APPENDIX 4 - WASTE TREATMENT AND DISPOSAL TECHNOLOGIES

Materials Recovery Facilities

In response to UK and Welsh Assembly Government policy it is likely that whichever principal process is considered to be the most suitable for management of municipal waste there will be a requirement to include some form of recycling or recovery stage to form part of a fully integrated waste management strategy.

A number of advanced 'Dirty' MRF's are being introduced, the two notable examples are Brightstar's 'SWERF' technology and HLC's Materials Recovery Energy Centre (currently in the commissioning stage in Neath Port Talbot). Both systems receive largely unsorted household waste and, through a series of screens and picking stations, aim to separate a high percentage of the recyclable materials. The main development in both these systems is the incorporation of thermal recovery into the process to increase the overall efficiency of the facility.

An alternative 'Dirty' MRF technology is offered by Wastec using the patented 'Kinetic Streamer' technology. Only one system currently operates in the UK at Stockton. A profiled reciprocating trommel device separates materials into two main steams; a light stream containing paper, plastic film and biodegradables and a heavy stream containing rigid recyclables. Each stream then goes for further processing to separate out individual material types.

The success of a 'Clean' MRF is dependent on being able to introduce effective segregation at source, which in turn requires that the public are committed to making it work. There are many examples throughout the UK where 'Clean' MRFs have been shown to be effective, and the development and use of such facilities should be included within the detailed options appraisal for Gwynedd Council.

MRF's can be 'low tech', whereby there may only be one sorting belt with several line pickers and perhaps an over-band electro-magnet to remove steel cans; these are normally specified in conjunction with 'kerbside' segregation schemes. Alternatively, they can have any number of additional items of equipment for sorting co-mingled dry recyclates.

Composting

It is clear that recovering dry recyclable materials from the whole waste stream (through a kerbside segregation scheme feeding a MRF) will assist in satisfying the recycling requirements of national policy, although there will still be a requirement to reduce the level of organic (biodegradable) materials going to landfill in response to the Landfill Directive. If the thermal processes discussed below fail to prove financially or technically viable it may be necessary, in the long term, to include a further biological (or mechanical-biological) process in order to further reduce the level of organic materials sent to landfill for disposal. There are four main types of composting process:

- Windrow composting
- In-vessel composting
- Vermiculture
- Anaerobic digestion

Windrow composting

Material for windrow composting is first shredded to reduce the material to a more manageable size and also to increase its surface area, as this leads to higher activity by the micro-organisms which drive the process. Materials are usually mixed to produce the ideal composting substrate and are constructed into elongated piles called windrows. Microbial activity in the windrows causes temperatures to rise to between 55-70°C. The windrows are monitored throughout the composting process to ensure that the optimum temperature, oxygen concentration and moisture content are maintained. The windrows are turned periodically, to introduce fresh air, and watered to maintain the ideal conditions for composting.

The high-temperature (thermophillic) phase at the beginning of the composting process usually lasts about 2-4 weeks as the microbes use up the available nutrients in the feedstock materials. During this stage, animal and plant pathogens which may be dangerous for animal and human health are destroyed, ensuring that the final product is safe to use. Composting continues after this initial phase at lower temperatures resulting in the destruction of compounds which might be toxic to plants (phytotoxins). This active phase lasts for a total of about 12-16 weeks, and once this is complete, the compost is allowed to mature for between 1 and 3 months. Once the compost has been matured, it is screened to remove the larger pieces of material, such as stones and pieces of wood. Compost sold as a soil improver is usually screened to a particle size of 10 mm diameter and smaller.

In-vessel composting

The principles of in-vessel composting are the same as open-air windrow composting, in that the process relies on the action of micro-organisms to break down feedstocks. However, in-vessel systems allow a greater degree of control over the process and can automatically adjust the temperature, oxygen and moisture regimes within the material. There are many different designs of in-vessel system and the most appropriate system for any given application depends on a variety of factors including nature of feedstock, degree of automation/ flexibility required, and financial and spatial constraints.

Since it is highly unlikely that composting of MSW putrescibles could be satisfactorily carried out outdoors (due to requirements of the Animal By-Products Regulations 2003), in-vessel composting would need to be considered as the minimum requirement.

Vermicomposting

Vermicomposting relies on the actions of earthworms, and the micro-organisms in their gut, to break down organic materials, and produce a nutrient rich product.

Anaerobic / Aerobic Digestion

The use of anaerobic/aerobic digestion (AD) for the treatment of municipal solid wastes is not extensive and the technology has yet to be fully proven for such applications. There are a number of pilot or small scale schemes in operation and several full-scale facilities are proposed. However, a large number of co-digestion anaerobic plants are in operation in Europe. A by-product of AD is a methane rich gas stream which can be used to generate electrical power which can be exported to the national power grid. AD is classed as a non-fossil fuel power source under the UK Government's Renewables Obligation[1]

A more recent, and novel, innovation is the Thornley aerobic digester. Situated in Durham, this site claims to be able to process up to 8,000 tonnes of MSW a year. Whole MSW is shredded, wetted and fed into the top of a 16m high digestion tower. The aerobic digestion tower is 12m in diameter and comprises of three sealed chambers, one on top of the other. Every three days the waste is moved vertically down to the next chamber. Therefore after 9 days the original charge of approximately 67 tonnes of MSW has been converted into a pasteurised, pathogen free material, with the biodegradable fraction now resembling a dark grey soil. The degraded material is then sorted to remove metals and other recyclables.

If the technology is shown in due course to be cost effective and reliable it is considered that there could be environmental and planning benefits since digestion facilities are seen as being less potentially polluting and more acceptable to the general public.

Thermal Treatment

Incineration

MSW incinerator plants have improved significantly over the last decade or so, particularly with the addition of sophisticated flue gas treatment and improved grate design. Modern energy from waste (EfW) or waste to energy (WtoE) incinerator plants are now generally considered as incorporating well proven, robust and reliable technology capable of meeting strict emission regulations.

[1] The Renewables Obligation introduced in April 2002 sets targets for all electricity generators to source a percentage of power from renewable energy sources. The aim is that by 2010, 10% of the UK's electricity should be supplied from renewable sources. The Obligation requires licensed suppliers to supply a growing proportion of their sales from eligible renewables. Targets have been set for each year up to 2010.

The enduring and most significant hurdle for this technology however, is adverse public perception normally based on experience of older and much less clean incinerator installations.

While it is generally believed that EfW plants treating less than 50,000 tonnes/annum cannot be economically viable this will become less of an issue as landfill prices steadily rise. Currently however, there are very few examples of EfW plants of smaller capacity in the UK that have operated successfully over an extended period of time. Experience from the few that are operational, or are planned, indicates gate prices in the order of £60-90 per tonne of waste incinerated. In view of the relative lack of operating experience in the UK and potentially high costs associated with a smaller EfW plant it is considered that this option should not be explored further at this stage.

Gasification and Pyrolysis

Gasification and Pyrolysis plants, whilst having an operating history within the oil and chemical industries, are still in the development stage when it comes to the treatment of MSW. The gasifier/pyrolysis reactors are normally based on proven technology, although the reaction products of these techniques and the need to use these as a fuel in other prime movers dictates the need for very sophisticated gas conditioning stages. Engine and gas turbine requirements for power generation are highly demanding, with upper limits on tars, alkalis, ammonia and particulates and continued development of this aspect alone is preventing full scale commercial operation of these processes.

The principal advantages of these processes appear to be the inert nature of the solid residues produced and an overall improved thermal efficiency. European studies have also indicated that in addition to being more efficient than modern EfW incinerators the capital and operating costs are likely to be lower. Added to this is the lower environmental impact of these facilities, in terms of emissions to atmosphere, much lower stack height and smaller building requirements.

Mechanical-Biological Treatment (MBT)

In its simplest form, Mechanical-Biological Treatment (MBT) describes the mechanical waste preparation and biological treatment parts of a standard integrated approach to waste management. This has evolved in recent years to a fully integrated system, within a single facility, which combines recycling, composting and (in certain cases) energy recovery.

MBT was originally developed to treat residual municipal wastes (those that remain after recyclables, and sometimes compostable wastes, have been removed through kerbside collection). The more advanced MBT systems can function without any additional collection infrastructure and they are also potentially suitable for un-segregated municipal waste.

The capacity of MBT plants ranges from small facilities treating 10,000 tonnes per annum or less, up to large scale facilities processing 150,000 tonnes per annum or even more. Treatment costs also vary, although figures in the order of £35-50 per tonne of waste delivered have been

quoted for the UK market. There is currently considerable interest in one or two specific technologies, including 'Sistema Ecodeco', promoted in the UK by Shanks Waste Solutions. There are several operational examples of this system in Italy, and at least three large plants have recently been granted planning permission, with further plants at a less advanced planning stage. The Materials Recovery and Energy Centre developed by HLC (Neath Port Talbot) Limited can be considered to be a form of MBT, since it incorporates recycling (though a 'dirty' MRF), composting and energy recovery through the thermal treatment of refuse derived fuel pellets.

It should be noted however, that there is a fundamental difference between the Ecodeco and HLC technologies. The Ecodeco plant is designed to receive residual wastes, whilst the HLC plant is essentially designed to receive largely un-segregated municipal wastes (although it is reported as being capable of receiving residual waste).

Landfill

Although many measures are being introduced in the UK and Europe to discourage the reliance on landfill it is inevitable that there will always be residues and waste that cannot be treated or recovered/recycled that will need to be disposed of to landfill. Landfill will therefore always remain an essential element of any fully integrated waste management strategy, whether on a local, regional or national scale, albeit at a much reduced rate.

For the strategy it will therefore be necessary to ensure that landfill capacity is available for the full duration of the strategy, and beyond. Gwynedd Council is fortunate in comparison to other Authorities in Wales in that there are two existing landfills within the Authority with considerable potential void remaining. The ongoing availability of these sites will, however, be dependent on the operator being able to secure and maintain in place the appropriate PPC permits.

A more detailed outline of Waste Management technologies including space requirements, environmental issues and visual considerations is set out in Tables below.

Outline of Waste Management Technologies

In these tables:

- Small – Medium Scale (up to 80,000 Tonnes per annum) Applications
- Large Scale (From 80,000 Tonnes per annum) Applications

Technology	Pretreatment requirements	Land requirements m^2	Environmental Issues	Visual Considerations	Other Information
Waste Transfer					
Transfer station road/rail/water	none	Upto 10,000 (small – medium) 10,000 upwards (large) depending on throughput	Odour (not inert sites) and significantly reduced by being in a building with air treatment (unless using intermodal units for collection), noise, traffic,	Bunkers of materials awaiting transport (inert sites); for biodegradable wastes best if enclosed in standard industrial type building with air control (unless using intermodal units for collection then storage of ISO containers)	Convenient way of bulking materials for transport purposes – intermodal collection and transport currently being trialed which makes transfer no more than a pile of ISO containers
Transfer station hazardous waste	none	Upto 10,000 (small – medium) 10,000 upwards (large) depending on throughput	Water pollution, safe storage of chemical wastes, depending on size may require COMAH and/or hazardous substances planning regulations, odour, noise, traffic	Stacked and palletised drums, and bulk tanks – could be housed in standard industrial type building	Convenient way of bulking materials for transport purposes – care must be taken in storage of hazardous wastes
Civic Amenity Site	None	1,200 minimum	Traffic, litter, noise,	Split level facility with at least 10 rollonoff skips and vehicle parking	Convenient way of segregating waste for recycling and composting

Technology	Pretreatment requirements	Land requirements m^2	Environmental Issues	Visual Considerations	Other Information
Waste Treatment					
Mechanical biological treatment	None but pre-sorting of recyclables preferable through source segregation	10,000 (small – medium) 16,000 upwards (large)	Risk of odour but should be eliminated through process controls, traffic, noise	High Industrial building	Modular units available at 60,000T size – slight saving on land take per unit when more than one sited together
Microbial inactivation	None but pre-sorting of recyclables preferable through source segregation	8,000 upwards (small – medium) 12,000 (large)	Risk of odour but should be eliminated through process controls, traffic, steam emission, noise	Large size horizontal tank shaped autoclave vessels with process pipe work and post treatment sorting via conveyor belt automated processes should be housed in an Industrial type building	Source segregation may become the preferred mechanism for segregation of recyclate due to action from reprocessors (large quoted for 100,000 – 150,000 T capacity)
Pulverisation	none but pre-sorting of recyclables preferable through source segregation	10,000 upwards	Risk of odour but should be eliminated through process controls, traffic, noise	Horizontal trommel drum with post treatment conveyors, batch process so waste storage required also; should be housed in an industrial type building	Source segregation may become the preferred mechanism for segregation of recyclate due to action from reprocessors
Hazardous waste treatment - biological	None except care to avoid inappropriate mixes of waste in process	10,000 (small – medium)	Risk of odour but should be eliminated through process controls, noise, traffic, water pollution, possible COMAH requirement depending on quantities stored and/or hazardous substances planning regulations,	Sewage works type installation, tanks both enclosed and open, could be housed in an industrial type building	

Technology	Pretreatment requirements	Land requirements m^2	Environmental Issues	Visual Considerations	Other Information
Hazardous waste treatment - chemical	None except care to avoid inappropriate mixes of waste in process	10,000	Risk of odour but should be eliminated through process controls, noise, traffic, water pollution, possible COMAH requirement depending on quantities stored and/or hazardous substances planning regulations,	Industrial process plant with palletised drums in stacks and bulk storage tanks	
Hazardous waste treatment – physical	None except care to avoid inappropriate mixes of waste in process	10,000	Risk of odour but should be eliminated through process controls, noise, traffic, water pollution, possible COMAH requirement depending on quantities stored and/or hazardous substances planning regulations,	Industrial process plant with palletised drums in stacks and bulk storage tanks	

Technology	Pretreatment requirements	Land requirements m^2	Environmental Issues	Visual Considerations	Other Information
1.1 Gasification	presorted to remove recyclate & size reduction preferred feedstock	4,500 –7,500 (small – medium) 15,000 upwards (large)	Risk of odour but should be eliminated through process controls, noise, traffic, air emissions well inside waste incineration directive standards, small quantities of hazardous wastes generated from flue gas treatment and water treatment, residuals can be treated as aggregate	Industrial building with stack (typically 30 – 35m high)	Modular units, 7,000 – 50,000 tonnes per annum. Power generation (large quoted for 100,000 T)
1.2 Pyrolysis	presorted to remove recyclate & size reduction preferred feedstock	4,500 – 7,500 (small – medium) 15,000 upwards (large)	Risk of odour but should be eliminated through process controls, noise, traffic, air emissions well inside waste incineration directive standards, small quantities of hazardous wastes generated from flue gas treatment and water treatment, residuals can be treated as aggregate	Industrial building with stack (typically 30 – 35m high)	Modular units, 20,000 – 50,000 tonnes per annum. Power generation
1.3 Incineration – mass burn	None	30,000 – 50,000	Risk of odour but should be eliminated through process controls, air emissions well inside waste incineration directive standards, small quantities of hazardous wastes generated from flue gas treatment and water treatment, noise, traffic, water pollution	Industrial plant with stack – height of stack dependant on topography	50,000 area will handle 250,000 tonnes per annum plant

Technology	Pretreatment requirements	Land requirements m^2	Environmental Issues	Visual Considerations	Other Information
Hazardous waste Incineration	None except care to avoid inappropriate mixes of waste in process	10,000	Risk of odour but should be eliminated through process controls, air emissions well inside waste incineration directive standards, small quantities of hazardous wastes generated from flue gas treatment and water treatment, noise, traffic, water pollution, possible COMAH requirement depending on quantities stored and/or hazardous substances planning regulations,	Industrial plant, either looks like a chemical plant or can be housed in industrial type building, with stack	
Integrated facilities	None but source separation of some waste streams increases quality of recyclate	13,000 – 40,000	Risk of odour but should be eliminated through process controls, air emissions well inside waste incineration directive standards, small quantities of hazardous wastes generated from flue gas treatment and water treatment, noise, traffic, water pollution	Industrial plant with short stack for residuals	40,000 relates to 260,000 T plant energy from waste
Recycling and composting					
Secondary metal smelting	Presorting to ensure clean single metal input	10,000	Air emissions regulated through IPPC, small quantities of hazardous wastes generated from flue gas treatment, process residues and water treatment, noise, traffic,	Industrial plant with stack	

Technology	Pretreatment requirements	Land requirements m^2	Environmental Issues	Visual Considerations	Other Information
1.4 Composting – invessel	Presorting to ensure biowaste only	75 – 120,000	Risk of odour and bio-aerosols but should be eliminated through process controls and containment, noise, traffic,	Very wide range of potential visual appearances from industrial buildings with external maturation of compost product to containerised units with external pipework; external maturation area	Large variety of options including small community or large industrial/commercial producer scale options
Composting - windrow	Presorting to ensure biowaste only; probably only applicable for green wastes in the long term	7,500 – 80,000 plus	Risk of odour and bio-aerosols – should not be located within 250m of occupied property, noise, traffic, windblown material, water pollution risks	Open air composting – rows of waste in various states of composting from as collected to brown earth like material, situated on a concrete pad – should have a water treatment plant to deal with run off.	7,500m2 just sufficient space for 5,000 tonnes green waste per annum 80,000 required for 80,000 T
1.5 Eco park	Clean sorted recyclates plastics, metals, glass may contain a front end MRF for sorting	40,000 – 100,000 upwards including MRF	Noise, traffic	Typically industrial units with external storage of segregated waste fractions, storage arrangements dependant on material type; grouped together around or near a MRF	Typically would be regional facilities even at lower size 80,000 equates to 150,000 T facility
Waste reprocessing industries	Clean sorted recyclates plastics, metals, glass etc	Upto 20,000	Noise, traffic	Typically industrial units with external storage of segregated waste fractions, storage arrangements dependant on material type	Typically would be regional facilities even at this size
Secondary aggregate production	Clean sorted construction and demolition waste	2,000 – 9,000 (small – medium) 9,000 plus (large)	Noise, traffic, dust	Crusher, and piles of aggregate, similar to aggregate quarries	May be done on demolition sites as temporary activity Plant of large size unlikely to be needed

Technology	Pretreatment requirements	Land requirements m^2	Environmental Issues	Visual Considerations	Other Information
Electrical and electronic equipment recovery	Segregated electrical and electronic equipment	Upto 20,000	traffic	Typically industrial units with external storage of segregated waste fractions, storage arrangements dependant on material type	Typically would be regional facilities even at this size
Metal recovery facilities	Segregated metals and large metal consumables e.g. cars	Upto 10,000 (small – medium) 10,000 plus (large	Noise, traffic, dust, water pollution risks	Open crushing, chopping, stacking of metals. Vehicle depollution sites under ELV likely to look more like a modern garage	
Anaerobic digestion	Presorting to ensure biowaste and size reduction only preferred feedstock but can operate on unsorted waste but more residuals to dispose of, also can be used for organic industrial wastes	2,000 upwards (small – medium) 26,000 upwards (large)	Traffic, risk of odour but should be controlled through process control, risk of water pollution but should be controlled through process control	Sewage works type installation, tanks both enclosed and open, could be housed in an industrial type building with shredder for basic pre-treatment, and gas collection pipe-work and gas storage	2,000 m2 Sufficient space for 500m3 tank processing 6,000 tonnes per year – also generates power
Clean Materials recycling facility	Presorting via separate collection for dry recyclables	Depends on waste collection method Upto 14,000 (small – medium) 14,000 upwards (large)	Traffic, noise, risk of odour but should be controlled through process control, risk of water pollution but should be controlled through process control	Standard industrial type building	

Technology	Pretreatment requirements	Land requirements m^2	Environmental Issues	Visual Considerations	Other Information
Dirty Materials recycling facility	none	Upto 14,000 (small – medium) 14,000 upwards (large)	Traffic, noise, risk of odour but should be controlled through process control, risk of water pollution but should be controlled through process control	Standard industrial type building	May have long term problems with marketing recyclates
Final Disposal					
Landfill inert	Source segregation of inert materials very limited definition	Dependant on depth of fill and length of anticipated life	Dust, noise, traffic	Similar to quarries	
Landfill biodegradable	Source segregation to ensure no hazardous materials	Dependant on depth of fill and length of anticipated life	Dust, noise, traffic, water pollution risk, odour, landfill gas, litter,	Similar to quarries but with added litter problems	Should not be sited within 250m of occupied property
Landfill hazardous	Source segregation to ensure no liquids or banned substances	Dependant on depth of fill and length of anticipated life	Dust, noise, traffic, water pollution risk, odour, landfill gas	Similar to quarries	