REVIEW

OF

**ALTERNATIVE WASTE STRATEGIES
AND TECHNOLOGIES**

PREPARED FOR THE

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OF THE

**SHADOW SCRUTINY PANEL INQUIRY
ON THE
WASTE MANAGEMENT STRATEGY**

FOR THE

BAILIWICK OF JERSEY

28TH MAY 2004

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1. REVIEW OF THE CURRENT POSITION

1.1 Clearly the existing incinerator has come close to the end of its commercially viable life. In current environmental compliance terms it cannot be compliant to most if not all EU legislations and directives nor the WID (Waste Incineration Directive) minimum operating guidelines. The dilemma facing Jersey is what to replace it with and if so how to manage replacement and not create difficulties in maintaining a disposal process during the build and commissioning phase of any replacement. This is further complicated by the limited space and availability of land to site the replacement plant.

1.2 87,500 tonnes of MSW is produced in Jersey. In addition, agriculture accounted for 13,000 tonnes, of which 1,000 tonnes was plastics and the balance green waste that was composted at Crabbé, along with a further 12,000 tonnes of green waste made up of grass cuttings, hedge-trimmings and the like generated twice yearly under the Island's compulsory branchage or hedge-trimming scheme which amount to a further 25,000 tonnes. The first three principal waste streams were domestic amounting to 33,000 tonnes, commercial 29,100 tonnes and inert industrial at 25,400 tonnes. The fourth and biggest waste stream arose from industrial, construction and demolition activities; and this amounted to 315,000 tonnes, aggregating to 427,500 tonnes per annum, to which should be added around 250 tonnes of clinical waste and more than 2,000 tonnes of seaweed and beach and street sweepings which were dumped at La Crête Quarry, making a grand total of 429,750 tonnes per annum.

1.3 The breakdown of the 20 principal components in percentage terms in a typical sampling within Jersey indicated the following waste profile:

Newsprint	5.0	Glass Bottles	2.5	Other Glass	1.0
Aluminium Cans	1.8	Other Aluminium	0.4	Metal Cans	2.0
Plastic Bottles	2.9	Other Plastic	7.6	Wood	7.3
Brick, Rubble	3.7	Ferrous Metal	2.0	Non ferrous	0.7
Corrugated Paper	11.7	Office Paper	1.8	Other Paper	3.5
Textiles	5.3	Food waste	33.5	Garden waste	4.5
Misc. Organics	5.5	Misc. Other	2.4		

1.4 The present waste disposal practices do not recycle very much waste and what they do recover for reuse or sale is of poor quality and thus limited revenue value. We will look at the various recyclables:

1.4.1 **Green Waste**: This is disposed of at Crabbé and there are quality control and odour issues that are difficult to address within the limited budget available. Waste potatoes are still dumped at this facility and are as much as two feet deep. As potatoes rot down so the leachate position is highly toxic and potentially harmful to groundwater and the environment. Recent press reports of potatoes layered 18 inches deep in storage areas is a recipe for prodigious quantities of leachate. The unfortunate decision to dump waste potatoes at Beauport produced an environmental disaster with leachate running onto the beach and recent estimates indicate that the leachate draining service must continue for another ten years transporting thousands of gallons of water from the contaminated site to Bellozanne for treatment.

1.4.2 **Aluminium:** This is recovered through Can Banks or Igloos that are strategically located throughout the island is sold to a scrap dealer who then arranges to sell off-island. Aluminium that is contained within "black bag" waste is generally lost and agglomerated in the bottom ash of the incinerator. The aluminium that is sold is dirty and retains its lacquered markings and has a value of around £300 per tonne. 50,000 cans are required to make up one tonne. If this material was sanitised and the lacquer removed and the clean material shredded to maximise loading into a standard 20-foot container where 14 tonnes can be loaded. If compacted then only 8 tonnes can be loaded into the same container which impacts on revenue returns. Some non-ferrous metals including aluminium from fragmented cars is recovered and sold in its recovered state to a scrap dealer.

1.4.3 **Steel:** None of the steel containers contained within the "black bag" waste is recovered. All is retained within the bottom ash and is agglomerated and stored at La Collette. Approximately 9,000 tonnes of ferrous metals are recovered from fragmentised end-of-life vehicles and appliances, which is in compliance with the EU Directive 2000/523/EC on End-of-Life Vehicles ("ELV"). Sale through scrap dealers rather than direct to steel mills does reduce sale proceeds and is practically loss making. If this was finely shredded 24 tonnes could be loaded into a standard twenty-foot container for off-site recovery.

1.4.4 **Plastics**: Some 3,450 tonnes of plastics are contained within "black bag" waste and from fragmentised components of ELVs. All of this material is currently incinerated and it should be remembered that for every 1,000 tonnes of plastics there is a requirement to use 10,500 barrels of oil. This disposal method is therefore causing the loss of 35,700 barrels of oil! The chlorines and heavy metals contained within the plastics (and sometimes their contents which are hazardous chemicals) are released to atmosphere in the fly ash and some is captured in the stack cleaning equipment but very little in real terms. If these plastics were sanitised, recovered, sorted into varietal specie such as PET, HDPE, PVC or whatever and where free from food or beverage deposits, labels and commingling problems of two plastic types welded together (for example the collar that remains after opening a pilfer-proof closure) then this plastic is tantamount to worthless. However, if separated the PET has a market value of £380 per tonne, the HDPE £220 per tonne and represents a valuable resource for use on-island in conversion to viable and regularly used products. Jersey Telecom purchases 8000 metres of plastic electrical conduit. Plastic foul sewer connectors, junction boxes and vents are expensive and could be made using simple injection moulding to make the island self-sufficient in certain products. A roofing tile made from PET and ground glass can last 150 years and be lightweight, attractive and durable.

1.4.5 **Glass:** Most glass is segregated at source and collected by waste collection vehicles once a week and is crushed and stored at La Collette. It has been proven that as an additive to asphalt it can assist in evening out the expansion irregularities in road surfaces and thus extend road surface life by a much as seven years. The inclusion of ground or powdered glass in concrete elements particularly those used in the repair of seawalls will ensure that they are resistant to erosion from the sea or water. Powdered it can also be included in hydraulic concrete or ready-mix concrete; in the same state it can be used to replenish sand loss in beach and coastal areas. Glass can also be added to paint to make it reflective. It does not have a high value and thus needs to be used on-island as it is uneconomical for off-island disposal.

1.4.6 **Ash:** Typically an incinerator produces around 20% to 25% of the gross incinerated waste as bottom ash and this usually depends upon secondary metals recovery. Since this is not practiced in Jersey the ash tends to be at the higher end of the residue scale. La Collette has approximately 8 years of capacity for ash and after that an alternative disposal site will be required. Thus any incineration proposal must examine the location and legally zoned disposal site for ash, which will generate leachate over time and have environmental implications for the surrounding land or sea. Fly ash is around 4% of gross weight and this represents around 3,500 tonnes of highly dangerous and toxic waste that must either be stabilised in bitumen or in concrete. If the latter then mixed on a 5:1 basis this would represent 17,500 tonnes of concrete that has to be used to dispose of this material and is a controlled waste. Normally when mixed with concrete it is disposed of to sanitary landfill. Past practices of commingling bottom and fly ash have caused environmental concerns relating to high toxicity at the Jardin de la Mer that was the previous disposal site. No information is available as to where the fly ash is disposed of now and any future incinerator will generate a higher proportion of highly toxic and hazardous fly ash because of improved stack cleaning methods which produce higher quantities of capture agents that have to be disposed of in a sanitary and controlled waste manner.

1.4.7 **Sewage Sludge and Sewage Screening**: Bellozanne is the principal treatment and disposal site for sewage that is collected initially in the cavern and commingled with storm water. This is then pumped to First Tower and then to Bellozanne where it is treated. The average daily volume of water being discharged to sea is 40,000 cubic metres. A simple bacteriological dosing unit will speed primary settlement and treatment and would involve less than £10,000 a year. The average sludge generation is around 2,600 tonnes a year and this is dried using electrical energy and then incinerated. The costs are high and there is an alternative disposal method that would save money and be environmentally friendly, such as bio-fortification using exothermic reaction to produce an odourless and dry fertiliser that can be manufactured to be bespoke to any vegetable varieties grown on the island. Using proprietary equipment this water can be purified and returned to the island's reservoirs to remove future drought problems and would then be treated again before distribution. To process that quantity of water requires around 2MW of electrical power and some capital equipment that would negate the need to ever run desalination plants again. The raw water feed to the connecting main to all reservoirs is a few hundred yards from Bellozanne.

1.4.8 **Waste Oil:** A simple collection system using wide-mouthed plastic containers could be distributed to every household, garage and workshop. A free collection and container replacement program would immeasurable improve wastewater quality and sewage digestion. The present ultra-violet system is blinded by grease and oil contained within the sewage. As mentioned earlier, grease can be eaten by microbiological treatment in the primary treatment stage. Oil at present is expensively disposed of by shipping off-island. It can be re-refined and/or converted to a fuel for electricity generation.

1.4.9 **Waste Wood:** This is recovered from Construction and Demolition waste generally, although some is generated through tree felling, pruning and branchage. This is currently shredded and shipped off –island to the north of England where it is reused in board manufacture. This is a very expensive procedure and involves a good deal of freight costs and capacity. The same shredded material could be consumed to generate electricity without environmental impact and instead of being a cost centre would represent a valuable fuel.

2.0 COMPOSTING

2.1 There are three types of composting operations widely in use. There is the **windrow compost** or otherwise known as the aerobic method that has been used for treating MSW. This is the method adopted at Crabbé. However, it has been widely found that only 22% of municipal solid waste (MSW) can be composted that leaves 78% that requires disposal, generally this is to a landfill which is not possible in Jersey. A budget cost of a ten acre sanitary landfill, assuming in the unlikely event that a site were available, is £12 million to produce a landfill gas management system and a leachate treatment plant. It is a 50-year legacy of management and EU law now requires a minimum of 50% diversion from landfill of all MSW.

2.2 Another type of composting is known as "**in vessel composting"** something like the Bedminster method which is where MSW is introduced into a closed rotating cylinder and fossil fuel is used to increase internal temperatures to around 110°F and after around seven to ten days the compost has been made but still only 28% of the MSW has been composted requiring a disposal site for 72%. It is expensive because of the fossil fuel element and still does not address the issue of what to do with the 72% residue.

2.3 The third type is **anaerobic digestion** where MSW and green waste including animal manures can be combined in an enclosed environment. Anaerobic processes could either occur naturally or in a controlled environment such as a biogas plant. Organic waste such as livestock manure and various types of bacteria are put in an airtight container called digester so the process could occur. Depending on the waste feedstock and the system design, biogas is typically 55% to 75% pure methane. State-of-the-art systems report producing biogas that is more than 95 percent pure methane. The process of anaerobic digestion consists of three steps. The first step is the decomposition (hydrolysis) of plant or animal matter. This step breaks down the organic material to usable-sized molecules such as sugar. The second step is the conversion of decomposed matter to organic acids. And finally, the acids are converted to methane gas.

2.4 This method could deal with the waste potatoes and agricultural waste of 12,000 tonnes and the other 12,000 tonnes of green waste made up of grass cuttings, hedge-trimmings and the like generated twice yearly under the Island's compulsory branchage or hedge-trimming scheme which amount to a further 25,000 tonnes. Methane would be produced and a lot of compost but sales of compost are limited on-island and competing sources and freight costs would probably make such an operation not commercially viable.

3.0 BIOMASS

3.1 A number of exercises throughout Europe using dendro-thermal plants has not been good. The attempt to use very poor quality land to grow willow is high and now that gasification technologies have been developed some biomass power plants are coming on stream. The cost of maintaining equipment and providing forest management during the long period of forest establishment could not be met in the financial framework that was provided for the projects. The cost of fuel harvesting was also found to be greater than the initial optimistic forecasts made out. Other schemes of growing fuel oils (e.g. jojoba - Australia) have been equally unproductive.

3.2 The second-class fuels that are produced as a processing by-product, offer better economic opportunities. Chipped or shredded timber, sawmill waste are all used as fuels. The manufacturing process leading to their creation produces a concentration of material (that although of relatively low specific energy when compared to oil or coal) is still valuable because of its immediate availability. The draw back with some of these fuels is that they are either produced on a seasonal basis or in insufficient quantities in Jersey.

3.3 To run a power plant using such fuels on a continuous basis, fuel storage would be required. Given their relatively low specific energy and the storage of significant fuel stockpiles to allow for continuous year-round power production would require very large areas. Such fuels when stored can degrade from oxidation originating from bacterial action, can absorb additional moisture and may be liable to spontaneously combust. These fuels are therefore best to be considered as seasonal energy sources.

3.4 True wastes, the third class, include materials that have only marginal fuel value, and may have a negative net usable energy potential. These materials often require a considerable energy input into their collection and pre-processing. Their use as fuels is dependant on other benefits such as environmental hazard reduction being the primary reason for collection and combustion.

3.5 An example of such a waste is sewage sludge. Sludge cake is generally auto thermal at greater than 29% solids. If cake can be produced at over 33% solids, the combustion of the waste can produce heat that is worthwhile recovering. The cost of producing a cake of 33% solids can however be considerable. Both physical (centrifuging and belt presses) and chemical (flocculants and filter aids) processes are needed to produce cake of high solids concentration. This is carried out at Bellozanne but no heat recovery is practiced and thus no co-generation of energy.

3.6 Where anaerobic sludge digestion is used to reduce sludge quantities, gas produced in the process could be available for use in later combustion processes. The gas which would contain between 60 - 65% methane (with the remainder being mostly carbon dioxide and water vapour) can be considered a poor quality but useful fuel.

3.7 Municipal wastes can have significant fuel values. MSW has been measured as having specific energy values of between 9MJ/kg and 14MJ/kg. Very high energy costs can however be incurred in collecting the

MSW, however since it is an environmental and social responsibility that the MSW be collected and disposed of, the cost of collection should not be assigned against the energy available from the material. The cost of specialised sorting and other handling procedures required for MSW combustion (as against sanitary landfill) however should be charged against the energy output

4.0 WASTE - EUROPEAN & UNITED KINGDOM REQUIREMENTS

4.1 The management of waste in Jersey has to be appreciated in the broader context. Worldwide concern regarding the further degradation of the earth's environment has led to recent and pending legislation by both the European Commission (hereafter called EU) and the UK Government aimed at reducing the impact of waste on the environment. In this context, waste can be defined as any substance or object, which a holder discards or intends or is required to discard.

4.2 The sources of waste and their estimated share of the total waste for both the EU as whole (15 countries) and for the UK and Jersey are as follows:

	EU%	**UK%**	**TPA**
Agriculture & Forestry	43	20	80
Mining & Quarrying	16	22	90
Manufacturing Industry	14	15	58
Energy	3	n/a	n/a
Water Purification & Distribution	3	9	35
Construction	12	17	70
Commercial	n/a	6	25
Others	2	4	15
Totals	100	100	400

4.3 We estimate that the total EU tonnage in 1995 was approximately 2,800 million tonnes, which would lead one to see that the UK produces approximately one seventh of the EU total. The main factors which account for the major differences between countries as follows:

4.3.1 *By economic activity* – particularly the two largest sources, Agriculture and Forestry and Mining & Quarrying

4.3.2 *By definition* - for example, only in the UK has the "commercial" definition and "municipal" has a widely different interpretation. This appears to be related to legislated responsibilities of local authorities.

4.3.3 *Reliability of data* – until recently in the UK there has been no requirement to accurately weight waste, or even if this was taking place, there was no requirement for any authority to collect data (especially for activities that involve a large number of small organisations).

4.4 In recent years major changes have arisen concerning waste disposal. The EU Landfill Directive and the UK Government's Waste Strategy 2000 for England and Wales have influenced the changes. Together these policy measures have lead to the imposition of stringent waste targets.

4.5 The EU Landfill Directive

4.5.1 Local authorities to implement a staged reduction in the amount of biodegradable waste allowed to be landfilled.

YEAR	REDUCTIONS IN 1995 LEVELS
2010	25%
2011	50%
2012	65%

4. 6 **Waste Strategy 2000 Targets**

YEAR	RECYCLE & COMPOST % HOUSEHOLD WASTE	RECOVER VALUE OF % MUNICIPAL WASTE
2005	25	40
2010	30	45
2015	33	67

4.7 In addition there are two other major targets:

4.7.1 For Waste Disposal Authorities:

Percentage of Household Waste Recycled and Composted

Actual 1998/99	Targets for 2003
Less than 5%	10%
Between 5% and 15%	Double 1998/99 figure
Above 15%	Minimum of 33%

4.7.2 For Industrial and Commercial Waste sent to Landfill:

- 2005 target 85% of 1998 levels

4.8 There are two other more general aims that need to be considered

4.8.1 **Waste Hierarchy:** Waste management is being directed by the UK Government to adopt a waste hierarchy with its priorities listed as follows:

4.8.1.1 Reduction

4.8.1.2 Re-use

4.8.1.3 Re-cycling and/or composting

4.8.1.4 Recover Energy

4.8.1.5 Disposal

4.8.2 **Proximity Principle:** Waste should generally be disposed of as near to its place of production as possible

4.9 It can be seen that the imposition of stringent waste management targets and methods will severely cut back the UK reliance on landfill for disposal of waste. Unfortunately, the targets use three different measures with a potential for confusion, viz:

4.9.1 Local Authorities biodegradable waste
4.9.2 Household waste
4.9.3 Municipal waste

4.10 It is therefore necessary to understand the relationship between these terms.

4.10.1 **Municipal Waste:** In the UK this covers the waste for which the Local Authorities are responsible for collection and disposal. This is made up of the following waste sources:

4.10.1.1 Household collection
4.10.1.2 Street Litter
4.10.1.3 Council recycling points
4.10.1.4 Municipal parks and gardens
4.10.1.5 Council office waste
4.10.1.6 Civic amenity sites
4.10.1.7 Some commercial (shops and small business where waste is collected by the Local Council).

4.10.2 **Household Waste:** Includes all municipal waste, excluding the inactive element of the Civic Amenity Site (largely building waste) and all commercial waste collected by the Local Authority.

4.10.3 **Bio-degradable Waste:** this is defined in the EU Landfill Directive as waste that is capable of undergoing anaerobic or aerobic decomposition, such as food, garden waste, paper and paperboard. It can exist in any of the major waste sources listed above but primarily in municipal, commercial, agriculture and in sewage sludge. However, EU Landfill Directive only applies to municipal waste. Municipal waste is largely collected from households as mixed waste. Therefore any breakdown of the biodegradable element has only been obtained by analysing a sample number of dustbins or wheelie bins.

4.11 **Growth in Municipal Waste**

4.11.1 To calculate the reduction to be achieved to satisfy the EU Landfill Directive it is necessary to estimate the amount of municipal waste that will be generated in the years 2010, 2013 and 2020. Since nobody appears able to produce a model that identifies the factors that have caused the continual growth of waste, this will be a difficult task.

4.11.2 Also, although the preferred solution would be to reduce the total waste, there is little indication that any of the EU countries have made significant impact on their historic growth in municipal waste. The UK Government's recent prediction is a 3% per annum increase in household waste.

4.12 Industrial and Commercial Waste

4.12.1 Much of the total waste arises from Agriculture, Sewage Sludge, Mining & Quarrying and Demolition and Construction, which are primarily the industries each with one major waste stream that is unlike the mixed nature of municipal waste. They are also industries dominated by large organisations or produce waste that is classified or hazardous. Thus they have developed their own waste disposal methods and often use specialised facilities. Usually they are subject to special legislation.

4.12.2 The problem areas, because they include a very large number of separate organisations and a wide mix of waste types, are the commercial and industrial classified companies. Other than hazardous waste or that which can be directly sold as scrap, the waste they produce has many similarities to the municipal waste for which Local Authorities are responsible. They can therefore use the same or similar waste disposal facilities but on a commercial basis.

4.12.3 In 1999 it is estimated that industrial and commercial waste together account for some 78 million tonnes of waste, more than two and a half time that considered as municipal waste, broken down as follows:

4.12.3.1 By sector:

Industrial		**Commercial**	
Food drink & tobacco	8	Wholesale	4
Textiles, wood, paper	7	Retail	7
Chemicals, rubber mineral	9	Hotels & Catering	4
Metals & metal products	8	Education	2
Other manufacturing	7	Other Business & Public Administration	13
Coke, oil, gas, electricity, water	3		
Transport & storage	4		
TOTAL	48	TOTAL	30

4.12.3.2 By Waste Streams:

Inert, in-house (small scale) construction	2
Paper & Card	7
Food	3
Other general & biodegradable	9
Metals & scrap equipment	6
Contaminated & Health care	5

Mineral waste and residues	6
Chemicals	4
General commercial	23
General industrial	13
TOTAL INDUSTRIAL & COMMERCIAL	78

4.13 Of the above totals, approximately 40% is recovered, primarily by recycling, and 55% (43.5 million tonnes) is disposed of to landfill.

4.14 The 2005 target for landfill is 85% of 1998 levels i.e., approximately 36 million tonnes or a saving of 6.5 million tonnes. Such a target does not take into account any increase in waste that may occur over the period. This presents the industrial / commercial sectors with several difficult problems, as follows:

4.14.1 The need to better estimate future variations in the amount and type of waste that requires disposal

4.14.2 The setting up and subsequent control of individual targets. (If some form of self-regulating s not introduced, it is possible that the rates/ taxes etc., charged for landfilling will be increased considerably as a deterrent).

4.14.3 The industrial and commercial sectors could become increasingly the dominant users of landfill.

4.14.4 The Local Authority increased recycling activities may well lead to a depression (at least in the short term) of the market prices which industrial / commercial organisations can currently obtain for their scrap or waste.

4.15 The above problems must be considered in the anticipated or proposed future arrangements that are relevant to Jersey.

5.0 WHAT IT MEANS FOR JERSEY

5.1 87,500 tonnes of MSW was produced in Jersey in 2000. In addition, agriculture accounted for 13,000 tonnes, of which 1,000 tonnes was plastics and the balance green waste that was composted at Crabbé, along with a further 12,000 tonnes of green waste made up of grass cuttings, hedge-trimmings and the like generated twice yearly under the Island's compulsory branchage or hedge-trimming scheme which amount to a further 25,000 tonnes.

5.2 The first three principal waste streams were Domestic amounting to 33,000 tonnes, Commercial 29,100 tonnes and inert Industrial at 25,400 tonnes. The fourth and biggest waste stream arose from industrial, construction and demolition activities; and this amounted to 315,000 tonnes, aggregating to 427,500 tonnes per annum, to which should be added around 250 tonnes of clinical waste and more than 2,000 tonnes of seaweed and beach and street sweepings which were dumped at La Crête Quarry, making a grand total of 429,750 tonnes per annum.

5.3 In 2000, the total Municipal Solid Waste ("MSW") that includes controlled waste arisings, more commonly known as mixed household, industrial and commercial waste, were estimated at 870kg per capita per annum. This compares unfavourably with an OECD average of 500kg per capita per annum.

5.4 A firm of independent specialist consultants has undertaken a recent assessment that would indicate a level closer to 400kg per annum of MSW is being generated; however, no evidence has been seen to substantiate this reduction. Even so, this is still much higher than the targeted maximum within the EU of 300kg per annum per capita (currently averaging 327kg)

5.4 Jersey Waste Management Strategy

5.4.1 The authorities within Jersey have jointly in the process of completing a strategy. It covers all the aspects of waste management in the island and gives attention to the changes that will be necessary for success. Its fundamental principle is to reduce the amount of waste which goes to incineration or La Collette, by:

5.4.1.1 Integration of waste management contracts

5.4.1.2 A joint minimisation and recycling strategy

5.4.1.3 Partnerships, involving the public and community. Parishes and the private sector.

5.4.1.4 Waste management and wider strategic objectives, now recognised as vital to the health and well being of domestic, commercial and industrial sectors of the community.

5.4.2 On the other hand, this study originated from an interest in pyrolysis as a new technology to provide Energy-from-Waste solutions for Jersey that could not justify incineration. In fact part of this report's aims is to provide the necessary technical and related information needed to help choice between the following three options for Jersey:

5.4.2.1 Recycling / composting

5.4.2.2 Recycling / composting and incineration with power generation

5.4.2.3 Recycling / composting and use of new technology such as steam treatment, reduction, segregation, with power generation

5.5 Effects of Recycling

5.5.1 The planning of a future waste strategy will be dependent upon the extent and amount of separation exercised in the community if a traditional disposal method of incineration is used. Three operations are involved in enlarging the collection of various recyclates:

5.5.1.1 Separate collections from households

5.5.1.2 Civic amenity sites including “can banks or igloos” for glass collection

5.5.1.3 Bring systems

5.5.2 Further, it is necessary to consider post collection aspects of recycling; including centralised composting that is already undertaken at Crabbé for some of the green wastes. It may also be desirable, probably in conjunction with other parishes, to incorporate sorting and packaging recyclates to improve their quality and hence value.

5.5.3 Due to these uncertainties, it seems prudent to allocate space for the foregoing at Bellozanne or La Collette. It may be more economical to consider some recycling at Bellozanne, which would enable operatives to record relevant detail, using computer-based systems that would be in use on such a site. In addition, any rejection of recyclates collection that might arise could be diverted to the general waste handling.

5.5.4 More efficient use of labour, plant and equipment would result. For a single site, such as Bellozanne, the relatively larger team of operatives creates greater flexibility to cover unplanned absences holidays and activity changes.

6.0 INCINERATION OF WASTE

6.1 For many years the only substantial option for disposal of waste, other than landfilling which is not a practical option for Jersey, has been incineration. Today in the UK about 2.5 million tonnes per annum of household waste is burned in incinerators.

6.2 The smallest of these processes, just over 90,000 tonnes per annum of waste generates 7MW electrical power from the heat produced, and the largest process 600,000 tonnes per annum but only generates 32MW of electricity. Jersey incinerates around 87,000 tonnes but only generates 2.5MW of electricity.

6.3 With the exception of Jersey, all these processes meet current anti-pollution standards but are not expected to fully meet the new Waste Incineration Directive (WID) without further modification.

6.4 Small incinerators in the range 10,000 to 30,000 tonnes per annum have been built but are expensive to build and run. The low thermal efficiency of such incinerators also means that electricity available for sale will not materially reduce running costs. It is worth noting that, in comparison to other forms of thermal degradation of waste, incineration requires large volumes of air and therefore produces large volumes of waste gas i.e.,

6.4.1 One tonne of waste requires 6.4 tonnes of air for complete combustion

6.4.2 One tonne of waste gives 0.24 tonnes residue including gas treatment additives and inert materials

6.4.3 One tonne of waste gives over 7 tonnes of exhaust gasses

6.5 Incinerators are generally built to process very large flows of waste for two reasons. Firstly, they are the only means at present of reducing very large volumes of waste. Secondly, to accommodate the high capital and running costs of cleaning exhaust gasses and providing power generation. A modern waste to energy incinerator would cost from £20 million to as much as £70 million, which is the current budgeted / indicated cost of an incinerator in Jersey.

6.6 Historical Perspective

6.6.1 There has been a long history of incineration, primarily to reduce the volume of waste but also to produce energy. The economic growth throughout the 20th century caused severe problems in the disposal of waste and the burning of this material, and together with burning of coal, which is a dirty fuel, has resulted in increased atmospheric pollution. By the early 1960's, the Government had introduced the Clean Air Act.

6.6.2 Major improvements were subsequently achieved, primarily by reducing the amount of dust emitted from domestic and industrial chimneystacks. Filtration caught the industrial flue ash but this still allowed polluting gases to pass to atmosphere. Incineration involves potential pollution from exhaust gas and ash also the transport of waste.

6.6.3 It also involves very tall exhaust gas chimneys, with a minimum of 50 metres in height, that are necessary to disperse the large volumes of combustion gases and prevent downdraught on to nearby land and buildings. These factors have generates a bad public image.

6.7 Environment

6.7.1 The drive to reduce the polluting effect of gas emissions led directly to the 1989 EU Directive, which came into force in December 1996. In the UK legislation was introduced by the *Environmental Protection Act 1990.* The impact of this legislation was dramatic. More than forty incinerators of MSW (Municipal solid Waste) were closed and only four upgraded to meet the new environmental standards at a cost of £10 million or more each.

6.7.2 By 1999, six additional energy from waste incinerators, that met the new standards, were operation and two more were under construction. In 2003 there are now 12 municipal waste incinerators in England and Wales.

Location	Owner	Capacity (t/year)
Bolton	Greater Manchester Waste	120,000
Cleveland	SITA Holdings (UK) Ltd.	220,000
Coventry	Coventry and Solihull Waste Disposal Ltd	260,000
Dudley	MES Environmental Ltd	90,000
Edmonton	London Waste Ltd	500,000
Nottingham	Wastenotts (Reclaimation) Ltd.	150,000
SE London	South East London Combined Heat and Power Ltd	420,000
Sheffield	ONYX Sheffield	135,000
Stoke	MES Environmental Ltd	200,000
Tyseley	Tyseley Waste Disposal Ltd	350,000
Wolverhampton	MES Environmental Ltd	105,000
Huddersfield	SITA Holdings (UK) Ltd.	150,000

6.7.3 In 1999, the EU issued a draft Directive to demand further improvements in exhaust gas emissions that have now become a legal requirement in the UK. The Directive proposes the limits to gas pollutants to the following maximum levels:

Milligrams/Cubic Metres (mg/m3) of Exhaust Gas

Dust	10	Sulphur Oxides	40
Carbon	10	Nitrogen Oxides	200
Hydrogen Chloride	10	Dioxins	0.1
Hydrogen Fluoride	1		

6.7.4 To meet these standards, more stringent gas cleaning plant will be required which will increase the capital and running costs of all incinerators. However, the UK and European Government consider that public health is paramount and increases in costs borne by the public are justified.

6.7.5 Dioxins are most often quoted as hazardous. There are some 200 compounds in this family of which only a few are hazardous and persistent in nature. All hydrocarbon fires produce these gases at extremely low concentrations and incinerators produce only a very small proportion of the total in the atmosphere. In fact, incinerators destroy more dioxin compounds that they create. Dioxins are also present in fly ash.

6.7.6 Most of the ash from the incinerators process is bottom ash that falls through the grate system and tends to be clinkered. After weathering this clinker could be recycled to replace mined rock as an aggregate. This bottom ash includes metals, glass etcetera that could be recycled and also includes other inter material in the original waste. No metals recovery is practiced in Jersey to extract metals from the bottom ash and it is all stacked at La Collette.

6.7.7 Flue ash, which also contains lime to reduce acidity, is filtered from the exhaust gas. It may also contain volatile metals such as cadmium and mercury that condense out at the temperature range of 280°C to 400°C. The exhaust gas treatment is designed to ensure that levels of any potential toxic chemical are well within the limits laid down by law.

6.8 Recycling

6.8.1 One benefit of incineration is that pre-sorting of waste for recycling can be avoided for the small items found in municipal waste. It is relatively easy to separate metals and glass from the bottom ash and much of these materials have a market. Notwithstanding the revenue possibilities, none of these practices are undertaken in Jersey.

6.8.2 However, the UK Government’s recent targets for recycling, 30% by 2010 cannot be achieved without recycling paper and compostable materials that constitute a considerable percentage of burnable waste. Therefore, incineration will only be permitted in future after pre-sorting of the waste streams if compliance with the recycling targets mandated by EU law are to be achieved.

6.8.3 Generating electrical energy from waste contributes to recouping cost of the running and maintenance of the plant. Typically modern incinerators generate 1MW for each 13,000 tonnes per annum of waste. The energy content of waste is on average 500 to 550 kWh per tonne. The UK Government accepts that waste is a renewable source of energy and its use in this way reduces the volume of waste to landfill and also helps to meet its target of 10% of all electricity generation from renewable sources in the UK by the year 2010.

6.8.4 It should be noted that a high proportion of waste is absorbed vegetation and wood, and when this is burnt, CO_2 which has been previously taken by plant life is returned to the atmosphere. When waste is burned, to produce electrical power, it replaces an equivalent amount of fossil fuel. The reduction is small but nevertheless is significant. Even more important, when considering global warming, is that waste, when landfilled, produces methane (CH_4) which is twenty three times worse as a global warming agent than CO_2.

7.0 GASIFICATION AND PYROLYSIS OF WASTE

7.1 At present, to reduce the volume of waste, incinerators are used in which the waste is burned with a large excess of air to ensure that all differing materials, i.e., vegetable matter to plastics, are completely reduced to gas and ash. Efficient waste management requires local treatment plant to meet the following criteria:

7.1.1 **Minimum Transport**: Lorries are potential polluters. Waste should be treated as close to point of collection

7.1.2 **Exhaust Chimneys:** Nobody wishes to have a tall stack in their neighbourhood, or have sight of one

7.1.3 **Environment:** Public opinion is demanding a green image. The likely impact being strict legislation for the treatment of "dirty" waste and the preservation of the environment.

7.2 The two types of thermal treatment plant that potentially meet these criteria are gasification and pyrolysis. There is nothing new in either of these processes the oldest being charcoal burning and more recently the conversion of coal to town gas which has been replaced by natural gas.

7.3 Gasification

7.3.1 Charcoal burning is still practised in the UK and is an example of gasification. Raw coppice wood is packed into a pile, (these days a steel cylinder is used) and a "slow" fire is started at the centre. Heat from the controlled slow burning releases alcohols and gases from the wood, which together with smoke, is exhausted to atmosphere leaving behind charcoal. The latter is nearly pure carbon. Unfortunately, in this process some 70% of the heat available from the wood is lost and only about 30% is left in the charcoal. It takes about eight tonnes of wood to produce one tonne of charcoal.

7.3.2 Gasification of coal to produce "town gas" was another example of gasification and was comparatively more efficient. Coal was heated in a retort with steam to produce gas, which was piped to homes and factories.

7.3.3 A similar process is used to gasify hydrocarbon waste whether it be vegetable, wood, plastics, films, paper, oil, or tyres. A number of differing systems are being developed for commercial use and these will be described. Heat from controlled slow burning of the waste partially breaks down the organic molecules to produce an energy gas, called synthesis gas or "syngas". This gas has about 70% of the energy in the original waste and can be burned either directly in an engine to produce electrical power, or in a boiler to raise steam.

7.3.4 Because partial burning requires air, the syngas will contain a high proportion of CO_2 and N_2 and therefore has relatively low calorific value, typically $6MJ/m^3$. This is sufficient to allow it to be burned cleanly at a high temperature to ensure that any toxic content is thoroughly broken down.

7.3.5 There are two major advantages to the process. Firstly, the bulk of the waste material is "burned" at a low temperature; there is no flame, and only the carbon glows to produce heat to drive off the syngas. Very little pre-treatment of the waste is required and recyclable materials can be removed from the ash. Also the ash is in a form that can be used after weathering in construction work and materials.

7.3.6 Secondly, because little air is required to complete the energy release process, the physical size of the plant is smaller that that required for incineration. The exhaust gas cleaning systems are much smaller and simpler than for incineration and importantly, only a small exhaust stack is required.

7.3.7 This means that relatively small volumes of waste can be treated economically by gasification. This satisfies the proximity principle. Jersey has small conurbations so requires compact and environmentally clean plant for waste treatment. Gasification meets such requirements very well.

7.3.8 The major disadvantages of gasification are that it is a slow process. The gasification zone operates at about 700°C to 800°C and the waste chars as the syngas is driven off. There are three distinct types of gasifier which operate as follows:

Type A: Untreated waste is piled into a container and the char zone is allowed to travel vertically downward through the pile. Air entry into the pipe is monitored to control the rate of gasification. This is a batch process and a number of containers are operated sequentially to direct gas into a single secondary burner and boiler.

Type B: Waste is dropped into a vertical container and falls by gravity through a char zone. Syngas may be taken off at the top or bottom of the container. If at the tope, some oil is produced with the syngas. If at the bottom, only gas is produced. Such gasifiers are very restricted in respect of the rate at which the waste that can be processed.

Type C: Waste enters a rotary gasifer and tumbles down into an included kiln. At the hot end the kiln, a burner provides hot inert gas to heat the waste and initiate the charring process. The residence time of the waste is much less than that of the other gasifiers. As a continuous process it is more amenable to control/ The ash automatically drops out of the rotating kiln and does not require any special handling equipment.

7.3.9 The gasifiers of particular interest are "the open core down draught" and the "rotary" designs brief described as Type A and Type C above. The reason for this is that the design allows a wide variety of fuels to be gasified with a much larger throughput than other designs. There are four distinct gas zones and the control of each zone is critical to minimise the production of oil and tars that contaminate the gas, these are:

7.3.9.1 Drying zone in which moisture is driven off

7.3.9.2 Volatile zone in which liquid/gaseous products are formed at low temperatures

7.3.9.3 Combustion zone in which the char volatiles are partially burned at temperatures of 120°C to 1,400°C

7.3.9.4 Reduction zone in which the bed temperatures drops to 1,000°C and gas reactions proceed to form CH_4, CO and H_2

7.3.10 Gasification is a complex process and the reactions that occur for both solid and liquid hydrocarbons are:

7.3.10.1 $C + 2H_2 = CH_4$ Methane
7.3.10.2 $C + H_2O = CO + H_2$ Carbon Monoxide and Hydrogen
7.3.10.3 $C + CO_2 = 2CO$ Carbon Monoxide
7.3.10.4 $CO + H_2O = H_2 + CO_2$ Hydrogen and Carbon Dioxide

7.3.11 Generally, the produced syngas has a low calorific value and can be about 6 MJ/m^3 or up to $10MJ/m^3$ with the addition of steam and oxygen. This gas is easily burned in a boiler to raise steam. It can also be burned in a spark ignition engine or gas turbine.

7.3.12 The chemical analysis of the gas is variable and depends upon the ration of vegetable and synthetic materials in the waste stream and the temperature control of the gasification process. A typical analysis might be:

Hydrogen	3%	Oxygen	1%
Methane	6%	Nitrogen	16%
Carbon Monoxide	25%	Carbon Dioxide	40%
Lower Hydrocarbons	9%		

7.3.13 The types of hydrocarbon material that can be gasified are unlimited. However, to ensure consistent safe operations, the waste stream should be either totally mixed or kept to a restricted mix of materials. The type of gasifier chosen, and the pre-treatment of the waste will determine the waste mix that can be gasified.

7.4 Pyrolysis

7.4.1 There is nothing novel in the thermal process called pyrolysis. It involves heating hydrocarbon material in the absence of oxygen, generally in the temperature range of 250°C to 850°C. The products of such thermal degradation depend upon the carbon-hydrogen ration in the heated material and the temperature of the reaction.

Temperature °C	**Chemical Reaction**
250	Breakdown of oxides and sulphides. Volatiles such as methanol are driven off.
350	Breakdown of carbon rich compounds. Some production of methane CH_4

400-600	Conversion of oils and heavy carbon rich compounds
600-700	Cracking of carbon rich compounds to gas and liquid hydrocarbons
850	Production of methane, hydrogen and carbon monoxide gas with some hydrocarbon gases. These are the main constituents of syngas.

7.4.2 The main advantage of pyrolysis is that products of the reaction are not diluted. Waste is heated in a closed vessel. Thermal degradation reduces it to oil or gas and solid carbon combined with ash. The oil and gas are energy rich and the carbon can be used as a clean burn fuel or reduced to gas by reaction with steam at 1000° C when the water is driven off as hydrogen and the carbon as carbon monoxide. This means that the efficiency of conversion of the material into heat and energy and is high at 70% or more.

7.4.3 Thermal degradation of waste material by pyrolysis is commercially relatively in its infancy because the drive to eliminate environmental damage is relatively new. Waste dumping and incineration have been the accepted norm. The recognition that pyrolysis is extremely efficient and does not lead to pollution give new business opportunities. For example, in Norway and Sweden, vast tonnages of waste wood are available. By pyrolysing such material at 500°C, good quality clean oils are produced that can be used as a fuel or as a chemical feedstock.

7.4.4 Wellman Process Engineering have developed such a machine which efficiently processes wood waste and converts it to oil. Such would mean that the current practice of moving off-island thousands of tonnes of wood waste could cease and cash saved.

7.4.5 As a further example, the pyrolysis of tyres has been developed in the UK and the technology is owned by the RCR Group and the recovered materials include:

Clean carbon powder	35%	Oil	36%
Steel Reinforcement	12%	Gas	17%

7.4.6 The pyrolysis of MSW that is a variable mixture of low calorific materials such as vegetation and high calorific materials such as plastics requires precise process control. High temperature is used to ensure complete waste degradation to gas that has the same major constituents as natural gas, i.e., methane and hydrogen. The calorific value of such gas has been demonstrated to range from 20MJ/m^3 to 32MJ/m^3 depending upon the process used and the material mix. This report is only concerned with high temperature pyrolysis i.e., 800°C to 850°C to produce syngas and which ensures that any toxic gases in the waste are destroyed.

7.4.7 Because waste material has oxygen present in its chemical makeup, some carbon monoxide CO and a very small amount of carbon dioxide CO_2 are produced. The chemical analysis of a typical pyrolysis gas might be:

Hydrogen	16%	Lower Hydrocarbons	5%
Methane	45%	Oxygen/Nitrogen	4%
Ethylene	16%	Carbon Dioxide	5%
Carbon Monoxide	9%		

7.4.8 Unlike gasification, pyrolysis has two by-products; heat in the form of hot gas and carbon-rich ash. The hot gas could be used for waste drying, for industrial operational purposes or space heating. Carbon ash can be recycled. Since the ash contains 45% inert materials, it could be mixed with clay to produce an engineering brick. Moreover, because the carbon is composed of fine particles it can serve as an active filter in some chemical processes.

7.4.9 Unlike incineration or gasification, the pyrolysis reaction requires that the MSW is finely chopped into small flakes and reduced to very small pellets. Commercially available machinery can complete this process, after the solid materials, such as metals; glass and rubble have been removed. The chopping process aids mixing of the diverse materials in MSW and also allows any drying to be carried out more easily.

7.4.10 Due to the high temperature of reaction and the small particle size, the speed of pyrolysis is extremely fast. Reaction times are measured in seconds and this leads to the term "fast pyrolysis" with liquids and gases produced.

7.4.11 The low sulphur pyrolysis syngas has a high calorific value and can be burned directly in an industrial spark ignition engine or gas turbine. The overall thermal efficiency is very good. If 70% of the heat in the original waste material is converted and the engine efficiency is 34% the overall thermal efficiency will be 21%. (Note: For comparison, incinerators achieve 15% at best).

7.4.12 Other uses of pyrolysis syngas are possible. If the pyrolysis plant is sited close to a gas burning power station, the gas could be piped to it and burned at a much higher efficiency that in a dedicated engine. This makes available an efficient way of meeting the "Government Renewable Obligation" which started in October 2001.

7.5 Combination Pyrolysis and Gasification

7.5.1 Some companies are developing combined Pyrolysis / Gasification plant to overcome perceived problems of gasification or pyrolysis. Gassification is a slow process and converts all the carbon to a low calorific gas. Pyrolysis is a fast and efficient process producing high calorific gas but leaving a carbon-rich residue.

7.5.2 One example of the pyrolysis / gasification combination begins with waste in a pyrolysis reactor followed by gasification of the carbon residue to produce a lower calorific value gas which is mixed with the initial pyrolysis gas. Optimising this process maximises heat recovery from the waste material it leaves inert ash.

7.5.3 A further example involves a rotary kiln system. In this the waste is fed into the cold end of a rotating steel drum and travels down to the hot end. The cold end is where gasification occurs. During waste movement, the waste is subjected to increasing temperature in an atmosphere largely devoid of oxygen, which is a form of partial pyrolysis.

7.6 The Future of Pyrolysis / Gasification Systems

7.6.1 Throughout the world, companies are developing engineering methods for the thermal degradation of waste materials. They are endeavouring to optimise their process to gain a competitive advantage in the waste management field in which they have chosen to specialise. The future of pyrolysis / gasification systems for municipal waste will also be determined by:

7.6.1.1 Commercial demonstration of the financial viability of gasification or pyrolysis

7.6.1.2 Demonstration of the performance and reliability of these new technologies

7.7 **Gasification Systems Available**

7.7.1 The gasification systems offered by **International Waste Solutions** with their "EWOX" system and by **Organic Power**, require minimal preparation of waste. Large items of metal and glass also rubble must be removed. The EWOX system can accept large items such as whole tyres and bundles of paper. By contrast, the Organic Power system requires to be bundled in disposable sacks for ease of handling and control of the thermal process.

7.7.2 With both systems, the gas that is driven off is immediately burned in a combustor to provide heat for the generation of steam. This steam could be used for process or space heating, or expanded in a suitable turbine to generate electricity. The exhaust gas is of relatively low volume (compared to an incinerator) and will meet proposed EU limits on gas quality to atmosphere. The ash requires treatment to remove remaining metals and glass, which are added to the recycled materials. The ash produced is produced in a non-oxidising atmosphere, and provided that it is rapidly cooled on discharge, the toxic chemicals such as dioxins cannot be formed.

7.7.3 These gasification systems can treat medical wastes. The combustor temperatures are operated above 1,000°C that ensures that any toxicity in the waste is destroyed.

7.8 **Combined Pyrolysis and Gasification Available**

7.8.1 Combined pyrolysis and gasification is carried out in systems designed by **Compact Power** and **Serpac Environmental**. Their mechanical and thermal arrangements differ. For both systems the gas driven off the waste is immediately burned in a combustor to provide heat for the generation of steam. This steam can be used for process or space heating or to generate electricity.

7.8.2 The **Compact Power** system requires the waste to be packaged into 100kgs slugs by compression or bagging. This makes the system particularly suited to sensitive wastes such as clinical and medical wastes. The waste is firstly pyrolysed in a horizontal tube at a temperature in excess of 1,000°C to produce syngas. The carbon-rich char is reacted with steam to produce Hydrogen and Carbon Monoxide that is mixed with syngas. In a given plant a number of horizontal tubes would be installed up to a maximum of eight that would treat 30,000 tonnes per annum.

7.8.3 The **Serpac Environmental** system is different. It uses a rotating kiln inclined at a low angle to the horizontal. Chopped waste is introduced at the upper "cold" end and tumbles down to the "hot" end, which is heated by gas burners giving a reduced atmosphere at 850°C. In this way the waste is firstly gasified and then pyrolysed to leave an ash that contains a small amount of carbon.

7.8.4 Systems that combine gasification and pyrolysis produce a gas of higher calorific value than gasification alone that permits its use in a spark ignition engine or gas turbines.

7.9 **Pyrolysis Systems Available**

7.9.1 Pyrolysis systems as designed by **Waste Gas Technologies** or **Graveson Energy Management** (GEM) are very different from gasification systems. The waste is firstly sorted out for recycling and inert solids removed except for fine dust material. It is then finely chopped to a flake-like consistency, sludge material such as paper or sewage can be added but requires drying to better than 20% water content.

7.9.2 The **Waste Gas Technologies** plant the waste is fed into a horizontal rotating cylinder through a shute system that prevents the ingress of air. The cylinder is heated externally to 850°C in a furnace, which causes a high quality gas to be driven off the waste in a matter of seconds. This syngas is washed to reduce acidity, remove dust and oil traces and cooled prior to being burnt in an engine.

7.9.3 The **Graveson Energy Management (GEM)** system has a fixed vertical cylinder into which the dried waste is introduced through an air exclusion system. It is agitated by a rotating vertical axis paddle, which keeps the waste particles in suspension and causes denser ash to fall towards the cylinder wall. The reactor cylinder is kept at an operating temperature of 850°C inside a large vertical cylinder, which encloses the reactor. The heating is provided by gas burners. The produced gas refined by a special oil bath, which also removes chlorides. This is a well-established practice in the industry.

7.9.4 Depending upon the average calorific value of the original waste, the produced syngas from all pyrolysis systems will have a high calorific value up to about $30MJ/m^3$. (Note: the calorific value of natural gas is about $39MJ/\ m^{3.}$ This is suitable for burning in a spark ignition engine or gas engine. A further possibility is to pipe the gas to a power station, which can burn the gas at much higher thermal efficiency and contribute to the "green" power from renewable sources.

7.9.5 Ash from a pyrolysis plant has high carbon content. It has a number of potential uses such as activated carbon filter medium, mixed with clay for brick production, briquetted as a clean fuel etc.

7.9.6 A further variation of pyrolysis is demonstrated by **Technip Pyropleg** process which was developed in the former East Germany, now owned by French contracting company Technip. This plant has been processing over 30,000 tonnes per annum of a mixture of wastes and has been operating for over 12 years being the longest running demonstrator of pyrolysis / gasification. The waste is fed into an externally heated rotating drum from which air is excluded. The internal temperature of 450°C gives a slow thermal reaction. A long residence time ensures that all waste is reduced to carbon-rich char. The syngas produced is burned at 1,200° C in a separate combustor and the heat used to generate steam for electrical power.

7.9.7 **Mitsui Babcock R21 System:** To make pyrolysis effective unsorted MSW is pre-treated by being subjected to a two-axle shearing type of refuse shredder and is shredded into the appropriate size. The shredded material is conveyed to the drying chamber that is located just in front of the pyrolysis drum. The drying medium is the exhaust gasses from a later stage of the process. In the pyrolysis drum the shredded refuse is heated at 450°C for about one hour in the absence of oxygen and is decomposed in pyrolysis gas and carbon.

7.9.8 The pyrolysis gas and the carbon from the pyrolysis drum are fed at high temperature and are combusted at around 1300°C to recover ash as molten slag. There is absolutely no requirement at all for supplemental energy for melting the ash. After cooling pyrolysis carbon with solid residue cooling drum, steel and aluminium are recovered by using screens, a magnetic separator and eddy current separator for the non-ferrous metals. Due to the low temperature and absence of oxygen in the pyrolysis drum all metals are recovered in a non-oxidised and non-molten state and has thus a higher commercial value.

7.9.9 The exhaust gasses from the high temperature combustion chamber undergo heat exchange to recover high temperature air that is used for pyrolysis in he pyrolysis drum and also for parasitic use as a drier before MSW enters the drum. High temperature and high-pressure steam (400°C x 40ata) can be recovered and due to the low air ratio (1:2) heat loss through flue gas can be reduced and it ensures higher efficiency in power generation. This electricity is used for plant operation and can be sold to Jersey Electricity to help plant-running costs.

7.9.10 The flue gasses are cooled within a flue gas cooler and this is fed into the first bag filter where the fly ash or dust is captured. This is then fed into the second bag filter where HCl and SOx are removed. Dust captured in the first bag filter is fed back into the combustion chamber where the dust is melted. The key advantages of the R21 is the very low levels of dioxin release with typically 10% of the emissions of an ordinary incinerator and very small quantities of residues representing less than 1% volume (5% weight) of MSW that requires landfilling. There is no requirement for supplementary fuel or oxidising agents; it exports both heat and power; no ash residue as ash is converted into a clean inert vitrified slag that has been used in the manufacture of asphalt for road surfacing in Japan; and finally the recovery of metals in a clean and non-fused state for resale.

7.9.11 Five plants have been operating successfully and commercially in Japan for five years. The cost for a 50,000 tonne process plant is £60 million and to deal with Jersey's volumes it would require two modules that would cost £120 million.

7.9.12 **Thermoselect:** It is claimed that through a continuous process residual waste can be converted into useable products. The process avoids the formation of nitrous oxides, dioxins or furans and other organic compounds as well as ash and filter dust. The process s licensed for use at two sites in Germany where it is in continuous operation. Inorganic, toxic metal compounds in the waste and organic compounds like dioxin and furans and all other hazardous substances like viruses, bacteria, fungi etc are completely destroyed.

7.9.13 Organic poisons cannot reform. The process involves an automated crane and waste press in batched quantities of around 500kgs (6Mg/h to 15Mg/h). The press compresses brittle components, distributes liquids throughout the mass and removes most of the residual air. Several hundred tons of pressure is applied that reduce the waste into a plug, which is then fed at intervals into a degassing or gasification chamber. With oxygen removed, the organic components of the waste products are carbonised over a period of about one hour all materials are converted at high speed in the directly connected high-temperature reactor with technically pure oxygen. From the organic components that have a dwelling time of at least two seconds at temperatures of 1200°C the smallest possible inorganic molecules are created as the main components of H_2, CO, CO_2 and water vapour. Chlorinated hydrocarbons like dioxins and furans as well as other organic compounds are safely destroyed.

7.9.14 Shock cooling of the raw synthesis gas prevents dioxins, furans and other organic compounds from reforming. The synthesis gas passes through several cleaning phases, in which hazardous materials are absorbed or condensed. It is only then that pure synthesis gas is available as a base product for chemical synthesis to produce ammonia or methanol, obtain H_2 or produce energy. If the pure synthesis gas is used to produce energy, hazardous emissions are within detectable limits. If the synthesis gas is the base for other chemical synthesis then the plant apparently operates with minimal emissions.

7.9.15 All inorganic elements of the MSW such as metals, alloys, composite materials, fillers etc., are melted in two stable high-temperature phases at temperatures above 2,000°C and then go directly into a homogenisation reactor at approximately 1,600°C. The homogenised metals and minerals are separated, shock cooled with water jets and taken out as a granulate that can be used immediately in industry with no further treatment. The process is proven. It has two operational plants in Germany and plans for ten other plants worldwide. The process is clean and with minimal emissions. However, with only 500kgs per hour throughput per module and with jersey producing 240 tonnes per day the number of modules needed to process Jersey's MSW would make the implementation cost of this technology prohibitively expensive.

7.9.16 **Wellman Process Engineering:** This company has been operating in the field of gasification for 70 years. It has constructed, delivered and commissioned more than 2,000 gasifiers that are largely used for the conversion of high sulphur coal into coal gas. The company has developed a fully operational and commercial pyroliser for pyrolysing such material at 500°C, and good quality clean oils are produced that can be used as a fuel or as a chemical feedstock. In addition, they have worked closely with Peter Brotherhood Limited who are steam turbine manufacturers to produce a gasification unit which accepts high volumes of pelletised or briquetted refuse derived fuel (RDF) such as that produced by the Thermsave thermal process which uses steam to break down, reduce and sanitise unsorted MSW to produce an homogenous pollutant free material (RDF) that lends itself to be briquetted and converted into syngas for ignition engines for the generation of power.

7.10 Summary – Pyrolysis / Gasification

7.10.1 A summary of the key characteristics of the various pyrolysis / gasification systems discussed above. All systems mentioned have common features, which are advantageous in comparison with incineration. These are:

7.10.1.1 Every system is modular in concept. Each reactor may be designed for waste throughput of 4,000 to 20,000 tonnes per annum. A number of reactors may be installed at a common waste management facility to treat larger volumes of the total waste tonnage.

7.10.1.2 The modular concept permits reactors to be designated to specific waste types. The operating parameters to be optimised to economic and environmental conditions.

7.10.1.3 Early operational experience can be obtained using a small number of reactors to deal with only a part of the waste stream.

7.10.1.4 The volume of air required to complete thermal degradation is less than that required for incinerations. This means that the exhaust gas chimney can be low and little higher that the industrial building containing the facility.

7.11 Conclusion – Pyrolysis / Gasification

7.12 The technologies briefly outlined within this report offer attractive solutions for the local disposal of waste, particularly for the smaller authorities and island states such as Jersey or the Cayman Islands.

8.0 ASSESMENT OF OPTIONS FOR JERSEY

8.1 The Options for Municipal Waste Post 2005

8.1.1 Three options are:

8.1.1.1 Maximise recycling

8.1.1.2 Satisfy all recycling targets and use a local Energy-from Waste incineration system for disposal

8.1.1.3 Satisfy all recycling targets and use a local Energy-from-Waste pyrolysis or gasification system for disposal

8.2 **Option One - Maximise Recycling:**

8.2.1 This would involve the installation of an RCR STAG composite waste treatment plant that would enable Jersey to achieve and exceed EU recycling targets. The process would generate around £2 million in metals recovery and £1 million in plastics recovery thus demonstrating that Jersey is capable of being a sustainable economy.

8.3 **Option Two – Use of Energy-from-Waste Incinerator:**

8.3.1 Only a portion of the waste stream would be of any interest to an Energy-from-Waste solution. Only MSW, which includes domestic, commercial and some light industrial inert materials would be suitable. However, the green waste, waste or rejected potatoes, branchage, horticultural and agricultural wastes would not be suitable and a composting operation would have to be maintained at considerable cost producing a material for which there is no ready market.

8.4 Option Three – Use of Energy-from-Waste Pyrolysis / Gasification System

8.4.1 One major advantage of a Pyrolysis / gasification plant is that it is expected to be considerably cheaper than incinerations for small plants (100,000 tonnes per annum or less). Therefore it is considered that at some time in the future, it would become an attractive disposal system for Jersey's industrial and commercial waste streams. Predicting

8.5 Disposal Costs for Option Two – Incineration

8.5.1 The requirement is for incineration in 2007/8 of all of the waste then arising in Jersey. An Incineration Cost Model has been developed with emphasis upon developing the costs for plants much smaller than 100,000 tonnes. The conclusion of this study is illustrated below. It shows the build-up of the cost by considering the major cost elements, e.g., capital repayment charges, running costs, etcetera and the offset to be made by selling electricity.

8.5.2 Analysis shows that power generation is uneconomic below 100,000 tonnes per annum. However, with a sales value of 2.2 pence per kWh has been allowed which is the avoidance cost of Jersey Electricity purchasing the equivalent amount of power from France. The net cost of waste disposal by incineration is anticipated to be approximately £84 per tonne, if electricity generation is incorporated. If it is not, then this figure reduces to just about the Jersey predicted estimate of £80.40 per tonne.

8.6 Disposal Costs for Option Three – Pyrolysis

8.6.1 In order for the gasification process to be entirely successful the heterogeneous nature of the MSW must be changed. It has also moisture content of at least 35% and at this level the performance and output of a gasification plant is poor. If an RCR STAG plant is utilised, then the MSW can be volume reduced and converted to a homogenous cellulose-based fibre that can be dried parasitically to sub 5% moisture content. All recyclates can be mechanically extracted in a sanitised state and available for sale or reuse locally or off-island.

8.6.2 The island of Jersey requires a composite RCR STAG plant of 120,000 tonnes that will be capable of dealing with all of the green waste presently deposited at Crabbé amounting to some 35,000 tonnes and all of MSW of around 87,000 tonnes per annum. The annual operating cost in 2005/6 for a 120,000 tonne RCR STAG plant, including electrical power generation with output sold for 2.2 pence per kWh would be £3,960,000 or the equivalent of £39.60 per tonne.

9.0 ENVIRONMENTAL IMPACT ASSESSMENT

9.1 Noise

9.1.1 The RCR STAG process requires no form of pre-treatment or sorting that would normally create noise. The process of incineration, gasification and pyrolysis will create a low frequency vibration that needs design consideration. The noise related to the flue gas throughput that is high for incineration, significantly lower for gasification and very low for pyrolysis. Noise from generating activities will only apply to gasification and pyrolysis plants. Noise will also result from additional transport to take recyclates to the port for offsite disposal and sale.

9.1.2 Siting of all the facilities , planning considerations, building design, sound-proofing measures and noise monitoring imposed by a strict regulatory regime IPPC (Integrated Planning Pollution & Control) that must satisfy a risk assessment approach. The main environmental impact will be an increase in noise from traffic movements leaving the waste facility at Bellozanne.

9.2 Visual

9.2.1 The principal visual impacts will be from transport leaving the facilities and the buildings and features (i.e., chimneys). With transport (as with noise) there will be an impact in terms of an increase in movements of waste vehicles that take recyclates from Bellozanne. In terms of chimney heights the incinerator option will have the greatest impact with a now prescribed 60 to 80-metre high flue stack in accordance with the new WID directive. The gasification and pyrolysis plants have significantly less impact with flue stack heights of between 10 and 15 metres and 5 and 6 metres respectively.

9.2.2 With suitable siting of the facilities, building design, waste delivery and collection times imposed through IPPC, waste management licensing conditions and planning regulations vehicle movements will be managed to minimise impacts on local residents or road usage. The chimney heights will be determined through existing regulatory schemes, though the incinerator will have the greatest impact on the visual environment.

9.3 Emissions and Particulates

9.3.1 Emissions from MSW incineration includes hydrogen chloride, sulphur dioxide, nitrogen oxides, carbon dioxide, heavy metals, particulates, dioxins and dibenzofurans. The formation of dioxins is avoided by rapid cooling the exhaust gases through the range 200°C to 450°C. ETSU (1998) report states that contact with fly ash accelerates dioxin formation. This would indicate that the pyrolysis process that does not produce fly ash (or only a very small amount) is likely to produce insignificant levels of those toxins.

9.3.2 Emissions from incineration, gasification and pyrolysis will be significant but if the RCR STAG process of steam reduction, sanitisation and ultimate segregation of recyclates and potential pollutants such as batteries and other hazardous chemicals then emissions fall dramatically and the comparison for this is shown below:

	RCR STAG Audited and Monitored Emissions from Combustion	EU IPPC Limits
Particulates <2.5	3	10
Particulates >1.0	6	10

Carbon Monoxide	8	50
Oxides of Nitrogen (Nox)	183	200
V.O.C.s	6	10
Hydrogen Chloride	4	10
Hydrogen Fluoride	0	1.00
Sulphur Dioxide	41	50
Heavy Metals	0.07	0.50
Cadmium	0	0.05
Mercury	0	0.05
Dioxins & Furans	0.02	0.10

9.3.3 However, flows of flue gases vary significantly. The slower flue gas flow rate of gasification and pyrolysis allows an increase in the efficiency of gas washing systems used for abatement. In pyrolysis some of the gas produced is burned as fuel to provide heat for the process thus reducing emissions. The RCR STAG process using treated MSW in the form of RDF has shown that emissions for pyrolysis are well within the limits of the Incineration of Waste Directive 2000/76/EC. Other issues are related to ashes produced by burning processes and potentials for dusts (storage and disposal) and transport of residues / ashes/ wastes to the final disposal point at La Collette.

9.3.4 Controls and monitoring to ensure that the burning processes work within the limits of the Incineration Directive 2000/76/EC will be regulated within the IPPC permit system for incineration, gasification or pyrolysis. Lower flue gas flows and improved gas washing efficiency favours gasification and even more pyrolysis. Damping down the residues and containment systems for ashes and residues would ensure minimum dust emissions.

9.3.5 Using steam at a temperature of 1000°C and injecting it into the carbon-rich char will cause a reaction to occur that would drive off the carbon and render the otherwise controlled substance into a simple silicate with similar qualities as foundry sand. The ash would represent around 5% of the gross volume of waste handled through the RCR STAG process plant whereas incineration would yield anywhere between 18% and 25% of ash that would need to be stored indefinitely at La Collette.

9.3.6 The foundry sand equivalent could be utilised immediately for concrete block or ready-mix concrete manufacture and thus render a very nearly zero landfill option. There is some 3.4% of clean, dust free inert materials that are usually fragments of concrete, brick, rock and earth that would need disposal but this could be to a disused quarry since it is completely inert and non toxic.

9.4 Odour

9.4.1 The most significant nuisance odour emissions from the municipal wastes and in this light the existing waste storage area at Bellozanne fares worse. Odours from the open storage of MSW are a sensitive issue for local communities. There will be some odours from incineration, gasification and pyrolysis though these will be minimal.

9.4.2 The control of odour for all facilities considered will be in the storage where the internal pressure of buildings will be slightly reduced to keep odours within the buildings. Air conditioning and odour abatement systems with frequent air changes within the waste storage and reception areas will contain the odour to avoid nuisance in the community.

9.5 Health

9.5.1 Emissions and particulates from the incineration, gasification and pyrolysis plants will in general be significant. The flow rates of flue gases decrease respectively across each of the options, therefore allowing more efficient removal of the pollutants (using the RCR STAG process this is assured) and by more efficient gas washing systems. Accordingly, the possible harm by dispersal of contaminants from the flue will be in the decreasing order: incineration; gasification' pyrolysis. As noted the dioxin emissions of gasification and pyrolysis are like to be significantly lower. However, using a homogenous pollutant free RDF form the RCR STAG process will entirely eliminate heavy metals and VOC emissions.

9.5.2 With modern controls and abatement methods,, monitoring and regulatory limits on these processes, emissions can be reduced to levels whereas the Environment Agency have concluded will not pose a health risk to people living nearby irrespective of size of plant, the profile of the people concerned or the activities of the surrounding area (Environment Agency 1996).

9.5.3 The existing reference plant for the RCR STAG system has been granted a full IPPC site license for the gasification and pyrolysis of RDF including power generation in February 2000 following exhaustive auditing of emissions from the gasification plant and the analysis of the air within the process plant including the steam vented from the autoclaves following a treatment cycle that was released during the discharge of treated MSW and prior to mechanical segregation of the recyclates.

9.5.4 The storage of ash and residues from incineration will also provide some health issues. The ash does not undergo any form of sorting and agglomerated ash that includes heavy metals residues from batteries and plastics is stored at La Collette where it inevitably generates a degree of leachate, simply through the rainwater passing through the heaped material into the surrounding sea. At present generation rates there is only a further 8 years capacity for the storage of ash from an incinerator. So any new incinerator purchase must factor in the cost of locating and obtaining approval for a suitable landfill site or open storage site for the bottom ash and a sanitary disposal site for the fly ash that is a controlled substance and subject to strict rules and regulations as to its disposal.

9.5.5 There are two aspects to the ash issue. The first is the internal health and safety issues. As assessment process under the Control of Substances Hazardous to health Regulations will identify and develop control systems and implement measures that will create a safe working environment. The second aspect concerns the emissions caused by the processes that can affect the environment and the population in the surrounding area. The use of regulations that will emerge from the Incineration of Waste Directive 2000/76/EC will provide limits for emissions through controls applied to gas, water and residue emissions. There are also health guidelines issued by the Health Authority in Jersey.

9.5.6 Other aspects such as dust created by residues or ashes will be dealt with by appropriate containment, storage conditions and handling procedures.

9.6 Fire or Explosion

9.6.1 The waste arriving at the proposed facilities could contain dangerous substances or items that may cause a significant risk. The processes of incineration that involve burning and high pressure have increased risks due to variations in the waste feed stocks. The RCR STAG system that is entirely using low temperature steam to saturation point within the autoclave will eliminate any type of risk of fire or explosion occurring.

9.6.2 Dusts from ashes and residues stored could provide an explosion hazard. MSW wastes have been known to catch fire in waste collection vehicles, storage areas and reception cells. The present arrangement of storing and stacking MSW at Bellozanne is fraught with danger during the summer months when broken glass and sunlight could create ideal combustion conditions, which have occurred in the past. The additional danger of explosion and landslip should also not be ignored in the manner in which the waste is stacked adjacent to the service / approach road to the Public Amenity drop off zone.

9.6.3 Waste types such as MSW are subject to minimal screening prior to arrival at Bellozanne. However, PSD and their waste collectors have imposed conditions for depositing wastes. Larger items are often segregated and taken to civic amenity centre at Belozanne by householders or collected by the Parish services. Increased segregation of household and commercial waste stream will occur in future years but would not be necessary if the RCR STAG system is adopted and thus the asociat4ed cost of segregated collection could be avoided.

9.6.4 The design of the incineration, gasification and pyrolysis plant will be regulated to ensure that the plant can withstand most scenarios that are likely to be caused without damage to the building, people or other problems that could occur. Fire protection systems and procedures would be built into any of the permits or licenses approved.

9.7 Litter

9.7.1 The main source of litter will be the MSW. The litter will occur wherever MSW is handled or stored or disposed of. The principle problems are comment to all the facilities.

9.7.2 Control of litter will be detailed in the site permits or licences and will include such measures as daily litter picking and monitoring of litter arising.

9.8 Water

9.8.1 The principal impact from the MSW at Bellozanne is the potential leachate due to storage of the wastes in the open and where it is subject to rain falling upon it and thus percolating through it to discharge to groundwater.

9.8.2 Water is also used in the cooling processes for incineration but it is contained in a closed system. The alkaline wastes from the cooling and cleaning processes and the quenching water for the bottom ash are filtered and recirculated.

9.8.3 The ashes of waste produced from incineration and gasification contain soluble substances. The carbon-rich ash produced in pyrolysis absorbs pollutants significantly reduce the solubility of the substances present. Under the *Water Resources Act 1991*, contamination of water by solids is an offence.

9.8.4 Water is controlled under two pieces of legislation the *Water Resources Act 1991* that deals with controlled waters and the *Water Industry Act 1991* that deals with the discharges to trade effluent or sewer. To comply with the *Water Resources Act 1991*the operator will be required to store wastes in appropriately contained areas or vessels that are bunded. Surface water drains at the sites will need either to be diverted to effluent with the consent of the water undertaker, or be protected.

9.8.5 All water from the RCR STAG process is recycled. The plant rinse water for conveyors, reception pits, floors etc.. is all recycled, purified and reused. The adjacent sewage works would be the source of raw water that is required to generate process steam and adequate purification equipment is included in order to produce sufficient quantities for this purpose from the water that would otherwise be discharged to the sea at First Tower.

9.9 Vermin

9.9.1 The most significant nuisance from vermin will arise from the storage of MSW. The operator will be required to carry out a risk assessment in licence or permit conditions and put in place pest control measures.

9.10 Socio-Economic

9.10.1 It is essential to avoid unnecessary cost to business or householders (Parish Rate Payers). Other impacts may include an increase in waste traffic. There is also a requirement to comply with legislation being implemented as a result of European Directives: Landfill Directive; End of Life Directives – electrical and electronic wastes; Packaging; vehicles; etc. Government recycling targets are being set on local targets. The Landfill Directive targets biodegradable wastes that are one of the main sources of the landfill gases that are emitted to atmosphere.

9.10.2 There is a higher potential energy yield that pyrolysis produces – pyrolysis 1MW per 10,000 tonnes; gasification 0.56 – 0.80 MW per 10,000 tonnes and incineration 0.56MW per 10,000 tonnes.

9.10.3 There is significant social sensitivity to incineration and therefore it is likely that the will be public concern over this method of disposal.

9.10.4 The options of gasification and pyrolysis being developed in this study could benefit from tax or permit regimes, though this may require some pre-segregation of waste types at the facility unless an RCR STAG system is used where no pre-sorting would be required. The renewable nature of the energy produced may attract future tax incentives. The incineration plant option would not be large enough for economic recovery of energy from waste.

9.10.5 Pyrolysis offers the most challenging opportunity for recovery of carbon that would in normal circumstances be otherwise expelled as carbon dioxide into the atmosphere. It could be argued that the process represents a carbon sink. Pyrolysis provides a solution for the management of sewage sludge. Both gasification and pyrolysis can help meet renewable energy targets and contribute to commitments made by the UK and European Governments to the Kyoto Protocol. Both processes convert waste into valuable intermediates that can be processed further for materials recycling, or energy recovery including active carbon from pyrolysis.

9.10.6 Ashes and residues from incineration, gasification or pyrolysis will lead to a decrease in number of waste vehicle trips compared with the transfer station route. These are estimated at 85% less for incineration wastes, 90% less for gasification and 90% les for pyrolysis wastes. This will have respective cost benefits. These residues and waste streams could potentially be recovered for use as secondary materials. For incineration the bottom ash is disposed of to landfill or after suitable leaching can be used for road base construction (Switzerland, Germany and Sweden). Fly ash (4% of input wastes) is treated as special waste in landfill designed to prevent the escape of toxic dust. It can be immobilised with the use of cement or bitumen.

9.10.7 To involve the public in decisions concerning the choice of options, there is a need to:

9.10.7.1 Clearly explain the option and communicate the differences of gasification and incineration as compares to incineration.

9.10.7.2 Explain the pressing need for solutions to the problem of Jersey's wastes.

9.10.7.3 Ensure that strict and effective operational and monitoring controls on emissions of the proposed plants or options will be imposed.

9.10.7.4 Inform that any of the schemes adopted relies on recyclables being taken out of the main waste streams and therefore does not compete with local recycling initiatives. Using the RCR STAG system this will not have to be done at source and there will be no obligation imposed upon householders or waste generators to segregate their waste. With the exception of bottle banks all other public amenity drop off sites could be withdrawn with appropriate savings in operating costs.

9.10.7.5 Explain the contribution the schemes will make to the island achieving waste recovery and landfill directives and clean emissions directives and targets, and

9.10.7.6 Relate the relative increase in cost of the options facing Jersey businesses and householders and the associated implications of this

9.10.8 The explanation could be in the form of a leaflet outlining these choices distributed to every household in the island. Public meetings and a centralised consultation process will need to coincide with any plans for development and adoption of these proposals.

9.11 Timing and Lead Time for Implementation

9.11.1 The existing incinerator is very nearly on its last legs. Some spare parts are now difficult to obtain and the downtimes experienced are increasing in frequency. The three options will all take time to pass through planning and regulatory procedures; they will all take time to construct, install, trial and commission.

9.11.2 The incinerator has the longest timing issue since it is also the largest in land take or area. Issues of alternative location while permitting the existing incinerator to operate effectively are clearly the main problem. Loss of car parks or other land will have to be made if an incineration option is chose. The timeframe for constructing an incinerator is between 24 and 30 months.

9.11.3 The RCR STAG process, combining the other technologies could be built into the end of the valley. Structural investigations, architects drawings and local building advice and estimate has been taken or obtained to design a building that will fit into on the sloping site of the existing public amenity drop off area. Its location does not affect the operation of the existing incinerator and the plant could be constructed, installed, trialled and when fully operational and only then would the existing incinerator be decommissioned.

9.12 Conclusions of Environmental Assessment

9.12.1 The table below summarises the main environmental impacts that will remain after management and control systems have been implemented.

9.12.2 Of the three techniques, the option producing the least significant environmental impact is pyrolysis. This impact is even more improved and lessened if the RCR STAG process is pre-treating the feedstock to create an homogenous RDF that is pollutant free. Not only will it speed up the process but will reduce emissions to a negligible amount.

9.12.3 Of the three techniques, incineration, gasification and pyrolysis, pyrolysis offers the least air emissions and the least health issues, the greatest potential for recovery of the solid wastes left and the highest level of energy that can be generated from waste sources.

9.12.4 The additional impact of transport to take process wastes to landfill from a gasification or pyrolysis plant will be minimal. This results in significant savings on fuel emissions relative to the transporting of incinerator bottom of 20,000 tonnes and fly ash of 3,500 tonnes with the latter having to be embedded into concrete and disposed of separately. It would be worth asking what happens to it now?

9.12.5 Public involvement in the next stages of the development process is essential and will require a process of consultation that allows open public access to the principle issues. There is an urgent need for an alternative means to deal with wastes arising in Jersey as the local landfill option for storing incinerator ash at La Collette has only eight years capacity left and after that there will be a need to locate and obtain planning consent for an alterative site for the storage of 20,000 tonnes annually of potentially toxic and certainly heavy metal contaminated bottom ash and the 3,500 tonnes of highly toxic fly ash which will have to be mixed with concrete on a five to one basis so representing another 17,500 tonnes of concrete!

9.12.6 The economic, environmental and social choices facing the community and the decision-makers and the legislation that is driving the process, must be presented clearly and unambiguously.

Table: Significant impacts after management and controls implemented

Option	**Incineration**	**Gasification**	**Pyrolysis**	**RCR STAG**
Noise			Additional chopping	
Visual	Significant Chimney	Noticeable chimney	Low chimney	Low chimney and built into the valley so very well concealed
Emissions		Lower emissions than incineration	Lower emissions than incineration & gasification	Lower emissions than the other three other options
Odours	Noticeable dependent wind direction	Some	Some	None
Health		Better than incineration	Better than incineration & gasification	Better than all three others
Fire/	Some	Minimal	Minimal	RDF stored in

Explosion				nitrogen charged Store.
Litter	Some	Minimal	Minimal	Minimal
Water	Some	Some	Minimal	None
Vermin	Existing Problem at Bellozanne	Negligible	Negligible	None
Socio Economic	Energy recovery not economic for the size of plant needed 25% of gross MSW weight as ash to go La Collette + toxic fly ash disposal issues.	Energy recovery materials recovery. Will achieve a reduction of ash to La Collette	Recovery of carbon and other materials highest energy recovery lower volume char to La Collette	Recovery of clean recyclates and the generation of clean green electricity and almost zero to landfill at La Collette
Timing	24 to 30 Months	12 to 15 months	12 to 15 months	12 to 15 months

10.0 FINAL CONCLUSION

10.1 The island of Jersey has geographical and space constraints. The existing incinerator is at the end of its economical life. It is also not compliant to any of the current EU directives on waste or incineration of waste. It is in effect beyond economic repair and there is an urgency to replace it with a technology that will provide a composite solution to the island as there is no available landfill and there is a limited outdoor storage area in the event of a catastrophic failure.

10.2 There are some logistical problems and issues to overcome with the siting of another incinerator as the ideal site is the one that the existing incinerator is sitting on and clearly with a build time of 24 to 30 months there is inadequate storage or any other facility that could deal with the equivalent of 200,000 tonnes of MSW over that period of time.

10.3 The adjacent car parks could be sacrificed or other buildings demolished to make way for a new incinerator with the consequent loss of amenity value of those buildings and the activities that are currently taking place there. The end of life vehicle fragmentising operation would clearly have to move if their building was to be sacrificed.

10.4 By utilising a new technology the existing sewage cake disposal plant could be used for medical waste incineration with consequential savings in the high cost of operation that includes electrically heated drying facilities for the cake, the pelletising of the material prior to then combusting it without any cogeneration at all.

10.5 The RCR STAG plant could be constructed at the head of the valley and there would be a small chimneystack. The site loss would be minimal and the construction would not interfere with the existing incinerator’s operation. The sewage cake could be commingled with the RDF for effective disposal as a renewable fuel. The visual impact and indeed the environmental impact would be minimal and the existing unsightly chimney could be taken down.

10.6 The quality of the recyclates would be very significantly enhanced and ergo higher revenues would be generated from the sale of these materials. The plastics could be sorted and then flaked for reuse and employment and wealth creating industry could be spawned converting specific plastic types back into viable products. Electrical conduit, piping, foul sewer connections, plumbing parts, roofing tiles are just some of the multitude of products that could be made locally and thus reinforcing the sustainable image and integrity of Jersey.

10.7 The existing incinerator or indeed the proposed incinerator would have little recyclates recovery and what was recovered would attract a very low price and may not be economical to ship off island for sale. In effect no metals are recovered from the bottom ash of the existing incinerator. Aluminium represents 2.2% of the waste that is equivalent to around 2,000 tonnes and at £1,000 per tonne this is £2,000,000 of lost revenue. Steel represents 4% of the MSW and equivalent to 3,400 tonnes of clean tin plated steel that would achieve

£175 per tonne equivalent to another £600,000. Other non-ferrous metals amount to £400,000 in sales value. £3 million of metals are not being recovered today which would be if the RCR STAG process were to be adopted.

10.8 Some 3,450 tonnes of plastics are recorded as being within the waste stream. The current value of that as a virgin raw material is averaging £300 per tonne that amounts to another £1 million that is currently being burned and releasing chlorines and heavy metals to atmosphere. The availability of this material at a price which represents around one third of the cost of new virgin material would bb an excellent incentive for an injection or blow moulding plastics company to start up to meet the islands needs with the consequential employment prospects.

10.9 The RCR STAG process generates double the amount of electricity than an ordinary incinerator with power generation capability. An incinerator will produce 0.56MW per 10,000 tonnes and with 87,000 tonnes of MSW this would produce about 4.5MW per hour at best. The RCR STAG process would produce 1MW per 10,000 tonnes but the system would be capable of processing the green waste currently being sent to Crabbé that represents another 30,000 tonnes and the 2,600 tonnes of dried sewage cake. The aggregate of waste that can be processed is around 120,000 tonnes which would mean that about 10MW to 12MW could be produced every hour that at the present 2.2 pence avoidance price from Jersey Electricity would equate to £2 million a year. Elsewhere in the UK and Europe a premium is paid for renewable or green electricity of more than double that of the brown electricity and if that were to apply in Jersey then electricity revenues would rise to £4 million.

10.10 The admitted operating cost of an incinerator is £80.40 per tonne and there is 87,500 tonnes which is equivalent to £7.05 million a year, added to which is the operating costs of Crabbé of say another £1 million and if we assume the same operating cost for incinerating the sewage cake pellets then this would be an additional £200,000. The incinerator solution would thus attract an operating cost £8.25 million and the States of Jersey would be required to borrow £70 million and perhaps more if there are costs overruns as there have been on past capital projects. The capital would have to be repaid and the debt serviced which over twenty years would ass a further £3.5 million in capital and an equivalent amount for interest. Thus £7 million of funding costs should be added to provide a total cost of £15.25 million for the incinerator option.

10.11 The admitted cost of operating the RCR STAG process is £39.60 per tonne and for the 120,000 tonnes of waste produced including that that would otherwise go to Crabbé is £4,750,000 and RCR will provide the funding for the project and provide a lease to the States of Jersey which at the lower cost of £40 million would be £4 million a year using the same financing model on a like for like basis. The total cost of the RCR STAG system would therefore be £8.75 million.

10.12 As a further bonus the States will enjoy the benefit of the electricity sales and the recyclates sales revenues that would conservatively equate to £5 million a year. If a joint venture was created between the States (or the States owned Jersey Electricity Company) and RCR on say a 50/50 basis, then the States would have returned to them half of the recyclates and electricity sales equivalent to £2.5 million which would reduce the cost of waste disposal to just over £6 million a year with no debt obligations.

10.13 A States-owned and operated incinerator would have an annual total operating cost of £15.25 million and this figure would increase every year linked to bank interest rates and inflation whereas the RCR STAG system would have an operating cost of £8.75 million but with participation or rebate of 50% of the recyclates and electricity sales the annual cost of operating the RCR STAG system would be £6 million and that price would be fixed for the first five years.