JERSEY TTSD
DIRECTLY DELIVERED WASTE
CATEGORISATION
SUMMARY REPORT

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1 INTRODUCTION

Fichtner has been commissioned to survey the incoming solid waste delivered to Bellozanne.

The solid waste can be split into two main categories:

1) Parish Waste. This is collected in Refuse Collection Vehicles (RCVs) and taken to Bellozanne, where it is tipped into the Energy from Waste plant bunker. The waste consists of household waste and some waste collected from commercial properties such as hotels and shops.
2) "Directly Delivered Waste", this refers to all other waste delivered to the site both by business and members of the public and is the main subject of this investigation. This category is subdivided into:
   - "Bulky waste" delivered to the pre-treatment area. This material is either separated for recycling or shredded prior to being transported to the bunker of the EfW Plant.
   - Waste delivered directly to the EfW Plant bunker. This is combustible material which cannot be recycled and which does not require shredding.

The loads of 3,541 vehicles delivering 664 tonnes to the pre-treatment site between midday on Tuesday 28th March and midday on Saturday 8th April 2006 have been surveyed. This excludes the parish waste deliveries. On the afternoon of Saturday 8th and on Sunday 9th April the vehicles were counted in, categorised by vehicle type and an inventory of electrical items taken. On the afternoon of Wednesday 29th and morning of Friday 31st March the waste delivered directly to the EfW Plant bunker, excluding Parish RCVs, was surveyed (57 vehicles delivering 13 tonnes in total). In parallel, operational data from the EfW Plant was gathered to enable a heat balance to be carried out.

1.1 Objectives

There were several objectives:

- To characterise the waste and its delivery in order to highlight any recycling possibilities.
- To understand the current refuse handling plant operations to facilitate the design of the waste reception areas for the new EfW plant;
- To estimate the Net Calorific Value (NCV) of the mixed waste incinerated in the EfW plant, and additionally the NCV of the Directly Delivered Waste with a view to the design of the new EfW Plant;

2 CONCLUSIONS

1) During the survey period 75 % of the Directly Delivered Waste (approximately 540 tonnes/week) was bulky waste delivered to the pre-treatment site for shredding prior to incineration, 25 % was delivered straight to the EfW bunker. The average composition of these waste streams is as follows:

Bulky waste delivered to the pre-treatment site

- 49 % Wood
- 12 % Plastic
- 9 % Metal (60 % of which was sent for scrap)
- 7 % Carpets
- 4 % Cardboard (60 % of which was sent for recycling)
- The remaining 19 % was split between a large number of material categories none of which contribute much more than 3 %.

Directly Delivered Waste tipped straight into the EfW bunker

- 55 % Household
- 12 % Paper
- 10 % Street Sweepings (much of this is water)
- 8 % Cardboard
- 7 % Plastic
- The remaining 8 % was split between a number of categories, none of which contribute more than 3 %.

2) During the week, the hourly period in which the greatest number of vehicles, including Parish RCVs, entered the Bellozanne site was between 11:00 and 12:00 with 66 vehicles entering on average. The peak number of vehicles entering the site during the week occurred between 09:00 and 10:00 on Monday 3rd April when 93 vehicles entered. Over the weekend, the busiest hourly period was also between 11:00 and 12:00 when on average 109 vehicles were observed. A peak number of 128 vehicles was observed entering the Bellozanne site between 11:00 and 12:00 on Sunday 2nd April.

3) During the survey period, 57% of the solid waste was delivered to Bellozanne in Parish RCVs, with the remaining 43% delivered directly in commercial and domestic vehicles.

4) The average split between commercial and domestic vehicles (excluding Parish RCVs) over a week was 60 % commercial and 40 % domestic.

5) A small van belonging to "Barnes Publishing" was observed delivering loads of printed paper directly to the bunker. On questioning the driver said that he was a regular visitor. This could constitute a 60 tonnes/year source of paper suitable for recycling.

6) If electrical goods are to be removed from the Directly Delivered Waste stream then provision should be made to collect and dispose of 350 items per week. These items consist mainly of televisions, video machines, computer equipment including printers and Hi Fis/speakers.

7) Approximately 10 % of the wood delivered to the pre-treatment area was uncontaminated, free from rot and of a reasonable size. During the survey period nearly 230 tonnes of wood was delivered per week.

8) The energy balance performed on the EfW plant gives an overall NCV for all the waste (including parish deliveries) of 9.4 MJ/kg.

9) The calorific value of the Directly Delivered Waste has been estimated from the composition of both the shredded bulky waste and the waste delivered straight to the bunker. This suggests an overall NCV of 10.1 MJ/kg. The NCV of the waste delivered directly to the bunker is estimated as 9.5 MJ/kg, that of the shredded bulky waste as 14.5 MJ/kg. The NCV of the shredded waste is less than 14.5 MJ/kg when it reaches the bunker since it is stored outside where it absorbs rain water.

10) The most common and vehement complaint from members of the public was that the various waste disposal facilities were not concentrated on one site. Travelling between La Collette, Bellozanne and the scrap yard "adds hours to your day".

3 RECOMMENDATIONS

It is suggested that:

1) The information gathered during this survey is used for the design of the new EfW plant's bulky waste reception and the proposed Community Amenity (CA) site;
2) The steam flow data from the current EfW Plant, along with the weighbridge data pertaining to all waste entering the bunker and an estimate of the mass of waste in the bunker at the start of each week be copied to Fichtner on a monthly basis. This is to enable Fichtner to estimate the NCV of the waste throughout a longer period to provide a sound basis for the design of the new Plant;
3) Electrical goods are removed from the Directly Delivered Waste stream. This could be achieved by the provision of designated "electronic goods" skips. More problematic than separation is disposal which would almost certainly require shipment to specialist disposal facilities in the UK or mainland Europe;
4) Barnes Publishing is investigated to see whether or not it is disposing of the quantities of paper that the survey suggests, and if so, this paper be diverted for recycling;
5) Options for the reuse of the good wood be considered. There is the possibility that it could be recycled along with the pallets and it may be worth investigating outlets on the Island for the larger more valuable pieces;
6) Whilst tyres and carpets represent homogenous waste streams which would be easy to separate, it is not suggested that this is done. The recovery of energy currently represents the most practical solution to their disposal. If in the future viable outlets arise, then the issue of their disposal should be revisited.

4 DISCUSSION

4.1 Waste Streams

The waste delivered to the Bellozanne site can be divided into several categories:

1) "Parish deliveries" which are tipped directly into the Bunker of the EfW Plant. These consist of household waste and commercial waste from hotels and shops. The EfW plant operators have long term operating experience with this material, and on occasions RCV contents are checked by tipping the waste directly on the tipping floor. The characteristics of the Parish Waste are similar to household waste in the UK, allowing for the fact the large majority of green waste and much of the glass has been removed.. These deliveries have not been investigated further in the current study beyond noting the tonnage delivered;
2) "Directly Delivered Waste", this refers to all other solid waste delivered to the site both by business and members of the public and is the subject of the investigation. This category is subdivided into:
   - "Bulky waste" delivered to the pre-treatment area. The majority of it is shredded prior to being transported to the bunker of the EfW Plant, this is referred to as "shredded waste". Designated skips are provided for cardboard which is sent for recycling and small metal items which are sent for scrap. Bins are also provided for recycling magazines/newspapers and glass. At the weekend when the EfW Plant tipping hall, La Collette reclamation site and scrap yard are closed, provision is made for the collection of bags of household waste, small quantities of rubble and large metal items such as fridges and cookers;
   - Waste delivered directly to the EfW Plant bunker. Deliveries which include household and other putrescible waste which does not require shredding, as well as mineral wool and large quantities of sawdust are directed to the EfW bunker.

4.2 Methodology

The Directly Delivered Waste was categorised by visually inspecting the loads as they were dumped. The volume of each fraction was estimated and recorded on a sheet along with the vehicle type and its registration number. The opportunity was taken to ask the driver whether or not their load was commercial or domestic in origin. The category commercial refers to all waste that has arisen in the course of business and is not limited to deliveries by waste disposal companies. The mass of each vehicle was recorded at the weighbridge as it entered and left the site and the difference calculated to give the mass of the load deposited. A representative density of each recorded category of waste has been determined (see Appendix B) and used in conjunction with the composition by volume and mass of each load to give the approximate composition by mass.

During Saturday afternoons and Sundays the weighbridge is closed. Over the weekend of the 18th and 19th March the weighbridge was kept open and all vehicles were weighed in. The average mass of domestic loads delivered over this weekend has been used to calculate the composition by mass of the deliveries surveyed on the afternoon of Saturday 1st April and all of Sunday 2nd April.

4.3 Results

Between Monday 27th March and Monday 10th April 2006, 857 tonnes of bulky waste was delivered to the pre-treatment site. This suggests a monthly arising of approximately 1700 tonnes which is very similar to the arising at the same time in 2004. It is evident from fig. 1 below that there are two peaks in bulky waste arisings, one in spring and another in summer. Whilst this survey was undertaken in spring and therefore probably during a peak, the variation in incoming bulky waste is not great and there is no reason to believe that the waste sampled is unrepresentative.

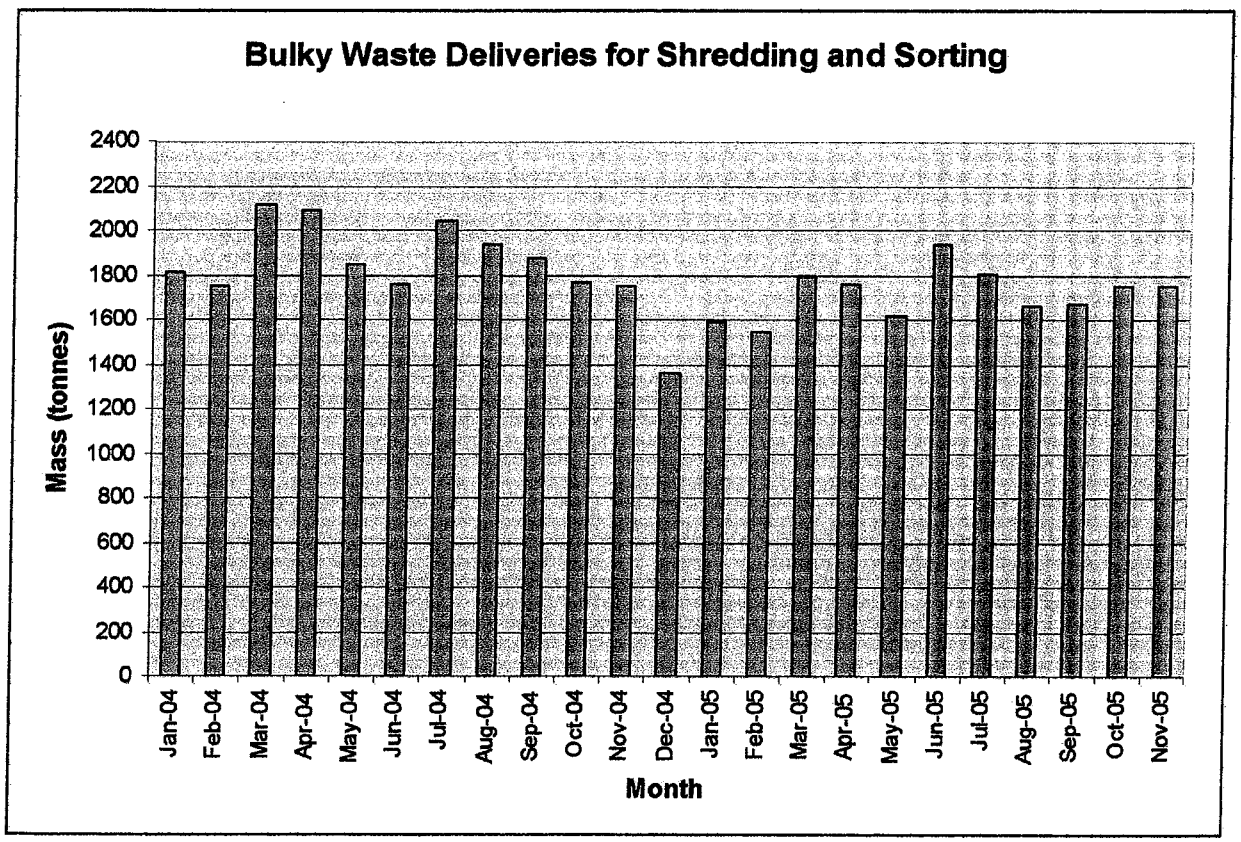

Figure 1: Historical bulky waste arisings.

During the same period, 273 tonnes of waste, excluding Parish Waste, was delivered straight to the bunker.

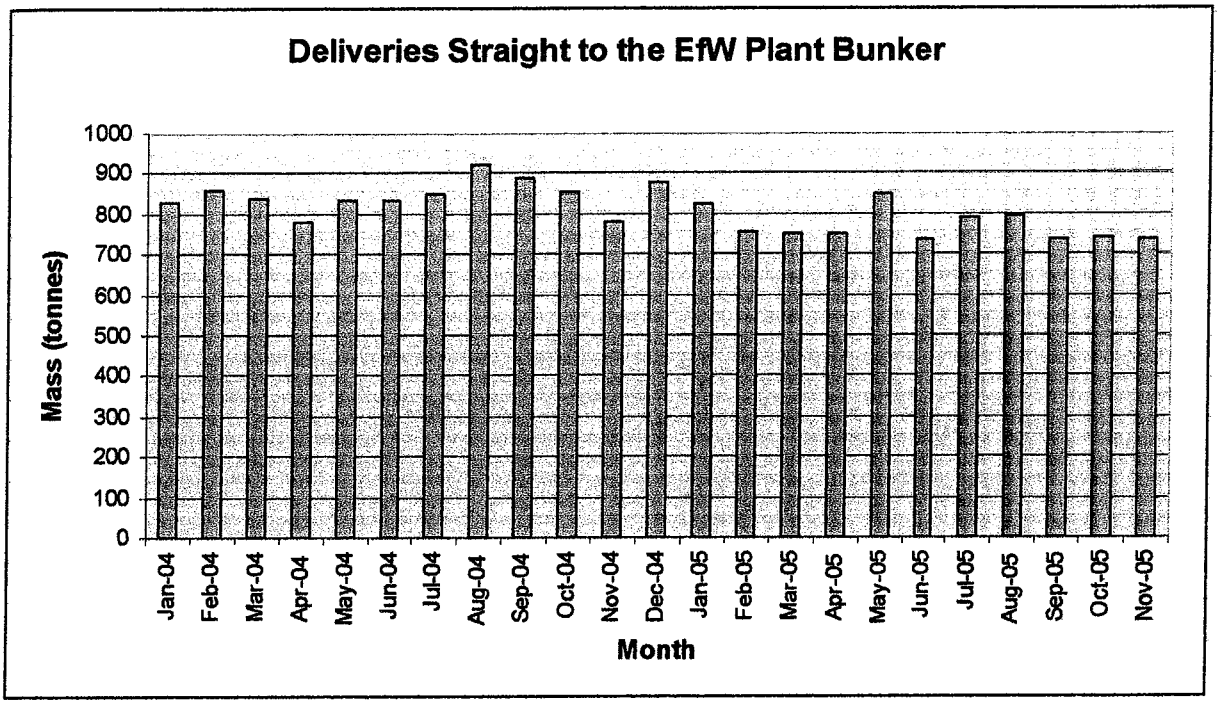

Figure 2: Historical arisings of waste delivered straight to the EfW Plant bunker.

A summary of the results from the survey of the bulky waste delivered to the pre-treatment site is tabulated below.

Bulky Waste Delivered to the Pre-Treatment Site												
Date	**28.03 (afternoon)**	**29.03**	**30.03**	**31.03**	**01.04**	**02.04**	**03.04**	**04.04**	**05.04**	**06.04**	**07.04**	**08.04 (morning)**
No. Vehicles Surveyed	120	282	278	216	426	365	342	339	313	276	301	282
Mass of Waste Surveyed (tonnes)	27	71	66	51	45	22	69	72	70	57	72	42
Mass of Waste Surveyed (% of total)	-	86	83	78	-	-	89	82	93	85	93	-
Type of Vehicle (% of deliveries)												
Skip	-	-	-	7	2	0	4	5	10	7	6	6
Large Van	-	-	-	42	21	10	38	25	29	32	27	14
Small Van	-	-	-	30	15	17	24	36	20	22	30	23
Tipper	-	-	-	-	7	1	10	15	24	22	22	14
Car	-	-	-	20	55	72	23	19	17	16	15	43
Source of Waste (% of deliveries)												
Commercial (%)	-	70	70	66	18	0	68	67	75	73	80	65
Domestic (%)	-	30	30	34	82	100	32	33	25	27	20	35
Material (kg)												
Good Wood	3354	6674	3068	179	3014	877	3911	3036	3423	1288	2235	558
Bad Wood	11885	31627	36791	26338	14289	4748	22517	36581	34356	18685	36975	22034
MDF	2635	393	0	0	0	214	968	180	45	11	188	0
Plaster Board	0	926	43	417	19	57	167	834	138	198	474	301
Ceiling tiles	0	2760	2308	1501	1263	118	242	253	1538	168	2991	0
Newspapers/magazines	0	199	21	40	514	257	836	228	199	398	861	931
Recycled	0	0	0	0	121	146	0	5	0	52	4	50

Bulky Waste Delivered to the Pre-Treatment Site												
Date	**28.03 (afternoon)**	**29.03**	**30.03**	**31.03**	**01.04**	**02.04**	**03.04**	**04.04**	**05.04**	**06.04**	**07.04**	**08.04 (morning)**
Newspapers/magazines												
Other Paper	1105	2992	1418	436	803	285	896	2514	2052	1601	1298	557
Cardboard	196	803	705	693	938	1276	2420	444	752	1116	276	227
Recycled Cardboard	108	584	780	451	569	834	3309	1048	859	4233	733	549
Plastic Film	553	480	439	901	223	130	528	945	853	771	907	54
Expanded Polystyrene	83	410	508	647	440	270	551	416	588	726	724	85
Plastic Foam	196	99	604	183	278	148	109	116	218	190	42	294
Plastic Insulation	63	164	740	252	143	20	209	36	732	83	274	94
Other Plastic	942	5411	4966	7548	4443	2331	8871	3609	7667	7075	4277	4550
Tyres	768	2270	1434	997	942	38	940	1820	1669	541	2000	310
Roofing Felt	381	1717	630	1735	4	60	1895	3036	1734	419	2812	106
Carpet	2352	6748	3539	3103	2073	936	4713	5538	4369	3108	3731	2630
Mineral Insulation	53	146	118	0	53	76	26	105	34	186	400	115
Textiles	162	921	404	808	673	283	1008	562	203	1145	2318	458
Upholstered Furniture	288	580	2034	820	2283	477	1847	1561	1261	3810	1430	1265
Ceramics	12	41	163	41	477	219	310	63	0	400	42	545
Ceramics to La Collette	0	0	0	0	31	48	0	0	0	0	0	0
Mattresses	1	216	430	288	749	289	1032	298	272	938	197	245
Food Waste	0	0	0	0	0	0	0	80	0	0	0	21
Glass	42	15	55	21	604	201	30	152	144	549	30	332
Recycled Glass	32	243	35	53	567	972	274	6	35	393	110	393
Metal	210	894	1007	3087	4597	1212	794	2361	1569	2601	1023	1218
Recycled Metal	179	1263	1138	99	2017	2855	7992	3197	3080	3902	2563	2412
Paint tins	0	0	29	30	173	162	165	100	117	201	93	106
Recycled Paint tins	0	8	90	27	19	63	221	88	0	18	209	128
Water	332	653	1944	0	407	0	545	420	1140	961	1302	0
Cement	49	0	0	0	92	0	0	0	0	0	152	0
Household	15	575	20	29	346	848	0	50	746	244	82	203
Green Waste	0	5	20	14	63	162	15	1411	136	71	62	8
Fibreglass	0	237	60	148	0	13	66	26	0	90	60	0
Sand	0	25	0	0	0	39	0	435	0	245	0	0
Oil	0	175	49	0	0	25	0	0	0	0	0	0
Cork	0	0	156	0	0	0	0	0	0	0	0	0
Rubble	0	0	0	0	51	162	0	0	0	0	0	307
Rubble to La Collette	0	0	0	0	118	136	0	0	0	0	0	0
Electrical	644	648	743	584	1610	791	1321	844	423	449	926	854

A summary of the results from the survey of the waste delivered directly to the bunker is tabulated below.

Waste Delivered Directly to the Bunker		
Date	**29.03**	**31.03**
No. Vehicles Surveyed	17	39
Mass of Waste Surveyed (tonnes)	5	8

Mass of Waste Surveyed (% of total)	-	-
Type of Vehicle (% of deliveries)		
Skip	-	7
Large Van	-	61
Small Van	-	20
Tipper	-	-
Car	-	12
Source of Waste (% of deliveries)		
Commercial (%)	95	93
Domestic (%)	5	7
Material (kg)		
Bad Wood	230	5
Newspapers/Magazines	760	122
Other Paper	50	372
Cardboard	140	759
Plastic Film	49	16
Expanded Polystyrene	0	6
Plastic Foam	0	4
Plastic Insulation	34	0
Other Plastic	0	627
Mineral Insulation	86	130
Ceramics	977	0
Food waste	140	46
Metal	0	108
Water	284	0
Household	1087	4848
Foliage	20	0
Ash	1503	0
Street Sweepings	0	1120
Soot	0	0
Electrical	0	37

4.3.1 Deliveries

The hourly number of all vehicles containing solid waste entering the Bellozanne site during the two weeks is shown in fig. 3 below. (This includes Parish RCVs).

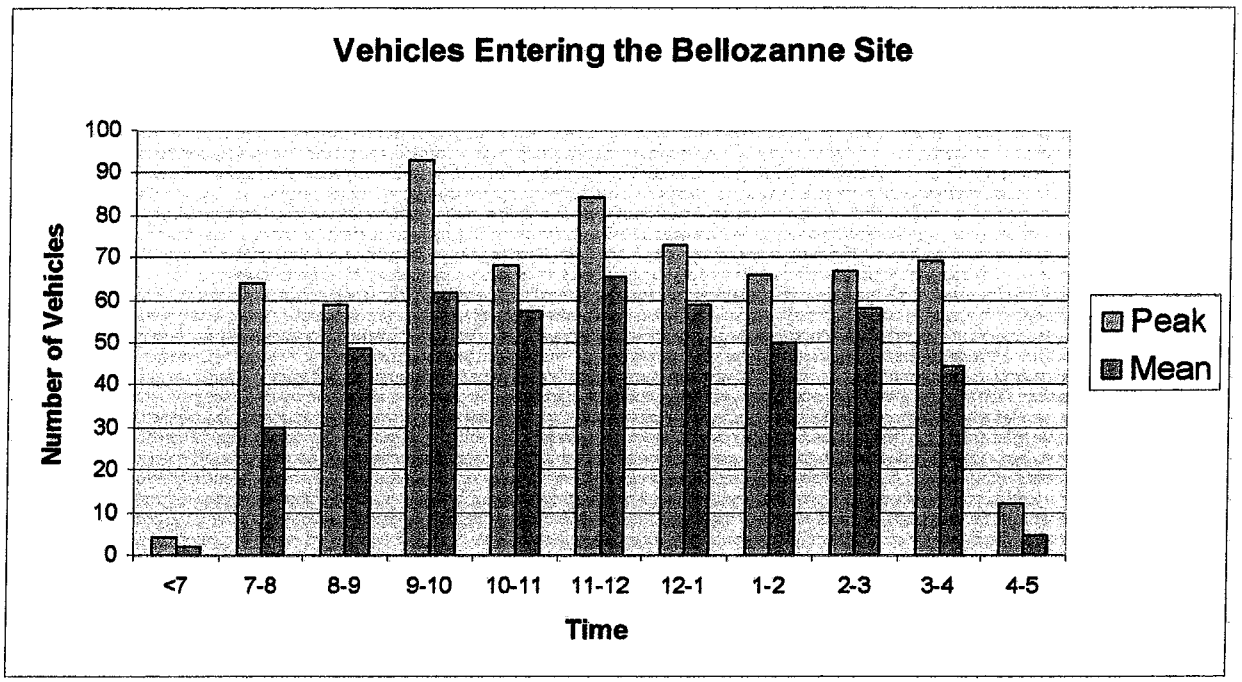

Figure 3: Site arrivals

Approximately 74 % of these went to the pre-treatment site, 22 % to the bunker (of which 9 % were Parish deliveries) and 4 % went elsewhere. The pre-treatment site and bunker both received peaks in flow just before the mid morning break and lunch. The pre-treatment site also experienced a peak during mid afternoon which was not shared with the bunker as almost all the Parish deliveries cease at lunchtime.

60 % of the vehicles were bringing commercial and 40 % domestic waste. The split between commercial and domestic deliveries at different times during the week is shown in fig. 4 below.

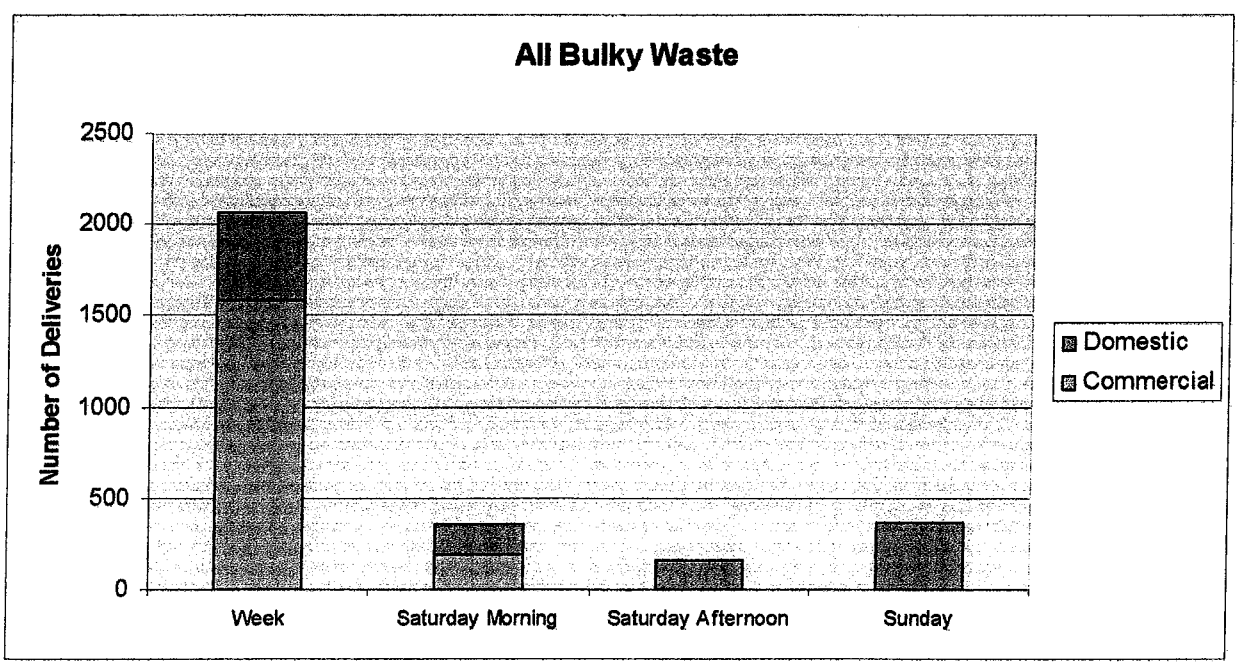

Figure 4: Bulky waste deliveries to Bellozanne.

5 % of the vehicles delivering waste to the pre treatment area were skips, 25 % large vans, 23 % small vans, 12 % tippers and 34 % cars. Fig. 5 details the vehicle split by weight.

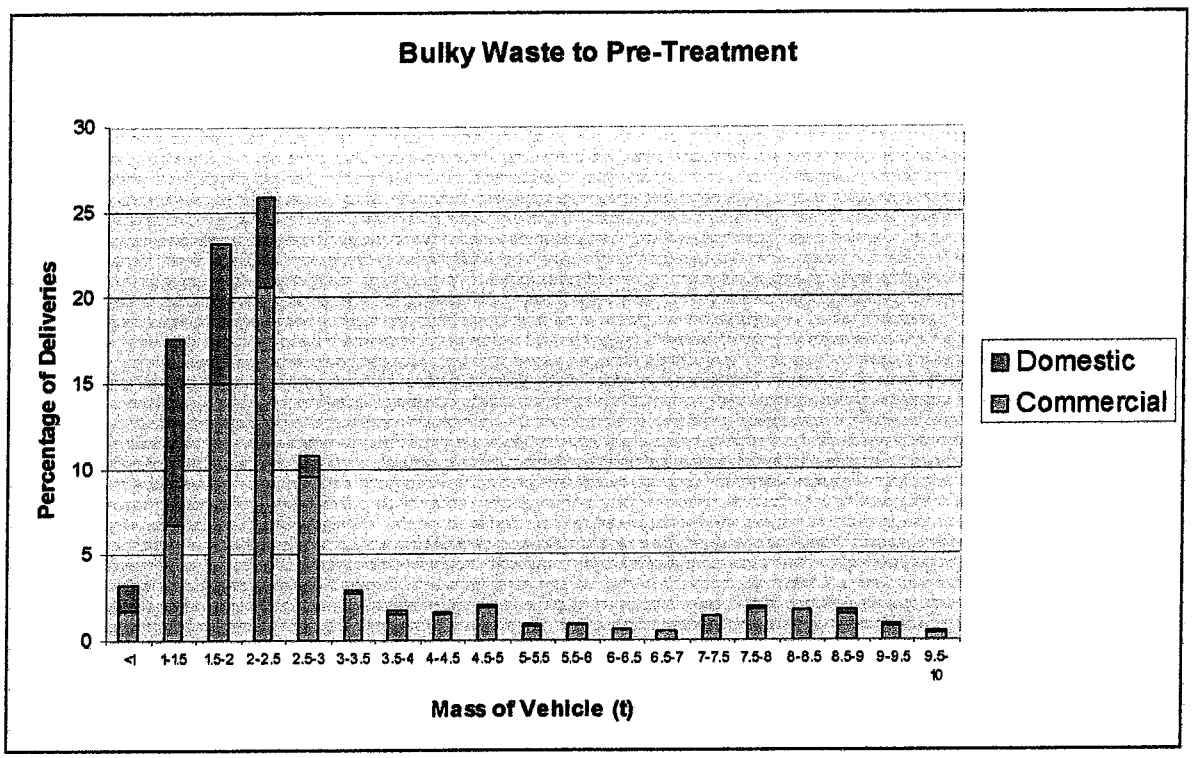

Figure 5: Mass of domestic and commercial vehicles.

It is envisaged that the majority of the bulky waste will be delivered to a site near the tipping apron in the new EfW plant with members of the public using a separate C.A. site located elsewhere. Differentiation between members of the public and business is not straightforward. The terms "Commercial" and "Domestic" are themselves ambiguous. This became apparent during the survey – a builder delivering waste generated whilst working on private properties can describe it either as domestic (in origin) or commercial since it is being delivered by a business. The vehicle itself is not an infallible indicator of the wastes origin - it is common practice for people to use a trademarked company van to clear out their garage at the weekend. It may prove simplest to send vehicles either to the tipping apron or C.A. site depending on the combined mass of vehicle and load. Fig. 6 highlights the consequences of choosing a particular cut-off mass by plotting the percentage, both of number of vehicles and mass of waste, which corresponds to a combined vehicle and load mass greater than that marked on the x-axis. In other words, if it were decided that any delivery weighing in with a combined mass greater than 3 tonnes was to be directed to the bulky waste site, then this site could expect receive 24 % of the vehicles and 62 % of the waste. The remaining 76 % of the vehicles would deliver the remaining 38 % of waste to the C.A. site.

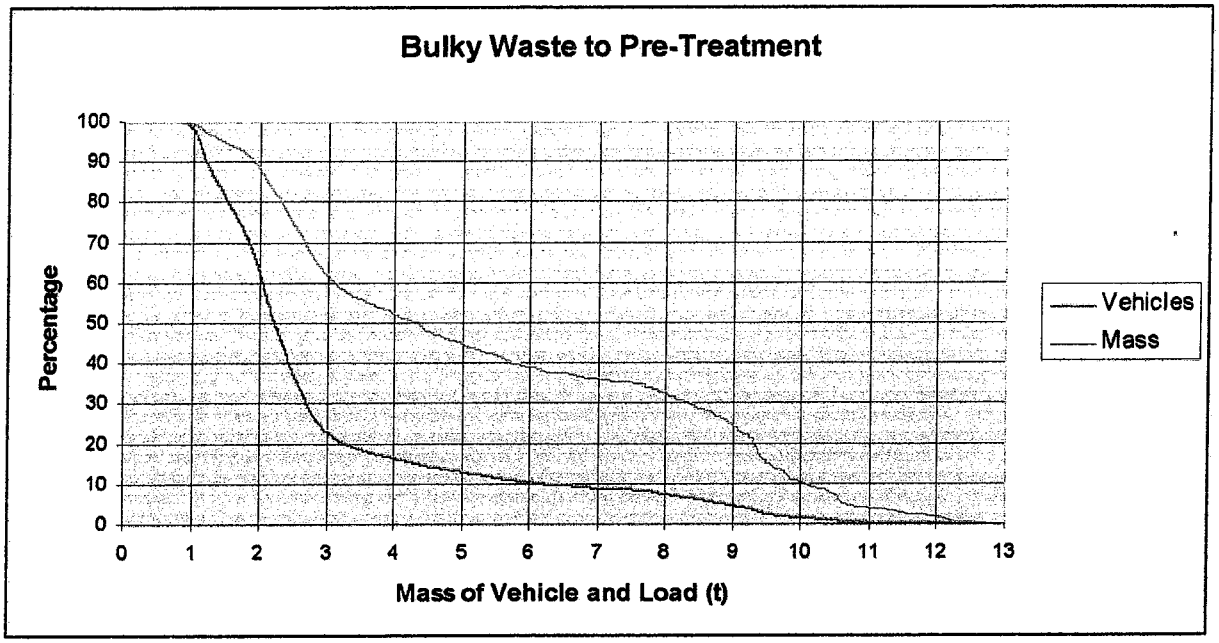

Figure 6: The percentage of vehicles and waste delivered by vehicles that exceed a given weigh-in mass.

Whilst surveying the waste delivered directly to the bunker the opportunity was taken to note how long parish Refuse Collection Vehicles spent in the tipping hall. The average length of time was 3 minutes 50 seconds and the standard deviation in times was 1 minute 10 seconds. This information is useful for the purposes of dimensioning the new EfW reception area.

4.3.2 Waste Streams that Lend Themselves to Separation

On the afternoon of Wednesday 29th and morning of Friday 31st of March a small van belonging to "Barnes Publishing", registration J75508, was observed delivering loads consisting entirely of printed paper into the bunker. On questioning the driver said that he was a regular visitor. The weighbridge data shows that this van delivered 2.27 tonnes of material directly to the bunker during the survey period. If all of this material was paper then it might be worth diverting for recycling – 2.27 tonnes represents approximately 15% of the cardboard sent from Bellozanne for recycling during the same period.

Tyres were often delivered in large homogenous loads. Between them the following companies accounted for over 60% of the tyres delivered (approximately 5 tonnes a week):

- Tyres and Exhausts;
- Channel Island Tyre Company;
- Trinity Tyres;
- Roberts Garages;
- The car breaking yard.

Nearly 30 tonnes a week of carpets were delivered during the survey period and they are another material that was often delivered in large homogenous loads, although their supply is not monopolised by a handful of organisations.

Whilst both tyres and carpets lend themselves to separate collection, there are few markets for them and at present recovering energy is the most practical option. If, in the future, new markets for these materials emerge then Jersey would be in a good position to exploit them.

4.3.3 Electrical Goods

The EfW Plant's bottom ash currently contains an elevated concentration of heavy metals and it is likely that this can be attributed to the incineration of directly delivered electrical goods which is a practice peculiar to Jersey. In the UK, it is normal for CA sites to collect electrical and electronic goods, including fluorescent light bulbs, separately from normal household waste. Removing electrical items from the waste stream prior to incineration would reduce this contamination facilitating the re-use of the ash as aggregate in a similar manner to common European practice.

Items such as fridges, washing machines, toasters, microwaves, electric fires and computers (as opposed to monitors) have not been classed as electrical goods since they were sent to the scrap yard with the other predominantly metal items. On the afternoon of Saturday 8th and throughout Sunday 9th April, 102 incoming electrical items which were mixed with the waste and shredded have been catalogued according to type. The split (by numbers not mass) is shown in fig. 7 below.

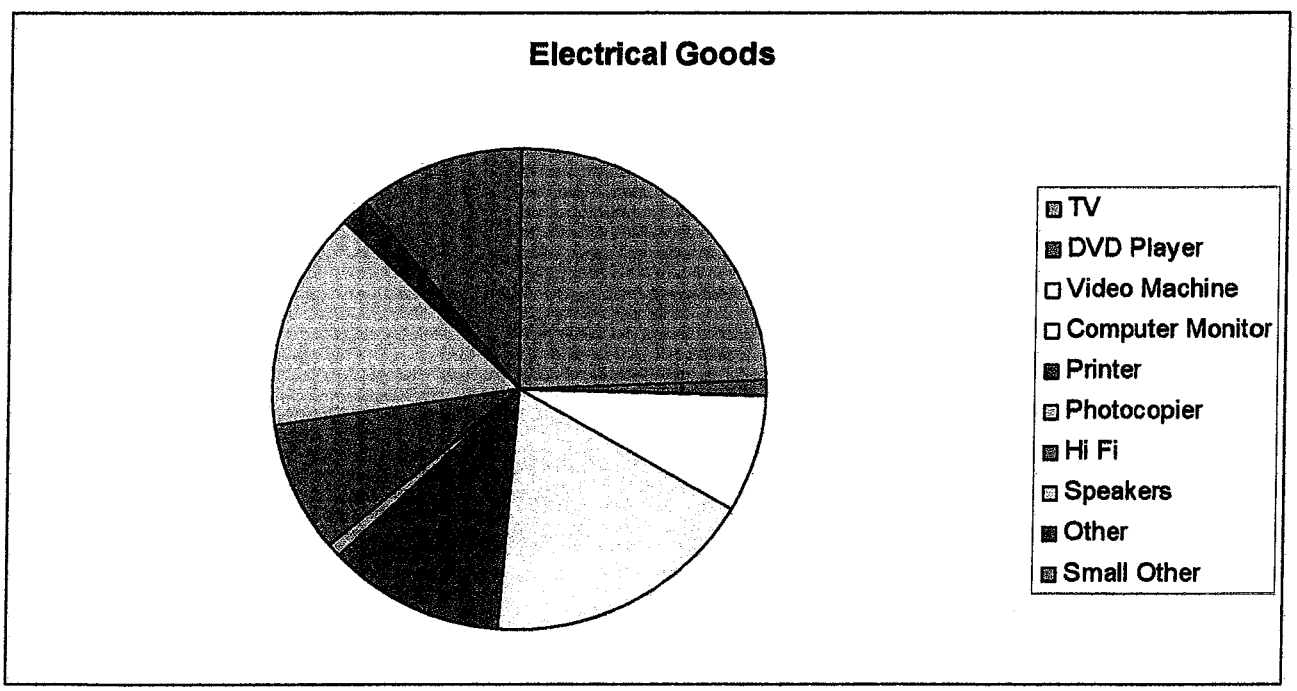

Figure 7: The types of electrical goods.

The mean number of electrical goods delivered per day in the various waste streams is shown below.[1]

[1] The mean number of deliveries to the pre-treatment site at the weekend has been used to calculate the number of electrical goods delivered with the bulky waste during the weekend. It is based both on the survey and data from the 18th and 19th March when vehicles were weighed in throughout the weekend.

Waste Stream	Mean Number of Electrical Goods Delivered Per Day
Bulky Waste During the Week	35
Bulky Waste at the Weekend	69
Straight to Bunker	7 (3 on Saturday morning)

This suggests that if all electrical goods were removed from the Directly Delivered Waste stream, one could expect to collect 350 items per week. The collection of these goods should be relatively straightforward. Cardboard and metal are already collected separately through the provision of designated skips and this survey suggests that in each instance approximately 60 % of the incoming material is captured. It is likely that a higher proportion of the incoming electrical items would be captured. Not only are electrical items discrete but there is a perception that they merit separation. We were often asked where they should be put – there was not an automatic assumption that they would be burnt. More problematic is the disposal of these goods once collected. This would almost certainly entail sending them to specialist facilities either in the UK or mainland Europe. Such disposal facilities should be encouraged by the Waste Electrical and Electronic Equipment (WEEE) Directive (2002/96/EC) (despite the UK's failure to meet the implementation deadline of 13th August 2005). The cost of this disposal should be offset against the re-use of the ash.

4.3.4 Good Wood

During the survey a distinction was drawn between wood which might be recovered (good) with a view to reuse and that which was contaminated, too small or rotten and therefore of no further use (bad). Approximately 10% of the wood delivered to the pre-treatment site was marked as good. This suggests that there is the potential to recover up to 23 tonnes a week of wood. When the new EfW plant is built, the bulky waste reception will be at La Collette where pallets are currently shredded for recovery .It may make sense to shred the good wood and send it for recovery with the pallets. Additionally there may be outlets on the Island for the larger and more valuable pieces. If a system is developed for withdrawing useful items (furniture in good condition, bicycles etc…) from the bulky waste stream and selling them at a nominal price then it might be possible to incorporate a section for the best pieces of timber.

4.3.5 Waste Composition

4.3.5.1 Bulky Waste

The estimated composition of the bulky waste is shown below.

Bulky Waste Composition	
Material	**% by mass**
Good Wood	5.0
Bad Wood	43.6
MDF	0.9
Plaster Board	0.5
Ceiling tiles	1.7
Newspapers/magazines	0.7
Recycled Newspapers/magazines	0.1

Bulky Waste Composition	
Material	**% by mass**
Other Paper	2.4
Cardboard	1.8
Recycled Cardboard	2.4
Plastic Film	1.0
Expanded Polystyrene	0.8
Plastic Foam	0.4
Plastic Insulation	0.4
Other Plastic	9.5
Tyres	2.0
Roofing Felt	2.3
Carpet	6.6
Mineral Insulation	0.2
Textiles	1.3
Upholstered Furniture	2.7
Ceramics	0.4
Ceramics to La Collette	0.0
Mattresses	0.8
Food Waste	0.0
Glass	0.3
Recycled Glass	0.6
Metal	3.1
Recycled Metal	5.5
Paint tins	0.2
Recycled Paint tins	0.2
Cement	0.0
Household	0.4
Household into skip at weekend	0.1
Green Waste	0.3
Fibreglass	0.1
Sand	0.1
Oil	0.0
Cork	0.0
Rubble	0.1
Rubble to La Collette	0.0
Electrical	1.4

4.3.5.2 Directly Delivered Bunker Waste

The sample upon which this composition is based is relatively small and one large delivery of a burnt roof is responsible for all of the bad wood (rafters), ash and ceramics (tiles). Since such deliveries are unlikely to be frequent its contribution has been removed to give the "adjusted composition" which it is felt is more likely to be representative. Both are shown below.

Directly Delivered Bunker Waste Composition	
Material	**% by mass**

	Surveyed Composition	Adjusted Composition
Bad Wood	1.7	0.0
Newspapers/Magazines	6.5	8.1
Other Paper	3.1	3.9
Cardboard	6.7	8.1
Plastic Film	0.5	0.6
Expanded Polystyrene	0.1	0.1
Plastic Foam	0.0	0.0
Plastic Insulation	0.3	0.3
Other Plastic	4.9	5.8
Mineral Insulation	1.6	2.0
Ceramics	7.2	0.0
Food waste	1.1	1.7
Metal	0.8	1.0
Water	2.1	2.6
Household	43.8	54.7
Foliage	0.2	0.2
Ash	11.1	0.0
Street Sweepings	8.3	10.3
Soot	0.0	0.0
Electrical	0.3	0.3

4.3.6 Calorific Value

The NCVs of the individual materials (based in the main on values from UK waste analyses, see appendix B for values) and the fraction of each material detailed in the above compositions have been multiplied together to give the overall NCV for the different waste streams.

4.3.6.1 Bulky Waste

Materials that are recycled or sent to La Collette have not been included when estimating the calorific value of the shredded waste. The NCV of the shredded waste has been estimated as14.5 MJ/kg. Since the bulky waste is not delivered directly to the bunker, there is the opportunity for the evaporation or more usually addition of water.. A water spray is employed by the shredder to reduce dust and once shredded the waste is stored outside in piles where it absorbs rainwater. This additional water means that when burnt, the shredded waste has an NCV less than that estimated from the composition, its effect is shown in fig. 8 below.

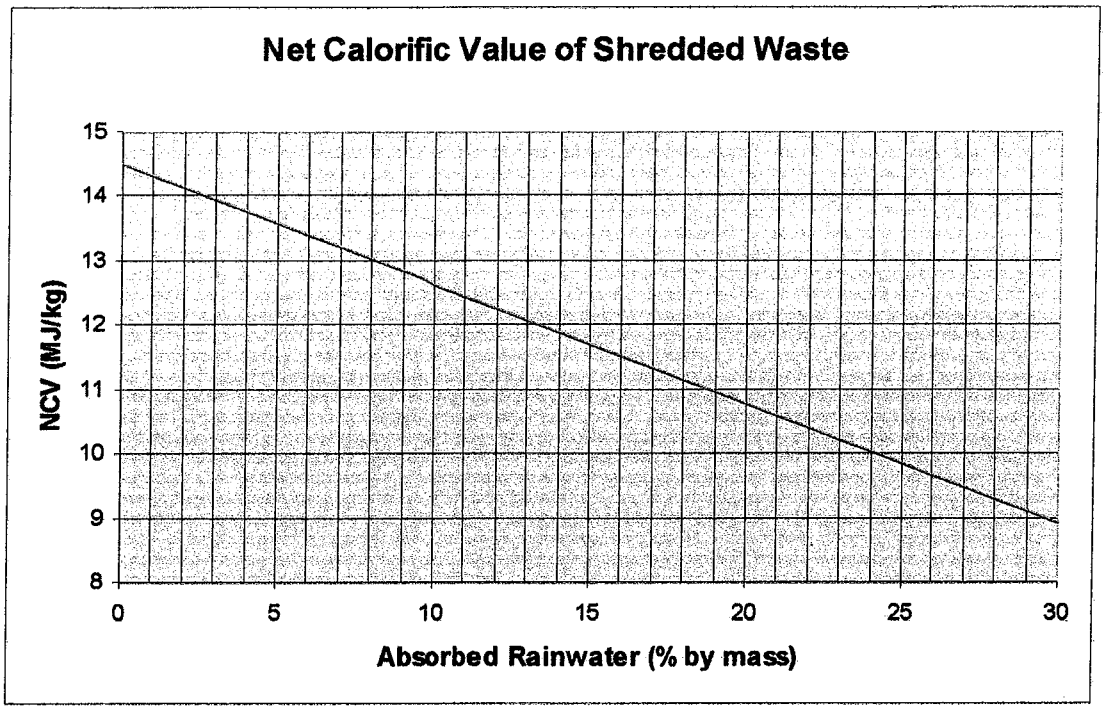

Figure 8: The effect of additional water on the NCV of the shredded waste.

4.3.6.2 Directly Delivered Bunker Waste

Using the composition estimated from the survey the NCV of this waste is 7.7 MJ/kg. This low NCV can be explained by the delivery of the burnt roof with its large mass of inert ceramic tiles and ash. Using the adjusted composition gives an NCV of 9.5 MJ/kg.

4.4 NCV of Total Waste

Over the survey period the average NCV of all the waste has been calculated from an energy balance (similar to that used in BS 845 or DIN 1942).

$$\dot{Q}_{in} = \dot{Q}_{steam} + \dot{Q}_{FG} + \dot{Q}_{ash} + \dot{Q}_{unburnt} + \dot{Q}_{R\&C} + \dot{Q}_{BD}$$

Where:

$\dot{Q}_{in}$ $= (\dot{m}_{waste} \times NCV_{waste}) + \dot{Q}_{air}$

$\dot{Q}_{steam}$ $= \dot{m}_{steam} \times (h_{steam} - h_{feed\ water})$

$\dot{Q}_{FG}$ $= \dot{m}_{FG}\ (T_{FG} - T_{ref}) \times Cp_{FG}$

$\dot{Q}_{ash}$ $= \dot{m}_{ash}\ (T_{ash} - T_{ref}) \times Cp_{ash}$

$\dot{Q}_{unburnt}$ $= \dot{m}_{unburnt} \times NCV_{carbon}$

$\dot{Q}_{R\&C}$ = 0.005 x $\dot{Q}_{steam}$ (assumed)

$\dot{Q}_{BD}$ = 0.025 x $\dot{m}_{steam}$ x $h_{drum\ water}$

The period 0800 27.03.2006 – 0800 09.04.2006 has been used to estimate the NCV of the total waste. During this period 1,663 tonnes of Parish waste, 977 tonnes of shredded waste, 273 tonnes of bunker waste, 12 tonnes of rags and 7 tonnes of grit were delivered to the bunker. It was estimated that there was 300 tonnes in the bunker at the start and 200 at the finish of this period giving a waste mass flow rate of 9,020 kg/hr.

During this period only boilers 1 and 2 were operating. The total average steam flow has been calculated from the plant log. The estimated temperature and pressure of the feed water, steam and in the boiler drum have been used in the calculation, as has the amount of blow down water and the flue gas temperature.

Further assumptions:

- Ambient air temperature was 10°C during the relevant period. Since the combustion air was not heated and 10°C has been adopted as the reference temperature, $\dot{Q}_{air}$ = 0;
- 3 % of the ash is unburned carbon;
- Cp_{FG} is1.15 kJ/kgK;
- Cp_{ash} is 1.1 kJ/kgK;
- The ash content of the waste has been calculated from the mass of waste burnt and ash produced;
- The ash is weighed on route to landfill after it has been stored outside for a period. Its water content is therefore a function of the water with which it left the EfW plant, evaporation and rain. It has been assumed that this is 20% by mass;

The input parameters and the sensitivity of the NCV to the assumptions are detailed below.

Parameter	Value – Averaged Over the Period	Effect on the NCV of the Waste of Increasing Parameter by 5% (%)
$\dot{m}_{waste}$	9020 kg/hr	**- 3.89**
$\dot{m}_{steam}$	26050 kg/hr	**+ 4.17**
T_{steam}	390 °C	**+ 1.40**
P_{steam}	40 bara	**- 0.12**
Excess O_2 (wet)	10 %	**+ 0.053**
T_{FG}	230 °C	**+ 0.76**
Cp_{FG}	1.15 kJ/kg	**+ 0.76**
$T_{feed\ water}$	125 °C	**- 0.81**
$P_{feed\ water}$	43 bara	**0.00**

$\dot{m}_{BD}$	650 kg/hr	**+ 0.042**
P_{drum}	41 bara	**+ 0.011**
Water content of ash when weighed	20%	**- 0.074**
T_{ash}	500 °C	**+ 0.042**
Cp_{ash}	1.1 kJ/kg	**+ 0.042**
$\dot{Q}_{R\&C}$	96 kW	**+0.021**

Based on the assumptions detailed above

- the overall NCV of the waste that was burnt during the two week period in question was 9.4 MJ/kg. The accuracy of this assessment is likely to be within ±10%.

As the NCV of the waste is very important in the design of the new plant, it is recommended that this method of evaluation is repeated over the next few months to build up a historical record of the energy content of the waste, thereby allowing the plant design to be specified accurately.

It is possible to estimate the NCV of the various streams:

- The combined NCV of all waste incinerated was 9.4 MJ/kg;
- The NCV of the Parish Waste is estimated as 9 MJ/kg from the waste composition, taking into account the current recycling on the Island;

This gives an estimated NCV for the combined Directly Delivered Waste of 10.1 MJ/kg. Given that the estimated NCV of the waste delivered to the bunker is 9.5 MJ/kg (see section 4.3.6.2) the shredded waste would have an NCV of 10.3 MJ/kg;

This suggests that when the shredded waste was delivered to the bunker, it had absorbed 22 % of additional water.

In order to verify the energy content of the residual waste over a longer period, it is recommended to repeat the above calculation. At intervals throughout the time period the moisture content of the shredded waste should be investigated. By carrying out such an exercise on a regular basis, the NCV of the waste can be estimated throughout the year. It is suggested that the steam flow data from the incinerator, along with the weighbridge weight data for all waste entering the bunker and an estimate of the mass of waste in the bunker at the start of each week be copied to Fichtner on a monthly basis.

4.5 Comments From the Public

The most common and vehement complaint was that the various waste disposal facilities were not concentrated on one site. Travelling between La Collette, Bellozanne and the scrap yard "adds hours to your day".

Perhaps the next most common complaint came from people bringing large loads of glass for recycling who objected to having to post the bottles into the bottle bank one at a time.

There was widespread support for more recycling in general and in particular for a mechanism whereby useful items that had been discarded could be set to one side for reuse.

Another sentiment people expressed was that their taxes were being squandered. The increase in the projected cost of the new EfW plant was often cited as an example.

4.6 Observations

The pre-treatment site is small and this lack of space results in a poor layout which often leads to people dodging vehicles in order to reach the cardboard and metal skips.

It is not immediately clear to a newcomer to the pre-treatment site what to put where. Whilst the staff are universally helpful, often the first contact a member of the public has with them is when they are told not to put something somewhere. Most of the public, and especially those who do not often visit the site and are therefore likely to put things in the wrong place, are keen to do the right thing and this negative experience of being corrected is unfortunate. Probably the best solution is very large signs. During the survey period, larger and clearer signs were erected which will be a help.

Many visitors are unclear as to the logic behind the separation of the waste. Some do not even know that the flammable portion is incinerated. Perhaps information signs explaining what happens to the different streams would be appreciated. The area by the recycling bins might be a suitable place for such signs.

We were often asked the opening times both to Bellozanne and the other waste disposal sites. It might help to display these prominently along with maps marking where the other waste disposal sites are – on being told that they could not dump something at the pre-treatment site some people did not know how to find the relevant waste disposal site.

Appendix A Survey Data

The deliveries of bulky waste recorded at the pre-treatment site between midday on Tuesday 28th March and midday on Saturday 8th April 2006 are detailed below. Following this, the direct deliveries of waste to the EfW Plant bunker recorded in the tipping hall on the afternoon of Wednesday 29th and morning of Friday 31st March are detailed.

On some occasions the number of electrical goods delivered, on some occasions the estimated proportion of the load occupied by electrical goods and on some occasions both was noted. Where only one item of information was recorded the other has subsequently been estimated and is shown below in blue. When it is the proportion of the load that has been subsequently estimated its effect on the other proportions is also shown in blue.

Each entry consists of

1) the site, "PT" = Pre-Treatment and "TH" = Tipping Hall;
2) the surveyor, "m" = Michael Harding and "t" = Thomas Ehrman;
3) the number plate;
4) the category, "C" = Commercial and "D" = Domestic;
5) the type of vehicle, "C" = Car, "LV" = Large Van, "SV" = Small Van, "T" = Tipper and "S" = Skip;
6) the mass of the vehicle;
7) the mass of the load;
8) and the percentage by volume of the load that falls into each material category.

Appendix B Density and Calorific Value of Material Categories

Material Category	Density (kg/m^3)	NCV (MJ/kg)
Timber		
Good	206	
Good Tight	322	
Good Loose	180	10.0
Bad	230	
Bad Tight	322	
Bad Loose	180	
MDF	280	
MDF Tight	440	15.0
MDF Loose	240	
Plaster Board	400	0.0
Ceiling Tiles	219	2.0
Paper/Card	58	10.7
Newspapers/magazines	138	10.9
Newspapers/Magazines Recycled	138	
Other Paper	38	9.9
Cardboard	56	
Cardboard Recycled	56	
Cardboard Tight	86	11.6
Recycled Cardboard Tight	86	
Cardboard Loose	47	
Recycled Cardboard Loose	47	
Plastic	134	31.2
Film	4	23.0
Dense Plastic	183	
Dense Plastic Tight	229	32.0
Dense Plastic Loose	151	
Plastic containers	84	
Expanded Polystyrene	24	35.0
Foam	26	25.6
Plastic Insulation	33	
Tyres	759	28.0
Roofing Felt	302	25.0
Carpet	191	30.0
Mineral Insulation	24	0.0
Textiles	69	14.7
Upholstered Furniture	277	11.4
Ceramics	390	0.0
Ceramics to La Collette	390	
Mattresses	58	8.4
Food Waste	300	3.7
Glass	164	0.0
Recycled Glass	164	
Metal	614	0.0
Metal to Scrap	614	
Paint tins	114	6.0
Paint tins to Scrap	114	
Water	1000	0.0
Cement	3000	0.0
Household	125	9.0
Green Waste	13	
Woody	20	4.9
Foliage	5	
Recycled Car Battery	1800	N/A
Fibreglass	140	21.0
Sand	1600	0.0
Oil	800	43.0
Cork	160	10.0
Rubble	1500	0.0
Rubble to La Collette	1500	
Hay	15	10.0
Straw	15	
Electrical	350	10.0
Ash	1000	0
Soot	500	25

- The density and NCV of the categories "Paper/Card" and "Plastic" has been estimated using a weighted average of their constituent categories.
- A mattress was broken down into its constituent parts and found to contain 43 % metal and 57 % textile/padding by mass.
- Several items of upholstered furniture were broken down and found, on average, to contain 58 % wood, 16 % metal, 17 % foam and 9 % textile by mass.
- It has been assumed that paint tins consisted of 70 % metal and 30 % paint by mass.
- Approximately 20 % of the material marked as carpet was underlay. Carpets consist of fibres and a polymer based backing, approximately 70 % carpet fibres are synthetic, for this reason a high NCV has been assumed.