

APPENDIX I

CASE STUDIES FOR MSW ASH RESIDUE RE-USE APPLICATIONS

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APPENDIX 1

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A1 UK CASE STUDIES

Edmonton: Ballast Phoenix has a long term contract with London Waste Ltd to process and market the production of incinerator bottom ash (IBA) at Edmonton, which is currently 140,000 tonnes per annum. Ballast Phoenix has a quality management system and processes the IBA to meet customer needs. The processed IBA is being sold to a broadening customer and applications base. There are some pilot projects in existence which include:

- a joint venture project run by ONYX and Hanson Aggregates at Aveley, Essex using ash from SELCHP;
- a project between Bardon Aggregates and Dudley Metropolitan Borough Council using ash from the local incinerator;
- a project run by Ballast Phoenix at Tyseley.

The existing Aveley and Dudley projects and a future project at Cleveland are described in more detail below¹.

Aveley, Essex: At Aveley landfill site, a pilot project has been set up to process incinerator ash to produce secondary aggregates. Various product sizes have been manufactured from the final screening plant to supply identified markets and include: 10mm aggregate for block manufacture, 20-10mm aggregate for coating and 40mm aggregate for bulk fill. These materials have been used in various trials. The pilot scheme is also investigating the following issues:

- the processing operation required to manufacture aggregates acceptable to the industry;
- the application and implications of relevant planning, waste handling and licensing operations;
- the removal, recycling and disposal of metal contaminants;
- the mechanical and chemical properties of the processed aggregates;
- the monitoring of the products and potential leachates.

Netherend Lane, Dudley: Recently, Dudley Metropolitan Borough Council, in conjunction with Bardon Aggregates, has used IBA in road reconstruction. The ash was used in the base course layer of a half mile stretch of road (Netherend Lane) in a residential area of Dudley in the West Midlands. The ash was obtained from Dudley's MSWI and taken to Castle Bromwich where it was processed by Ballast Phoenix. Then at Bardon's coating plant in Leicestershire, it was processed to produce a bituminous material called ASHphalt. The amount of ash used was equivalent to several days of production at the incinerator. This had dual environmental benefits - avoiding the need to landfill the ash and reducing the requirement to use virgin aggregate for the road. The percentage of ash allowable in the ASHphalt depends on local circumstances and the traffic category of the road. In this case, at least 50% of primary aggregate was replaced by ash. ASHphalt is the subject of a patent application.

Cleveland: Construction of the Cleveland Waste Management facility will be completed during summer 1999. Ballast Phoenix has a contract to design and project manage construction of the facility followed by a long term contract to include the processing and marketing of 65,000 tonnes per annum of IBA.

A2 DUTCH CASE STUDIES

In the Netherlands the government policy is to achieve utilisation of more than 80% of incinerator residues. In practice, approximately 95% of the bottom ash is currently utilised. The principal motivation for utilisation in the Netherlands is the shortage of suitable natural aggregate and the lack of available landfill space. The primary use of bottom ash is in the following applications:

- road base material for roads and industrial sites
- material for embankments, noise and wind barriers
- aggregate in concrete and concrete products, and
- aggregate in asphalt concrete

A total of more than 2 million tonnes of bottom ash has been used in the listed applications. In addition, 30-40% of the fly ash produced since 1984 has been used as a fine aggregate filler in asphalt concrete. The following is a summary description of several major ash utilisation projects²:

Caland Wind Barrier: This project carried out in 1985 used more than 650,000 tonnes of bottom ash in an embankment with a length of 700m and a height of 15 m. The ashes are covered with a primary cover layer of 0.5 m compacted clay with a sand drainage layer (0.5 m) and top soil (1 m) overlaying the clay layer. The slope of the compacted ash is 1:2 and 1:2.5. The mean compaction factor was 97.5% with a wet density of 1840 kg/m³. Groundwater quality is monitored on both sides of the embankment.

Highway A-15 Rotterdam: Approximately 400,000 tonnes of bottom ash was used in an embankment for this major roadway construction. Ash is covered with a compacted sand-bentonite mixture with a minimum thickness of 20 cm to reduce water infiltration.

Road Base Material: Several projects with bottom ash as road base material have been carried out in Rotterdam and North Holland. In Rotterdam, primarily a mixture of ash, crushed rubble aggregate and additive (50%-50%-10%) has been used. The base thickness is 25-30 cm.

Concrete Paving Blocks: A project in Keilehaven carried out in 1984 used more than 300,000 concrete paving blocks in which the coarse aggregate was replaced up to 40% with the 5-8 mm fraction from bottom ash. After five years of traffic, it was concluded that there was no difference in physical properties between standard concrete paving blocks and those using bottom ash as the coarse aggregate replacement. Laboratory investigations of environmental properties of concrete paving blocks with 20% replacement of the coarse aggregate by bottom ash indicated no significant difference from conventional paving blocks.

Hartel Canal Pilot Project: A pilot project with asphalt containing bottom ash was carried out in 1987 along the banks of the Hartel Canal. A length of approximately 50 m was coated with about 100 tonnes of asphalt containing 30% bottom ash. It was found that the mixture temperature was required to be 40°C higher and the bitumen content 3% higher than traditional material.

A3 SWEDISH CASE STUDY

In Sweden, use of compacted bottom ash as roadbase underlying asphalt pavement and as embankment was evaluated in a test road segment located in Malmo². Use of fresh bottom ash, bottom ash which had been aged for one year and natural aggregate was compared. All ash was screened to less than 20 mm and had ferrous metal magnetically removed prior to use. It was found that aged ash (moisture content 16%) was readily compacted while compaction of fresh ash (moisture content 23%) resulted in failure of bearing capacity during compaction. Both ash types had an optimum moisture content of about 14% for proctor

compaction. Maximum compacted dry density for ash was between 1.79 and 1.82 tonne/m³. Test results on the road indicated that the ash layers physically performed similarly to the natural aggregate. Environmental evaluation indicated that release of trace elements from bottom ash was similar to or less than that observed for natural materials.

A4 DANISH CASE STUDIES

Danish incinerator facilities produce approximately 420,000 tons of bottom ash annually (including grate siftings and boiler ash which in most cases are mixed with the bottom ash) the overwhelming majority of which is utilised. Since 1974, screened and sorted bottom ash has been utilised in Denmark for civil engineering purposes, particularly as sub-base material at parking lots, bicycling paths, and paved/unpaved residential and major roads³. As a sub-base material, the bottom ash is usually substituted for the diminishing supplies of natural gravel in various parts of Denmark. Thus, the incentives for utilisation include both natural resource conservation and economic benefit. A substantial portion of the economic benefit is derived from the avoided costs of landfilling, which is typically 150 euros per tonne.

A5 CANADIAN CASE STUDY

Because of the availability of landfill and the modest production of incinerator ash, there is little incentive, either economic or environmental, to pursue ash utilisation applications in Canada. The only notable example of ash utilisation is the use of bottom ash from the Burnaby Incinerator facility to construct access roads within a landfill². The bottom ash undergoes ferrous removal prior to leaving the Burnaby facility, the Greater Vancouver Regional District, but no other processing is done other than compaction during placement. As utilisation becomes more wide spread in other countries, it is expected that the practice will be considered more seriously in Canada.

A6 AMERICAN CASE STUDIES

In the United States, several factors have influenced the possible uses for incinerator residues in construction applications. The shortage of existing landfill space and the difficulty of securing new sites has created a situation in which either disposal fees are costly, disposal space must be sought in distant locations, or disposal will not be possible. Hence, recycling and reuse of residual wastes has been suggested as the preferred management option.

The following paragraphs highlight summary information for key demonstration projects utilising municipal solid waste incineration residues in the U.S.⁴

Following successful testing for the Sumner county, Tennessee, waste-to-energy plant, the American Ash Recycling Corporation (AAR) of Jacksonville, Florida, built a 110-ton-per-hour ash recycling facility for the Metropolitan Government of Nashville and Davidson County, Tennessee, waste-to-energy plant. The AAR facility recovers non-ferrous as well as ferrous metals from the ash and is selling those materials in addition to the aggregate itself. The AAR facility is not only processing current ash production from the Nashville waste-to-energy plant, but is also processing previously generated ash – reclaiming space from the landfill. The state of Maine recently approved the use of AAR's processed ash for beneficial use. AAR will build a plant in Scarborough, Maine.

In 1988, the SEMASS Resource Recovery Facility in Rochester, Massachusetts, began to manufacture Boiler AggregateTM, an engineered, granular product made from the facility's bottom ash. In 1994, the SEMASS ash processing plant produced 29,000 metric tons of Boiler AggregateTM. In the process, 3600 metric tons of non-ferrous metals were recovered from the ash, in addition to 13,200 metric tons for ferrous metals recovered from the trash prior to combustion. An asphalt access road constructed at the site using 30% Boiler AggregateTM substitution has performed well. The state of Massachusetts recently approved the use of Boiler AggregateTM in asphaltic paving.

The city of Commerce, California, has been using the ash from its waste-to-energy plant for 5 years. So far more than 1000,000 tons of ash has been used for road base at the landfill, and more than 8,000 tons of ferrous metal has been recovered. For the last two years the city has not had to dispose of any ash.

Some processes treat waste-to-energy ash prior to beneficial use. Wheelabrator Environmental Systems, for example, has developed and patented an ash stabilisation process, WESPHix®, which is marketed since 1987 and advertises as the most widely used in the United States.

Rolite, Inc., of Wayne, Pennsylvania, has been processing combustion ash since 1988. Rolite's cement-based stabilisation process produces small, ash-cement balls with good physical properties as a lightweight aggregate in concrete. The product has been evaluated for use in landfills as daily cover, gas venting and drainage layers, and for structural fill.

Beneficial Ash Management of Morrisdale, Pennsylvania, has been using fly ash and fluidised bed combustion ash from coal fired power plants to create a cement-like material or grout which it has in turn used to successfully "cap" strip mine reclamation sites with impermeable barriers to prevent acid mine drainage. Because of the large amounts of grout needed for such mine reclamation, use of conventional Portland cement would be prohibitively expensive. The alkali-activated, ash-based grouts, similar to the cement used by the Romans (much of which is still intact today) are far less expensive. Now the company has established a sister company, Municipal Ash Management, to make similar grouts from waste-to-energy ash.

The State of Florida has certified that bottom ash from Tampa's McKay Bay Refuse to Energy Facility is a suitable material for road construction and therefore considered a recovered product not subject to regulations for waste materials. The state has also approved Permabase®, a soil cement substitute made from ash from the Hillsborough County, Florida, waste-to-energy facility.

The State of New York at Stony Brook built a boathouse of hollow masonry blocks made from a mixture of waste-to-energy ash and Portland cement. Thorough testing found that the blocks did not release environmental contaminants and performed well structurally. The university and others have also demonstrated the suitability of beneficial use of waste-to-energy ash products in the ocean by building artificial reefs and erosion control structures.

NREL is cosponsoring a series of five studies on the use of waste-to-energy ash. A completed study in Laconia, New Hampshire, examined substitution of bottom ash for rock in an asphalt mixture. Used for resurfacing a federal highway, the asphalt performed well and produced no adverse environmental consequences. A study of using energy-to-waste ash for road-base aggregate in New Jersey found that there was no adverse environmental consequences of storing the ash in exposed piles prior to use. This ash was mixed with asphalt for paving the entrance to an industrial park in Elizabeth, New Jersey. The city of Honolulu, Hawaii, is testing the use of their waste-to-energy ash in place of soil in landfill maintenance.

Two other NREL studies are underway in Virginia. One will test the use of ash mixed with Portland cement to build containers for "pop-up" railroad-crossing barriers. The other will examine the environmental consequences of using the blocks made from waste-to-energy ash and phosphate cement for revetment walls for beach erosion protection. In addition, to the NREL studies, a Federal Highway Administration evaluation of the use of ash products for road construction projects in six states found that they worked well.

A7 REFERENCES

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