EXECUTIVE SUMMARY

Israel like many developing economies has relied on the use of the open dump for the disposal of its waste for many years. In the late 1980s, 96% of Israel's municipal waste was disposed in about 500 uncontrolled garbage dumps. Most dumps were poorly managed and many had reached or were soon to reach capacity. Uncontrolled dumps were associated with environmental problems such as risk of groundwater and soil contamination, odour, air pollution (including generation of greenhouse gases), aesthetic blight, threats to flight safety, and consumption of expensive tracts of land. Although many sites have been closed there still remains a number that continue to operate. Most of the dumps were located on or near to groundwater recharge zones that was putting the groundwater at risk. As Israel has a high dependence on groundwater as a source of potable water something needed to be done.

Recognition of the severity of the problems led, in 1993, to a government decision, mandating closure of the country's unregulated dumps, their replacement by state-of-the-art regional and central landfills, financial aid to local authorities for transporting their wastes to a regulated landfill for a defined time period and advancement of recycling and energy recovery.

Therefore the first step was to take a strategic view that it would close all of the open dumps and create 4 regional state of the art landfills engineered to international standards. To identify the location of these new sites the existing sites were transposed onto a groundwater map of Israel that identified hydroteologically sensitive zones. This in turn allowed the best locations to be identified both
hydrogeologically and strategically for either new sites to be created or where existing sites could be upgraded.

Clearly it has been demonstrated that Israel wishes to improve the image of waste management and particularly landfill. The establishment of regional landfills as described above and the efforts to rehabilitate the remnants of past landfill activities is a demonstration of Israel's commitment to bring waste management up to recognised international standards.

Furthermore though the efforts of the International Solid Waste Association, the Israeli Solid Waste Forum and the Israeli Government's Ministry of the Environment training is being provided for the waste industry practitioners. As recently as November 2004 a Landfill Operations and Maintenance Workshop was held in Tel Aviv which was attended by around 90 delegates from the waste industry which included operators, academia, consultancies, NGOs and the waste regulators. Lecturers presented a series of 10 lessons over 2 days from the United States and the United Kingdom. The lessons covered day to day site operations, leachate and landfill gas management, equipment selection and maintenance, health and safety, waste screening, special (hazardous) waste management, groundwater monitoring and closure/post closure care.

INTRODUCTION

Israel like many developing economies has relied on the use of the open dump for the disposal of its waste for many years. In the late 1980s, 96% of Israel's municipal waste was disposed in about 500 uncontrolled garbage dumps. Most dumps were poorly managed and many had reached or were soon to reach capacity. Uncontrolled dumps were associated with environmental problems such as risk of groundwater and soil contamination, odour, air pollution (including generation of greenhouse gases), aesthetic blight, threats to flight safety, and consumption of expensive tracts of land. Although many sites have been closed there still remains a number that continue to operate. Most of the dumps were located on or near to groundwater recharge zones that were putting the groundwater at risk. As Israel has a high dependence on groundwater as a source of potable water something needed to be done.

Recognition of the severity of the problems led, in 1993, to a government decision, mandating closure of the country's unregulated dumps, their replacement by state-of-the-art regional and central landfills, financial aid to local authorities for transporting their wastes to a regulated landfill for a defined time period and advancement of recycling and energy recovery.

Therefore the first step was to take a strategic view that it would close all of the open dumps and create 4 regional state of the art landfills engineered to international standards. To identify the location of these new sites the existing sites were transposed onto a groundwater map of Israel that identified hydroteogeologically sensitive zones. This in turn allowed the best locations to be identified both hydrogeologically and strategically for either new sites to be created or where existing sites could be upgraded. As a result:-
Two existing landfills, Ashdod (in the southern coastal area) and Evron (in the Western Galilee) were to be prepared and equipped to serve as regional sites on a temporary basis (about three years);

Two existing landfills, Duda'im (northwest of Beersheba) and Talya - Hagal (in the northern Jordan Valley) were to be improved according to strict environmental requirements and expanded within one year to serve as central sites for a significant part of the country's waste with the exception of hazardous waste.

As an incentive for the local authorities that had the two landfills, which were planned for expansion (Dudai’m and Talya – Hagal), within its boundary a levy of 75 cents per tonne is paid to the local authority. The local authority is to put aside 50% of this levy to provide for the aftercare of the site for a period of 25 years following the statutory 5-year cover beyond final restoration that has to be provided by the operator. The remaining 50% can be used for any other environmental project that the local authority identifies. This could range from the provision of conservation areas to be used as public open space or simply the surfacing of highways to prevent the production of dust.

REGIONAL LANDFILLS

Dudai’m/Ganei Hadas Landfill Complex
This landfill complex was developed on a former landfill for which it could be demonstrated that it was not within an hyrogeologically sensitive area with groundwater some 40-60 metres below the base of the landfill. Although the former site has been closed an overtipping scheme has been agreed. Before waste can be placed in this extension area the old landfill will be sealed with an engineered cap to engineering standards equivalent to that which would normally be required for the basal seal.

There are two landfills at this complex: the Dudai’m and the Ganei Hadas landfills.

When the Dudai’m site was identified as a potential regional facility there were objections from the Beer-Sheva Municipality. However the National Planning Board overturned these objections in 1996. Permission was granted in the first instance for landfilling to continue for 3 years and another additional 3 more years, all together 6 years. In addition to that the project was approved with a substantially decreased area of operation and the amount of waste was limited to 2,715 tons per day.

Because of that it was essential to have two landfills, one for the nearby area – Duda’im, which is run by the Regional Council of Bnei-Shimon, and the Ganei Hadas a central landfill, needed urgently as a solution for the Hiria dump, which is owned and operated by a private company. (M.M.M United Landfill Industries (1998) Ltd.). However there will be sufficient landfill void available at the complex for landfilling to continue well beyond this date.

DUDAI’M LANDFILL SITE
Site Entrance - Dudai’im Landfill Site

The base and sides of the landfill are engineered using a composite clay and high-density polyethylene liner overlain with a sand leachate collection layer. The leachate collection system is connected to a sidewall riser to allow the leachate to be removed for treatment by evaporation in the leachate evaporation lagoon to the west of the site.

The site has a total capacity of 7 million cubic metres that includes 2 million cubic metres already in place in the former dilute and attenuate phase. The current operational phase has a total capacity of 4 million cubic metres with the overtip providing a further 1 million cubic metres. Based on an input rate of 1,500 tonnes per day this will yield a site life of approximately 10 years from when operations commenced in 1998. To extend the life of the landfill for municipal waste a dry (industrial) landfill has been developed to the north east of Dudai’m landfill. This site is operated and engineered to the same standard as Dudai’m and uses the same site infrastructure. Any putrescible waste is removed for separate disposal and only wood, plastics and inert wastes are finally landfilled. The waste separation activity is labour intensive and what material cannot be removed mechanically is separated manually.

Landfill gas is extracted from the MSW site and used to generate 1.7MW of electricity using Jenbacher engines. A standby ground landfill gas flare is available to burn the gas should the engines be down for maintenance or plant failure.

**GANEI HADAS LANDFILL SITE**

Unlike Dudai’m the Ganei Hadas landfill immediately to the north is operated by the private sector. It is engineered and operated to the same standards as the Dudai’m landfill. Leachate is controlled by pumping it form the site through the sidewall risers and then re-circulated by spraying it on to the fresh waste using a tanker fitted with a spray bar. Additionally leachate is used for dust control on site roads within the containment engineering.
The site is permitted to dispose of 3,000 tonnes of waste per day with a current input of 2,715 tonnes per day (a million tons per year). The input is primarily municipal waste transferred from Tel Aviv great area some 100 kilometres to the north.

The site covers an area of approximately 40 hectares and is excavated to a depth of 18 metres below ground level. The finished site profile will be 52 metres above ground level at its highest point. The site operates 6 days a week closing Friday afternoon and re-opening Saturday evening.

Although there is a long-term objective to generate 5MW of electricity from the landfill gas economics do not allow that currently. As a result landfill gas is burned at a number of low temperature candlestick flares. The landfill is expected to generate 7,000 cubic metres of landfill gas per hour at its peak.

Of particular interest at this site is the establishment of a small zoo as an initiative to improve public perception.

Zoological Gardens - Ganey Hadas Landfill Site

**Effe Landfill Site**

Effe landfill is a regional/central landfill some 140 kilometres to the south of Tel Aviv. Originally it was envisaged that the site would be rail linked enabling it to be used for waste from all over Israel as it has a life time of several decades and is in an area of industrial dereliction from the mining of phosphate ore. The waste input was expected to be in the order of 5,000 tonnes per day but in reality without the rail link is now running at between 500 and 1,000 tonnes per day.

The site occupies a total surface area of 200 hectares of which the first phase of the landfill that was opened in the spring of 2003 covers an area of 60 hectares. This phase is sub divided into a series of 10 cells with a surface area of approximately 6 hectares each with an approximate capacity of 6 million cubic metres of void space.
To create the landfill the mining overburden is excavated to 20 metres below the natural ground surface. To create the first cell some 500,000 cubic metres of overburden had to be re-located within the complex. Waste will then be deposited to an average height of 60 metres above the natural ground surface giving a maximum depth of waste of 80 metres.

The site has been engineered on the containment principle despite the groundwater receptor being 400 metres below the base of the site. The engineering formation comprises 1.5 metres of compacted natural materials, 400 mm of compacted clay and a High Density Polyethylene geomembrane. This formation is protected by a geofabric and overlain by a sand drainage layer. The drainage layer has within it a network of leachate collection pipework connected to sidewall risers.

During the site development concern was expressed as to how the integrity of the engineering could be measured. Clearly it was not practical to install monitoring boreholes to a depth in excess of 400 metres so it was agreed that visual monitoring of the adjacent river on a monthly basis would be adequate. Much of the year the river is dry so it would be relatively easy to identify leachate breakouts on the riverbed. Landfill gas monitoring would be undertaken using traditional borehole techniques but again potential receptors are so far from this remote site that landfill gas migration is unlikely to be of concern.

Although the area is semi-arid, complexity of quarry zones and flood events resulted in engineering challenges. The site was designed to resist on site runoff events of 1/50 years and 1/100 years in the Effe wadi that bisects the Landfill into its two phases. Furthermore it was necessary to build a new access road raised by 40 meters above the surrounding ground and a 160m long culvert 2x2 m square.
Hiriya landfill was identified as one of the landfills that needed to shut as part of the rationalisation of landfills identified as part of the Government’s strategic review. Not only was it considered to be no more than an open dump it was also on the flight path to Tel Aviv international airport which was of major concern since the site attracted copious numbers of gulls. An attraction for bird spotters as it had a diverse population but a real risk as a potential for aircraft bird strike.

As a result the landfill was closed in 1998 and a transfer station built which receives 2,700 tonnes of municipal waste per day from the Dan Region. This is then transferred to the regional landfills at Effe and Ganei Hadas. In addition Arrow Ecology has developed a Biological Mechanical Treatment process to treat 70,000 tonnes of municipal waste per annum. After the separation of plastics, ferrous and non-ferrous metals and inert waste including glass the residue is anaerobically digested to produce methane and compost. The methane gas is then converted to electricity in Caterpillar spark ignition engines.

Clearly the landfill as it stands remains an environmental liability. It is an unengineered landfill covering an area of 45 hectares. It contains 16 million tonnes of waste and has leachate perched to a depth of 40 metres from the base. The landfill is also a landscape eyesore as it stands 60 metres above the surrounding plain. Until now there has been no control of landfill gas but more recently 60 gas wells have been installed which will be ultimately connected to a power generation plant to produce electricity for the long-term vision for the site or as a supply for public consumption.
As part of the rehabilitation process an Ayalon Park charrette was established in January 2003 that brought together local and foreign planners experienced in designing parks and rehabilitating disturbed site, architects, landscape architects, ecologists and engineers. This has resulted in an overall planning concept being developed for Hiriya landfill and the surrounding land.

Despite the charrette only deliberating in January 2003 and the Ayalon Park statutory plan awaiting final approval preliminary work is already under way. Already a network of paths for pedestrians and cyclists have been established along the Ayalon and Shafirim streams that are currently being paved with recycled materials. 2,500 children have planted trees along the Ayalon stream and in areas of Park Darom. Work has also commenced on the establishment of a visitor’s centre and recycling park at Hiriya landfill.
Collective Ideas Plan

Following the approval of the plan for the area in late 2004 by a sub-committee of the National Planning and Building Board the Israeli Government in April 2005 approved a decision to establish the Ayalon Park in an area that spans 800 hectares. The Hiriya landfill will form the focal point for the park that will be rehabilitated to provide recreational and leisure areas. A recycling park will be included in the overall development. It is likely that a wetlands area will be established which will not only help to create a diverse habitat close to Tel Aviv but which can be used to assist in the treatment of leachate from the landfill. Some consideration is also being given to the establishment of workshop units for recycling industries near to the visitors centre.

The development will be funded on a like for like basis between the Government and the local community. The government has committed to a ceiling of 10 million shekels ($2.2 million) per year for the next 5 years with 3 million shekels ($668,000) being allocated for the planning of the park this year.

CONCLUSION

Clearly it has been demonstrated that Israel wishes to improve the image of waste management and particularly landfill. The establishment of regional landfills as described above and the efforts to rehabilitate the remnants of past landfill activities is a demonstration of Israel's commitment to bring waste management up to recognised international standards.

Furthermore though the efforts of the International Solid Waste Association, the Israeli Solid Waste Forum and the Israeli Government's Ministry of the Environment training is being provided for the waste industry practitioners. As recently as November 2004 a Landfill Operations and Maintenance Workshop was held in Tel Aviv which was attended by around 90 delegates from the waste industry which
included operators, academia, consultancies, NGOs and the waste regulators. Lecturers presented a series of 10 lessons over 2 days from the United States and the United Kingdom. The lessons covered day to day site operations, leachate and landfill gas management, equipment selection and maintenance, health and safety, waste screening, special (hazardous) waste management, groundwater monitoring and closure/post closure care. This was all put into perspective by showing an educational video "The Land that Time Forgot" produced for the United kingdom Environment Agency as a training tool for it's field officers.

ACKNOWLEDGEMENTS

The authors wish to express their thanks to Warwickshire County Council, the Israel Ministry of the Environment, the Israeli Waste Forum, the Chartered Institution of Wastes Management and the International Solid Waste Association for their assistance in the preparation of this paper.

RETURN