabled a high level three point risk assessment to be undertaken for various elements of the project. It should be noted that there may be additional unidentified risks in addition to the list of identified risk areas detailed below. Each risk area has been assessed and quantified by Entec’s in-house Quantity Surveyor. Three costs for each risk area have been estimated; a minimum cost, most likely cost and a maximum cost. These costs, along with probability distributions are entered into a statistical software package simulation, Crystal Ball.

The identified site specific risks are as follows:

- |  |  |
|--|--|
| 1. Abnormal foundations – Geology        | No SI data available. Believed to be worse than neutral. An EFW plant may need Piling or other abnormal foundation if ground is poor. Alternatively hard rock will incur additional costs to break out and remove from site. Building footprint and excavation volume unknown at this stage. |
| 2. Contaminated Ground                   | No SI or LQA data available. Some contamination is expected but not at heavy brownfield levels.  |
| 3. Existing structures / site topography | These site specific items will affect earthwork costs and infrastructure costs.  |
| 4. Road upgrade and A46 connection       | Provisional sum for modification to road layout due to number of vehicle movements, including approx 200m of carriageway/slip road and overbridge for river crossing.  |

5. Environmental measures	The façade of EFW buildings may need minor enhancement or upgraded from "normal" industrial cladding . Alternatively a sympathetic landscaping scheme may need to be implemented or existing trees retained. Architectural design (e.g. Spittelau incinerator) would incur cost premium.
6. Diversion of Existing services	No details available - it is likely there will be existing services that will need to be disconnected & removed. It is uncertain if any other services cross the site and would need to be diverted. New services could possibly use those required for the existing EFW.
7. Functionality uncertainty	Generic pricing is based upon "norms". Capex Rate per tonne is subject to plant type / performance. Ash processing not included within base estimate but may be required and higher emission controls may be needed if the site is in an Air Quality Management Zone.
8. Market Conditions	Market competition, workload, supply chain procurement. Best Capex may not be the lowest. Bidder preferences. Location factors.
9. New services	Unknown capacity & location results in risk associated with new grid connection costs. Base cost includes "generic" costs but site specifics will vary. Grid connection generic cost is already included. An existing EFW plant is currently served .
10. Flood Risk	Site is within river Sherbourne flood plain and may need containment / design work to ensure robust defences.

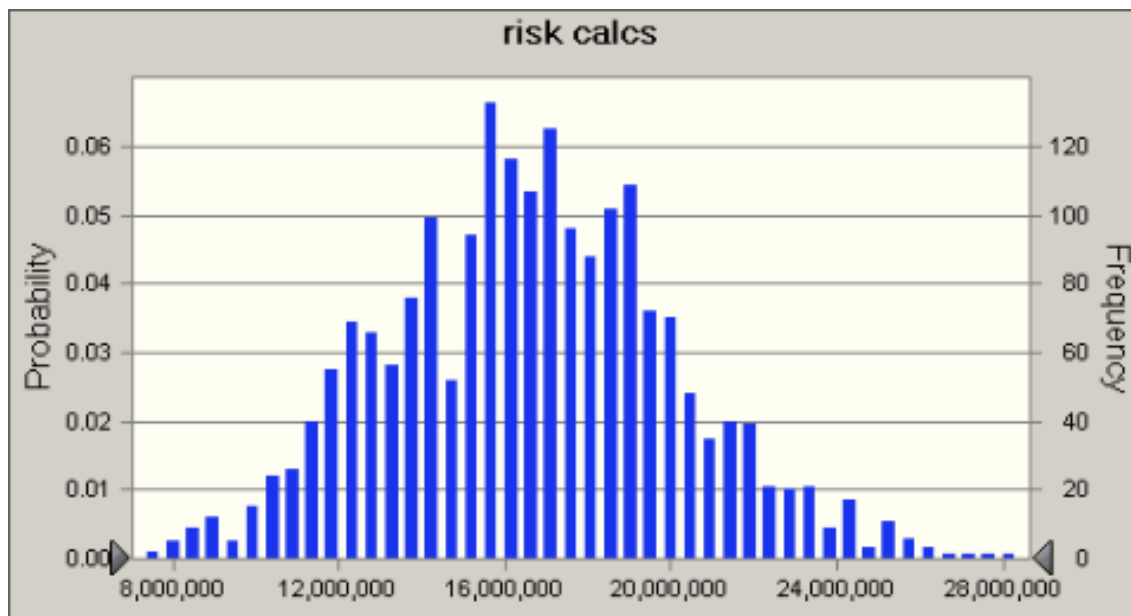
Details of the risk priced assumptions are detailed in Appendix A. Summary statistics from the Crystal Ball simulation are presented in Table 6.3.

**Table 6.3 Crystal Ball Capital Costs - Summary Statistics**

Summary Statistic	Forecast Values
Trials	2,000
Mean	16,600,030
Median	16,610,000
Mode	16,930,000
Standard Deviation	3,449,458
Skewness	
Kurtosis	0.1344
Coeff. of Variability	2.89
Minimum	0.2078
Maximum	7,250,000
Range Width	28,360,000
Mean Std. Error	21,110,000

The results of the Crystal Ball cost estimate distribution is presented in Figure 6.1. The chart presents the frequency distribution of additional capital costs for the Reference Project facility given the identified and costed risks presented in Appendix A.

**Figure 6.1 Three Point Risk Estimate Probability Distribution**



From the distribution 'curve' presented in Figure 6.1, and based on the limited knowledge of the Reference Project site, there is 90% certainty that the capital cost of the facility will be less than £21.1m above the baseline capital cost estimate of £137.2m (i.e. 90% certainty that the capital cost of the facility will be less than £158.1m). This represents an estimate of +16% of the capital cost. As more information becomes available about the project and the site, the level of accuracy of the cost estimate should increase.

## 6.3 Indicative EfW Operating Costs

### 6.3.1 Breakdown of Operating Costs

Operating costs are split into a number of categories:

1. Facility maintenance costs;
2. Facility lifecycle costs;
3. Variable operating costs (including consumables and by-product disposal); and
4. Fixed operating costs.

It should be noted that many of these cost data are very sensitive to external market factors and are highly variable. For instance, the cost of insurance is heavily influenced by the wider

insurance market, the cost of electricity is influenced by many technical, market and regulatory factors in the electricity supply industry and the cost of staffing can be influenced by local employment market conditions. For this reason, there is also significant uncertainty in any such indicative cost numbers.

### 6.3.2 Facility Maintenance and Life Cycle Costs

Maintenance and Life Cycle costs are presented in Table 6.4. Costs are presented as a percentage of the plant and equipment capital costs.

**Table 6.4 EfW Facility Life Cycle and Maintenance Cost Assumptions**

Cost Element	Cost per Annum
Facility Maintenance Costs	£1.7m
Facility Life Cycle Costs	£1.3m

### 6.3.3 Variable Operating Costs

Variable operating costs are sub-divided into two categories; costs associated with consumables required in the combustion and treatment of residues processes, and costs associated with the disposal of process outputs (e.g. APC residue and bottom ash). These costs are variable and directly correlate to the tonnages of waste processed. Table 6.5 presents a summary of the variable operating cost assumptions.

**Table 6.5 Variable Operating Cost Assumptions**

Consumable	Quantity Required	Unit Cost
Lime	13.0 kg/tonne	£156 per tonne
Activated Carbon	1.0 kg/tonne	£560 per tonne
Ammonia (30% Solution)	4.0 kg/tonne	£153 per tonne
Process Water	0.6 m <sup>3</sup> /tonne	£0.80 per m <sup>3</sup>
Bottom Ash Disposal (inc. transport)	(25% of input tonnage)	£10 per tonne
Recovered Metal	(~2% of input tonnage)	No cost
APC Residue Disposal (inc transport)	(4% of input tonnage)	£171 per tonne
Total Consumables Costs (per tonne of waste treated)		£13.00 per tonne of EfW throughput

### 6.3.4 Fixed Operating Costs

Fixed operating costs are costs associated with the on-going operations of the facility, and do vary dependant on the input waste tonnage. Table 6.6 presents the fixed operating cost assumptions.

**Table 6.6 Fixed Operating Costs**

<b>Fixed Operating Cost</b>	<b>Annual Cost</b>
Staffing	£750,000
Environmental Compliance	£35,000
Office Expenses	£40,000
Other Unspecified	£50,000
Total Annual Cost	£875,000
Equivalent Cost per Tonne waste treated	£3.00

## 6.4 Income

A prudent approach to income from the EfW has been assumed, with a revenue of £40/MWh(e) used in the modelling. However, the revenue is dependant on the calorific value of the waste and the income per MWh(e).

It is assumed that metals will be recovered from the bottom ash. A prudent approach has been adopted and zero income has been modelled for this product.

## 6.5 Commercial Waste

Income from the collection of commercial wastes has been accounted for at a rate that results in the net income equating to zero. That is the income assigned to the tonnage of trade waste equates to the disposal costs (landfill/ EFW gate fees and haulage) assigned to the tonnage within the model.

## 6.6 WCA Collection Costs

The capital and operating costs associated with the operation and expansion of waste collection to deliver the modelled improvements in kerbside collections is not included in this analysis.

## 6.7 Costs for other Facilities – Food Waste Treatment

The Reference Project assumed that food waste collections will be rolled out. It is anticipated that sufficient merchant capacity either currently exists or is planned within the region to receive and process collected food waste. Therefore, no capital cost have been incorporated in the

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Reference Project model, however a gate fee of £45 per tonne has been modelled. This figure is comparable with ‘gate fee’s’ for IVC’s in various other authorities and reflects the anticipated cost for this service.

## 6.8 Cost of Other Facilities

Reference Project model assumes that any other waste facilities required will be sourced on a “gate fee” basis from merchant provision.

Table 6.7 presents the anticipated gate fees.

**Table 6.7 Waste Facility Gatefee Assumptions**

<b>Treatment Facility</b>	<b>Gatefee Assumption (per tonne)</b>
Windrow composting	£25.00
Transfer Station	£11.00
Materials Recycling Facility	£28.00



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# **Appendix A**

## **Capital Cost Estimates – Three Point Risk Adjusted Costs**

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**Coventry Capital Costs**

		<u>£ CAPEX/T</u>	<u>t/yr/unit</u>	<u>Capex</u>
EfW	Plant	456.67	300,000	137,001,000
	Other	0	0	0
	<b>Generic/Neutral Site Capex</b>			<b>137,001,000</b>

**Site Specific Risks**

	<u>Min</u>	<u>Likely</u>	<u>Max</u>
<b>(1) Abnormal foundations - Geology</b>			
No SI data available. Believed to be worse than neutral. An EFW plant may need Piling or other abnormal foundation if ground is poor. Alternatively hard rock will incur additional costs to break out and remove from site. Building footprint and excavation volume unknown at this stage. Prov allowances:			
	Min	500,000	
	Likely	1,000,000	
	Max		2,000,000
<b>(2) Contaminated Ground</b>			
No SI or LQA data available. Some contamination is expected but not heavy brownfield levels.			
	Min. -	0	
	Likely -	250,000	
	Max. -		500,000
<b>(3) Existing structures / site topography</b>			
These site specific items will affect earthwork costs and infrastructure costs			
	Min.	0	
	Likely	250,000	
	Max.		500,000
<b>(4) Road upgrade and A46 connection</b>			
Provisional sum for modification to road layout due to number of vehicle movements. approx 200m of carriageway/slip road and overbridge for river crossing			
	Min.	2,000,000	
	Likely	3,000,000	
	Max.		5,000,000

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**(5) Environmental measures**

The façade of EFW buildings may need minor enhancement or upgraded from "normal" industrial cladding . Alternatively a sympathetic landscaping scheme may need to be implemented or existing trees retained.

Architectural design (e.g. Spittelau incinerator) would incur cost premium

500,000	2,000,000	5,000,000
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**(6) Diversion of Existing services**

No details available - it is likely there will be existing services that will need to be disconnected & removed. It is uncertain if any other services cross the site and would need to be diverted. New services could utilise those required for existing EFW.

Min.

250,000

Likely

500,000

Max.

1,000,000

**(7) Functionality uncertainty**

Generic pricing is based upon "norms". Capex Rate per tonne is subject to plant type /performance. Ash processing not included within base estimate but may be required and higher emission controls may be needed due to AQMZ

Min. no increase

0

Likely

1,000,000

Max

4,000,000

**(8) Market Conditions**

Market competition, workload, supply chain procurement. Best Capex may not be the lowest. Bidder preferences. Location factors

Min. no increase

0

Likely +2.5%

3,425,025

Max +5%

6,850,050

**(9) New services**

Unknown capacity & location results in risk associated with new grid connection costs. Base cost includes "generic" costs but site specifics will vary. Grid connection generic cost is already included. An existing EFW plant is currently served

0

0

1,000,000

**(10) Flood Risk**

Site is within river Sherbourne flood plain and may need containment / design work to ensure robust

500,000

1,500,000

4,000,000

gross, un-mitigated

3,750,000

12,925,025

29,850,050

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<u>Confidence</u>	<u>Min</u> <b>10%</b>	<u>Likely</u> <b>50%</b>	<u>Max</u> <b>90%</b>
	137,001,000	137,001,000	137,001,000
	12,180,000	16,610,000	21,110,000
3 point Estimate	149,181,000	153,611,000	158,111,000

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