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INVESTIGATION OF MUNICIPAL SOLID WASTE MANAGEMENT IN GCC STATES

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CHAPTER VIII

Composting: Case Study from Kuwait

8. Composting: Case Study from Kuwait

Due to the importance of composting as an alternative in any waste management scheme, especially within the GCC states, the past and future trends in waste composting in Kuwait will be examined as an example of a GCC state.

The GCC states combined produce a total of 2.9 million tons/year of MSW, of which on average 47% by weight is compostable materials and potential feedstock for the GCC's several composting facilities. About 1.4 million tons per year of such materials would be potentially available for composting plants, which have operating capacities ranging from 500 to 700 tons/day. This means that enough compostable material is produced by the GCC to fulfil the required amounts for such composting plants. Moreover there may be a potential for setting up a regional composting plant in view of the large amounts of compostable materials generated within the GCC.

In general, composting seems to be economically feasible in the GCC if the governments would support the marketing of the compost product. To further emphasise the need for government support, an example, the Kuwait

Organic Fertiliser Company (KOFCO) will be discussed here. Recently KOFCO announced in private that it was accumulating losses due to the hard stance of the government in not buying KOFCO's compost product. Although the **Agriculture Authority** in Kuwait is in need of soil conditioner, and as a result, imports large quantities of compost from Holland, Germany and even Saudi Arabia through local contractors, KOFCO has not been given the chance to market its product to the Agriculture Authority. The **Agriculture Authority**'s officials indicated that the authority is currently involved in legal contracts with local contractors who import compost on behalf of the authority. They also mentioned that as soon as the current contracts are finished and a new budget is approved for supplying compost, they would invite KOFCO to be treated as one of the local contractors after approval of the quality of its compost (See appendix VII on Criteria for specific applications of compost). Currently, KOFCO is in a weak position financially. Government support in terms of obtaining part of its requirements for compost from KOFCO would surely enhance KOFCO's financial position. KOFCO's statement of cash flow for the year ending 31 December 1996 shows the company's weak condition.

TABLE 8.1: KOFCO's financial position as of 31 December 1996

Cash Flow-Operating Activity	**1996**	**1995**
	KD	**KD**
Loss for the year	512,282	30,807
Adjustment for non-cash items:		
Depreciation & amortisation	197,318	7,545
Provision for inventory–write off	76,502	-
Other costs written off	27,314	-
Operating loss before working capital changes	**211,148**	**23,262**

Due to both the need to conserve the limited available land and the need for soil conditioner, the GCC states have to consider composting as the most viable waste management alternative. Table 8.2 shows the quantities of MSW and the proportion of compostable materials generated in the various GCC states based on data presented in earlier chapters.

TABLE 8.2: MSW quantities and potential portions for composting

	UAE	**Saudi Arabia**	**Bahrain**	**Qatar**	**Kuwait**	**Oman**
MSW (t/y)	527668	1413950	155000	187975	675648	511000
Compostable Materials (%)	35	41	53	58	50	40

8.1 Composting as an MSW Management Alternative for Kuwait

The amounts of MSW entering the three main landfills in Kuwait could potentially be decreased by 70%. This would be possible if a complete and clearly defined strategic plan for the recycling and the composting of Kuwait's MSW were prepared. A comparison of the percentages of the compostable portion of the MSW in the USA and the State of Kuwait indicates that the former's compostable materials, including paper waste, can constitute anywhere from 30 to 60% of the waste stream (Chertow, 1989; in the State of Kuwait, the proportion of the compostable materials (i.e., 45 to 70%) exceeds that of the USA. The major advantages of operating a recycling-composting facility in Kuwait are as follows:

- A major reduction in the total volume of waste prior to disposal in landfills, resulting in increased lifetimes for the present sites.
- The production of compost, which may be used as a soil-conditioner or mulch, to strengthen and provide Kuwait's soil with the required nutrients and to improve the air-water relationship in the soil, which would increase the water-retention capacity and encourage more extensive development of root systems.

- The generation of income from selling recyclable materials to various industries such as the paper and carton plant, the glass plant and the aluminium plant, among others.
- Creation of a simple but effective scheme for MSW management from an ecological and environmental point of view.

8.2 Kuwait's Experience in Composting

Kuwait's old composting plant, which was built south ofSulaibiya in the late 1960s, has been a perfect example of both poor management and poor operation by the authorities. The pilot plant was owned and operated by the Municipality of Kuwait. The plant, which used a process provided by Djeroment of France, had a low yield rate of 10,000 tons/year, barely half of its designed capacity of 100 tons/day of MSW. The final product was coarse compost containing large portions of non-compostable materials due to major difficulties involved in the operation of the plant such as:

- Poor screening, which caused major damage to the shredders by the passing metal objects.
- General lack of spare parts.
- Waste in plastic bags passing intact across the vibrating screen.

- Insufficient power of the magnetic drum causing less removal of ferrous metal, which damaged the crushers.

In 1984, the Municipality of Kuwait decided to abandon the compost pilot plant since it was not feasible to continue operating it as it produced a poor quality of compost product at a cost of KD 16/ton while demanding only a KD 1/ton selling price. The Municipality, during its operation and management of the plant, did not encourage or even request that residents separate out the compostable portion of the waste they generated. Source separation would have helped decrease the operational problems. This is an obvious example of the lack of decision, which would have saved the plant from deterioration.

8.3 Further Developments

In 1988, Kuwait's government appointed a local consulting firm to prepare a feasibility study for setting up one or more industrial plants for MSW recycling and composting as an alternative for waste management in Kuwait. A summary of the main findings and conclusions of the study are as follows:

- In general, the amounts and characteristics of MSW are sufficient and suitable for processing and conversion into soil conditioner.
- The study recommended that, as a first step, only a single compost plant be constructed with a design-input capacity of 700 tons/day of MSW operating on a single 8-h shift. The expected compost product amount from such a plant was estimated at about 200 tons/day.

The market potential for the three major consumers, i.e., the government, farms and private dwellings, were also constructed (Table 8.3).

TABLE 8.3: Land Available for Compost Application

Consumer	**Land in million (km^2)**	**Application (Tons per 3169 m^2 per year)**
Government	18.6	5.0
Farms	140.9	7.0
Private Dwellings	212.5	0.5

Table 8.3 indicates that although the largest land is shown under the private dwellings, the annual amounts of compost needed is rather small in

comparison with the amounts that would be needed by the farms. Farms would need a total amount of 312,000 tons of compost per year. On the other hand both government and private dwellings would require together about 60,000 tons of compost per year. The need to green the land in Kuwait and other GCC states is part of the governments' policy on beautifying their cities. It is expected that the demand on compost will continue to grow in this region. The future demand for compost is predicted as follows (Table 8.4):

TABLE 8.4: Future Compost Demand in the State of Kuwait

Year	1990	1995	2000	2005	2010
Demand (tons)	428.9	552.0	656.7	779.4	897.4

It goes without saying that almost 50% of the total input of the 700 tons of MSW are organic. Moreover, typical loss from evaporation and rejects amounts to more than 40%. Thus as a second step, more compost plants could be installed according to the demand for the compost product and after sufficient experience in composting is gained.

The initial compost plant was recommended to be built south of the Amghara area (an industrial zone). The capital cost of the project based on estimates for European equipment and local civil work was as follows:

TABLE 8.5: Capital cost for compost plant in Kuwait (figures are in K.D)

Plant and machinery (installed)	4,764,270
Civil work	3,885,000
Site preparation & development	8,000
Subtotal	8,657,270
Pre-operating expenditure	1,079,614
Working capital	327,553
Total Cost	10,064,437

The likely revenue from the project's main products, i.e., compost and by-products such as paper, glass, and metals, is provided in Table 8.6.

TABLE 8.6: Expected Revenue from sale of Compost and Recyclable Materials in K.D

Product	Amount (t/y)	Price/t (K.D)	Revenue (K.D)
Paper	5040	13	65520
Glass	6804	6	40824
Metals*	11088	90	997920
Total	22,932		1,104,264

*Metal is considered to be mainly aluminium.

The revenue from the sales of the by-products per year is equal to K.D 1 million, which is greatly dependent on the sale of the recycled aluminium, appears to be overestimated in this study. It is estimated that the cost of the by-products separation and marketing would amount to K.D 50,000 as follows (Table 8. 7):

TABLE 8.7: Cost of by Products Separation and Marketing

Item	K.D
Manpower	36,420
Transportation	4,200
Equipment	1,800
Administration	3,600
Other	4,000
Total	50,000

The likely revenue from the sales of the compost product (200 tons/day) is estimated at about K.D 8000, which can be expressed per year (300 working days) as about K.D 2.4 million. The selling price per one ton of compost is estimated at about K.D 40 for high quality product. This may be an optimistic assumption, since it is difficult to achieve this high quality product from MSW.

The estimated operating cost of producing the final compost product is about K.D 26 per ton. The project's implementation was recommended to extend over 2 years. Two policy options were studied for the establishment of procedures for the compost plant. The first option calls for the Kuwaiti government to finance and operate the compost project, which will have a lifetime of 20 years. The second option was based on the assumption that the Kuwaiti government would finance the entire project, and employ a subcontractor from the private sector to operate and manage the compost plant. The final conclusion and recommendation addressed the strategic importance of the project and indicated that the implementation of such a project should be immediate. Moreover; the project was recommended to be financed and owned by the Kuwaiti government. The project's required financing was estimated to be around K.D 10 million. Managing and

operating the compost plant was recommended to be left in the hands of a capable private-sector company, thus allowing income to be based on performance.

Until July of 1990, the government-company established to conduct the management and operation tasks for the compost plant had not completed the required steps for full implementation. Then, on 2 August, Iraq invaded the State of Kuwait and all activities were postponed.

After Kuwait's successful liberation, great interest was shown by the private sector in waste treatment and reuse. A group of investors established Kuwait's fertiliser company (i.e., KOFCO) as a result of the government's encouragement of the private sector to participate in the privatisation process of various governmental projects. The private company prepared a feasibility study covering both the technical and financial aspects of waste recycling and composting in Kuwait. The proposed compost plant was designed to accommodate 700 tons/day of domestic waste. According to Municipality officials, the plant they desire should be able to handle a minimum of 1400 tons/day of MSW and a maximum of 2100 tons/day. The Municipality's intentions were to permit the private sector to build two separate compost plants; one south of Kuwait's metropolitan areas and

another north-west of Kuwait City. This was basically to create an equal opportunity to serve all of the districts within the metropolitan areas. The land requirement for each of the proposed compost plants is 60,000 m^2. The Municipality displayed some flexibility in terms of collecting and transporting the MSW to the sites of the composting plants during the first few years of the projects. Moreover, the Municipality indicated that companies interested in recycling and exporting valuable materials from wastes might well be permitted to perform their operations in conjunction with the compost operations. A major problem with the present situation is the unclear relationship between the investors and the Municipality. The absence of co-ordination between the two parties is noticeable. A complete management scheme for the collection and transportation of MSW to the compost plants should be established, and the roles of both investors and authorities should be clarified.

Based on voluntary transportation of MSW by both the public and the Municipality's contractors or others, the scheme in Figure 8.1 may be the most likely scenario for MSW delivery to the proposed compost plants. By law, the Municipality's contractors and other contractors are obligated to deliver the

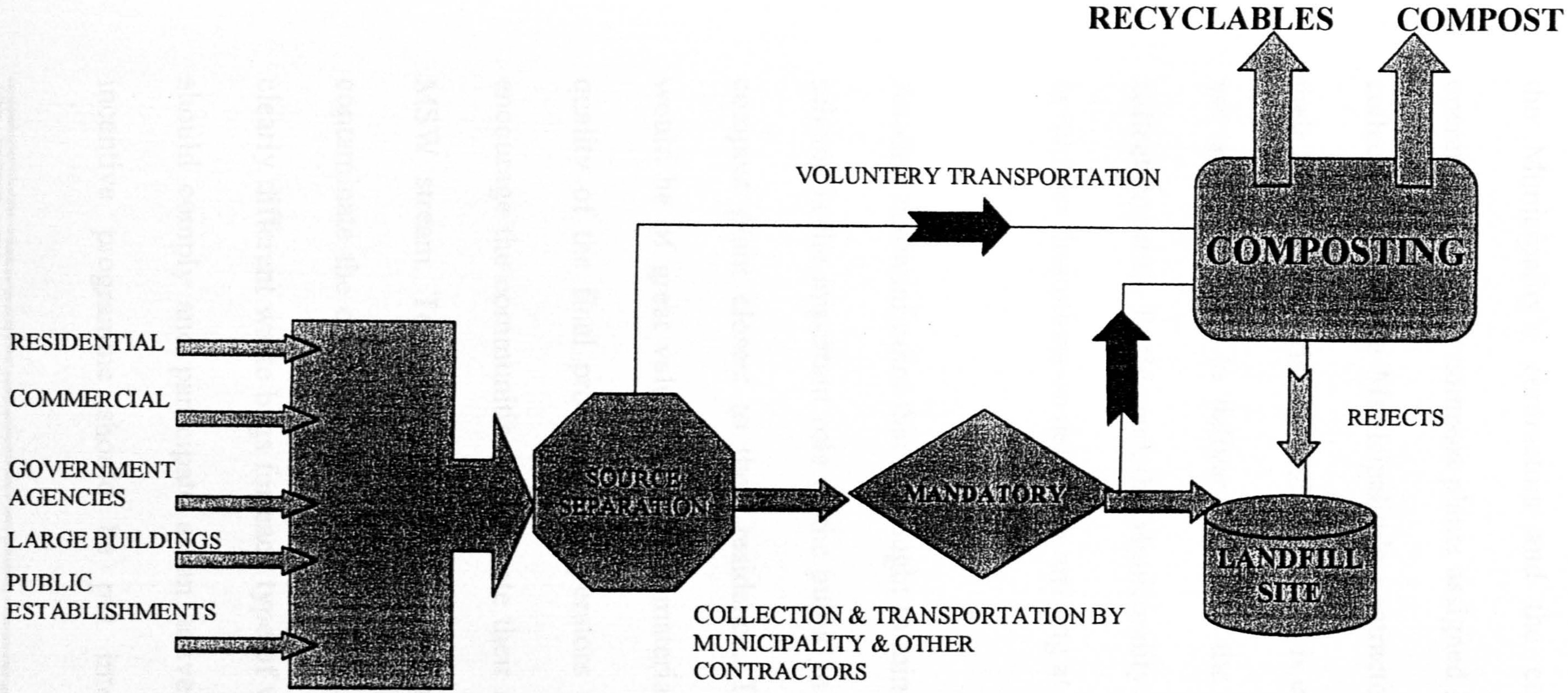


Fig. 8.1 The likely scenario for MSW delivery to the proposed compost plant in Kuwait.

MSW that they collect to the Municipality's landfill sites. It is apparent from the present law that there will be a serious conflict of interest between the Municipality's contractors and the compost plants' owners and operators. Since the compost plants assigned locations are far from certain collection areas, the Municipality's contractors would prefer to transport their loads to the existing landfill sites. It is essential that the Municipality ask all contractors to deliver MSW to the compost plant nearest their collection areas. To this end, the Municipality might consider setting weight or number limitations on deliveries arriving at the landfill sites per day.

Another essential point that is brought to mind by the visual portrait of the scheme is the important role of the public in delivering their MSW to the compost plant closest to their residence. Their source-separated MSW would be of great value to compost material production in terms of the quality of the final product. The operators of the compost plant should encourage the communities to separate their recyclable materials from the MSW stream. To ensure that other unwanted waste materials do not contaminate the organic portion, it is essential to provide the public with clearly different waste bags for each type of waste. The public, as a result, should comply and participate as an active partner in this scheme. An incentive programme should be put into effect to encourage the

communities to participate in voluntary recycling programmes. Whether a bring or curb-side collection programme is to be considered, the private sector (i.e., the compost and recycling plants' investors) and the responsible authorities (e.g.., the Municipality of Kuwait and the EPC) should be involved jointly in setting up the best scheme for waste utilisation, environmental, protection and economic benefit. Moreover by involving the public in the decision-making process, something that has not occurred for the past few years, better results would be expected from such recycling programmes.

8.4 Lessons learned from this case study

In conclusion the main lessons that may be learned from this case study, which could be applied to the other Gulf States, are:

(1) In general, composting seems to be economically feasible in the GCC if the governments would support the marketing of the compost product.

(2) Due to both the needs to conserve the limited available land and the need for soil conditioner, the GCC states have to consider composting as the most viable waste management alternative.

(3) There are several advantages for operating a recycling/composting facility in the GCC States as stated earlier.

(4) Encouragement and support of local producers of compost.

(5) Standards for the quality of the compost produced should be applied based on the purpose of using the compost. For example different quality compost is required for different applications. Not all applications require high quality compost. Therefore it is economically not feasible to produce high quality compost and then apply it for growing grass on the sidewalk.

CHAPTER IX

Co-operation in Regional Recycling

9. Co-operation in Regional Recycling

The GCC member states do not experience increased population density or land scarcity as greatly as the industrialised developed states in Europe, America and Japan do. Consequently landfill, a waste management alternative, is considered the most appropriate waste disposal technique. Landfill is dominantly used by all of the GCC member states, and all landfill sites in the GCC region are governmentally owned. Although some of the GCC member states have placed recycling at the top of their waste management priorities, the low cost of landfill and the availability of land, usually old quarries make recycling programmes infeasible, uneconomical and unachievable. The only comprehensive form of recycling available within the GCC member states is the recycling of paper and cartons. The majority of the GCC states unlike the European Union, which has planned to meet a 15% recycling target for packaging sector and that amount to 1.7 million tons per year, never set a national or a regional recycling targets (Modern Plastic International, 1997, P.17).

Composting is another major alternative form of MSW utilisation applied by the GCC member states despite the unfortunate failure of a large number of composting plants in the region (see Chapters 7 and 8 for details). If

compost is to be used as a soil conditioner, composting which incorporates efficient means of material pre-sorting (due to the high organic matter in the GCC's MSW stream) may be the best alternative for the utilisation of MSW.

However, millions of tons of MSW are generated in the GCC states, the municipalities in this region have not made plans for the recycling of plastics. For example, It was estimated that plastic constitutes about 12% of the total MSW in Saudi Arabian cities (Khan et. al., 1987).

GCC municipalities concentrated in the last twenty years on composting as an alternative for MSW treatment. Therefore plastics and other components of the waste stream were not of equal importance when compared with food waste and other organic materials, which contribute more to the production of compost.

Plastics processors in the GCC states have not adopted recycling as a mean to correct the plastics waste disposal problem. Those processors may produce products based on recycled plastics if the municipalities put into affect regulations, which would enforce plastics recycling provided that economic benefits would exist. Currently plastics waste materials of all

types are being collected and exported to Arab countries such as Lebanon, and Egypt for further processing.

The cost of recycling in the GCC region could be moderate to high according to the collection system selected for the recycling programme. Almost all of the cities within the GCC member states use mechanised systems for the daily collection of MSW. Therefore, the same daily collection system used for MSW might well be used for the collection of recyclable materials, both on the same day and at the same time, or according to a different timetable.

Collection of recyclable materials may take different forms. It is possible to use a trailer (for recyclable materials) attached at the rear of a regular collection vehicle. Another form may be that of a collection vehicle consisting of three or four compartments that accommodate various types of wastes such as paper, plastic, aluminium and glass. Several studies in the USA have indicated that same-day collection programmes for recyclable materials are more favourable to the public since they do not need to learn new collection schedules (Environmental Protection Agency, 1989). Public interest and attitude is a key element in the success of any recycling programme, and within the GCC's member states, the municipalities have

shown, so far, no organisation or strategic planning for the start of a recycling programme. The GCC municipalities will need to offer their citizens a mechanism for sorting and recycling by implementing collection or bring systems. What are obvious in this region are the lack of knowledge on the public's side and the lack of action on the municipalities side, when it comes to implementing MSW recycling.

The GCC's member states have distinctive cultural traditions and habits that differ greatly from those of the Europeans and the Americans, and which consequently effect the waste generation rate, buying attitudes and the degree of participation in community programmes. An example of such traditions and habits is the large amount of food that is discarded after each wedding ceremony during which a large meal is served to the guests. The guest list is usually quite large, and the hosts provide excess food to avoid the social and cultural embarrassment of running short. As a result, wedding ceremonies, which have become occasions for showing off and competing among the families of this region, are strong signs of the throwaway society.

Most GCC states claim to be interested in resource conservation, environmental protection and minimisation of potential human health

hazards. Thus, this chapter provides strategies for developing the most effective recycling programme marketing considerations, regional co-ordination options and general information on local recycling industries.

9.1 Definition of Recycling

According to the Environmental Protection Agency of the USA (Environmental Protection Agency, 1989, p152.), recycling is defined as "the process by which materials otherwise destined for disposal are collected, re-processed or re-manufactured, and re-used." The GCC states should soon begin to consider recycling as an essential part of their future MSW management plans. Internationally, recycling is becoming one of the most important considerations of resource conservation, beside material reuse and effective land use. For example, in the USA, several recycling programmes involving private-sector sponsorship and others run entirely by private enterprises have proved to be successful. Some such successful recycling programmes have included oil collection in Alabama, and voluntary curb-side recycling in Austin, Texas (Environmental Protection Agency, 1989). In Germany, the Coca-Cola Company uses lightweight, refillable glass bottles that can be reused at least 25 times before being sent to The Netherlands for recycling. The Federal Environmental Ministry in

Bonn, Germany, co-ordinates the responsibility of source reduction and recycling with private companies (Shea, 1992). It goes without saying that independently recycling will not solve present or future waste management problems either in the GCC or in the world. Consequently, recycling should be viewed as a segment that connects other segments in a loop of integrated waste management.

Various authorities within the GCC have different definitions of recycling. In general, a clear definition of recycling is lacking. Therefore, a standard definition for recycling should be agreed upon. Recently, the Environmental Committee of the GCC proposed a unified plan that includes definitions of and regulations for hazardous and non-hazardous waste collection, handling, storage, and disposal.

There is no doubt that co-operation in the field of recycling on a regional basis cannot be fully understood without definitions for the basic terms used in recycling and its elements. Moreover, the top management of the GCC's authorities concerned with environmental and municipal affairs should discuss a regional approach to recycling not only from an economic viewpoint but also from environmental and social viewpoints.

9.2 Benefits of Recycling

It is important to view the benefits of recycling as a driving force for regional co-operation in utilising MSW effectively. Therefore, it is essential to present the major benefits of recycling and make use of these benefits as a means of promoting co-operation among the GCC states. The three main benefits are:

- The prolongation of the life of the local landfill sites due to reduction of waste amounts arriving at the landfills.
- The encouragement of expansion and development in the waste utilisation industries, which will consequently affect the economy of such industries positively.
- The minimisation of the use of virgin materials that are usually imported, which would help in protect and save the international environment and its resources, and reduce the exchange of hard currency.

Based on these benefits, a simple estimation of savings in land value in some of the GCC states is presented in Table 9.1, which shows the land requirements for MSW disposal in each of the GCC states based on two alternatives. The first alternative assumed a complete absence of recycling,

and the second alternative assumed different levels of participation in recycling. In the second alternative, a 20% recycling rate was considered. As a result, the savings in land value was estimated based on an assumed price of US$350/m^2 of land, which is the average price of land in Kuwait. The estimated total savings in the value of land were over US$40 million annually. These savings could be used for the development of a regional co-operation fund to provide financial support for recycling and other environmental issues in this region.

TABLE 9.1: BENEFITS OF RECYCLING PRESENTED BY SAVINGS IN LAND VALUE

GCC STATES	SOLID WASTE TON/YR	LAND REQUIREMENTS FOR DISPOSAL		SAVINGS IN ** LAND VALUE $/YR
		NO RECYCLING (M^2)*	RECYCLING (M^2)*	
Kuwait	675648	135129.6	108103.7	9459072
Saudi Arabia	1413950	282790	226232	19795300
U.A.E.	527668	105533.6	84426.88	7387352
Qatar	187975	37595	30076	2631650
Bahrain	155000	31000	24800	2170000

Source: Author estimation and personal communication.

* Land requirements calculations is based on a density of 0.5 tons for MSW and an average depth of the land fill sites of about 10 meters.

** Savings in land value is determined with an assumption of $350 per m^2 Kuwait Municipality Planning Department 1994.

NOTE: It was assumed a recycling rate of 20% for the calculations in this table. Also, Sultanate of Oman is not included since data is not available yet.

The other benefit of recycling is the development of the national economy through the encouragement of private-sector participation. The GCC states' municipalities may play the role of the co-ordinator or even mediator between the government and private-sector industries. According to several companies that are currently involved in recycling paper and glass, the major issue they face is the absence of governmental support (personal communication). Whether the government's support is tangible or intangible, the need for the right kind of support for industries that help save the environment and resources should be given the highest priority.

There are a few cases of success in the field of recycling performed by private industrial companies within the GCC region; yet, strong and continuous support and co-ordination by the governments are obviously absent. In the UAE, a paper trading company, Zenith Paper Traders, exported around 40,000 t of waste paper from the Gulf region to India during 1993. The total value of the waste paper exported in that year amounted to US$6.5 million. In Saudi Arabia, Saady Surfactant Industries of Al Khobar, which manufactures a range of cleansing chemicals, recycles a significant proportion of the plastic recovered from the MSW stream into new bottles using their own bottle bank. According to the company's officials, the recycling of the plastic waste, in general, from household

waste is a difficult task for the municipalities since it is economically not viable. Collection, separation, and cleansing of those products are both difficult and expensive. Moreover both single resins and mixtures of plastics can be recycled, but the end products from a mixture often have inferior physical properties and are lower in value than those from just one type of plastic. As a result the success of plastics recycling, in the GCC, may depend on the adaptation of available technologies to separate mixed plastics into single resins, and on increasing the markets for products of mixed plastic recycling.

In 1993, the Union Paper Mills based in Dubai, UAE, produced about 27,000 t of recycled paper and cardboard products for use in the packaging industry. The production level in 1993, was four times that of 1988. The company exports about 50% of its production to other GCC states, Iran, Pakistan, India and Sri-Lanka. The remaining 50% are marketed to packaging companies within the UAE. In order to cut some of the costs of production, the company uses its own collection fleet by means of annual contracts with banks, business, etc., but not with households. Also, there are several independent scrap collectors that provide about 100 t/d of waste paper. Some of the major problems in the operation of the mills are obtaining the amounts of waste paper needed and low product yield of

recycled paper products. According to the company's operators, for every ton of finished products, about 1.2 t of raw material, i.e., waste paper, is required.

9.3The Need for a GCC Recycling Strategy

The GCC member states should investigate establishing an association that is aimed at starting recycling programmes in each state. The association's main strategic objectives should include the following:

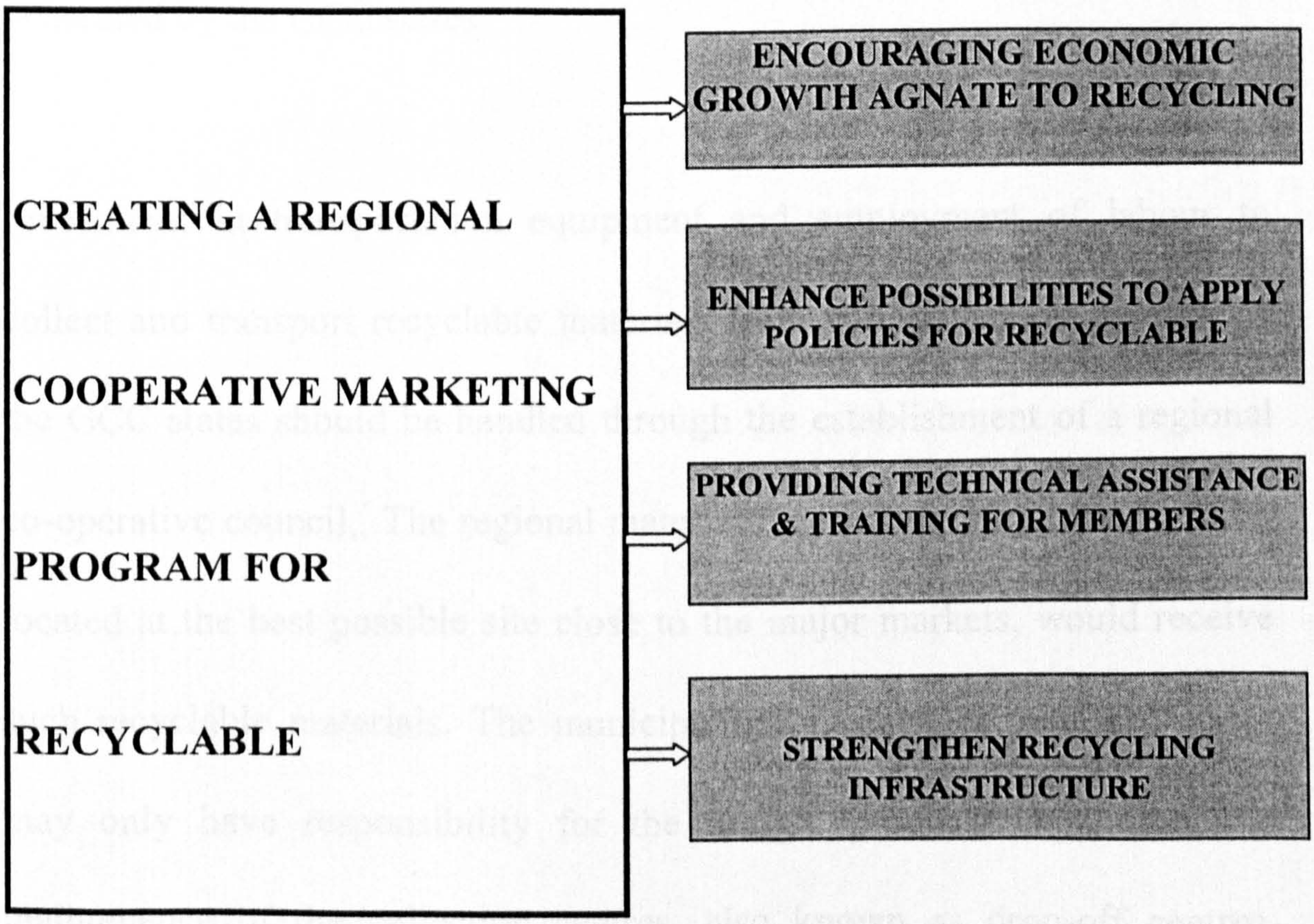
- To create a regional, co-operative marketing programme for recyclable materials.
- To encourage economic growth related to recycling projects.
- To enhance feasible policies for converting recycled materials into commercial products.
- To provide technical assistance and training for members of the association.
- To strengthen recycling infrastructures in the GCC region.

The establishment of such an association would enable the GCC member states to negotiate contracts with end-users of recyclable materials through a co-operative marketing programme, and thus to obtain the best prices by capitalising on the leverage of large volumes of recyclable materials.

Furthermore, industries based on or associated with recyclable materials would receive greater encouragement to develop and expand in the region, were the GCC member states, through their municipalities, to provide recyclables procurement policies. As a result, the strategic plan for regional recycling would be enhanced.

Figure 9.1 shows a block diagram of the strategic purposes of the proposed GCC recycling association.

FIGURE 9.1: THE STRATEGIC PURPOSES OF THE PROPOSED GCC STATES RECYCLING ASSOCIATIONS



9.4 Regional Approach

9.4.1 Centralised Collection, Processing and Marketing

The aim of this section is to determine the feasibility of regional co-operation in the recycling of MSW in the GCC states. The regional approach proposed for recycling in the GCC area is based on the present status of waste management in each of the GCC states. Therefore, the regional approach proposed in this section is aimed at the economies of scale for collection, processing and marketing of recyclable materials generated by the GCC states.

Investment in transportation equipment and employment of labour to collect and transport recyclable materials from various centres in each of the GCC states should be handled through the establishment of a regional co-operative council,. The regional material recovery facility (MRF), to be located at the best possible site close to the major markets, would receive such recyclable materials. The municipalities in each of the GCC states may only have responsibility for the design, purchase, operation and maintenance of the collection centres, also known as drop-off centres, within their own jurisdictions. The collection of the recyclable materials from the several drop-off centres is to be the responsibility of the regional

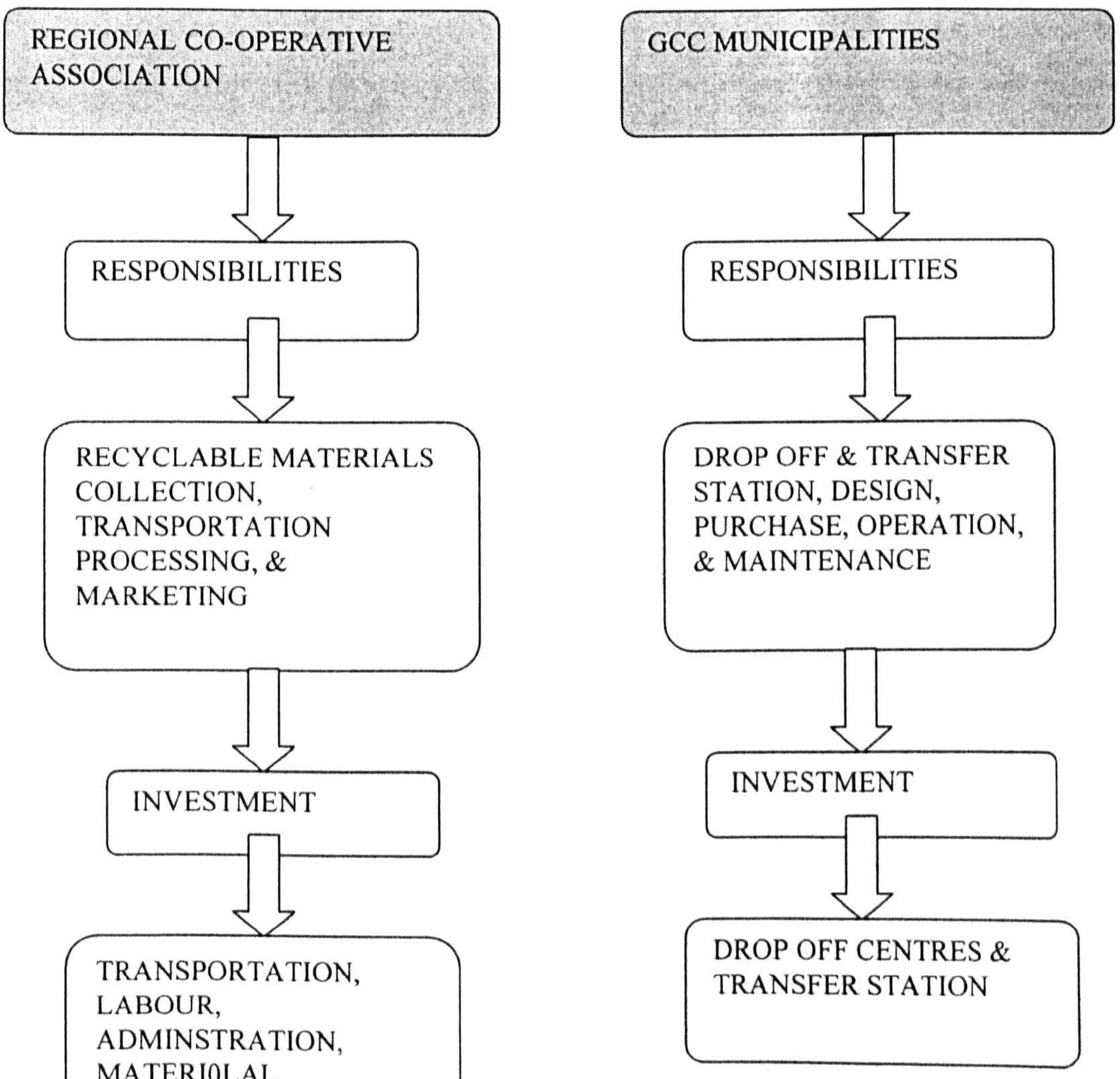
co-operative council, provided that the drop-off centres are equipped to handle at least 45-m^3 trailers and to function as transfer stations. The most important objectives of the regional recycling approach are:

- The creation of sufficient amounts of recyclable materials to attract serious buyers of recyclable materials with the best prices.
- The construction of economies of scale through the reduction of the costs associated with the running of several independent recycling programmes.

The future creation of a regional co-operative association would put the responsibility of constructing a strong recycling industry in this region in the hands of the combined governments of the GCC states. In the proposed scheme, which is presented in Figure 9.2, the regional co-operative association would be responsible for the collection and transportation of the recyclable materials collected from each of the GCC capital cities to the regional MRF in the industrial city ofJubail in Saudi Arabia. Jubail, which is located in the eastern province of Saudi Arabia, is a modern, well-designed, industrial city. Jubail is close to Kuwait, Bahrain and Qatar, and relatively close to the UAE and Oman. The financial facilities that are provided by the Saudi government to project developers in Jubail are encouraging. Also the existing industries inJubail would benefit from the

proposed MRF. The regional co-operative association would also invest in transportation equipment, labour and associated costs required for the recyclable materials to reach the MRF and be marketed within the region and internationally. The municipalities in each of the GCC states would bear the responsibility for the design, purchase, operation, and maintenance of the drop-off centres and transfer stations.

FIGURE 9.2: GCC REGIONAL CO-OPERATIVE ASSOCIATION SCHEME



9.4.2 Market Study

Consideration should be given to the market for recyclable materials, future market trends, and market specifications when planning for the construction and operation of a successful recycling programme. One of the major steps in a market study is to investigate the current market prices, in this case of recyclable materials that have an economic value. The market prices of the potential recyclable materials generated from each of the GCC states were investigated and are listed in the Table 9.2. This table presents the recyclable material prices obtained from various buyers in the GCC states through a telephone survey and personal interviews. The main reason for the buyers' survey was to determine which of the buyers surveyed would offer the proposed GCC's MRF the best opportunity for selling its collected recyclable materials. The survey included the following questions:

- What are the required materials' specifications?
- What are the minimum or maximum quantities to be handled?
- What are the transportation requirements, and who will transport the collected recyclable materials?

- What are the current offered prices and expected future prices of recyclable materials?

Answers to the survey's questions were used to establish a list of the most eligible buyers.

TABLE 9.2: RECYCLABLE MATERIALS PRICES ($ PER TON)

COMPONENT	SAUDI ARABIA	KUWAIT	QATAR	BAHRAIN	U.A.E.	OMAN	ACHIEVABLE PRICES*	AVERAGE
Glass	45	40	30	38	40	35	40	38
Metal (Aluminum)	900	1000	850	900	900	850	900	900
Paper (mixed)	116	66	60	60	80	60	80	74
Plastics (mixed)	83	100	55	80	85	75	80	80

Source: Author estimation and personal communication.

* Achievable price:

Those prices that can be obtained for recyclable materials of a volume and a quality expected from the GCC states central material recovery facility.

TABLE 9.3: MARKET STUDY FINDING SUMMARY FOR THE GCC STATES REGION

RECYCLABLE	1993 GCC REGION PRICE RANGE($/TON)	OFFEROR	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
			GCC states region recyclable price forecast ($/Ton)										
GLASS													
Clear	35 – 40	Gulf Glass Manufact. Kuwait	40	38	38	36	35	35	36	36	38	40	40
METAL													
Aluminum	600 – 1000	Saudi Iron Co. Metal Recycling	1000	1020	1080	1100	1120	1130	1130	1135	1135	1140	1150
PAPER													
Corrugated	50 – 60	Gulf Paper Manufact. Kuwait	52	55	57	60	60	55	55	55	50	50	50
Newspapers	10 – 20	AlArfaj Recycling plant, Kuwait	5	8	10	12	15	18	18	18	16	16	16
High grade	175 – 220	Zenath Paper Traders, Dubai	200	205	215	220	220	220	230	230	240	250	250
Mixed(1)	10 – 30	Union Paper Mills, Dubai	50	55	59	60	65	65	70	75	75	75	80
PLASTIC													
PET	60 – 130	Alzamel Plastic Co.	80	90	105	115	130	130	135	140	140	140	140
HDPE	150 – 220	Saudi & AlArfaj Recycling Plant, Kuwait	160	175	190	199	200	200	210	210	215	215	220
Mixed(2)	80 – 120	Emirate National Plastic, Abu Dhabi	100	110	115	115	120	120	125	125	130	135	135

1. Mixed paper may contain all the various types of waste paper mention in this table.
2. Mixed plastics contain both PET, HDPE types

Table 9.3 shows the present and expected future market prices of recyclable materials quoted by local buyers.

The recyclable materials specifications required are provided in Appendix VIII. The buyers did not state minimum or maximum quantities they are able to receive due to the absence of legislation mandating or insuring the delivery of recyclable materials to recycling facilities operated by the private sector.

The control of the flow of recyclable materials is an issue facing many private-sector enterprises and cities around the world. Therefore, the operators of recycling facilities should take protective measures since there is a possibility that insufficient quantities of recyclable materials will be delivered to their facilities. For example, under Florida law, the power over flow has been granted to local governments to direct the flow of solid waste to resource recovery facilities and to ensure that these facilities receive an adequate quantity of solid waste. That law has encountered opposition from the private waste recycling industry and waste transport companies(Rogoff and Williams, 1992). The same law, however, seems to be an adequate solution to the issue of waste flow in this region.

In the buyers' survey conducted as part of this project, transportation was considered by all the buyers to be the responsibility of the seller. As a result of this survey, the municipalities of this region should be in a better position to plan successful recycling programmes since the information collected will assist in providing achievable prices and the most attractive scheme of waste management possible. The proposed regional co-operative council of the GCC should be able to secure solid commitments with the different buyers available. Also, the prices of recyclable materials in Table 9.3 are considered to be underestimated, and thus the forecasted prices are conservative projections for the future. In this part of the study, the offers made assist by presenting the most likely predictions of recyclable prices based on the buyers' understanding of the national and the international market demands, and future changes.

9.4.3 Marketing Considerations

9.4.3.1 Types of Recycled Materials

It is rather important before starting a regional or local recycling programme that decision-makers determine which recyclable materials they are going to consider for collection. Thus, it is essential to understand the factors driving the recycling market and the market potential of a given recyclable. Some of the main points that need to be considered are:

- Understanding that the market is only in need of recyclable materials that are in demand. As a result, the revenue from the selling of the recyclable materials is market-driven. But, increases in demand for products produced from recyclable materials never drive up demand for virgin materials, which limits the amount of recycled products possible.
- Considering recyclable materials to be virgin materials is a big mistake. Recyclable materials should meet certain specifications regarding contamination, etc., before they are introduced into the market.
- Several factors affect the market prices of recyclable materials, including changes in the national and international economies, the presence of excessive amounts of recycled materials on the market (e.g., the 1991 German packaging ordinance requiring the recycling of all packaging materials regardless of the consequences) and the continuous competition between recycled and virgin materials.
- There is always a chance for new markets to be established, based on guarantees from various jurisdictions within a specific region to supply the required quantity and quality recyclable material.

Moreover, it is important to determine the most viable recycled component to be collected, which will, in turn, increase the overall recycling programme's revenue. The following components were considered in this study.

9.4.3.1.1 Glass

The main purpose of recycling glass is usually for the production of bottles and other containers. Yet, glass can also be used as a raw material for secondary products, namely fibreglass insulation. Glass can be collected whether or not it is separated according to colour, i.e., green, clear and amber, or mixed. However; few recycling companies will accept loads of mixed glass; the majority will not accept mixed glass at all. Moreover; recycling companies prefer to have their loads arrive as crushed glass, not as whole bottles or containers. Great emphasis is put on the transportation costs, which basically direct the method of handling of the material.

9.4.3.1.2 Aluminium

Aluminium is considered to be one of the most valuable recyclable materials. There is great potential for collecting such recyclable items from

both commercial and residential buildings. Aluminium, in the form of beverage containers, can be collected in both residential and commercial recycling programmes. The preparation of the aluminium containers for further processing is very simple and easy. Aluminium cans can be collected, separated and crushed all before reaching the processing plant. Moreover; aluminium, as a recycled material, generates much more revenue on the market than any other recycled material.

9.4.3.1.3 Paper

The most interesting thing about waste paper is the fluctuation in its demand on the recycled products market. There are various types of waste paper, such as corrugated cardboard, newspaper, computer (non-laser) paper, high-grade and mixed paper. It goes without saying that there are huge differences in price for the different grades of waste paper. The continuous increase of paper waste in the packaging industry makes it an essential item on the recycled materials list. Moreover, the development of new methods of improving the quality of recycled paper could put more recycled paper products than virgin paper products into users' hands. The waste paper market may well flourish if the newspaper companies,

ministries of education, and government offices in the GCC support the use of recycled paper products.

9.4.3.1.4 Plastics

The greater the use of plastic containers by the beverage industry, the more the public will appreciate the idea of recycling plastic. Incentives may be one way of increasing participation in the collection of plastic containers for recycling. Post-consumer plastic-resin recycling technology has developed more rapidly in the last half century than technologies for any other recovered material. However, only 5 to 10 y ago, post-consumer, high-density polyethlene (HDPE) and polyethylene terephthalate (PET) plastics were only vaguely considered recyclable but now hold a stronger place in the market. The recyclability of other resins, such as polystyrene, polyvinyl chloride, low-density polyethylene, polypropylene and mixed plastic resins, is improving, but much remains to be done.

9.4.3.2. Options for Marketing Recycled Materials

Basically there are two options in marketing recycled products. The first option is negotiated sales contracts, and the second option is open market selling. The selection of either option is usually based upon the feasibility of each option for the selling association.

9.4.3.2.1 Option I

Municipalities that are seeking to reduce the amount of solid waste arriving into their landfill sites often use negotiated sales contracts. These municipalities are not interested in generating high incomes from the selling of waste to contractors for recycling. This option serves the needs of sellers who do not have sufficient storage area to accumulate large quantities of waste for later sale when the market demands it. The buyers in this option have better chances of obtaining the prices they wish, since they are the ones who carry the risk of the fluctuations of the open market. The main advantage of this option for the sellers is the existence of a guaranteed buyer for a period of time agreed upon to take over responsibility for their wastes. In this case, the seller is not concerned about market depressions or fluctuations that might affect the buyers.

In order to establish a good contract that meets the needs of the seller, a general understanding of various contract prices should be known. There are three different ways to arrange the contract prices. The first is what is known as a fixed-price contract. This kind of contracts is usually used for short-term agreements. The contract's prices are negotiated between the seller and the buyer at a fixed value. The terms of reference are the most important part of this kind of contract since they form the main document within the contract and determine the obligations of both parties. The second contract price arrangement is known as a floating-price contract. In this type of contract, both the buyer and the seller have some form of protection. This protection is based on the tying of the recycled product's price to a percentage of a mutually recognised market quotation. This type of contract is widely applied in countries where the open market prices of various recycled products fluctuate constantly. The third type of contract price arrangement, the floor or escalator price contract, is similar to the floating contract with the exception that it guarantees a minimum price to the seller, as well as price increases connected to growths in the market demand.

9.4.3.2.2 Option II

Selling recycled materials on the open market (Option II) might well provide much better revenue than Option I. The main factor in this option is the presence of multiple market outlets for the recycled materials to be sold. In the case of the GCC's proposed recycling association, it may be an alternative to consider, since reasonable amounts of recycled materials are going to be available and stored until the right time for sales to take place. This option is tailored for sellers who have the ability to hold onto their items until the market picks up, and there is an increase in the demand for the recycled materials. It should be noted that the recycled materials' market is, in general, a fluctuating market. The fluctuation in the demand for certain recycled materials is based on several factors, as was mentioned earlier in this chapter. A regional MSW approach in the GCC might provide the GCC with the ability to negotiate long-term contracts with brokers or manufacturers.

9.4.4 Business Plan for the Jubail Material Recovery Facility (JMRF)

It is envisioned that the Jubail Material Recovery Facility (JMRF) would be established by the GCC governments with a main objective being to develop industries to use recycled materials as their feedstock for the

production of various products. The GCC's governments should provide the capital investment for the JMRF on an equal basis. Therefore, potential profit should be equally distributed among the GCC states. The JMRF will play the role of a holding company that provides both the required amounts of MSW according to specifications and standards based on the demand of the recycling industries, and a percentage of the required capital investment for developing recycling industries. The JMRF may invest funds with other companies, such as investment companies or industrial companies, to set up recycling industries in the Jubail industrial area. The GCC's governments are expected to play an essential role in the development of policies to facilitate the flow of recyclable materials from their cities to the JMRF. Moreover, the GCC states may offer concessions to industries using recyclable materials as the raw material in their production as an encouragement of and protection for business.

9.4.5 Computer Spreadsheet Model of the Recycling Plan's Financial Projection

Through the use of a computer spreadsheet model, a financial projection for the recycling plan was developed (Table 9.4a), for the GCC's regional MRF. Table (9.4b) shows the first year financials of the GCC proposed Regional MRF in Jubail. The spreadsheet helps to clarify the financial

Table 9.4a:Financial Model for GCC proposed Regional Material Recovery Facility in Jubail

GENERAL DATA AND BASIC ASSUMPTION		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Total population@3.3%		18,294,835	18,898,564.56	19,522,217.19	20,166,450.35	20,831,943.21	21,519,397.34	22,229,537.45	22,963,112.19	23,720,894.89	24,503,684.42	25,312,306.01	26,147,612.11	27,010,483.31	27,901,829.25
MSW(TPY)@3.7%		7,766,066	8,053,410.42	8,351,386.61	8,660,387.92	8,980,822.27	9,313,112.69	9,657,697.86	10,015,032.68	10,385,588.89	10,769,855.68	11,168,340.34	11,581,568.93	12,010,086.98	12,454,460.20
TPY per capita		0.424495	0.426139	0.427789	0.429445	0.431108	0.432778	0.434453	0.436136	0.437824	0.439520	0.441222	0.442938	0.444645	0.446367
KgPY per capita		424.495	426.1387367	427.7888383	429.4453294	431.1082349	432.7775794	434.4533881	436.1356858	437.8244977	439.5198491	441.2217653	442.9302717	444.6453937	446.3671571
Average estimated future recyclable (TPY)															
	assumed% MSW														
Glass	3	232,982	241,602	250,542	259,812	269,425	279,393	289,731	300,451	311,568	323,096	335,050	347,447	360,303	373,634
Aluminium	2	155,321	161,068	167,028	173,208	179,616	186,262	193,154	200,301	207,712	215,397	223,367	231,631	240,202	249,089
Paper (mixed)	15	1,164,910	1,208,012	1,252,708	1,299,058	1,347,123	1,396,967	1,448,655	1,502,255	1,557,838	1,615,478	1,675,251	1,737,235	1,801,513	1,868,169
Plastic (mixed)	7	543,625	563,739	584,597	606,227	628,658	651,918	676,039	701,052	726,991	753,890	781,784	810,710	840,706	871,812
Total	27	2,096,838	2,174,421	2,254,874	2,338,305	2,424,822	2,514,540	2,607,578	2,704,059	2,804,109	2,907,861	3,015,452	3,127,024	3,242,723	3,362,704
Expected annual recovery rate (%):															
Glass		5%	5%	5%	5%	5%	10%	10%	10%	10%	10%	15%	15%	15%	15%
Aluminium		5%	5%	5%	5%	5%	10%	10%	10%	10%	10%	15%	15%	15%	15%
Paper (mixed)		5%	5%	5%	5%	5%	10%	10%	10%	10%	10%	15%	15%	15%	15%
Plastic (mixed)		5%	5%	5%	5%	5%	10%	10%	10%	10%	10%	15%	15%	15%	15%
Annual expected recycled quantities:															
Glass		11,649	12,080	12,527	12,991	13,471	27,939	28,973	30,045	31,157	32,310	50,258	52,117	54,045	56,045
Aluminium		7,766	8,053	8,351	8,660	8,981	18,626	19,315	20,030	20,771	21,540	33,505	34,745	36,030	37,363
Paper (mixed)		58,245	60,401	62,635	64,953	67,356	139,697	144,865	150,225	155,784	161,548	251,288	260,585	270,227	280,225
Plastic (mixed)		27,181	28,187	29,230	30,311	31,433	65,192	67,604	70,105	72,699	75,389	117,268	121,606	126,106	130,772
Total		104,842	108,721	112,744	116,915	121,241	251,454	260,758	270,406	280,411	290,786	452,318	469,054	486,409	504,406
Recycled % of total MSW		1.4	1.4	1.4	1.4	1.4	2.7	2.7	2.7	2.7	2.7	4.1	4.1	4.1	4.1

Sources:

(a) GCC General Secretariat, Riyadh.

(b) Author estimation based on previous studies.

(c) Author estimation.

(d) Author estimation based on regional & international personal communications.

Table 9.4a:Financial Model for GCC proposed Regional Material Recovery Facility in Jubail

REVENUES

	average price	Price sensitivity	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Material prices ($/ton)																
Glass			40	38	38	36	35	35	36	35	36	36	38	40	40	40
Aluminium			1000	1020	1060	1100	1100	1100	1000	1000	1000	1000	1000	1000	1000	1000
Paper (mixed)			50	55	60	60	60	60	60	60	60	60	65	65	70	70
Plastic (mixed)			100	110	115	115	120	120	120	120	120	125	125	125	125	125
Glass	37	25%	30	28.5	28.5	27	26.25	26.25	27	26.25	27	27	28.5	30	30	30
Aluminium	1036	25%	750	765	810	825	825	825	750	750	750	750	750	750	750	750
Paper (mixed)	60	25%	37.5	41.25	45	45	45	45	45	45	45	45	48.75	48.75	52.5	52.5
Plastic (mixed)	118	25%	75	82.5	86.25	86.25	90	90	90	90	90	93.75	93.75	93.75	93.75	93.75
Revenues form recyclables sales																
($ per Year)																
Glass			349,473	344,283	357,822	350,746	353,628	733,408	782,274	788,584	841,233	872,358	1,432,340	1,563,512	1,621,362	1,681,352
Aluminium			5,824,549	6,160,859	6,764,523	7,144,828	7,409,178	15,366,636	14,486,647	15,022,649	15,578,383	16,154,784	25,128,766	26,058,538	27,022,696	28,022,535
Paper (mixed)			2,184,206	2,491,524	2,818,593	2,922,881	3,031,028	6,286,351	6,518,946	6,760,147	7,010,273	7,269,653	12,250,273	12,703,533	14,186,915	14,711,831
Plastic (mixed)			2,938,592	3,325,422	3,521,975	3,614,355	3,828,959	5,867,261	6,084,358	6,309,471	6,542,921	7,067,718	10,993,835	11,400,607	11,822,429	12,259,859
Total Revenue($/Y)			10,396,821	11,322,088	12,461,313	13,032,881	13,622,795	28,253,656	27,872,116	28,880,850	29,972,810	31,364,512	49,805,214	51,726,182	54,653,402	56,675,578

Sources:

(e) Personal communications with regional & international recycling companies.

(f) Author estimation.

Table 9.4a:Financial Model for GCC proposed Regional Material Recovery Facility in Jubail

OPERATIONAL COST		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Transportation/collection															
Number of truck-trailer/Y		23	24	25	26	27	56	58	60	62	65	101	104	108	112
Truck-trailer cost ($)		2,795,784	2,899,228	3,006,499	3,117,748	3,233,096	6,705,441	6,953,542	7,210,824	7,477,624	7,754,296	12,061,806	12,508,094	12,970,894	13,450,817
													1	2	3
Cost of collection & Transportation		3,192,436	3,310,556	3,433,846	3,560,069	3,691,792	7,656,776	7,940,076	8,233,859	8,538,512	8,854,437	13,773,077	14,282,680	14,811,140	15,359,152
Maintenance @20% of trailer cost		559,157	579,846	601,300	623,548	646,619	1,341,088	1,390,708	1,442,165	1,495,525	1,550,859	2,412,362	2,501,619	2,594,179	2,690,163
Labor		195,705	202,946	210,455	218,242	226,317	469,381	486,748	504,758	523,434	542,801	844,327	875,567	907,963	941,557
Fringe benefits		78,282	81,178	84,182	87,297	90,527	187,752	194,699	201,903	209,373	217,120	337,731	350,227	363,185	376,623
Total		6,821,363	7,073,753	7,335,482	7,606,895	7,888,350	16,360,438	16,965,774	17,593,508	18,244,468	18,919,513	29,429,303	30,518,188	31,647,362	32,818,315
Processing:															
Machinery	10,000,000	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99	1,026,117.99
Labor		223,928	226,159	228,421	230,705	233,012	235,342	237,696	240,073	242,473	244,898	247,347	249,820	252,319	254,842
Buildings	2,900,000	205,224	205,224	205,224	205,224	205,224	205,224	205,224	205,224	205,224	205,224	205,224	205,224	205,224	205,224
Maintenance		41,845	41,845	41,845	41,845	41,845	41,845	41,845	41,845	41,845	41,845	41,845	41,845	41,845	41,845
Total		1,496,306	1,498,546	1,500,807	1,503,091	1,505,398	1,507,728	1,510,082	1,512,459	1,514,860	1,517,284	1,519,733	1,522,207	1,524,705	1,527,228
Administration:															
Recycling manager		48,000	49,440	50,923	52,451	54,024	55,645	57,315	59,034	60,805	62,629	64,508	66,443	68,437	70,490
Office	250,000	25,653	25,653	25,653	25,653	25,653	25,653	25,653	25,653	25,653	25,653	25,653	25,653	25,653	25,653
Clerical		14,400	14,832	15,277	15,735	16,207	16,694	17,194	17,710	18,241	18,789	19,352	19,933	20,531	21,147
Total		88,053	89,925	91,853	93,839	95,885	97,992	100,162	102,397	104,699	107,071	109,513	112,029	114,620	117,289

Table 9.4a:Financial Model for GCC proposed Regional Material Recovery Facility in Jubail

SENSITIVITY ANALYSIS

			1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
REVENUES																
Total Revenue ($/Y) decreased by		25%	10,396,821	11,322,088	12,461,313	13,032,801	13,622,785	28,253,656	27,872,116	28,880,850	29,972,810	31,364,512	49,805,214	51,726,182	54,653,402	56,675,578
EXPENSES																
Transportation increased by		25%	8,526,704	8,842,192	9,169,353	9,508,619	9,860,438	20,450,548	21,207,218	21,991,885	22,805,585	23,649,391	36,786,628	38,147,735	39,559,202	41,022,894
Processing			1,496,306	1,498,546	1,500,807	1,503,091	1,505,398	1,507,728	1,510,082	1,512,459	1,514,860	1,517,284	1,519,733	1,522,207	1,524,705	1,527,228
Administration			88,053	89,925	91,853	93,839	95,885	97,992	100,162	102,397	104,699	107,071	109,513	112,029	114,620	117,289
Total Expenses ($/Y)			10,111,063	10,430,662	10,762,013	11,105,549	11,461,721	22,056,268	22,817,462	23,606,741	24,425,144	25,273,747	38,415,875	39,781,971	41,198,528	42,667,412
Total Capital Cost	12,250,000															
increased by	10%															
NET INCOME		-13,475,000	285,758	891,426	1,699,300	1,927,252	2,161,064	6,197,388	5,054,654	5,274,109	5,547,666	6,090,766	11,389,339	11,944,211	13,454,874	14,008,166
IRR	22.21%															
NPV	8,974,447															
Discount Rate	15%															

Table 9.4b: 1st Year Financials of the GCC Proposed Regional Material Recovery Facility in Jubail

		1993	Remarks
Total population@3.3%		18,294,835	3.3% annual growth rate
MSW(TPY)@3.7%		7,766,066	3.7% annual increase
TPY per capita		0.424495	
KgPY per capita		424.495	
Average estimated future recyclable (TPY)			
	assumed%MSW		Conservative assumption of
Glass	3	232,982	MSW generated amounts by
Aluminium	2	155,321	GCC states. These percentages
Paper (mixed)	15	1,164,910	are below the average amounts
Plastic (mixed)	7	543,625	generated by the GCC states.
Total	27	2,096,838	
Expected annual recovery rate (%):			
Glass		5%	Given the reluctant of the
Aluminium		5%	population these targets are
Paper (mixed)		5%	moderate and could be
Plastic (mixed)		5%	achieved.
Annual expected recycled quantities:			
Glass		11,649	
Aluminium		7,766	
Paper (mixed)		58,245	
Plastic (mixed)		27,181	
Total		104,842	
Recycled % of total MSW		1.4	

Material prices ($/ton)

	average price	achievable price	
Glass	37	40	Provided by Recyclable
Aluminium	1036	1000	materials buyers within
Paper (mixed)	60	50	GCC states.
Plastic (mixed)	118	100	
	Price sensitivity		
Glass	25%	30	Achievable price decrease by 25%
Aluminium	25%	750	
Paper (mixed)	25%	37.5	
Plastic (mixed)	25%	75	

Revenues form recyclables sales ($ per Year)

Glass	349,473
Aluminium	5,824,549
Paper (mixed)	2,184,206
Plastic (mixed)	2,038,592
Total Revenue($/Y)	10,396,821

			1993	Remarks
Expenses:				
Transportation/collection				
Number of truck-trailer/Y			23	Tons/truck tons*50wk/Y*2trip/wk
Truck-trailer cost ($)			2,795,784	$120,000 cost per truck
Cost of collection & Transportation			3,192,436	Tons*$30.45/ton includes vehicle & fuel exclude driver and mate.
Maintenance @20% of trailer cost			559,157	
Labor			195,705	$500/driver and $200/mate.
Fringe benefits			78,282	
Total			6,821,363	
Processing:				
Machinery		10,000,000	1,026,117.99	$10mm amortised 15Ys @7%
Labor			223,920	$186.6*100
Buildings		2,000,000	205,224	$2mm amortised 15Ys @7%
Maintenance			41,045	Machinery amortised cost*4%
Total			1,496,306	
Administration:				
Recycling manager			48,000	increase by 3% annually
Office		250,000	25,653	250K amortised 15Ys @7%
Clerical			14,400	increase by 3% annually
Total			88,053	
Total Capital Cost		12,250,000		
Increase by		10%		

SENSITIVITY ANALYSIS

REVENUES		
Total Revenue ($/Y) decreased by	25%	10,396,821
EXPENSES		
Transportation incresed by	25%	8,526,704
Processing		1,496,306
Administration		88,053
Total Expenses ($/Y)		10,111,063
NET INCOME	-13,475,000	285,758

Sensitivity Analysis	
IRR	22.21%
NPV	8,974,447
Discount Rate	15%

feasibility of regional co-operation in MSW recovery and processing. All of the GCC's member states are included in the plan. The spreadsheet presents data on population; amounts of MSW generated; prices of recycled materials, and transportation, collection and processing costs; public education programme costs; and revenues from the selling of the recycled materials. In this model, some assumptions were made and held constant to facilitate the calculations. The assumptions are listed below.

- Financing: Capital costs were assumed to be interest-free since the governments of the GCC states were assumed to fund the required capital and share the revenues according to their contribution of waste to the regional MRF. Therefore, this project is considered a service provided to the GCC communities rather than an investment based on a set number of years in which to accomplish a full return of the initial capital expenditures. Such return is only valid in the case of the capital spent on the truck-trailers. The rest of the expenditures were assumed to be financed using a conventional 7% discount rate over 15 y for the processing equipment, office buildings and storage construction.
- Offsets: Offsets, such as the landfill savings to each GCC state, were not recommended for use in this analysis because of the

inaccuracies that might occur when constructing the determination of the true waste-per-ton cost of landfill at each of the GCC's landfills.

- Collection: Bimonthly pickups from all the proposed drop-off centres within the GCC (mainly within the city limits of the capitals of each of the GCC states) to the regional MRF in Jubail, Saudi Arabia was assumed. The average estimated distance between the capital cities of the GCC states and the proposed MRF in Jubail, Saudi Arabia, is 1500 km. Table 9.5 shows the estimated distances between some major GCC cities and Jubail, Saudi Arabia. NB: The local recycling facilities should be supplied with recyclable material before transporting any to the central facility in Jubail.

TABLE 9.5: Average distances between some of GCC cities and the proposed MRF in Jubail

City	Distance (km)
Dubai	2000
Doha	2200
Manama	1000
Kuwait	500

- Transportation: Transportation costs were based on the best quotes provided by local trucking companies operating in Kuwait. The quotes were compatible with those from other GCC states obtained in a later stage of the analysis through phone contacts. The cost of transporting a ton of recyclable materials from within the city limits of each of the GCC states to the proposed MRF in Jubail, Saudi Arabia, is on average US$30.45/t.

- Processing: Processing costs for the GCC's regional MRF were based on the cost of equipment. In this case, it is the cost of balers since the MRF will perform the required separation and classification of the waste according to the buyers' specifications. The basic assumption in this case is that several balers will be needed to process the recyclable materials into 1-m^3 bundles to be picked up by interested buyers. Moreover; it was assumed that the cost of the required conveyors and forklifts for the processing are included in the cost of the balers.The numbers, types and capacities of the balers and conveyor belts will be determined by the operating team, which will process recyclable materials for a test period and monitor the processing to determine whether or not sufficient recyclables can actually be collected through the various drop-off centres within the GCC states.

- Maintenance: Maintenance is assumed to be 20% in the case of the truck-trailer and is based on the total cost of the trucks available for service per year. This percentage also covers the spare parts required for the fleet per year. The maintenance cost for the equipment in the processing unit was based on 4% of the baler's annualised cost.

The basic calculations included in the spreadsheet are as follows.

9.4.5.1 Transportation and Collection

1. The estimated number of trucks is given by the following equation.

   No. of Trucks = t of waste/y/size of truck/no. of wk/y 2 trips/wk

2. The cost of purchasing each truck is equal to US$120,000. Consequently, the total cost of the trucks will be equal to the number of trucks times US$120,000.
3. The cost of drop-off containers is assumed to be zero since they will be provided by the GCC's local authorities.
4. The cost of the construction of the drop-off centres is also assumed to be zero since the GCC's local authorities will handle the construction.
5. The cost of transportation and collection is estimated according to the following equation:

Average estimated distance from drop-off centre in each GCC state to the MRF in km (2 round trips) (12 mo) (2 trips/mo) (US$30.45/t)

NB: An increment of 1% in the average cost of transportation per year is considered starting in the second year.

6. Maintenance is estimated to be 20% of the cost of the truck-trailer.
7. Labourers' salaries are estimated according to the following equation:

No. of trucks (US$500/driver + US$200/labourer)

8. Fringe benefits are assumed to be equal to 40% of the labourers' salary.

9.4.5.2 Processing

10 The cost of the baler is estimated according to the following amortisation equation:

$$\frac{\text{US\$10m X } (1+.07)^{15} \text{ X } .07}{(1+.07)^{15} - 1}$$

11 The cost of the labourers' salaries is estimated according to the following equation:

US$186.666 * 100 labourers * 12 mo

12 The cost of the construction of storage areas is estimated according to the following equation:

$$\frac{\text{US\$2m X } (1+.07)^{15} \text{ X } .07}{(1+.07)^{15} - 1}$$

13. The cost of maintenance is estimated according to the following equation:

Baler's annualised cost * 4%

9.4.5.3 Administration

14. The cost of the offices is estimated according to the following equation:

$$\frac{\text{US\$250,000 X } (1+.07)^{15} \text{ X } .07}{(1+.07)^{15} - 1}$$

9.4.5.4 Sensitivity Analysis

Revenues were reduced by 25% in order to test the viability of the project. This was based on a reduction of average price for the recyclable materials by 25%. The operational cost was increased by 25%, which was mainly an increase in the transportation item. Moreover, The total capital cost of the project was increased by 10% which resulted in a net income of a negative value for the first year equal to US$ –13,475,000. A discount rate of 15% was used which resulted in a net present value of US$ 8,974,447. The

Fig. 9.3:Total Revenue decreased by 25%Vs. Total Expenses increased by 25%

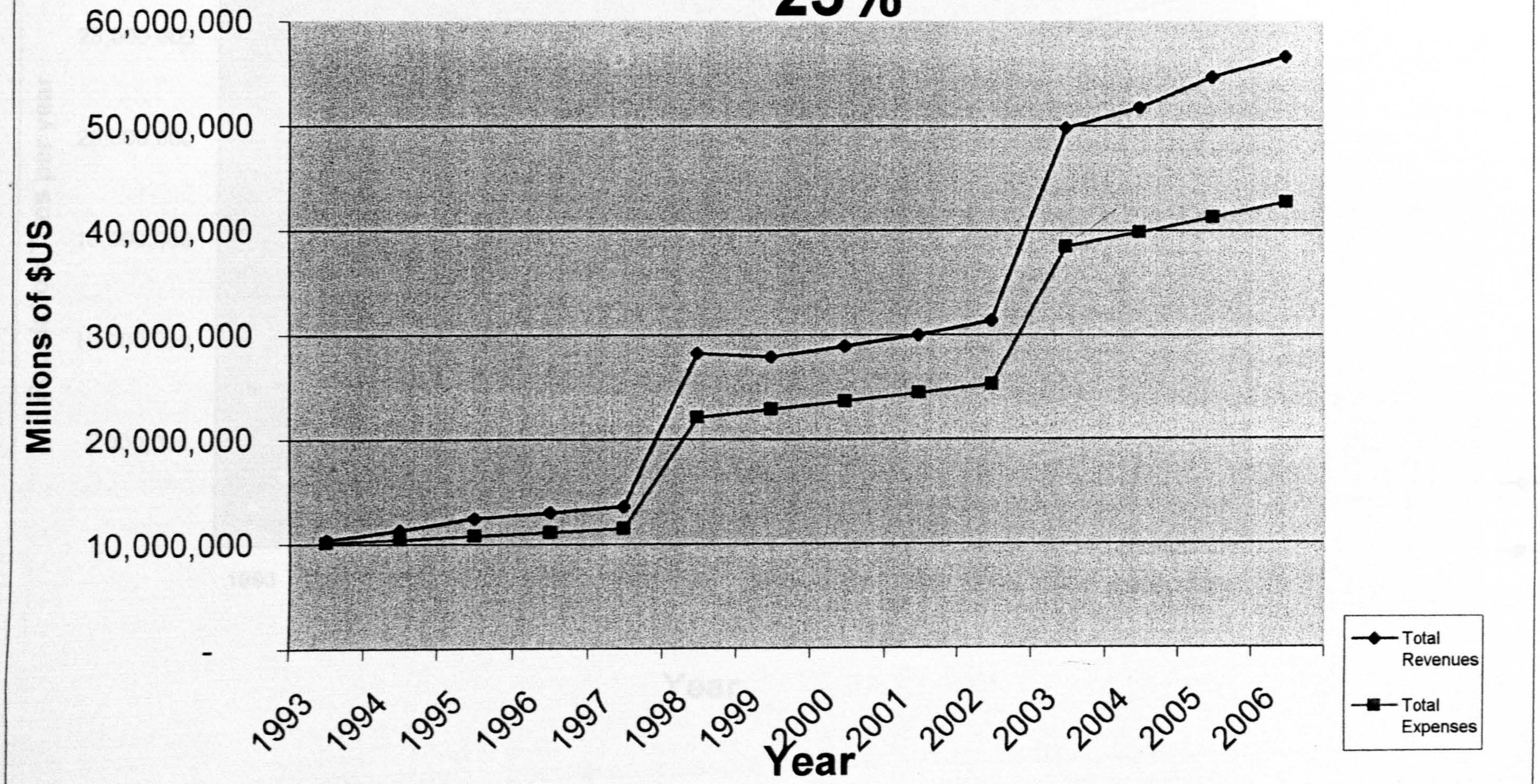
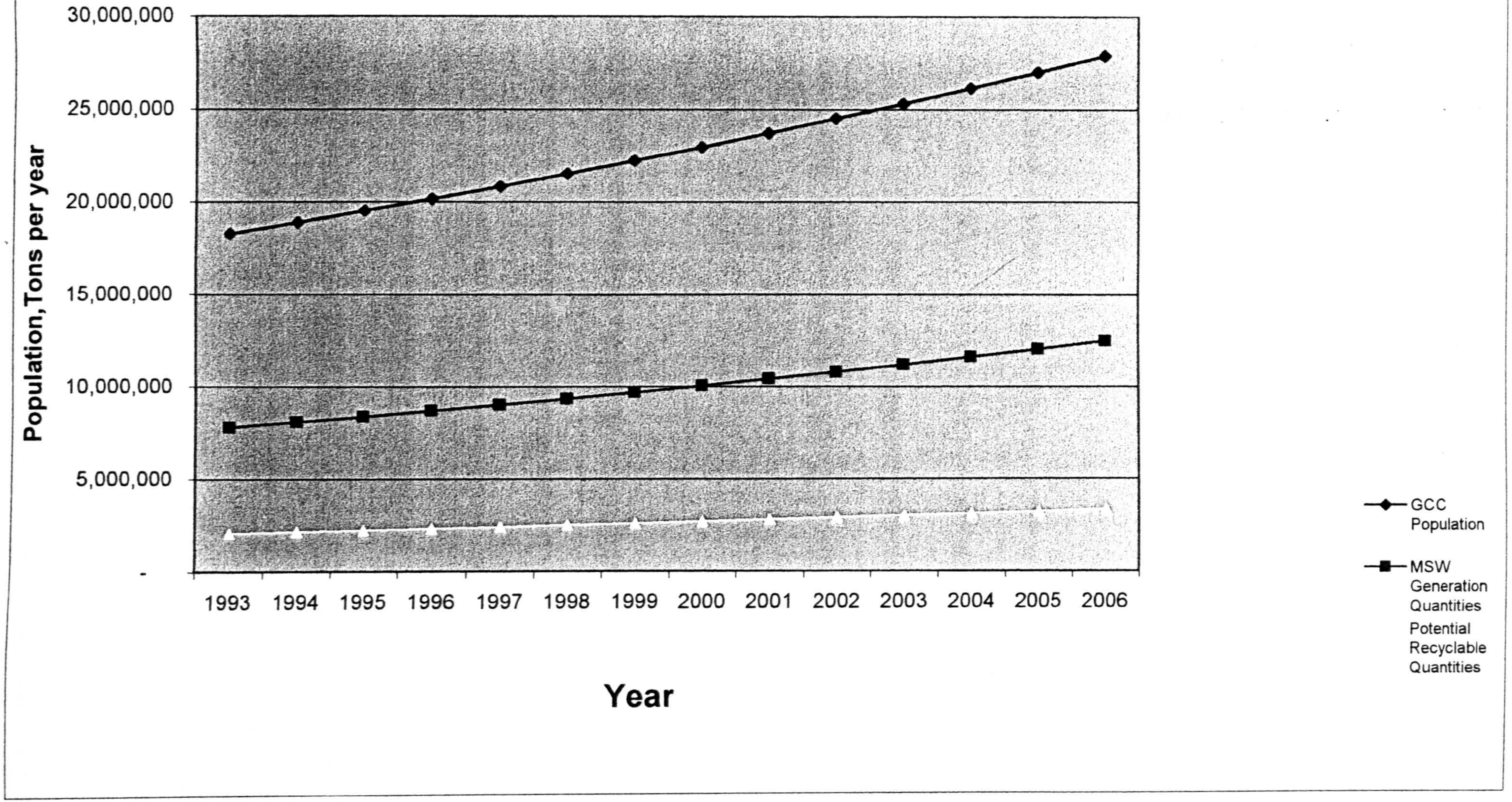


Fig. 9.4:GCC MSW Potential Recyclable Quantities 1993-2006



Internal Rate of Return of the project was calculated at 22.21%, which is considered an attractive return in view of the current market IRR for similar projects of 15-20%. It is then recommended to proceed with such investment opportunity based on the conservative measures considered in this model and other qualitative factors, which would benefit the environment such as, waste reuse and recycling.

9.5 Conclusions

The study of regional approach concluded that there is sufficient evidence, both practical and financial, to indicate that a co-operative regional program is feasible for the GCC states. A regional recycling program would minimise costs while providing a foundation of support to the states' objective for meeting future recycling goals. In addition, the study concludes that:

- The least costly method of conducting a recycling program for the six GCC states involves creating a regional co-operative association that would be responsible for transportation equipment, labour, administrative support, and market development.
- Aluminium offers the greatest financial returns, given processing costs and current marketability. Collection of large quantities of aluminium will have a major impact on revenues of the regional program.

- Recyclable buyers should be contracted on a long-term basis in order to guarantee future income and protect, as much a possible, against market volatility.
- Given the local demographic, a successful regional program for the GCC states must include careful consideration of methods to maximise citizen participation in the major cities.

9.6 Recommendations

The regional co-operation program study concluded the processing of the following recyclable materials:

- Aluminium
- Glass
- Paper
- Plastic

Such a regional approach will dramatically reduce costs by taking advantage of available economies of scale while generating greater revenues since prices are paid for high-volume sales.

For maximum cost savings, the regional co-operative association should handle the collection, processing and marketing of recyclable materials. Each GCC State on a mutually agreeable basis should share the necessary working and investment capital.

For maximum cost-effectiveness of the program all GCC states must agree to contribute all of the materials listed above to the regional materials recovery facility after fulfilling first the local demand.

To ensure that all quantities of high-value recyclable materials are collected, drop-off centre collection containers must be secured against scavenging.

A regional recycling co-ordination office should be staffed to handle administration of the regional program.

Public education in each of the GCC states would be promoted and paid for by the municipalities. Co-ordination between the municipalities and the regional recycling co-ordination office on public education program is necessary to ensure uniformity and continuity of the flow of high-value recyclable materials.

To facilitate the start of a regional program, it is recommended that the GCC municipalities review the financial analysis in this study and, using the computer spreadsheets, revise their plans as necessary. This validation exercise is an important step in developing regional plans since all the GCC states will have to accept and work with similar data to facilitate the startof a regional program.

The regional co-operative association upon its formation it should establish close relationships with the GCC municipalities, stressing the need for their involvement. For the regional program to be successful, the municipalities will need to be included because of their responsibility in managing solid waste in each city in the GCC states. The municipalities will have an important role in increasing the interest in participating in the regional program by charging tipping fees for non-source separated solid waste loads that arrive at the landfill sites.

The following ideas should be put into effect as soon as practicable:

- Ministries should be required to separate office paper for recycling. Also, receptacles should be provided in each area within the cities of the GCC for collection of recyclable aluminium cans.

- Commercial business, institutions, and industries should be urged to adopt voluntary programs to recycle.

Economic incentives should be considered, such as:

- All landfills should institute a tipping fee that is sufficient to provide economic incentives for users to reduce their loads.
- Two different fee rates could be used to make the municipality's strategy clear to users, whereby those bringing non-source separated solid waste loads to the landfill are charged more than those bringing loads without recyclable materials.
- The municipality could decide to waive the tipping fee entirely for those bringing loads free of recyclable materials.

A successful regional recycling program will be realised through conscious solicitation of co-operation among states, municipalities, commercial businesses, schools, and citizen volunteer groups and organisations. Effort should be made to reach out and involve these groups.

The author hopes that the idea and information contained in this section may be adopted by the municipalities of the GCC and incorporated into the planning and implementation of their recycling programs.

9.7 Public Participation: Survey Conducted at Kuwait University

This survey was intended to explore the likelihood of public participation in recycling programmes in the GCC states. Public involvement in waste recycling schemes is an essential factor for their continuation and success.

9.7.1 Construction and Design of the Questionnaire

9.7.1.1 Objectives

The objective of the questionnaire was to identify means for establishing recycling programmes in Kuwait, and to ascertain the extent of knowledge of recycling in general.

9.7.1.2 Sample

A sample of 150 students from Kuwait University, which covers various disciplines including engineering, the sciences and arts, was selected. The number of students from each college was as follows: 50 from engineering, 69 from arts and 30 from the sciences. The sample group was selected from a number of classes studying environmental subjects.

9.7.1.3 Observations

The results, in Table 9.6, provide many important insights into the students' aspirations and motivations with regard to waste recycling. This was the

first such survey ever to have been conducted at Kuwait University involving students with the purpose of obtaining insights on attitudes towards recycling in Kuwait.

9.7.1.4 Respondents

A total of 69 males, or 46.3% of the sample, and 80 females, or 53.7% of the sample, responded to the questionnaire. In total, 149 (100%) questionnaires were completed.

9.7.1.5 Age Distribution

The age distribution of the respondents is given below.

AGE DISTRIBUTION OF THE SAMPLE

Age	Number	Percent
18	19	12.8%
19-21	58	38.9%
22+	72	48.3%

9.7.1.6 Questions

The questionnaire included 14 questions that investigated the respondents' knowledge, attitude and reaction regarding waste management in Kuwait. The questionnaire was structured, but additional space was provided to allow students to make their own comments. A pilot study was conducted using five staff members from the Municipality of Kuwait. The pilot did not identify any problems with the questionnaire.

TABLE 9.6: RESULTS AND THE QUESTIONNAIRE DISTRIBUTED AT KUWAIT UNIVERSITY INVESTIGATING STUDENTS' ATTITUDES TOWARD RECYCLING

No.	Question	Number	Percentage
Q1.	**Domestic waste is**		
(a)	A mixture of organic, ferrous and non-ferrous materials.	5	3.40
(b)	Biodegradable and non-biodegradable materials.	5	3.40
(c)	Waste such as food, paper, glass, textile and metals.	89	60.00
(d)	All of the above.	50	33.50
	Total	**149**	**100.00**
Q2.	**The best disposal technique for MSW is**		
(a)	Open dumping.	0%	0
(b)	Incineration.	0%	0
(c)	Composting.	32	21.50
(d)	Recycling.	89	59.70
(e)	Sanitary landfill.	28	18.80
	Total	**149**	**100.00**
Q3.	**Are you willing to apply the source separation alternative by using different plastic bags for different waste materials?**		
(a)	No objection, if the plastic bags are provided free of charge.	39	26.20
(b)	Willing on my own expense.	10	6.70
(c)	Not willing.	100	67.10
	Total	**149**	**100.00**
Q4.	**Which collection programme for recycling do you prefer the most?**		
(a)	Collection on the same day as trash collection by Municipality's trucks.	113	75.80
(b)	Drop-off facilities close to home.	0	0
(c)	Material recovery facility far from home.	0	0
(d)	Any programme mandated by the Municipality.	36	24.20
	Total	**149**	**100.00**
Q5.	**Would you accept money for your sorted recyclable materials?**		
(a)	If an adequate amount of money were provided.	60	40.30
(b)	Not necessary.	0	0
(c)	I would consider it as an insult.	13	8.70
(d)	I would accept if it were a lot of money.	76	51.00
	Total	**149**	**100.00**
Q6.	**Do you think mandatory recycling is the solution for better participation by the public?**		

(a)	Yes, I agree.	104	69.80
(b)	No, I do not agree.	13	8.70
(c)	Municipalities should encourage participation through well-organised and managed advertisement programmes.	32	21.50
	Total	**149**	**100.00**
Q7.	**Do you have any idea how much it costs to collect and dispose of MSW in Kuwait?**		
(a)	KD 20 million.	36	24.20
(b)	KD 30 million.	37	24.80
(c)	KD 40 million.	37	24.80
(d)	More than K.D 40 million.	39	26.20
	Total	**149**	**100.00**
Q8.	**Do you think that products that originally were recycled have better or similar quality than products manufactured from virgin materials?**		
(a)	Products from virgin materials are better.	22	14.80
(b)	They have the same quality.	13	8.70
(c)	I have no idea.	114	76.50
(d)	Products originally were **recycled** are better	0	0
	Total	**149**	**100.00**
Q9.	**Are you willing to buy products made from** recycled **materials?**		
(a)	Yes I would.	12	8.10
(b)	If they are good quality.	80	53.70
(c)	I would not buy them.	57	38.20
	Total	**149**	**100.00**
Q10.	**What do you think of landfills constructed near residential areas?**		
(a)	Cause many health problems.	93	62.40
(b)	Will influence the value of the real estate.	56	37.60
(c)	Cause traffic problems	0	0
	Total	**149**	**100.00**
Q11.	**What would you do to your old white goods and old furniture at home or the office?**		
(a)	Sell them to scrap dealers	65	43.60
(b)	Call the Municipality to collect and dispose of them.	80	53.70
(c)	Dispose of them in an open area close by.	0	0
(d)	I would reuse them.	4	2.70
	Total	**149**	**100.00**

Q12.	**Besides the regular glass recycling processes, what are the other areas for glass reuse?**		
(a)	Road construction.	134	89.90
(b)	Decorative work.	0	0
(c)	Fibre sheets.	0	0
(d)	Bricks and pipes.	0	0
(e)	All of the above.	15	10.10
	Total	**149**	**100.00**
Q13.	**Which would you prefer to buy, a bottle of water made of glass or plastic?**		
(a)	Plastic bottles since they are lighter and easy to discard.	85	57%100.00
(b)	Glass bottles because they are easy to recycle.	59	39.60
(c)	No difference; both can be recycled.	5	3.40
	Total	**149**	**100.00**
Q14.	**Slaughterhouse wastes can be**		
(a)	Used in manufacturing wool, fat, and protein.	11	7.40
(b)	Used in cosmetics, soaps and some surgical tools.	10	6.70
(c)	Used as organic fertilisers.	67	45.00
(d)	Landfill to enhance waste decomposition.	61	40.90

9.7.2 Discussion

(1-2) From the answers to Questions 1 and 2, it is clear that there is some general knowledge of what the constituents of domestic waste are, and recycling was indicated as the best disposal method by around 60% of the sample.

3. Even though there is some understanding of the importance of waste recycling and utilisation in general, most of the students (67%) indicated unwillingness to participate in source separation.

4. There was a negative attitude toward drop-off facilities (i.e., the bring system) and an MRF on the part of all students in the sample. The collection method that interested the most students was for recyclable

materials to be collected on the same day as trash is collected by the Municipality; around 76% supported that scenario.

5. Answers to this question provided a clear-cut idea as to the importance of incentive programmes for the collection of recyclable materials. About 90% were willing to receive money for their recyclable waste materials.

6. Around 70% of the students agreed that mandatory recycling was the way to achieve better participation by the public.

7. Percentages were almost equal on this cost question, which implied the lack of awareness of the financial aspects of waste management activities on the part of the students.

(8-9) Answers to these two questions indicated that the students had had no opportunity to experience any recyclable materials that had been remanufactured for reuse.

10. It was obvious that most of the students (62%) were aware of the effect on health of living near insanitary landfill sites. About 37% were concerned with the economic issues related to property devaluation.

11. Answers to this question showed the traditional consumption habits of the Kuwaiti society. Only 2.7% indicated that they would reuse furniture and white goods.

12. Around 90% of the students believed that road construction were the major field for the reuse of glass recyclable. This may be due to the great interest of most of the young people in this region in the safety and comfort of the roads since they care a great deal for their automobiles.

13. A majority of the students (57%) seemed to favour the use of plastic bottles just because they are easy to handle, without taking into consideration any other impacts. About 40% have some idea about glass recycling, and as a result, they favour the use of glass bottles over plastic ones.

14. The answers to this question showed that students look down on the use of certain waste as recyclable material. About 86% of the students did not approve of the use of slaughterhouse wastes for cosmetics, but would accept their use in fertilisers and landfill materials.

9.7.3 Conclusions

These students should be more environmentally aware than the Kuwaiti society as whole. Therefore, it is likely that a considerable amount of education needs to be carried out if a recycling scheme is to be successful. Generally speaking, one need to have some driving motivation in order to learn that driving force guide his or her behaviour towards pre-set objectives. It is also important that one should not depend on a single driving force. In this case (i.e., a recycling programme in Kuwait), the driving forces capable ensuring the success of a recycling programme need to be identified. Some of the driving forces are incentives, national duty, civilised behaviour, and religion.

- Incentives: The questionnaire showed that incentives are well accepted and would assist in developing a successful source-separation-recycling programme. Industries can be responsible for providing a certain amount of cash through recyclable buy-back programmes.
- National Duty (i.e., Patriotism): If municipalities presented their recycling objectives in a form that emphasises the idea of participating in recycling as a patriotic action which will be praised by the society in general, more participation would be expected.

Moreover the sustainability of the concept should be promoted on a large scale.

- Civilised Behaviour: The people of the GCC states would appreciate being recognised as civilised citizens because of their participation in recycling programmes within their own municipality's limits. Therefore, it is essential that authorities responsible for the various aspects of the recycling programmes stress the idea that involvement and participation in recycling programmes indicate a high level of civilisation in a society.
- Religious Behaviour: Stressing what is mentioned in the Muslim Holy Book, Al-Quran, about the people who waste continuously, those called Satan's brothers, would compel people to avoid being described as such. Also, by emphasising that cleanliness is part of the faith, Islam itself could be used as a driving force to enhance the process of waste minimisation and utilisation. During the Muslims' Friday prayer, great emphasis on waste recycling and minimisation could be presented in the speech given prior to the prayer. The mosque and other religious facilities could play a very important role in bringing the public closer to understanding the need for and participating in protecting the world's resources.

Generally, pressuring forces should be avoided as much as possible. The following are forms in which such pressure can be exerted.

- Cultural traditions.
- Looking down on waste handling and utilisation as a profession.
- Rejection of participation and involvement (i.e., indicative of a careless society).

The elimination of such pressuring forces can be accomplished by various means, which should be integrated with each other to achieve the maximum benefit. A plan for the education of the public should be carefully prepared to include almost, if not all, levels of the society. Some of the means of increasing public participation and involvement in recycling programmes are as follows.

- Media: Television, radio, newspapers, etc., could all be used to convey various messages to the public about waste minimisation and utilisation. Creativity in presenting the messages is of a great importance as the public must be enticed to pay the required attention to what is being presented through the media. Simplicity in the

presentation is another important factor. Also, the content that is presented must include the main objectives of recycling.

- Educational Institutions: Lectures and seminars could be given to all levels and grades in the schools. Documents, pamphlets, etc. could be used to describe the benefits and objectives of participation in recycling. One important step that should be developed and implemented through the GCC states' educational systems is the introduction of a unified curriculum on waste and the environment for kindergartens and elementary schools, in particular, and for the other levels of the schools as well. Providing the new generation being during the early stages of life with information about the environment and environmental issues that affect human well being may well create more awareness and concern in the society in the future.

9.8 Case Study: GCC Co-operation in the Recycling of Oil Waste

Oil waste can be defined as those lubricating oils that have gone through their intended use cycle and must be disposed of, or treated and reused (McCabe, 1989). Oil waste can be used to describe several kinds of oil, such as spent automotive lubricating oil and spent industrial oil. In this section the need for utilising spent automotive lubricating oil in the GCC states is presented.

Until recently in almost all of the GCC states, the last destination of oil waste has been the landfill, with the exception to one plant built in Kuwait during the early eighties. This region generates large amounts of spent automotive lubricating oil due to the climatic conditions which require that oil in vehicles be changed more frequently than in other parts of the world with more moderate climatic conditions.

Yet, one of the major problems that faces the oil waste recycling plant in Kuwait, for example, is the incomplete combustion of the automotive oil waste. This is due to the users' desire to avoid automotive problems by changing the oil in their automobiles more frequently than is necessary. According to the Ministry of Public Works in Kuwait, oil waste is a major

problem for their wastewater treatment plants due to the large amounts of oil waste that are disposed of in the sewer system.

On the other hand, the education of the public by the authorities on such a problem and the enforcement of the laws are far from adequate. The Municipality of Kuwait has tried to set up a system for the collection of oil waste at its landfill sites by providing sufficient area for the interested oil-waste recycling company to construct the tanks needed for storage until the oil waste can be transported to the plant.

Several managerial problems between the company and the Municipality on the one hand, and between the oil waste producers and the recycling company on the other hand, caused the system to fail. In general, most of the oil waste arriving at the storage tanks at the landfill site did not meet the minimum standards of the recycling company. Oil waste may contain several additives to enhance its use in motors. These additives are basically added to the organic base stock, which composes the automotive oil in the first place. Some of these additives are considered to be carcinogenic; therefore, special treatment and handling are required. Since the interest of this study is directed towards oil waste generated from vehicles' engines that it is very important that the most dangerous contaminant in this type of

oil waste, i.e., lead is noted. The concentration of lead in the oil waste may vary according to the engine's conditions. Most of the vehicles within the GCC region use the unleaded type of gasoline, which decreases the potential hazard to the public and the environment's health.

In the following section, a case study on oil-waste recycling technology as the Kuwait Lubricating Oil Company applies it in Kuwait is presented.

9.8.1Oil-Waste Recycling Technology Used in Kuwait

In 1972, a group of Kuwaiti investors decided to construct a plant for the recycling of oil wastes in Kuwait. After an intensive study of the international experience available, the Kuwaiti investors selected a German technique owned by a company by the name of Meinken.

The Meinken technology had been applied in more than 60 plants all over the world. Many plants belonging to various companies use theMeinken technology because of its efficiency and quality of production.

9.8.2 Project Stages

After almost 10 years of intensive research and investigation of the technical and financial aspects of the Meinken technology, the establishment of the Kuwaiti Company for the recycling of oil waste was announced. In 1983, the construction and assembly of the mechanical equipment was started, and the end of 1984 finished the work. In March of 1985, the German Company, Meinken, began conducting the operation of the oil waste recycling plant in Kuwait.

A few months later that same year, the Kuwaiti Company took over operation of the plant. Since then, the Kuwaiti Company has been producing various types of recycled oil for both the local and international markets.

9.8.3 Plant Production and Specifications

The plant's production varied from 5,000 to 150,000 tons/year after and before the invasion of Kuwait by Iraq, respectively. In a recent visit to the plant, the operation's manager indicated that the production was maintained at about 5000 tons/year during 1992 and part of 1993. And, as a result of

the continuous improvements in the plant, the production was raised to about 10,000 tons/year during 1994. The plant operates normally on a 24-hour basis; however, since the liberation of Kuwait in 1991, the plant has been operating only 16- hour daily. The operation's manager indicated that a few operating problems due to lack of maintenance have been experienced, but nothing major. The Meinken technology, according to the present status of the plant, seems to be very durable and efficient.

During a visit to the plant, which is located in Mina Abdullah in the south of Kuwait, it was observed that oil waste was being transported by several tankers belonging to different contracting companies. The plant itself has its own fleet of tankers which transport oil wastes from the industrial areas, such as Shuwaikh and Sharq, where a large number of garages are located.

The plant is experiencing a problem with the type of oil waste arriving at the collection and storage area; it does not meet the specifications for the oil waste. Most of the garages do not take care of their collection tanks; they allow a high percentage of water to be mixed with the oil waste that is stored for collection and transportation to the recycling plant. The plant, as a result, has had to bear the financial burden of distilling the oil waste to meet their specifications before it can be processed.

9.8.4 Marketing of the Products

According to the Kuwaiti oil waste recycling company's officials, the local market demand is estimated at about 7700 tons/year, while the rate of production ranges from 10,000 to 11,000 tons/year. The excess in production is exported to several countries, among which are some of the GCC states. The marketing of the re-refined oil is a rather difficult and complicated process. For example, the plant is in need of government support through importation laws. If the government were to issue a decree by which all of its offices would use the local oil recycling plant's products, it would increase the rate of recycling. Moreover, it would support the recycling plant financially and decrease the environmental effects of polluting the landfills with such oil waste.

The market in Kuwait is wide open for all types of oil products imported from many countries, and the government as to quantities has set no limits. Kuwait as an oil-producing country is basically able to provide the market with several types of oil for the various needs within the country through its own Kuwait National Petroleum Company (KNPC). Virgin oil no longer has a competitive advantage over the re-refined oil, also called recycled oil waste.

Presently, some of the GCC states, i.e., Saudi Arabia, the UAE, and Bahrain, are in the process of producing recycled oil from oil waste generated within their countries.

It seems that the private sector in those states has learned from the experience of the Kuwaitis in operating the Meinken-technology oil-waste recycling plant.

A survey of the oil-waste recycling plants in the GCC states is presented in Table 9.7. The results of the survey indicate that more waste oil is generated than is recycled in the GCC region.

TABLE 9.7:OIL WASTE RECYCLING FACILITIES IN THE GCC STATES

State	Oil waste generated tons/y (1)	Capital cost (2)	Initial capacity tons/y (3)	Production rate tons/y (4)	Available for marketing tons/y (5)	Commission date (6)
Kuwait	38000	$ 6 Million	15000	11000	7700	1985
Saudi Arabia			50000	40000*	27600	1994
U.A.E	35000	$ 5.5 Million	20000	16000*	11040	1994
Bahrain		$ 10 Million	40000	30000	20700	1994
Total			125000	97000	67040	

Source: Kuwait Lubricants Company (Recycling plant in Mina Abdullah)

* Estimated figures based on 80% of the initial capacity.

(5) Figures are based on 60% of the production rate plus 15% chemical additives.

9.8.5 Conclusion

The oil-waste recycling case study is an example of potential recycling activities in the GCC. The possibility of utilising oil waste in producing new products is a viable option that can be capitalised on by the different GCC states. Several important conclusions that can be drawn from this case study are summarised as follows:

- Kuwait's oil-waste recycling plant is an example of private-sector involvement in investments pertaining to waste processing and utilisation.
- The project has proved to be successful without government subsidisation.
- Private investors are self-motivated to conduct intensive research on both the market and the financial aspects of waste recycling projects to ensure project continuity and success. On the other hand, the GCC governments lack such motivation due to fear of the financial risk involved.
- The selection of the proper technology by the GCC's investors is essential due to the insufficient capabilities of the technicians who will maintain the equipment.

- Both private and government authorities should promote awareness programmes for the public.
- The market demand for recycled oil is high in the GCC.

CHAPTER X

Construction and Demolition Waste in GCC: Kuwait as a model

10. C&D Waste in the GCC: Kuwait as a Model

The main objective of this chapter is to investigate the potential for utilising C&D waste in Kuwait. It is hoped that by investigating Kuwait's C&D, a model will be established for the GCC states. The investigation was directed toward answering several questions that are related to C&D waste. The questions may be summarised as follows:

- What are the amounts of rubble waste generated in Kuwait and other GCC states?
- Is there a market or demand for C&D recycled products in these states?
- What are the environmental and technical aspects of rubble recycling?
- What are the financial aspects of a C&D waste-recycling project?

Rubble waste, or building or C&D waste, as a more general term, is considered to be one of the most rapidly increasing types of solid waste around the world; yet, there is no proper utilisation or recycling of such waste for future applications. In developed countries such as the USA, building wastes form about 10% by weight of the total waste stream (Von

Stein, 1993). Yet, in periods of growth, the production of building waste can reach even higher proportions. Ferguson (1994) indicated that in the United States, some studies reported that construction waste forms 23% of America's municipal solid waste. In Kuwait, the generation of building waste is almost double the amount of the total MSW collected per year.

During 1992, the total amount of MSW in Kuwait was estimated to be about 700,000 tons, while for the same year the total amount of C&D waste, not including earth and sand, was estimated to be about 1.2 million tons. Taking into consideration the fact that those estimates were rather conservative, the rate of generation of building waste in Kuwait in proportion to its population is quite high.

Both the amount and composition of C&D waste materials differ from one country to another. Moreover, several studies on C&D waste generation rates conducted in the 1970s and 1980s in the USA reported a wide range from about 0.1 to 3.5 pounds/person/day in the rates of generation (*Recycling Today*, 1992). The per capita generation rate for Kuwait is estimated to be about 1.1 pounds/day, while the national average in the USA is estimated at about 0.72 pounds/d/person (Wilson, 1977).

Table 10.1 presents the amounts of C&D waste, as disposed of, at the GCC landfill sites in 1992. This information is based on a personal investigation of previous reports and personal communication with the departments concerned with C&D waste in the GCC's municipalities.

TABLE 10.1: AVERAGE AMOUNTS OF C&D WASTE IN THE GCC STATES

State	Annual Amount of As-Disposed C&D Waste (t/y)
Kingdom of Saudi Arabia	4,750,000
State of Kuwait	1,200,000
UAE	967,249
State Qatar	852,000
Sultanate of Oman	67,890
State of Bahrain	100,000
Total	7,937,139
Average	1,322,857

Source: Personal communication.

10.1 Market Potential

There is considered to be a market in Kuwait for direct reuse of products generated from demolition projects. However, this market (i.e., the demand for rubble waste, is a function of the quantity and cost of the waste, and the

level of competition. In general, to be able to reuse the basic building materials from the demolition process, it is essential to perform the demolition with care in order to preserve the materials.

A major component of building demolition rubble waste in Kuwait is the concrete rubble aggregate used as a supplement to natural aggregate resources. Table 10.2 shows the types and number of quarries in Kuwait as of 1990.

TABLE 10.2: TYPES AND NUMBERS OF QUARRIES IN KUWAIT IN 1990

Type of Quarry	No.	Area (km)
Aggregate Quarries	45	1 x 1/each
Natural Sand Quarries	47	0.5 x 0.5/each

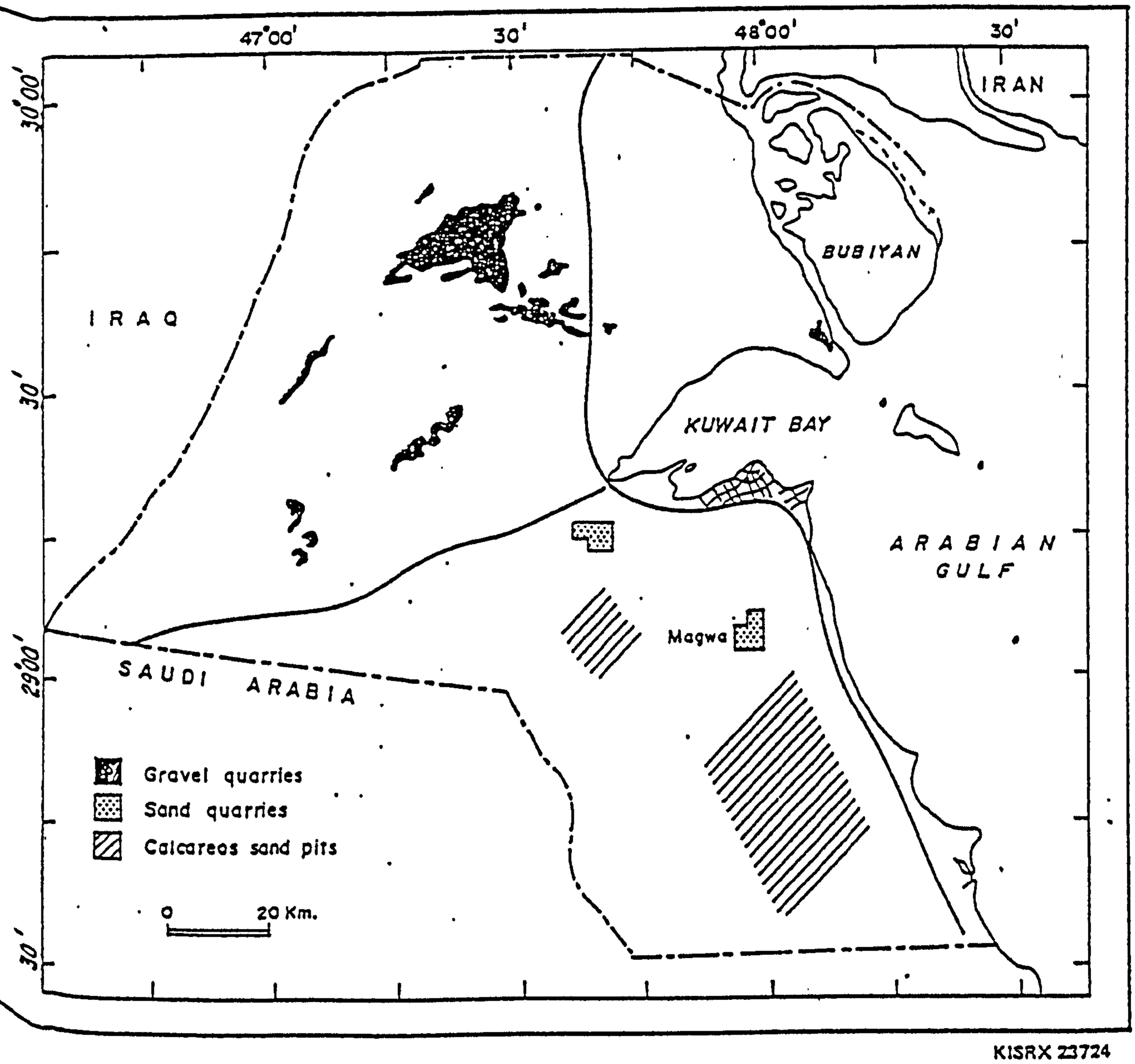
Source: Ministry of Commerce and Industry, 1991.

The aggregate quarries are used to extract and crush natural aggregates. The other type of quarry, i.e., the natural sand quarry, is used to supply both fine and coarse sand. These quarries may vary between 1.5 and 7 meters in depth depending on their locations. The quarries are located in northern and

southern Kuwait. The lifetime of the quarries varies between 1 and 5 year. Since the Gulf War, these quarries have been difficult to reach due to military and political insecurity and the danger of the presence of hidden landmines in the areas where they are located. Therefore, the demand for imported aggregates has increased dramatically. Moreover, the need for rubble waste to be reused has also increased. Figure 10.1 shows the locations of the sand and gravel quarries in Kuwait.

Rubble waste, whether plain or reinforced concrete bricks and blocks, is normally suitable for recycling. Much research in this field has been done within the last 10 years (Hansen, 1986). According to Lindsell and Mulheron (1985), crushed concrete rubble can be used for the purposes mentioned in Table 10.3.

Figure 10.1: Location map of sand and gravel quarries in Kuwait



Source: Kuwait Institute for Scientific Research.

TABLE 10.3: SUITABILITY OF DIFFERENT CATEGORIES OF RECYCLED AGGREGATES FOR VARIOUS APPLICATIONS

Category of Recycled Aggregate	General Bulk Fill	Base for Fill in Drainage Projects	Materials for Road Construction	New Concrete Manufacture
Crushed Demolition Debris	Suitable	Usually suitable	Not usually Suitable	Not suitable
Clean, Graded, Mixed Debris	Suitable	Usually suitable	Suitable in Some cases (sub-base only)	Suitable in some cases
Clean, Graded Bricks	Highly suitable	Suitable	Usually suitable (sub-base only)	Suitable in some cases
Clean, Graded Concrete	Highly suitable	Highly suitable	Suitable	Usually suitable

Source: Lindsell and Mulheron (1985).

An investigation of the market for the reuse of timber indicated that timber (in good condition), can be de-nailed and reused. Crushed wood can be used in the compost industry to improve the structure and the quality of the compost. Today, new methods of gasification and pyrolysis have been developed which make way for the possibility of generating energy from wood from building waste. However, energy in Kuwait is cheap, so this use is not an attractive option for this region at present.

Metal, i.e., aluminium and steel can also be extracted from demolition waste for reuse. Construction steel can be of a great value if it is recovered undamaged. In Kuwait, where the man-hour is less expensive than in Europe, it might be of interest to save and reuse reinforcing bars since the salvage of such reusable items is labour-intensive. Copper can be obtained from electrical installations using high-voltage cables. Metals can be scrapped and regenerated by several scrap dealers in Kuwait.

10.2 Technical Aspects of C&D Waste Recycling Facilities

The recycling of C&D waste in this region is most likely to be based on the recovery of some of the rubble components shown in Table 10.4.Gavilan, R. M. & Bernold, L.F. (1994), estimated that an average of 10% of the purchased construction materials leave the construction site as waste.

TABLE 10.4: COMPOSITION OF C&D WASTE

Type of Waste	Composition
Rubble	Dirt, bricks, cinder blocks concrete
Asphalt	Roads, bridges, parking lots.
Tar-based materials	Shingles, tar paper.
Ferrous metal	Pipes, roofing, flashing, steel.
Non-ferrous metal	Aluminium, copper, brass, stainless steel.
Harvested wood	Stumps, tops, limbs
Untreated wood	Framing, scraps
Treated wood	Plywood, pressure-treated and creosote-treated laminates
Plaster	Sheet-rock, gypsum, dry wall
Glass	Windows, doors
Plastic	Vinyl siding, doors, windows
White goods	Appliances
Contaminants	Lead-based paint, asbestos, fibreglass, fuel tanks.

Source: C.T. Donovan Associates Inc., 1990 Personal communication.

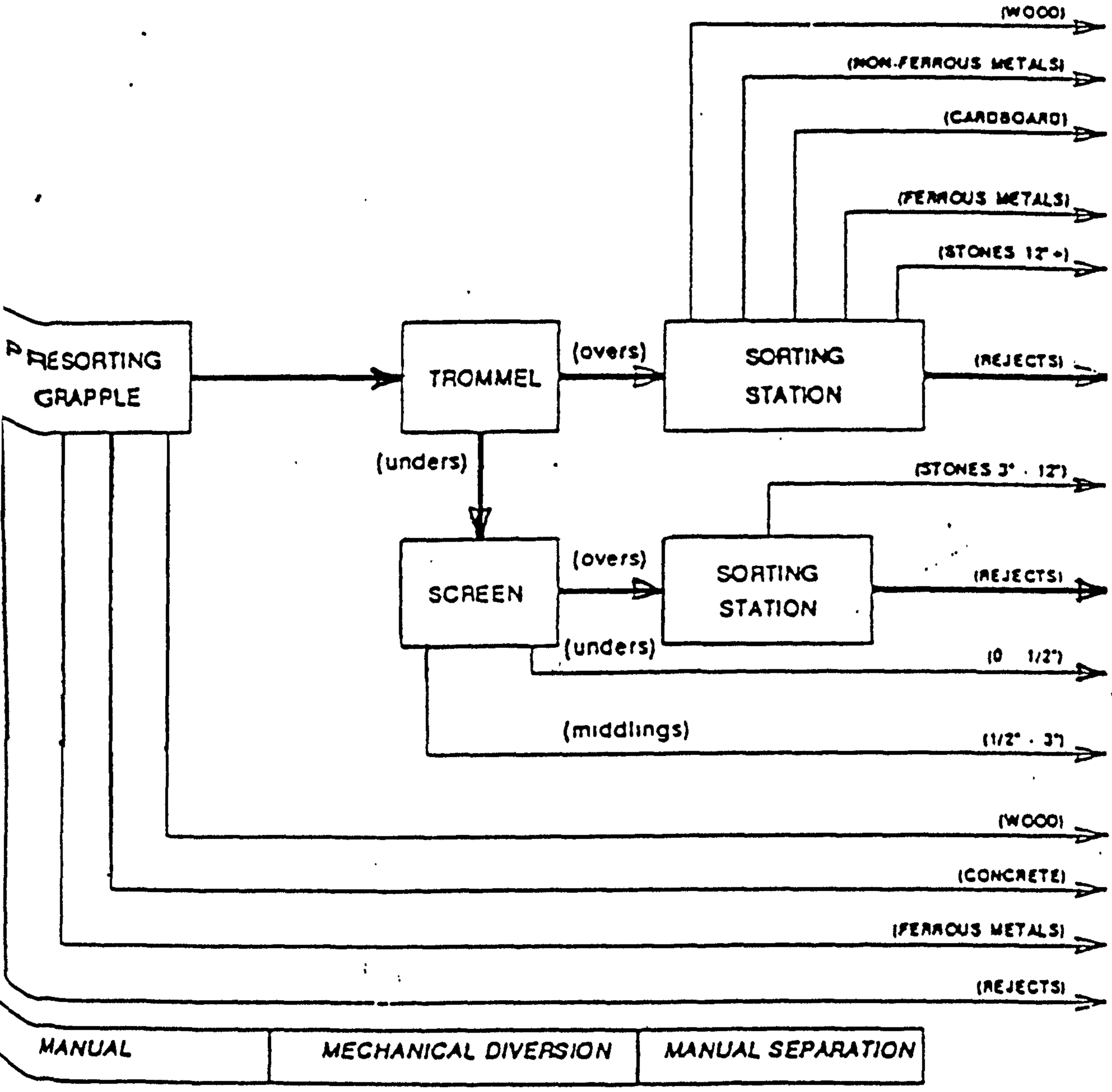
Since a major part of the C&D waste in this region consists of concrete, sand, and bricks; it is technically justified to build C&D waste recycling plants with that in mind. The need for the different sizes of aggregate used in the construction and development of infrastructures in this region is

paramount. Therefore, the recycling of C&D waste should be based on the crushing of rubble components.

In the search for a technology for handling C&D waste, European and American references were the author's primary source of information. The concrete processing techniques are basically divided into two primary approaches. The first approach, which is known as mobile crushing, is based on the execution of the recycling of C&D waste on site. The second approach, called stationary crushing, involves the crushing of concrete at a C&D waste recycling facility.

The capacity of a crushing unit is the basis for determining the capacity of a C&D waste recycling plant. A flow diagram of a C&D recycling facility in Basel, Switzerland is shown in Figure 10.2. Currently; many mobile crushing units are being used by major contractors in Europe and America, as well as in major projects sponsored by the governments of the Arabian Gulf region. The main advantage gained from the increased use of mobile crushing units is the reduction of transport costs for C&D waste. According to transportation companies in some of the GCC states; the cost of transporting a load of demolition waste in an 18-m^3 truck averages between

Figure 10.2: Flow diagram of Basel, Switzerland, C&D waste recycling facility



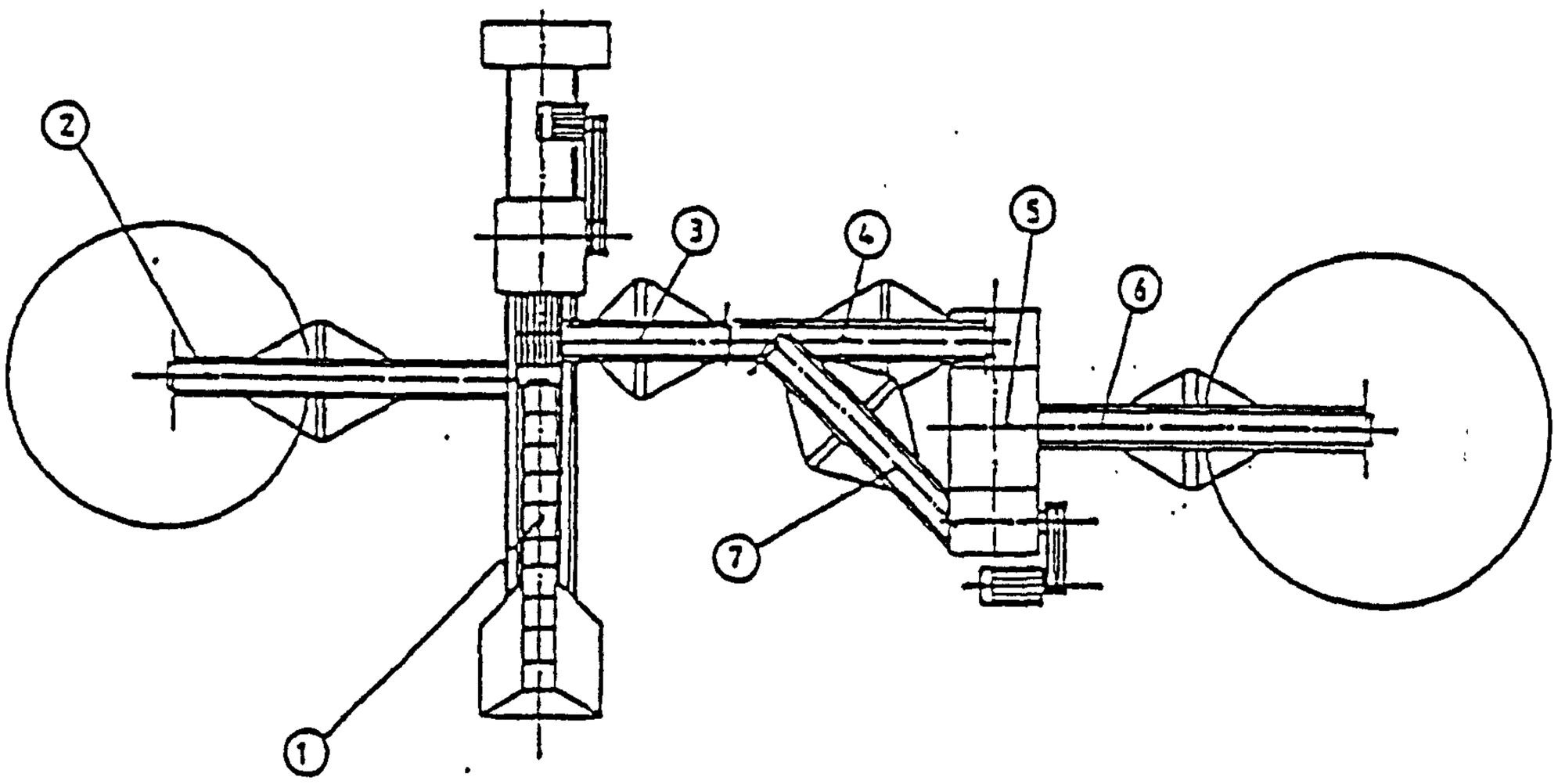
US$45 and 65/load depending on the distance from the source of generation to the nearest landfill.

There is an important difference between the waste management systems of America and the Arabian Gulf region in terms of the disposal cost. The disposal cost in Kuwait, for example, is about US$2.45 per ton. This is considered very low in comparison with the rates in Europe and America. In addition, the disposal operation in Kuwait is rather primitive in type, and does not really cost as much as those in developed countries where stringent regulations and disposal procedures must be followed. In addition, in both America and Europe, the cost of waste disposal continues to increase due to the continuous increase in the transportation charges and the limited space available for waste disposal. For example, the costs of disposal at a C&D waste recycling facility in Connecticut in the USA range from US$11 to 15 per ton (Von Stein and Savage, 1993).

Different types of recycling plants are available in different parts of the world. Yet, the main difference between them is their capacity, which ranges from 50 to 250 tons/hour. usually, the bigger the plant, the better the quality of aggregate produced. The average number of crushers in either a mobile or a stationary plant is 2 to 3. In most cases, the mobile plants

contain a single crusher (i.e., a simple mobile plant) or more than one crusher (i.e., an enlarged mobile plant), screens, and conveyors which are built as a unit on a semi-trailer chassis. An enlarged mobile plant often has a fixed location called the home base where the treatment plant is usually mounted. Figure 10.3 shows a sketch of a simple mobile plant with two crusher sections. Usually, mobile plants have some sort of mechanical system for the sorting of impurities from the crushed concrete and other rubble components. Due to the fact that theaquamators, which are basically wood/stone separators based on a water basin, require a number of fixed installations, most mobile plants are not be equipped with such equipment. Sufficient time has to be considered in advance for any operation of the mobile plant. A minimum of two days is required for moving a simple mobile plant. Normally, it is estimated that a minimum of 25,000 tons of rubble waste should be treated to make it economically advantageous to move an enlarged mobile plant (which requires nearly five working days before actual operation of the plant can begin).Figure 10.4 is a sketch of a larger treatment plant with two crushers. Such a larger plant is usually equipped with an aquamator, or vacuum air filter, for the separation of light materials from the crushed rubble. Stationary plants involve large capital investments and more preventive measures against vibrations, noise and dust. Site preparation, once allocated, is costly.

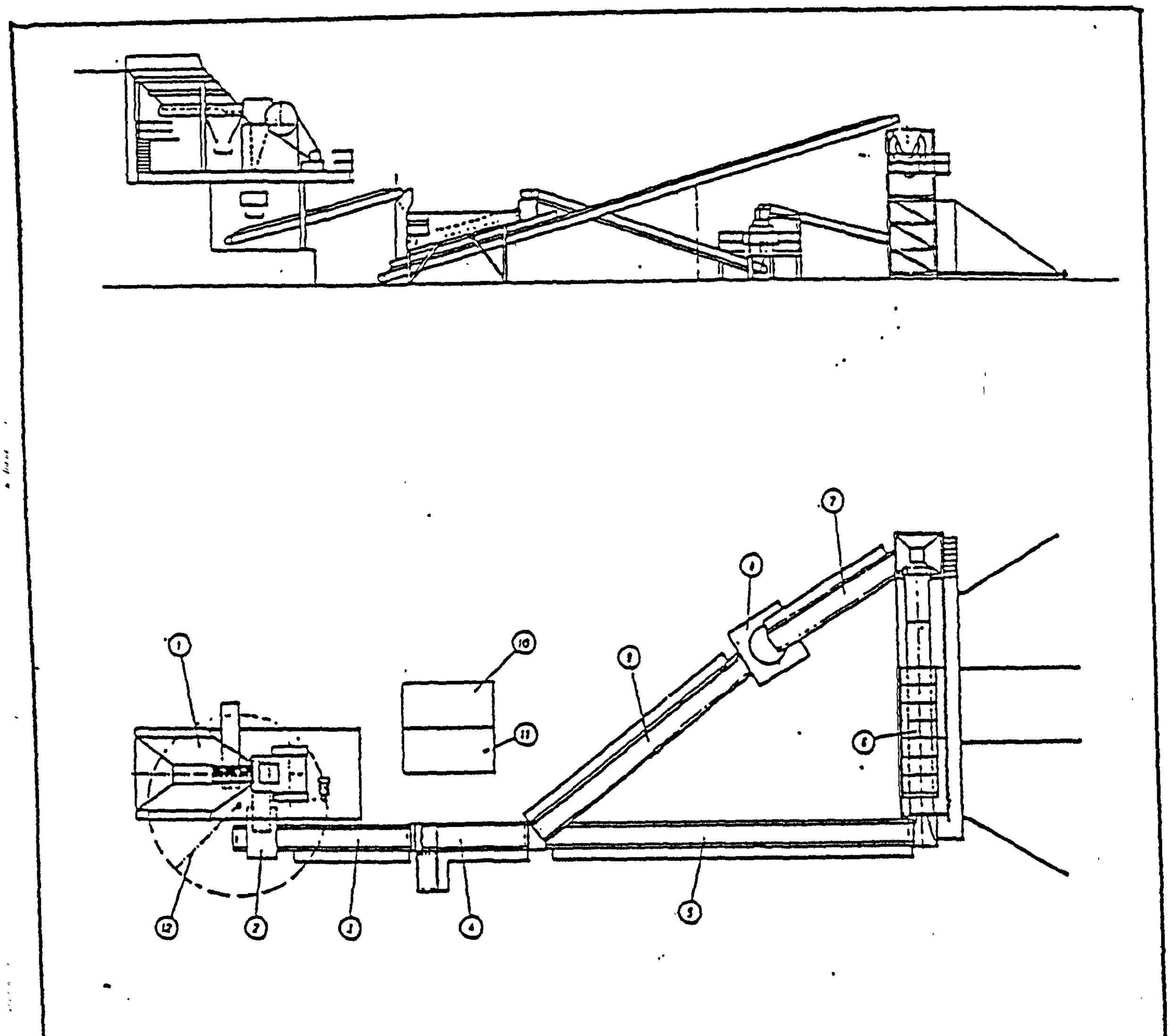
Figure 10.3: A sketch of a simple mobile plant with two crusher sections in C&D waste recycling facility



1. Primary crusher, conveyor belts and screen
2. Conveyor
3. Conveyor
4. Conveyor
5. Screen, crusher, supporting structure, and feeder
6. Conveyor
7. Conveyor

Source: Industrial Investment Company (IIC).

Figure 10.4: A sketch of a stationary plant with two crusher in C&D waste recycling facility



Source: Industreil Investment Company (IIC).

10.3 Financial Aspects of C&D Waste Recycling Facilities

The basis for estimating the feasibility of establishing a C&D waste recycling facility is a general economic model presented below in which the total costs of a C&D waste management system are optimised for Kuwait, in particular, and for the other GCC states, in general.

Along with the principles of privatisation, which have recently been widely considered by most GCC states, objectives essential for the establishment of a C&D waste recycling facility should be targeted, namely:

- Incorporation of the development of the C&D waste management system with the State's master plan.
- Reuse and recycling of C&D waste materials to supplement the use of the State's limited natural aggregate resources.

Considering the private sector's point of view regarding the establishment of a C&D waste recycling project, i.e., minimisation of the total system's cost and maximisation of the total system's profit, private-sector development of such a project may well be the best possible scenario for the State from an economic point of view. The State's government should,

however, play an important role in monitoring the waste management system, which has the potential to adversely impact the environment, and in providing proper channels for continuous and constructive communication with the investors.

10.4 Total Cost of the System

10.4.1 Selective Demolition Costs

Selective demolition basically means sorting of demolition waste at the project site rather than hauling all the components of the demolition waste to the recycling facility for sorting and processing. From an economic perspective, the idea of selective demolition may increase the time of the demolition operation, and consequently, the cost of the whole operation. However, selective demolition will decrease the process of transporting unwanted or unnecessary demolition waste components, such as earth and sand, which comprise about 50% of the total C&D waste in the Arabian Gulf, to the recycling facility. In general, the cost of demolition is based on the nature and complexity of each demolition project.

10.4.2Hauling Costs

The hauling cost is a function of the hauling distance and the quantity of the demolition waste in a given project. In most of the GCC states, the distance from the metropolitan areas to the sites of the C&D waste landfills is within a range of 30 to 40 km, which is a relatively short hauling distance. In general, hauling costs can be minimised if the location for the crushing plant is properly chosen. Furthermore, the plant's location can affect the undesired activity of some hauliers with regard tofly-tipping in open areas. From an economic point of view, the insurance of a continuous supply of the C&D waste to the recycling facility is of essential importance for the progress of the whole operation of the C&D waste management system.

10.4.3Recycling Costs

The construction of a recycling facility for the production of recycled aggregates and metals involves special financial investments and running costs. Summaries of the investment and running costs of two different proposals of recycling facilities in Kuwait submitted to Kuwait Municipality by different investors are shown in Tables 10.5 and 10.6. The Projects Department turned down these proposals at Kuwait Municipality for no apparent reason. It is suspected that the Municipality was welling to

accept proposals from investors in order to determine the size of the project investment and returns. Consequently, the Municipality decided to tender this project to a qualified contractor who should be expected to pay the municipality certain fees for obtaining C&D wastes and processing it at one of the landfill sites.

TABLE 10.5: INVESTMENTS FOR A PROPOSED C&D WASTE RECYCLING FACILITY:

PROPOSAL A	
Factor	**Cost Estimate (KD)**
Total machinery & equipment	1,062,000
Total vehicles	120,000
Total miscellaneous	126,000
Total civil works	450,000
Subtotal	1,758,000
Total design at 5%	88,000
Total contingency at 10%	175,800
Total cost	2,021,800

(KD 1 is about Sterling pound 2.2026)

Proposal A was based on the following data:

- The yearly generation of C&D waste, comprising 50% building waste materials with recycling potential and 50% earth and sand, is estimated to be 3.5 million tons.
- Only stationary system is to be used for recycling C&D waste materials.
- An actual annual capacity of 500,000 tons is assumed.

TABLE 10.6: INVESTMENT FOR A PROPOSED C&D WASTE RECYCLING FACILITY:

PROPOSAL B	
Factor	**Cost Estimates (KD)**
Total machinery & equipment	3,655,000
Total vehicles	1,730,000
Total miscellaneous	1,180,000
Total civil works	705,000
Subtotal	7,270,000
Total design at 5%	363,500
Total contingency at 10%	727,000
Total cost	8,360,500

(KD 1 is about Sterling pound 2.2026)

In the case of proposal B, the following data were considered:

- The yearly generation of C&D waste is estimated to be 4.0 million tons with recyclable materials constituting about 2.2 million tons of the total.
- Both stationary and mobile systems are to be used to increase the chances for a continuous supply of C&D waste materials
- An actual annual capacity of 700,000 t is assumed.

The statement of earnings presented in table 10.7 includes a 6-mo start-up period for Kuwait's concrete crushing venture company (Proposal B). This joint venture company represent one of the companies that was pre-qualified by Kuwait Municipality to participate in the bidding process mentioned earlier. The statement of earnings shows positive cash flow starting in the third month of operation. The total income of the first year is estimated at about $35.5 million (K.D 10.8 million) against total expenses of $7.2 million (K.D 2.2 million). The project seems to be a viable investment opportunity for the private sector. The Joint Venture Company is structured according to the commercial laws of the State of Kuwait, which require the Kuwaiti ownership must be at least 51% while the foreign ownership must not exceed 49%. The statement shows that both Kuwaiti and foreign partners are making reasonable net earnings however the actual

Table 10.7: Kuwait Concrete Crushing Venture – Statement of earnings (six months start-up)

KUWAIT CONCRETE CRUSHING VENTURE
STATEMENT OF EARNINGS
INCLUDING SIX MONTH STARTUP

	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5	MONTH 6	MONTH 7	MONTH 8	MONTH 9	MONTH 10	MONTH 11	MONTH 12	TOTAL
INCOME													
CONCRETE CRUSHING	0	0	864,000	1,728,000	2,592,000	3,456,000	4,320,000	4,320,000	4,320,000	4,320,000	4,320,000	4,320,000	31,560,000
RECOVERED REBAR	0	0	22,500	45,000	67,500	90,000	112,500	112,500	112,500	112,500	112,500	112,500	900,000
TOTAL INCOME	0	0	886,500	1,773,000	2,659,500	3,546,000	4,432,500	4,432,500	4,432,500	4,432,500	4,432,500	4,432,500	32,460,000
EXPENSES													
WAGES	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	1,800,000
MAINTENANCE - PARTS AND SUP	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	450,000
FUEL	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	90,000
CASUALTY INSURANCE	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	90,000
EQUIPMENT RENTAL	52,500	52,500	52,500	52,500	52,500	52,500	52,500	52,500	52,500	52,500	52,500	52,500	630,000
DEPRECIATION	0	0	0	0	0	0	175,000	175,000	175,000	175,000	175,000	175,000	1,050,000
INTEREST	0	0	0	0	0	0	210,000	210,000	210,000	210,000	210,000	210,000	1,260,000
ROYALTY PAYMENT	0	0	0	0	0	0	300,000	300,000	300,000	300,000	300,000	300,000	1,800,000
TOTAL EXPENSES	255,000	255,000	255,000	255,000	255,000	255,000	940,000	940,000	940,000	940,000	940,000	940,000	7,170,000
NET EARNINGS	(255,000)	(255,000)	631,500	1,518,000	2,404,500	3,291,000	3,492,500	3,492,500	3,492,500	3,492,500	3,492,500	3,492,500	25,290,000
LESS SIX MONTH OWNERSHIP INT	(130,050)	(130,050)	322,065	774,180	1,226,295	1,678,410	1,781,175	1,781,175	1,781,175	1,781,175	1,781,175	1,781,175	12,897,900
DIXIE INTERNATIONAL INTEREST	(124,950)	(124,950)	309,435	743,820	1,178,205	1,612,590	1,711,325	1,711,325	1,711,325	1,711,325	1,711,325	1,711,325	12,392,100

Source: Kuwait Concrete Crushing Company.

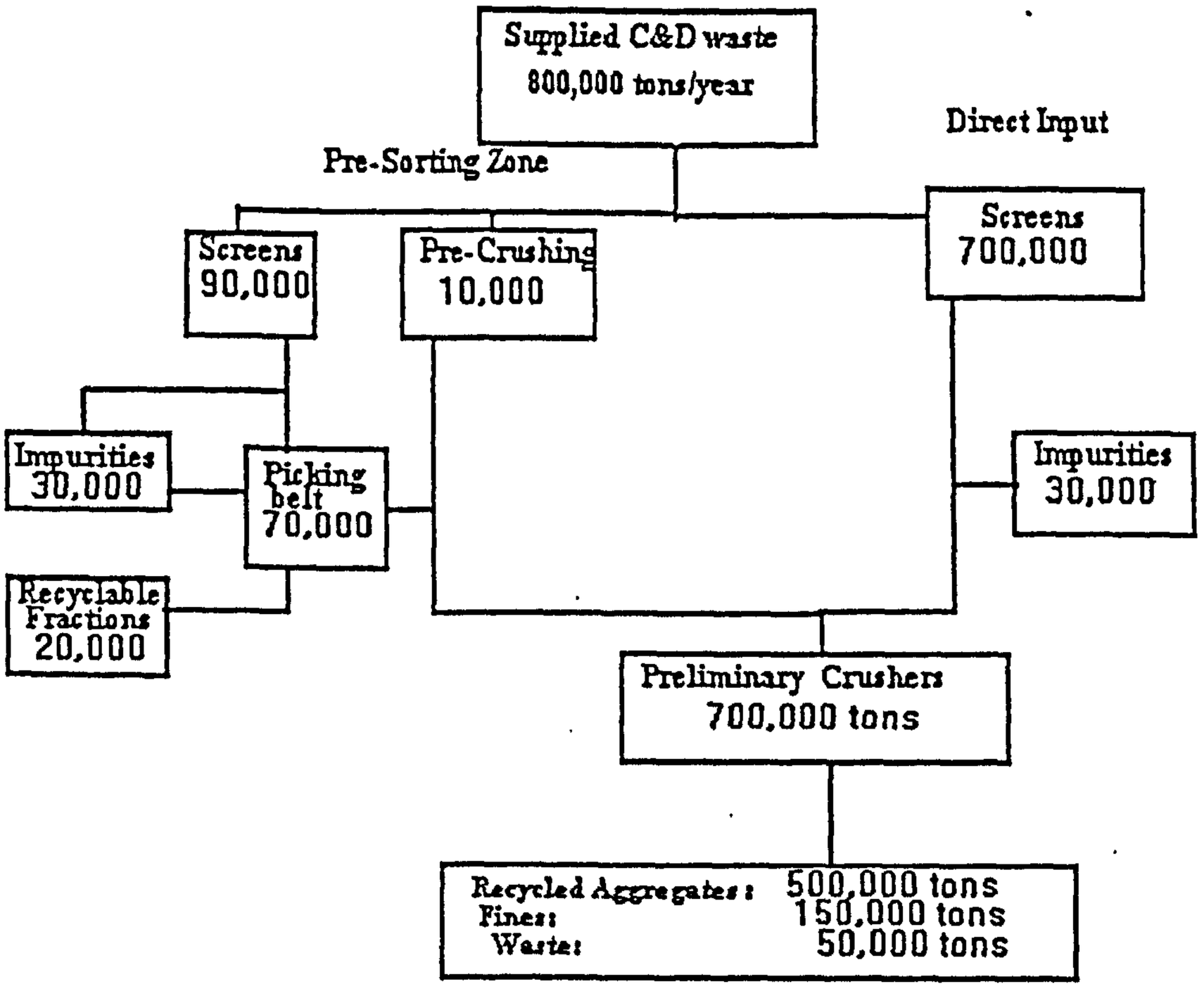
work in this project is almost totally done by the foreign partner who is responsible for the daily operation of the facility. The Kuwaiti partner role is more less a facilitator and a co-ordinator between the joint venture and the government. In other words the Kuwaiti partner is the administrator of the project while the foreign partner is the operator of the project.

The design of a crushing facility for the production of the main item of this process, which is recycled aggregate, requires the assumption of a waste flow within the proposed recycling facility. The mass-balance of the C&D waste materials coming into the proposed plant layout for Proposal B is presented in Figure 10.5.

10.5 Environmental Aspects of C&D Waste Recycling

As the Deputy Director of the Department of Environmental Affairs in the Municipality of Kuwait, the author supervised the performance of a study to set environmental requirements for the establishment of a C&D recycling plant to be operated by a private-sector company. The basic information needed for the project was obtained from the files of the private-sector company, the Environmental Protection Department at the MPH and a few studies and reports on C&D waste utilisation that were available. The final

Figure 10.5: Waste flow in C&D waste recycling facility (Proposal B)



report of the study presented to the Council of the Municipality of Kuwait covered the following environmental issues: noise pollution, dust air-pollution, soil and water pollution, workers' health and safety, and vibrations. Brief descriptions of these aspects of C&D waste generation are presented below.

10.5.1 Noise Pollution

According to a study conducted for the Municipality of Kuwait by a national consulting firm, the IIC, in early 1989, noise levels were measured at an established crushing plant in Denmark. The results indicated that noise levels ranged between 85 and 93 dB(A) (7 m away from machinery and without muffler arrangements). However, Kuwait's laws, i.e., Decree Number 45 issued in 1979 by the MPH with regard to the level of noise pollution from such an industry, require that the level of noise not exceed 90 dB(A) in an 8-h shift. The Decree further states that noise levels greater than 115 dB(A) are not acceptable under any circumstances. The maximum noise levels and the associated exposure times allowed by the Decree are presented in Table 10.8.

TABLE 10.8: MAXIMUM C&D NOISE LEVELS AND EXPOSURE TIMES

Noise Level (dB(A))	Maximum Exposure (h)
90	8
95	4
100	2
105	1
110	½
115	¼

The Decree also indicated that with regard to heavy machinery and crushing plants using large hammers, the noise level should not exceed 140 dB(A) in any situation. The levels of noise produced from C&D waste recycling plants should be reduced to acceptable levels such as those set by the Decree.

There are several means by which the level of noise generated from crushing plants can be reduced, such as:

- Covering the source.
- Choosing a low location for the plant, i.e., a gravel pit.
- Surrounding the plant's site with vegetation.

In the case of Kuwait, in particular, and the GCC states, in general, reduction by means of vegetation is out of the question. This is due to the climatic conditions, which make it very costly to surround a plant's site with the dense, high-growing vegetation required to ensure significant reduction in the level of generated noise. Noise reduction by covering the source is also a very expensive option; thus, the most appealing alternative may be choosing a depressed location for crushing plants. Every GCC state has many gravel pits where a crushing plant could be located at a depressed elevation. This would reduce the level of noise by approximately 15dB(A) according to the IIC.

10.5.2Dust Air Pollution

In the crushing and screening of C&D waste, great amounts of air pollutants are generated. Air pollutants may be of different types, but crushing plants produces mostly dust. A few counter measures are available for the reduction of the amount of dust air pollution emissions. Filtration,

humidification and covering are the measures most commonly used in various crushing plants. After the air pollutants are filtered and collected; sanitary landfill will, in most cases, be the final solution for disposal.

10.5.3Soil and Water Pollution

It is important to consider the problem of soil and water pollution at crushing plants, since there are several possible means by which both the soil and water may become polluted. Some of these possibilities are:

- Heavy washout of materials which may contain substances such as sulphate and chlorides, heavy metals and organic components.
- Rising of groundwater levels.
- On-site liquid spillage.

In general, the region of the GCC is rather dry, considering the amount of rainfall per year. Therefore, the possibility of heavy washout of the heavy metals and other components is very slim. However, the groundwater level may rise and cause problems in some areas. Protective measures should be taken in such cases. Many possible options can be applied, such as the use of plastic liners, which is the most common technique employed in several

countries. As a matter of fact, the problem of rising groundwater is most likely to occur in sites, which were previously used as quarries for sand and aggregates. Therefore, the proper selection of a recycling plant's location should be considered from the beginning to avoid the problem of soil and water pollution.

The GCC region lacks water; thus, water is a very important resource for this region therefore it is of a great importance to protect it and to maintain its purity as much as possible. A cost-effective way to minimise the problem of groundwater contamination is not to issue permits for the establishment of crushing plants in sensitive areas where the groundwater might be adversely affected.

10.5.4Workers' Health and Safety

It is essential to provide measures to ensure the safety of the environment, which will as a result have a direct positive effect on the workers' health and safety. The more care that is taken with regard to the protection of the environment, the fewer human health and safety problems will be encountered in the operation of such crushing plants. There are a number of

ways to protect the workers' health during his/her interactions within the operating site of a crushing plant. These means include:

- Masks to prevent the inhalation of sand particles dispersed in the air at the site.
- Dust collection equipment that decreases the amount of pollutants in the air.
- First-aid equipment that is available at the site.
- Special protective clothing and gloves for the workers at the site.

Moreover, routine medical check-ups are of great importance in such operations, since the workers may encounter health problems such as lung infections, difficulties in breathing, hearing problems, etc., which may be directly or indirectly related to the workers' involvement in the operation of crushing C&D waste for recycling purposes.

10.5.5Vibrations

A complete survey of the area around the site selected for the construction of a crushing plant to determine the potential impact of vibration-sensitive land-use close to the site. Vibrations should be taken into account when

dealing with mobile crushing plants, as well. This type of crushing plant lacks an insulating concrete foundation, an important issue that is addressed in the design of stationary crushing plants.

10.6 C&D Waste in Kuwait

The lack of a tracking system for C&D waste in the GCC states has a major negative effect on both the disposal and the recovery of C&D waste. The GCC municipalities and other concerned authorities lack co-ordination in the control of C&D waste, and as a result, hardly any accurate information on the subject could be compiled. There is a need for better follow-up once C&D permits are issued to generators. Data on waste characteristics such as volumes; quantities; sources; routes of transportation; types of components hauled; possible recycling quantities by type, weight and volume; and means of disposal need to be recorded. A major issue that has begun to arise at various C&D landfill sites in the GCC states concerns the improper disposal of toxic and hazardous waste. This too indicates a need for greater control of C&D waste management.

Even though C&D waste is mostly inert material such as dirt, bricks, concrete, etc., which do not cause major problems for the environment,

other materials are contained in the C&D waste in the GCC states. Materials, such as treated wood and gypsum drywall do cause environmental problems. In the case of the latter, i.e., gypsum drywall, its anaerobic decomposition produces hydrogen sulphide, a toxic, foul-smelling gas.

Another major problem is the illegal dumping of C&D waste in the deserts and old quarry sites of the GCC states. Since dumping waste in an illegal dump site is an inexpensive alternative to using a legal landfill site designed for C&D waste, fly tipping (the undetected dumping of waste wherever possible) of C&D waste by various generators is being noticed. In Europe and America, the rising cost of C&D waste disposal has caused an increase in fly tipping as a way some waste transports reduce costs and increase income. For instance, in the USA, disposal fees for C&D waste at different recycling facilities vary from about US$3.88/tonin Lexington, Kentucky, to about US$2.50/ton in Bridgeport, Connecticut (Apothker, 1990).

Currently, in the GCC states, there is no disposal fee for C&D waste. This means that the transportation companies charge the public for the transportation of their C&D waste to the nearest municipality landfill site. At the disposal site, such as those in Kuwait, the landfill site operators do not charge the transport of the C&D waste any fees. Yet, fly tipping is

common; violators in Kuwait give different reasons for fly tipping than fly tippers in the USA and Europe. The main cause for fly tipping in the GCC region is the availability of open area around the metropolitan districts, which makes it very easy to unload C&D waste and return to the work site within a short period of time. If more enforcement and better waste management system control that verifies the quantities and the destination of C&D waste, were applied, the problem of fly tipping could be eliminated. In Kuwait, it has been estimated that the annual amount of rubble waste accumulated at uncontrolled tipping sites is approximately 1,100,000 tons.

Laws should be enforced whenever possible as one means of preventing the illegal dumping of C&D waste. Moreover, an educational programme via the media on C&D waste recycling should be developed with the aim of identifying the possibility and potential of developing several lines of products from such waste. Also, the GCC governments should encourage the private sector to invest in and develop appropriate recycling facilities for the recovery of concrete, asphalt, glass, plastics and other recyclable materials from C&D waste.

According to several investors, "the government should allow the private sector to invest in, manage and operate those facilities which the government has not been able to manage and operate without financial loss" (personal communication). The main request the private sector has for the government is that the government set up a full-scale recycling facility for the production of aggregates and other recyclable materials contained in C&D waste. The facility should then, of course, be operated cost-effectively and economically.

The GCC's governments should require that the generators of C&D waste plan in advance to conduct source-separation of recyclable materials. Moreover, projects financed by the GCC's governments should use products that are generated from C&D waste recycling facilities. Creation of a market for recycled C&D waste components by the GCC governments can be well justified when one takes into account the economic loss that results from not using, particularly, concrete and asphalt as secondary materials for construction projects. Furthermore, it is important to realise the benefits that will accrue from stopping the continuous flow of C&D waste to the limited landfill sites. Given the specific density of the rubble materials in Kuwait (about 0.87 ton/m^3), it is clear that the GCC buries a volume of about 9,123,148 m^3/y of recyclable C&D waste.

In the USA, C&D waste has not received much attention from the Environmental Protection Agency. This is due to the fact that there is not much information available concerning C&D waste (*Recycling Today*, 1992).

In a recent C&D waste recycling conference held in Philadelphia, Pennsylvania (Winzinger, 1992), the annoyance caused by the federal and state regulations for obtaining permits and approval for C&D recycling facilities was highlighted. It was pointed out that there is a need for a law to require an estimate of the C&D waste generated by the various sources, as well as its means of disposal for better monitoring and process control in C&D waste management.

Authorities at the Municipality of Kuwait also operate with a critical gap in their information on C&D waste according to Issa AlKandari, Deputy General Manager of Services Affairs (personal communication). The same is also true of other GCC states. Generally, information on waste is hard to obtain from government officials simply because accurate information does not exist. This is especially true when data on C&D waste is involved. Currently, the Municipality of Kuwait pays about US$1 million per year for the disposal of C&D waste by a private contractor that handles all aspects

of C&D waste disposal at the three main C&D landfill sites.Issa AlKandari has voiced concern over the various difficulties facing his department with regard to the problem of C&D waste disposal. In his opinion, the main shortcomings are (personal communication, 1992):

- Absence of proper equipment at landfill sites, such as weighing scales, safety devices, pollution prevention mechanisms, etc.
- Interruption of the daily operations at landfill sites by scrap metal scavengers, which causes delay and creates hazardous conditions.
- Presence of hazardous waste at the C&D landfill sites due to the lack of competent, professional inspections.

It is quite clear that C&D waste is mismanaged at the Municipality's landfill sites. As a result of the absence of a proper plan for utilising such waste, much valuable material is disposed of. In 1991, the private sector responded to the Municipality of Kuwait's invitation to construct and operate a C&D waste recycling facility. Since 1991, the Municipality's officials have been reluctant to approve the contractor's proposal. The proposal calls for sharing 10% of the net profit from the production of aggregates at the proposed C&D site in one of the Municipality's landfills for the next 10 years. The offer is very reasonable when taking into account

the fear many investors have of entering this new field of business in the Kuwait as well as in all other GCC states.

As mentioned previously, the officials at the Municipality of Kuwait are reluctant to award a contract or appoint a contractor mainly because they feel uncomfortable with both the quality of the data available on C&D waste and the technology for C&D waste recycling. Moreover, the invitation to the private sector to establish a C&D waste facility is part of the privatisation policy initiated by the Kuwaiti government after the Gulf War ended in early 1991. However, the policy plan encompassed a great deal of organised thought on the definition of objectives and proper procedures leading to successful implementation of the plan. More precise and well defined objectives and implementation plans for the construction of a C&D waste recycling facility is forthcoming from the officials of the Municipality of Kuwait.

The establishment of an initial database at the Municipality of Kuwait containing a list of the contractors involved in C&D activities, estimates of C&D waste (weight, volume and density parameters), future forecasts of C&D waste quantities, analyses of C&D waste components, and the number of trip-loads arriving at each C&D landfill site may well be the

cornerstone of a strategic plan to manage C&D waste more properly in the future.

Furthermore, the Municipality of Kuwait should act to prevent the open dumping operations that have been taking place since 1980. The C&D waste recovery plan should include the various parties involved in the C&D industry in order to maximise the benefits and eliminate unnecessary costs. Both the government and the private sector should co-operate to explore new methods for the operation and management of a C&D waste recycling facility.

10.7 Present Status of C&D Waste Management in Kuwait

In the State of Kuwait, ordinary contractors involved in the building sector basically handle the C&D waste management system. The Municipality of Kuwait determines which landfill sites are to be used for C&D waste disposal. In general, the landfill sites are actually old quarry sites that were excavated to obtain clean sand and gravel. The present condition of these landfill sites is far from sanitary since improper disposal of C&D waste is taking place in them. Moreover, there are a number of uncontrolled landfill sites in operation at various locations in the desert.

Generally speaking, the GCC's municipalities, including the Municipality of Kuwait, regulate the demolition or construction of any project by issuing permits for such activities. However, many instances of demolition that took place without proper permission, and the consequent unsanctioned demolition waste disposal, have been observed in residential areas around Kuwait. Much of this improper waste handling could be corrected if a more planned and controlled C&D waste management system were adopted.

Before receiving final payment, contractors who perform major projects for the government are required to obtain a certificate from the Municipality of Kuwait indicating that the site is clear of any rubble or waste. Although, this is the proper and official procedure, the contractor is not responsible for the transportation of the project's waste to the assigned landfill sites. The contractors, quite understandably, favour the shortest distance for dumping their waste, so due to the Municipality's lack of control over the truckloads of rubble waste and their disposal, fly tipping in Kuwait has increased.

The main landfill sites utilised by the Municipality of Kuwait for C&D waste are shown in Table 10.9. (Note that although these sites carry the same name as of the domestic waste landfill sites, they are actually

physically different sites). The table also provides data on the surface area, depth, and term expectancies of the sites in Kuwait.

TABLE 10.9: MAIN LANDFILL SITES UTILISED FOR C&D WASTE IN KUWAIT

Landfill Site	Surface Area* (km^2)	Site Depth* (m)	Expected Term of Operation** (y)
Al Jahra	21.50	5-10	20
Mina Abdullah	2.35	10-15	3
7th Ring Road	5.34	5-10	5
Jeleeb Al Shuyoukh	3.66	5-10	5

*Determined from aerial photographs provided by the Survey Department, Municipality of Kuwait, 1993.

**According to the Cleansing Department, Municipality of Kuwait, 1993.

At the gravel pits in the northern part of the State, a major environmental issue is evolving because contractors are combining C&D waste disposal with loading of natural materials such as gravel and sand. Trucks that are suppose to haul clean sand and gravel find it convenient to haul loads of debris from residential, commercial, and industrial areas to be fly-tipped in the north en route to the gravel and sand pits.

10.8 Investigation of C&D Waste Activities in Kuwait

The nature of C&D waste generated from various sources varies in a one geographic area as to quality and quantity from those of other geographic areas. For example, the renovation of a house within the GCC will produce mostly bricks, and concrete, while the renovation of a house in the USA will produce mostly drywall and wood. Such variation even occurs within the same geographic region.

For example, predominately concrete is used in construction (and subsequent demolition) in Kuwait, whereas in the UAE, steel is the material of choice. Usually, the main contributor to C&D waste is the primary infrastructure projects such as highways, airfields, and major buildings. Yet, such projects are not conducted on a regular basis.

Table 10.10 presents the number of trip-loads arriving at the main C&D waste landfill sites in Kuwait from the various sources per day.

TABLE 10.10: NUMBER OF TRIP-LOADS AND THEIR CORRESPONDING AVERAGE TOTAL WEIGHT

Landfill Site	Main C&D Waste Source	No. of Trip-Loads/d	Average Total Weight (t/y)
Al Jahra	Residential	60	216,000
7th Ring Road*	Residential, commercial and industrial	300	1,080,000

Calculations are based on an average trip-load of 10 tons and 360 days/year.

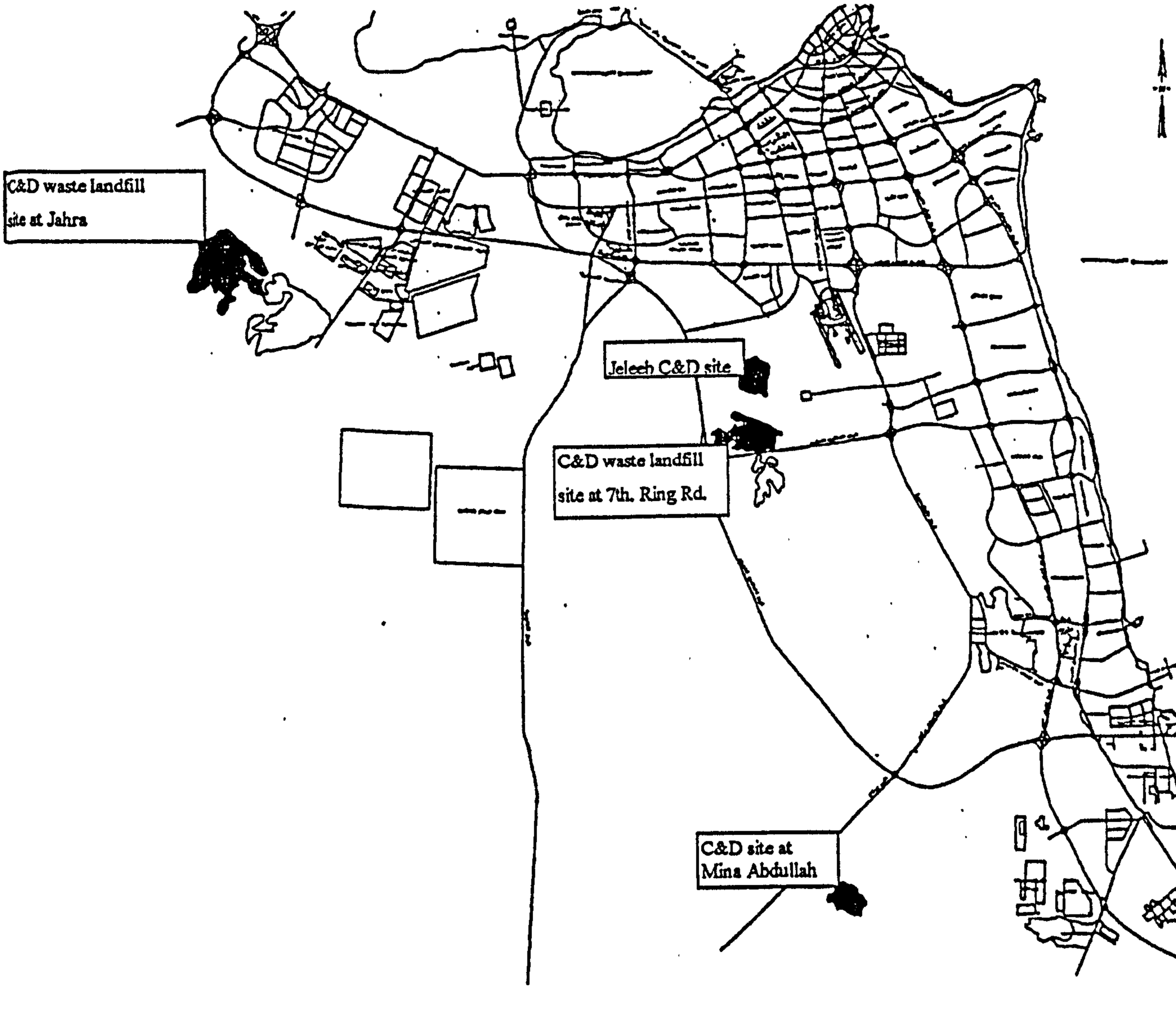
* Also included were a few trips to the Jeleeb Al Shuyoukh site.

Source: Municipality of Kuwait, Cleansing Department, Landfill Section, and personal communication.

10.9 C&D Waste Quality in Kuwait

From 11 January to 24 February 1992, qualitative and quantitative analyses of the composition of 16 truckloads of C&D waste were conducted. Kuwait was divided into four zones as follows: southern zone, city centre, central zone, and northern zone. The four sample trucks (one from each zone) loaded with the different types of building wastes passed over a weighing scale at the Jeleeb Al Shuyoukh C&D landfill site. The locations of the landfill sites are shown in Figure 10.6. After the unloading of the building waste by zone of origin, the waste was sorted into various fractions and weighed. Table 10.11 shows the physical analysis of Kuwait's C&D waste from the representative sample. Relatively larger fractions, such as blocks

Figure 10.6: C&D waste landfill sites in Kuwait



Source : Kuwait Municipality.

and tree trunks, were manually sorted. Much of the earth and grit were separated from the bulk of the building waste with the use of a 10-mm net screen. Table 10.12 presents the characteristics and specific density of the samples of C&D waste.

TABLE 10.11: PHYSICAL ANALYSIS OF KUWAIT CONSTRUCTION AND DEMOLITION WASTE (REPRESENTATIVE SAMPLE)

SELECTED DEMOLITION ZONE	REINFORCED CONCRETE	CEMENT BLOCKS	WOOD	METALS	PAPER	PLASTIC	GRITS	EARTH	TOTAL
SOUTHERN	1.75	8	0.98	0.64	0.25	0.9	2.65	39.19	54.36
CITY CENTRE	3	4.9	1	0.46	0.36	0.1	2.99	69	81.81
CENTRAL	10.55	8.97	3.5	0.41	0.04	0.1	10.75	10.16	44.48
NORTHERN	1.63	4.75	0.1	0.02	0.01	0.031	0.1	0.13	6.771
TOTAL	16.93	26.62	5.58	1.53	0.66	1.131	16.49	118.48	187.421
AVERAGE	4.23	6.66	1.40	0.38	0.17	0.28	4.12	29.62	46.86
PERCENTAGE	9.0%	14.2%	3.0%	0.8%	0.4%	0.6%	8.8%	63.2%	

Source: Author estimation.

TABLE 10.12: RUBBLE WASTE SAMPLE CHARACTRISTICS AND SPECIFIC DENSITY

ASSIGNED ZONE	RUBBLE WASTE NET LOAD (TONS)	RUBBLE WASTE VOLUME CUBIC METERS	RUBBLE WASTE SPECIFIC DENSITY TONS/CUBIC METERS	TYPES OF WASTE & PROJECTS NATURE
SOUTHERN				
	16.744	18	0.93	RUBBLE (CONSTRUCTION)
	3.9	6	0.65	RUBBLE (REPAIR)
	11.972	18	0.67	RUBBLE & NON-FERROUS METAL (DEMOLITION)
	14.494	18	0.81	ASPHALT (ROAD RESURFACING)
	7.25	6	1.21	FERROUS & NON-FERROUS METALS (REPAIR)
SUB-TOTAL	**54.36**	**66**	**4.259**	
CITY CENTRE				
	22.738	19	1.20	RUBBLE & ASPHALT (ROAD CONSTRUCTION)
	19.869	18	1.10	RUBBLE (CONSTRUCTION)
	9.5	6	1.58	NON-FERROUS METAL (REPAIR)
	22.138	19	1.17	RUBBLE & NON-FERROUS METAL (DEMOLITION)
	7.6	6	1.27	RUBBLE (REPAIR)
SUB-TOTAL	**81.845**	**68**	**6.316**	
CENTRAL				
	13.34	18	0.74	RUBBLE (DEMOLITION & REPAIR)
	12.448	18	0.69	RUBBLE (DEMOLITION)
	10.343	18	0.57	RUBBLE (DEMOLITION)
	8.346	6	1.39	FERROUS & NON-FERROUS METALS (REPAIR)
SUB-TOTAL	**44.477**	**60**	**3.398**	
NORTHERN				
	3.493	6	0.58	RUBBLE (REPAIR)
	3.246	6	0.54	RUBBLE (REPAIR)
SUB-TOTAL	**6.739**	**12**	**1.123**	
TOTAL	**187.421**	**206**	**15.096**	
AVERAGE	**11.714**	**12.875**	**0.944**	

Source: Author estimation.

10.10 Examination of Present and Future C&D Waste Generation in Kuwait

In order estimate of the total annual amount of C&D waste generated in the State of Kuwait, a comprehensive payload statistical analysis based on records of truckloads arriving at the main controlled landfill site inJeleeb Al Shuyoukh was performed. The examination process took place during the period from 11 January to 24 February 1992, and the results are presented in Table 10.13. A number of assumptions were made in the analysis given in Table 10.13:

- The equivalent volume-payload-per-day figures were derived by multiplying the average number of trips by the truck size and the empty factor, which was estimated to be 20%.
- The conversion of the equivalent volume into tons was based on the specific density determined previously to be 0.94 t/m^3, according to findings from the sorting analysis.
- In general, it was concluded that the total projection of the amount of disposed C&D waste in Kuwait is about 1.2 million tons per year. This is a conservative estimate of the amount of C&D waste generated annually. Yet, due to the rapid increase in the construction

of new residential and commercial buildings, large amounts of rubble waste are expected in the near future.

TABLE 10.13: STATISTICAL ANALYSIS BASED ON TRUCKLOAD RECORDS

(a) Truck Size (m^3)	(b) Average No. of Trips/d	(c) Equivalent Volume (m^3/d)	(d) Payload (t/d)
18	180	2,592.00	2,462.40
12	41	393.60	373.92
10	25	237.50	225.63
8	14	89.60	85.12
6	3	14.40	13.68
3	37	88.80	84.36
Total	300	3,415.90	3,245.11
Average	50	569.32	540.85
Total/Year		1,229,724	1,168,240

Source: Author estimation.

10.11 Estimation of Future Building Waste Generation in Kuwait

According to the Master Plan for Kuwait (1983), the following basic projects are important to the future generation of building waste in the country:

- The population growth from 1990 to 2005 represents approximately 35%.
- The stock of housing is assumed to increase by 239,000 from 1990 to 2005.
- A construction programme for the metropolitan area comprises 55,000 new dwelling units and renewal of 82,000 units.
- Commercial and government office floor space is expected to increase by 120 and 63% respectively.
- The number of schools and hospitals is expected to increase.
- Two new towns, with a total combined population of 365,000, will be built by 2005.
- Retail floor space will require an increase of 768,000 m^2, equal to 45%, from 1990 to 2005. The total demand for commercial and office floor space will increase from 2.1 million square metres in 1990, to 2.7 million square meters in 2005, equal to a 29% increase.

According to the Industrial Bank of Kuwait (1997), the following trends are expected in future:

- Buildings and structures erected during the boom period from the late fifties to the early seventies, before the stabilisation of good building practices, are foreseen to undergo widespread demolition and be replaced by more modern structures.
- Many concrete structures affected by chloride alkaline-silica reactions or other damage will undergo extensive repair work.
- The secondary network of roads, especially in the city area, will be changed or repaired.
- Introduction of new construction methods and materials will change the percentage distribution of waste components.

Table 10.14 shows estimations of the building waste to be generated in Kuwait in the future. The estimates are based on an analysis of the general trends in the European countries, which indicate that rubble waste is expected to double from 1990 to 2000. It is foreseen that building waste in Kuwait in the year 2000 may also increase to double the 1.2 millions tons estimated for 1992.

With 35% growth in the population and 41% growth in GPD in the next decade, according to the Master Plan, a 35 to 40% growth in building waste is recommended as a conservative planning figure for the purpose of this research project.

TABLE 10.14: ESTIMATION OF BUILDING WASTE TO BE GENERATED IN KUWAIT IN THE FUTURE

Item	Weighted Average (%)	Amount of C&D Waste Fraction (t) 1992	Projected Amount of C&D Waste Fraction (t) 1997	Projected Amount of C&D Waste Fraction (t) 2002	Projected Amount of C&D Waste Fraction (t) 2007
Reinforced Concrete	9.033	105,527	142,461	192,322	259,635
Cement Block	14.203	165,925	223,999	302,399	408,239
Wood	2.977	34,779	46,952	63,385	85,569
Metal	.816	9,533	12,869	17,373	23,453
Paper	.352	4,112	5,551	7,494	10,117
Plastic	.603	7,044	9,509	12,837	17,330
Grit	8.798	102,781	138,754	187,318	252,879
Earth	63.216	738,515	996,995	1,345,943	1,817,023
Total		116,8240			

Source: Author Estimation

Conclusions

- Kuwait and the GCC States should establish the building waste management system and organisation as soon as possible.
- It should be the goal of the GCC states to clean the desert for C&D waste, and recycle all accessible inventory of reusable waste.
- Due to the new laws which prevent any new excavation for gravel in Kuwait it is important that any recycling system to be established must concentrate on maximum production of recycled aggregates.
- The market in Kuwait is currently in need for recycled concrete. Large amounts of recycled concrete can be used in various applications through major government and private projects.
- Returns on investment from establishing a private recycling facility for C&D waste is viable, provided that the municipality will set the proper legal framework and the logistics among the involved parties.
- Environmental sense is clear in the case of saving the desert from being damaged by the gravel industry.
- Co-location of the recycling facility and a gravel pit or a landfill is suggested.
- For the future C&D waste handling system in Kuwait a decentralised system based on smaller stationary and mobile plants may be used.

CHAPTER XI

Conclusions and Recommendations

11. Conclusions and Recommendations

11.1 The Study in Perspective

Although a few studies have been conducted on MSW in each of the GCC states, this study has collected data on MSW management in the GCC states and treated them as one. Much of the information available on the organisation, economic co-operation agreement, practices, treatment alternatives, and potentials for regional co-operation in the fields of MSW and MSW recycling have been investigated and analysed. Statistics on MSW types and generation rates; composting plants and their production rates, and compost prices; amounts and prices of recyclable materials; oil waste plants, and their production rates and demands, and C&D waste amounts have been collected and presented for the first time. It is hoped that this contribution will serve as a useful database for the GCC's policy- and decision-makers in the field of MSW, in order that they might make sound management decisions regarding MSW in the future.

A computer spreadsheet model of a recycling plan including all members of the GCC has been designed for the GCC Municipal Affairs Ministers, Chairmen, and General Managers. The recycling plan is a new idea and would permit the development of other economic activities related to the

use of recyclable materials in various industries. The presentation of Kuwait as a model in developing such a project for the utilisation of C&D waste can be generalised for other GCC states. Also, the presentation of Kuwait as a model in its operation of an oil waste recycling facility can be an example for decision-makers in other GCC states.

Since accurate data on the MSW stream is important for the municipalities of the GCC states, data were collected on different types of waste. This was to enable the planners and managers in the field of municipal affairs to make their estimations and projections more precise.

In any future planning and development of projects for the utilisation of MSW, the municipalities of the GCC states should make maximum use of the information and data available from research in the field of waste management, as has not been done in to date.

11.2 Conclusions and Recommendations

The degree of attention given to MSW management issues by the different GCC states varies. Most of the authorities involved in policy or decision-making regarding MSW management in the GCC states lack current

knowledge of the state of the art and the technology that may be applicable to this region. The field of MSW should not be viewed as a lower professional field that attracts people with low educational capabilities. This field should employ, especially in this region, people with experience and expertise. Waste management operations today require qualified engineers and scientists to meet the demands of maintaining a sustainable environment. An investment in the education of several engineers in waste management, engineering, and operations through the establishment of an institute in one of the GCC states is essential at this time. The creation of such an institute would definitely bring with it hope for regional co-operation and integration in the field of waste management.

Due to the lack of information on MSW in this region, the GCC states' municipal authorities should make a start by compiling data on the characteristics and amounts of waste generated. Such data can be stored in a central databank at the GCC headquarters in Riyadh, Saudi Arabia. Future researchers may not have to face the problems of missing information and/or uncollected data faced by this researcher. Such a databank of MSW reports, studies, and research abstracts would serve as a regional reference where information and results could be exchanged on any problem that has been studied by any of the other GCC states' municipal authorities.

11.2.1 CURRENT MSW LEGISLATION AND SYSTEM

The municipalities of the GCC states have taken responsibility for the management of MSW. All of the municipalities of the GCC emphasise the importance of following up their own legislation. The decrees vary slightly from one GCC municipality to another. Yet, the updating of the legislation to match current changes and developments is not being discussed or investigated. Such legislation should be filtered and upgraded by a team of experts including policy-makers, planners, lawyers, engineers, economists, and decision-makers. The objectives of such modifications of the legislation would be to decrease the gap between the GCC states in the areas of waste materials' exchange and trade, and to increase co-operation and integration of resources for the benefit of the region.

The GCC's MSW systems fail to encourage the separation of household waste an important element in any strategic plan based on alternatives such as waste materials' recycling and composting. More encouragement is required by all of the GCC's municipalities. Encouragement of students in their classrooms, employees at their offices, heads of households in their homes and non-nationals in their own languages is urgently needed. There are several methods for such encouragement; the GCC's municipalities

should determine the best possible means to impact their populations. The development of an educational awareness programme may well have a great impact on public participation in support of the objectives of a waste management strategic plan.

During the early stages of this thesis and up until the time of the writing of this chapter, few studies have covered the GCC states as a single body. Moreover, not many studies have been produced by the different GCC states regarding MSW management in general. One of the main obstacles of this thesis was finding books, reports, or any kind of document describing MSW in the GCC states. The only book that addressed several Arab cities, including some in the GCC states, was *General Cleaning and Waste Disposal in the Arab Cities*, issued in 1986 by The Arab Institute for Cities Development. Although the book included a decent survey of the waste management systems in many Arab cities and contained a lot of data, the section pertaining to the GCC states was too general and the Gulf's cities failed to provide much of the requested information. This low level of co-operation was due to many reasons. Officials responsible for waste management in the cities or states of the GCC were not confident of the data they held in their hands. Inaccurate and unscientific methods of data collection, estimation techniques, and analysis of findings forced the

officials to avoid participation in any compilation of information on solid waste at that time (i.e., 1986).

Another issue with data collection in this region is the secretive way in which departments and offices that belong to the various governments are managed. This closing of doors to researchers should be stopped immediately, and more co-operation and explanation should be provided upon request. Receipt of information pertaining to the types and estimated amounts of waste of any city in the world is not likely to make a researcher any more powerful or dangerous than if he/she were not given such information. The lack would merely make him/her less able to adequately evaluate the situation. Such information is harmless; therefore, the release of such data will have no negative effect whatsoever on the state.

In the GCC states, much of any business is done on the basis of good relations and mutual benefit. A great part of this thesis was done that way. Without relevant connections, it would not have been possible to obtain any information regarding MSW in the GCC. This should not be the standard method for researchers seeking knowledge and working toward modification and development.

Several conclusions were drawn from investigating the MSW management in Kuwait. One of the most important conclusions with regard to Kuwait's MSW management is the absence of a strategic plan. This is also true for other GCC states. The GCC states have yet to produce strategic plans pertaining to all aspects of waste management. Some of the GCC's municipalities have made only a very limited effort in specific areas of waste management.

11.2.2 WASTE MANAGEMENT ALTERNATIVES

11.2.2.1 DISPOSAL

An important observation is that environmentally unsound waste disposal operations are being applied by most of the GCC states. A landfill site assessment was conducted. The GCC states, and Kuwait, have to apply appropriate engineering techniques in managing MSW disposal. In Kuwait, the problems at the Qurain dump had great environmental and social impacts. Poor planning, design, and operation of landfill sites cannot be allowed to continue any longer due to the direct and indirect effects on the economy, society, and environment. The GCC's municipalities must realise that soon they will face a waste crisis in which no land will be available for waste disposal; a situation that is already being encountered by European

and American cities. It is much easier to avoid falling into such a waste crisis than to solve it once it has occurred.

11.2.2.2 RECYCLING

The GCC's municipalities should soon begin national recycling plans with which the people of the countries can help through co-operation and participation in diverting large amounts of MSW from the landfill sites. An assessment of the impact of recycling on the land-area required for disposal in Kuwait indicated that more than 50% savings in the land-area assigned as landfill sites was possible. Currently, some of the GCC states spend large sums of money on MSW collection and disposal. It is strongly recommended that the municipalities conduct field studies of their waste collection and disposal operations in order to obtain much more accurate ideas of the size and real cost of such activities before assigning any areas to cleansing contractors. The cost of waste collection in Kuwait, for example, is high and could be investigated further through cost-benefit analysis and other types of economic evaluation.

An investigation of the possibility of privatising the waste management services in the GCC states indicated that some states have already taken the privatisation route, while others are still either performing the waste

management services on their own, or investigating the possibility of privatisation as an alternative. It is recommended that sharing information in this matter take place between the various GCC municipalities so that they may explore the positive and negative sides of the privatisation of the waste service together. Shared, acceptable requirements for the privatisation of waste collection, utilisation and disposal in the GCC states would assist in future regional pooling of resources and would definitely create an economy of scale. This would give the GCC's major municipalities the opportunity to keep current with national and international changes in the field of waste management operations.

11.2.2.3 COMPOSTING

The GCC states have had experience in the area of MSW composting. Such experience was investigated, and the picture was not pretty. Several composting plants in the GCC were operating under unsatisfactory conditions. Moreover, high operating costs due to the high cost of maintenance has been a major factor in the disappointing performance of these plants. Several modifications, and in some cases, complete changes are required. Simple, less sophisticated composting plants are what are needed for this region. Better agreements with the providers of the know-how should be studied before falling into one-sided benefit deals. Great

attention should be given to the design of any new composting plants for this region. Insuring the quality of the product for further use and application on a large-scale are important factors for the continuation and progress of any GCC composting plant. As a first step, the GCC states should set common compost standards, which will direct the compost plant managers of the region to produce a higher quality compost product than is currently available. These standards can be developed with other experienced entities such as the EEC's Composting Commission. As a second step, the GCC states may then apply stringent rules and measures to ensure the quality of compost produced in this region.

Co-composting is a modern technique that can be implemented by the GCC states. It is recommended that further studies and visits to European and American co-composting facilities by a joint team of experts in waste and wastewater treatment from the GCC and other countries be made to determine the possibility of using such a technique within the GCC states.

For Kuwait, composting is one of the most important waste management alternatives. Kuwait, like other GCC states, is in need of compost as a soil conditioner to strengthen its soil by providing the required nutrients and improving the air-water relationship of the soil, which in turn will increase

the waste retention capacity and develop the root system more extensively. Composting, therefore, should be the number one choice of the Kuwait government for MSW reuse, especially considering the government's proposed plan to green main areas within the State of Kuwait.

11.2.3 MINIMISATION AND REUSE OF MSW

The term waste minimisation is lacking in the overall waste management legislation and strategies of the GCC states. Although waste minimisation is a known alternative to then European and American authorities responsible for waste management it is a difficult alternative to be measured. The GCC even face a bigger issue with waste minimisation concept than the European and Americans since they, the GCC states, have not shown any sign of implementation of such concept. GCC states could benefit from the various works done by others in this field such as the report on Waste Minimisation conducted by the Institute of Waste Management – Waste Minimisation Working Group. As mentioned earlier in this thesis the GCC states need to unify their waste management terminology's among which is the definition of waste minimisation. Waste minimisation which also known as waste prevention and waste reduction should not be treated in isolation from the other waste management alternatives hierarchy. The GCC states should realise the importance of developing a unified

Sustainable Waste Management Strategy, which will take into consideration the interrelationships between the various alternatives of the waste hierarchy. Households, local authorities, central government, and the industry sector can implement waste minimisation. Each will play a vital role in the success of a national and regional waste minimisation programme. In the UK and USA several programmes are established to reduce the generation of waste and or to prevent certain types of waste from entering the waste stream. The most important factor affecting the waste minimisation or prevention in the GCC is the lack of public awareness on one hand and the lack of the local authority promotions of action programmes. In Kuwait for example the local authority, the Municipality, provide households with wheeled bins having a capacity of 240 litres, which indirectly encourage them to dispose of larger quantities of food waste. Moreover the Municipality on behalf of the households pays for the waste collection and disposal operations. Such a scheme of waste management would not support the objectives of waste minimisation. There is a need for change in both public behaviour and government legislation toward waste minimisation. To achieve such a change, for example, the government need to introduce recycling targets, encourage the creation of voluntary recycling groups, and encourage the co-operation among the industry, the public and the government itself. The GCC region is in need

for composting and recycling as waste management alternatives, which would be affected by the waste minimisation alternative. The author believes that on the long run waste composting and recycling will benefit from the waste minimisation due to the eventual diversion of certain types of wastes and the concentration on more value added types. This would have excellent results on the availability and possibility for the utilisation of waste materials within the GCC states. The opportunity for establishing a recycling industry based on segregated waste at the source will be an eventual consequence of waste minimisation.

11.2.4 REGIONAL CO-OPERATION IN RECYCLING

The most important part of this thesis is the new approach introduced for regional co-operation in the GCC in the field of waste material recycling. The unique role and objectives of the proposed GCC Recycling Association would give the GCC states great capabilities in marketing, negotiating contracts, and obtaining the best prices possible. Another important part in this thesis is the computer spreadsheet model of the recycling plan's financial projection, which helps in understanding the financial feasibility of regional co-operation in MSW recovery and processing. The officials in the GCC's municipalities when considering a regional venture to construct a central recovery and processing facility can use this model as a guide.

The attitude of the public as one of the essential driving forces of the recycling alternative, was investigated through the use of a case-study, which included a questionnaire directed to a sample of Kuwait University students. The responses indicated that Kuwait, and other GCC states as well, should increase their environmental protection educational programmes. The development of such an educational curriculum and its presentation to different grade-levels at schools, colleges and universities would educate both the curriculum-developing groups and the students. The GCC states should stress education in waste management as part of the schools' curricula since these young students are the next generation to face the waste crisis as they become part of the workforce in the society.

A case study on the utilisation of oil waste indicated that the GCC states generate large amounts of oil waste that is being disposed of in landfill sites or directly in the sewer systems. Several major problems have occurred due to such practices. The GCC authorities should create a financial support mechanism for private oil waste recycling plants. This would make more likely the continuation of the operation of these plants in the GCC states. An oil-waste-recycling-awareness programme should be initiated in order to avoid the problem of low oil waste quality at the different sources.

Educating the public would eliminate the mixing of water with oil waste, which creates problems in the plants' operations.

11.2.5 POTENTIAL RECYCLING OF C&D WASTE

Finally, C&D waste, an important type of MSW, was investigated using Kuwait as a model. Estimations of the C&D waste generated in Kuwait and other GCC states indicate that there is enough to be processed by more than 10 plants. Large amounts of C&D waste are disposed of in landfill sites without being used further. Economically, this is a pure waste of possible revenue and a lost opportunity. Moreover, the landfill sites, in the case of Kuwait, will soon be in demand for city expansion and development projects, which means extra money will be required for the removal of the waste and treatment of the sites. C&D waste recycling plants are proven successes, and more modifications are being added. Therefore, the GCC states should invest in such plants to avoid both environmental and economic losses.

11.3 Suggestions for Future Research

A number of issues of wider interest remain and could affect the composting and recycling of MSW in the GCC in the future. Further research in these areas could be productive.

MSW separation at the source is becoming an important factor in the progress of both wastes composting processes and waste recycling operations. Further research is needed in this area to determine the best mechanism for the application of source separation in the GCC states.

Since educational and awareness programmes and curricula are an essential part of any waste management strategic plan, future research is required in this area for the production of curricula pertaining to waste management at all levels of the society.

Analysis of the MSW in the GCC states demands further study to determine the variations in both the chemical and physical characteristics, and their implications for waste management policies and decisions.

Landfill disposal is one of the main waste management alternatives being applied in each of the GCC states. Further assessment of the waste disposal operations and the behaviour of waste inside these landfills are required. A survey of waste disposal landfills in the GCC states should be conducted to study the impact of improper waste disposal operations in the long run.

An economic investigation of the increasing costs of waste collection and disposal in the GCC states is in badly needed. The high expenditures on waste management operations and services in the GCC states require economic and technical studies to determine the real value of the waste services.

More research is required in the field of waste composting. Since compost is an essential product for the improvement of the GCC's environment, further research is needed to determine the best possible design for compost plants in this region. Moreover to identify the most efficient technical means for improving the quality of the compost product and to set the standards for the compost product.

Several research studies have yet to be done pertaining to waste materials' recycling. Waste materials such as rubber, plastic, and textiles are hardly

being investigated at the present time; yet, many of the investors in this region are interested in knowing the potential of recycling such waste materials.

There are many other research possibilities related to MSW management in the GCC states. What should be the aim of researchers in this case is identification of the problems of the waste authorities in order of priority, and collaboration with such authorities to maximise the benefits of the research outcomes. In this region, it is not easy to co-ordinate orco-operate with waste authorities. Therefore, this could be another area for research: the means of communications between private and government entities. Consequently, stronger relationships and understanding of these ultimate objectives may enhance the advancement of each and every city within the GCC.

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- Dr. Ali Muhammad Khuraibet, Lecturer, The Public Authority for Applied Education and Training, Kuwait.
-
- Dr. Mohammed AlHammad, General Manager of the Arabian Institute for Cities Development, Riyadh, Saudi Arabia.
- Dr. Mohammed AlMohanna, Environmental Science Department, King Abdulaziz University, Jeddah, Saudi Arabia.
- Mr. Ralph Keeble, Vice President- Technical Operations, Browning Ferris Overseas, Inc.
- Mr. Jeff Lensilo, Operation Mananger, AlMullah Environmental Systems Company, Kuwait.

- Mr. Mohammed Mountaser, Operation Manager, AlMullah Environmental Systems Company, Kuwait.
- Mr. Zafar Ali, Manager Kuwait Projects, Engineering Science, Inc., Kuwait.
- Mr. Wagih Massoud, Chief Accountant, Gulf Paper Manufacturing Company, Kuwait.
- AlNouri, M., Manager of Gulf Glass Manufacturing Company, Kuwait.
- Mr. Aabdul Maksoud AlSha'er, Urban Planner, Salem AlMarzouk & Sabah Abi-Hanna, Kuwait.
- Mr. Ibrahim Hammad, General Manager of AlAhlea Circle Cleaning Company, Kuwait.
- Mr. Yousef AlAdsani, President of Arab Towns Organisation, Kuwait.
- Mr. Wasel Mansour, General manager of Arab Towns Organisation, Kuwait.
- Mr. Hatim Abdel Ghani, Director of Information, Arab Towns Organisation, Kuwait.
- DR. Mohammad Ahmed, Head of Studies & Information Department, Industrial Investment Company, Kuwait.
- Mr. Mohammed AlAloush, Projects Manager, Industrial Investment Company, Kuwait.
- Mr. Adnan AlZawati, General Manager of AlSoulah Trading and Cleaning Company, Kuwait.
- Mr. Mustafa Alyan, Managing Director, Tanzifco Cleaning Company, Kuwait.
- Mr. Issa AlKandari, Head of Cleansing Department, Kuwait Municipality.
- Ms. Fatmah AlShatti, Consultant, Environmental Protection Council and Head of Hazardous and solid waste section, Ministry of public Health, Kuwait.
- Ms. Raja'a AlSafar, Studies sections, Environmental Affairs Department, Kuwait Municipality.
- Ms. Huwidah AlHuwidi, Studies sections, Environmental Affairs Department, Kuwait Municipality.
- Mr. Reda Osman, ex-General Manager, National Cleaning Company, Kuwait.
- Mr. Sauad AlArfaj, General Manager, AlArfaj Cleannig and Recycling Company, Kuwait.

- Mr. Abbas AlHasawi, Controller of Landfill section, Kuwait Municipality, Kuwait.
- Dr. Abdul Hamid Aboufayed, Managing Director, Abu Dhabi Recycling Company, Abu Dhabi, UAE.
- Imad AlZuhair, Managing Director, National Environmental Services Company, Kuwait.
- Dr. Yopussef Guettari, Public Health Expert, Abu Dhabi Municipality, Public Health Section, UAE.
- Abdulla Khalifa AlQubaisi, General Manager, Abu Dhabi Compost Plant, UAE.
- Mr. Ebrahim Baqer, Deputy Municipality Engineer, Abu Dhabi Municipality, UAE.
- Mr. Mohamed AlQassim, Operation Planning Engineer, Dubai Electricity and Waster Authority, UAE.
- Ms. Ahlam Saeed Al-Lamki, Head of Population & Labour Market Studies Department, Abu Dhabi, UAE.
- Mr. Imran Sheikh, Manager of Technical Services, Gulf Oil Middle East Limited, Dubai, UAE.
- Dr. Gulam Rasool, General Manager, Dallah Gulf Company, Abu Dhabi, UAE.
- Mr. Saad Al-Inaizi, General Manager, National Environmental Preservation Company, Jubail, Saudi Arabia.
- Mr. Husam Al-Zubair, Exective Vice President, Zubair Enterprises, Muscat, Sultanate of Oman.
- Mr. Bader AlMunifi, Managing Director, Kuwait Metal Collection and Shredding Company, Kuwait.
- Dr. Anwar Abdullah, Director, The Co-operation Council for the Arab States of the Gulf - Secretariat General, Riyadh, Saudi Arabia.
- DR. Ahmad Khayyat, Projects Manager, Dubai Investment Company, Dubai, UAE.
- Dr. Ibrahim Alam, Vice Mayor, Ministry of Municipality, Jeddah Governorate, Saudi Arabia.
- Ms. Laila Al-Yatama, Head of Municipal Health Section, Environmental Affairs Department, Kuwait Municipality.
- Ms. Aisha AlOlaimi, Research Project Directorate, Kuwait Foundation for the Advancement of Sciences, Kuwait.
- Mr. David Gross, P.E., Chairman of Department of Chemical Technology, University of Dayton, Ohio, USA.

- Mr. Gregory Ondich, Director, Office of Research and Development, U.S. Environmental Protection Agency, Washington, U.S.A.
- Mr. Donald Kachman, Environmental Specialist, Division of Solid & Infectious Waste Management, Ohio Environmental Protection Agency, U.S.A.
- Dr. Saed AlHafar, Head of Environmental Studies Unit at Qatar University, Doha, Qatar.
- Dr. Mohammed Sadeqi, Assistant Research Scientist, Energy Department, Kuwait Institute for Scientific Research, Kuwait.
- Mr. Carlo Micoli, Managing Partner, Abu Dhabi Metal Processing Company, Abu Dhabi & Dubai, UAE.
- Kuwait Municipality.
- Municipality of Dubai
- Municipality of Abu Dhabi.
- Municipality of Doha.
- Municipality of Jeddah.
- Municipality of Manama.
- Municipality of Muscat
- Municipality of Dohfar.
- GCC Secretariat General.
- Arab Towns Organisation.
- Arabic Institute for Towns Development.
- Kuwait Environmental Public Authority.
- School of Engineering at Kuwait University.
- University of Dayton, Ohio, U.S.A.

A list of some GCC companies involved with recycling activities

A list for some of the GCC Companies involved in recycling activities

Kuwait:

AlArfaj General Trading Establishment
Alshuwayikh
Tel: 484 2009

Dar AlAman Commercial Establishment
P.O.Box 41049
Tel: 433 2876

Kuwait Scarp Company
P.O.Box 2446 Salmiya 22025
Tel: 245 9710

AlQallaf Junkyard Establishment
Tel: 477 2407

Gulf Paper Manufacturing Company
P.O.Box 7506 Fahaheel 64006
Tel: 326 2072 / 326 2069
Fax: 326 3778

Gluf Glass Manufacturing Company
P.O.Box 26996 Safat 13130
Tel: 326 2257
Fax: 326 0458

United Arab Emirates

Gulf Glass Industries
P.O.Box 6022 Sharjah
Tel: 385500
Fax: 385155

Union Paper Mills
P.O.Box 41 Dubai
Tel: 481608

Fax: 222651

Emirate National Plastic Industry
P.O.Box 8711 AbuDhabi
Tel: 223541

Scarp Mould
P.O.Box 16763 Jebel Ali
Tel: 435437
Fax: 435287

Abdul Salam Syed Raza Scarp Company
P.O.Box 20439 Sharjah
Tel: 810177
Fax: 336336

Lucky recycling Ltd.
P.O.Box 5328 Dubai
Tel: 228815
Fax: 435566

Zenath Paper Traders
P.O.Box 7113 Dubai

Eimartes Trading Agency
Dubai

Solo Industries LTD.
P.O.Box 6187 Sharjah
Tel: 330581

Bahrain

Gulf Plastic Industries
P.O.Box 894
Fax: 728987

Union Packaging Industries Company
P.O.Box 5968
Tel: 250978

Fax: 258651

Gulf Oil Recycling Company
P.O.Box 15009 Manama
Tel: 723750

Oman

Packaging Company Ltd.
P.O.Box 5818 Ruwi , AlSuwaiq
Tel: 562081/2

Batina Bags Factory
P.O.Box 3437 Ruwi , AlKhuwair
Tel: 697374

Oman Organic Feritlizer&Chemical Industries
P.O.Box 6781 Ruwi, Bausher
Tel: 591013 / 4

Oman Lubricants Company
P.O.Box 9074 Mina AlFahal
Tel: 560525

Scrap Processing&Earth Moving Company
P.O.Box 879 Muscat, AlAzaiba
Tel: 590704

Amiantit Oman
P.O.Box 417 Muscat
Tel: 626600

Ahmed AlHathy Trading
P.O.Box 5885 Ruwi
Tel: 750004/ 5

Saudi Arabia

Dammam National Glass Company
Dammam

Alzamel Plastic Company
Riyadh

Saudi Iron Company
Riyadh

CEPCO
P.O.Box 8234 Jeddah 21482

Al-Zenaid Trading Establishment
P.O.Box 4089 Al-Khobar 31952
Tel: 8992161

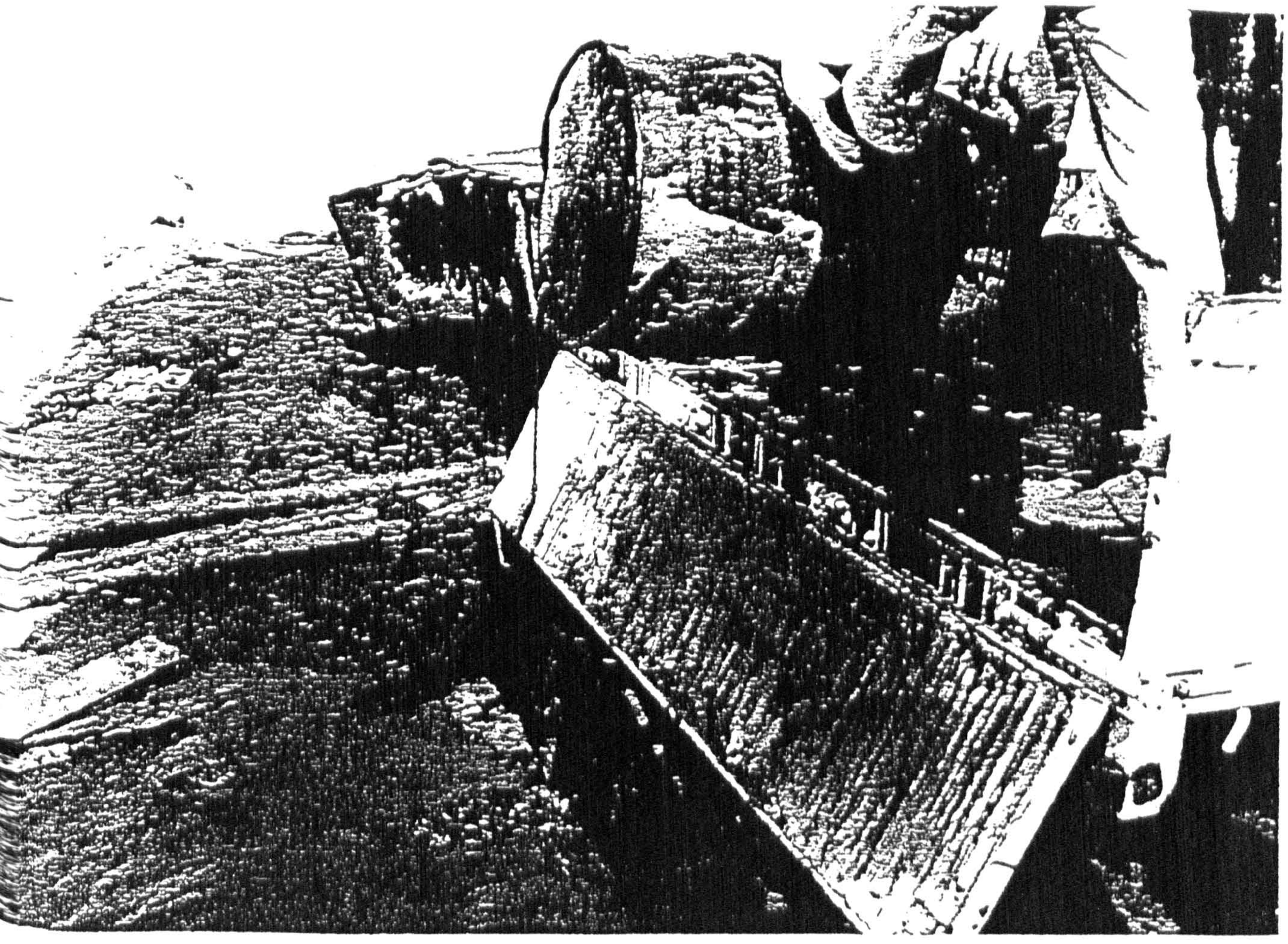
Albawardi Materials Recycling
P.O.Box 112 Dammam 31411
Tel: 8344984

National Environmental Preservation Company (BeeA'h)
P.O.Box 10628 Al Jubail
Tel: 3410911/1026

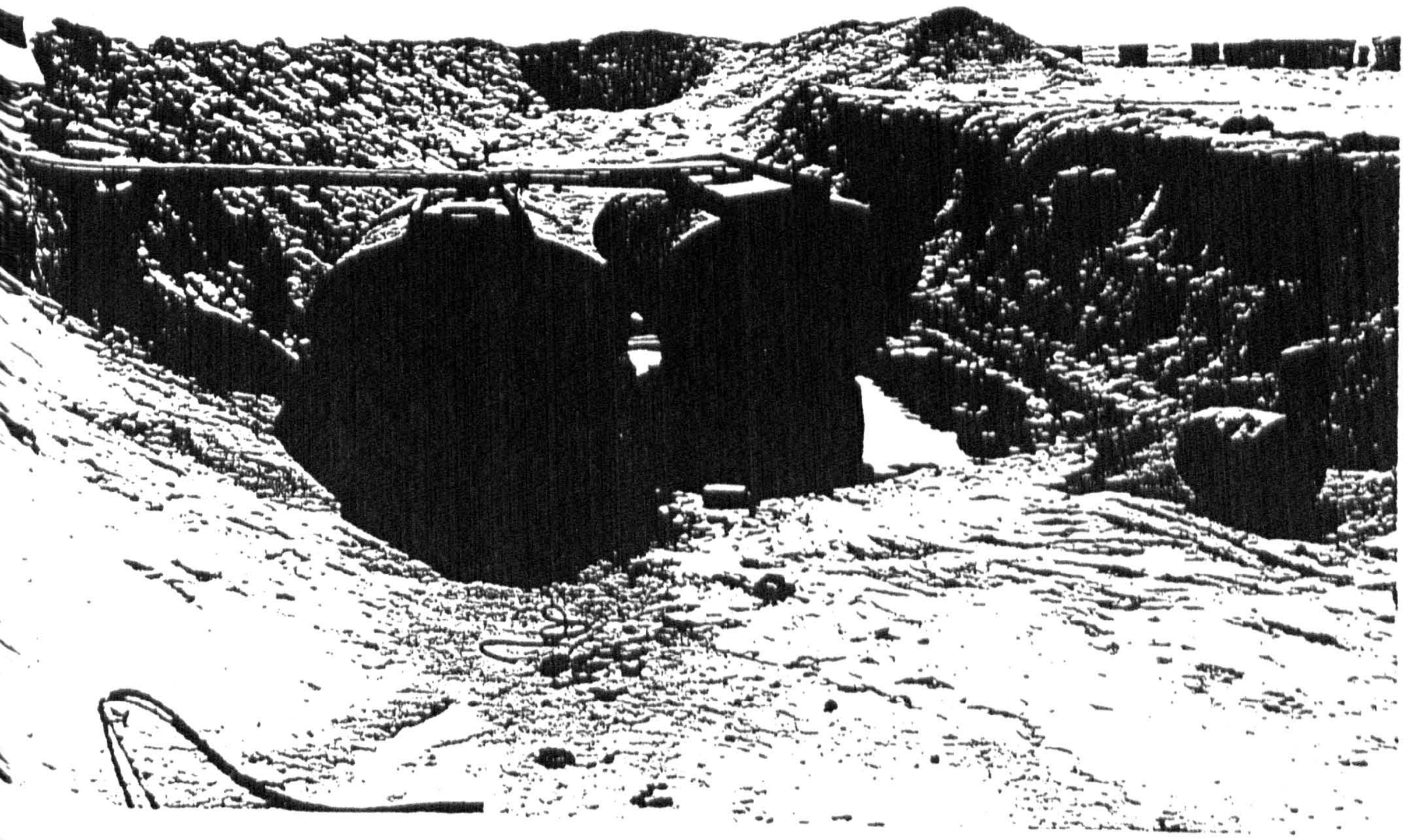
A collection of photographs on MSW in the GCC states

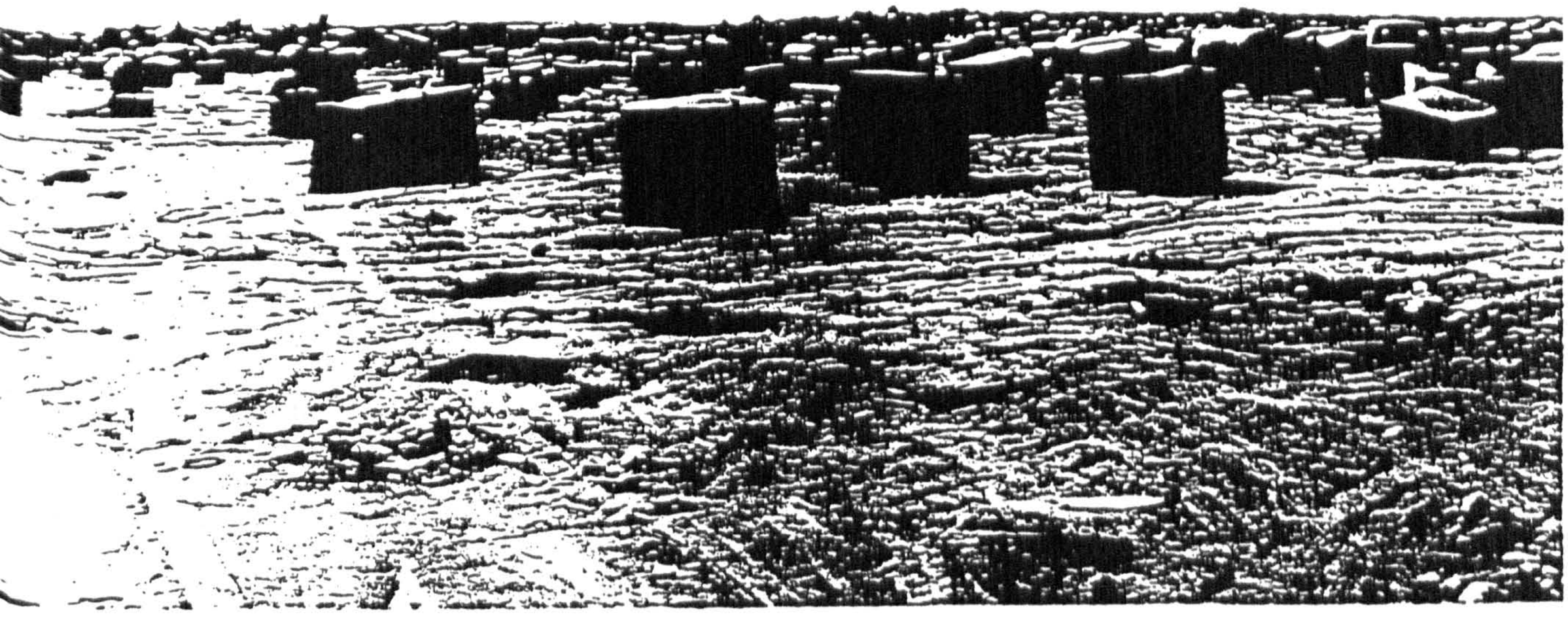
A scene of carious to the environment where blood, white goods, tree trunks, and galvanised drums is being dumped in a landfill.

A view of the landfill tipping edge where MSW is shown here uncovered although the workday is over



Direct spill of consumed oil brought from garages creating hazardous landfill environment

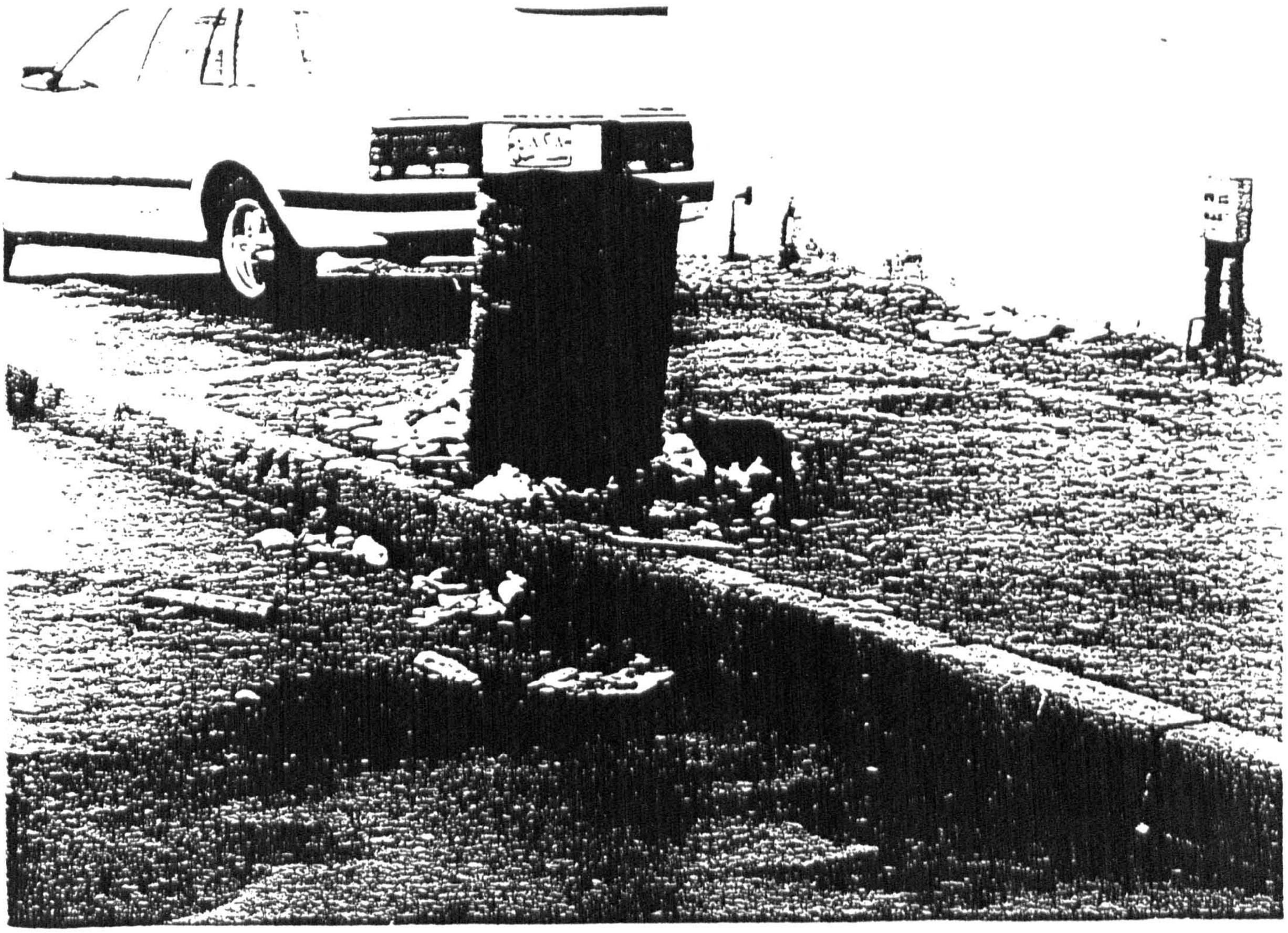




Old water tanks are dumped in landfill sites instead of recycling

Burning MSW happens more frequent during the summer time mostly by scavengers who could not take control of the landfill site

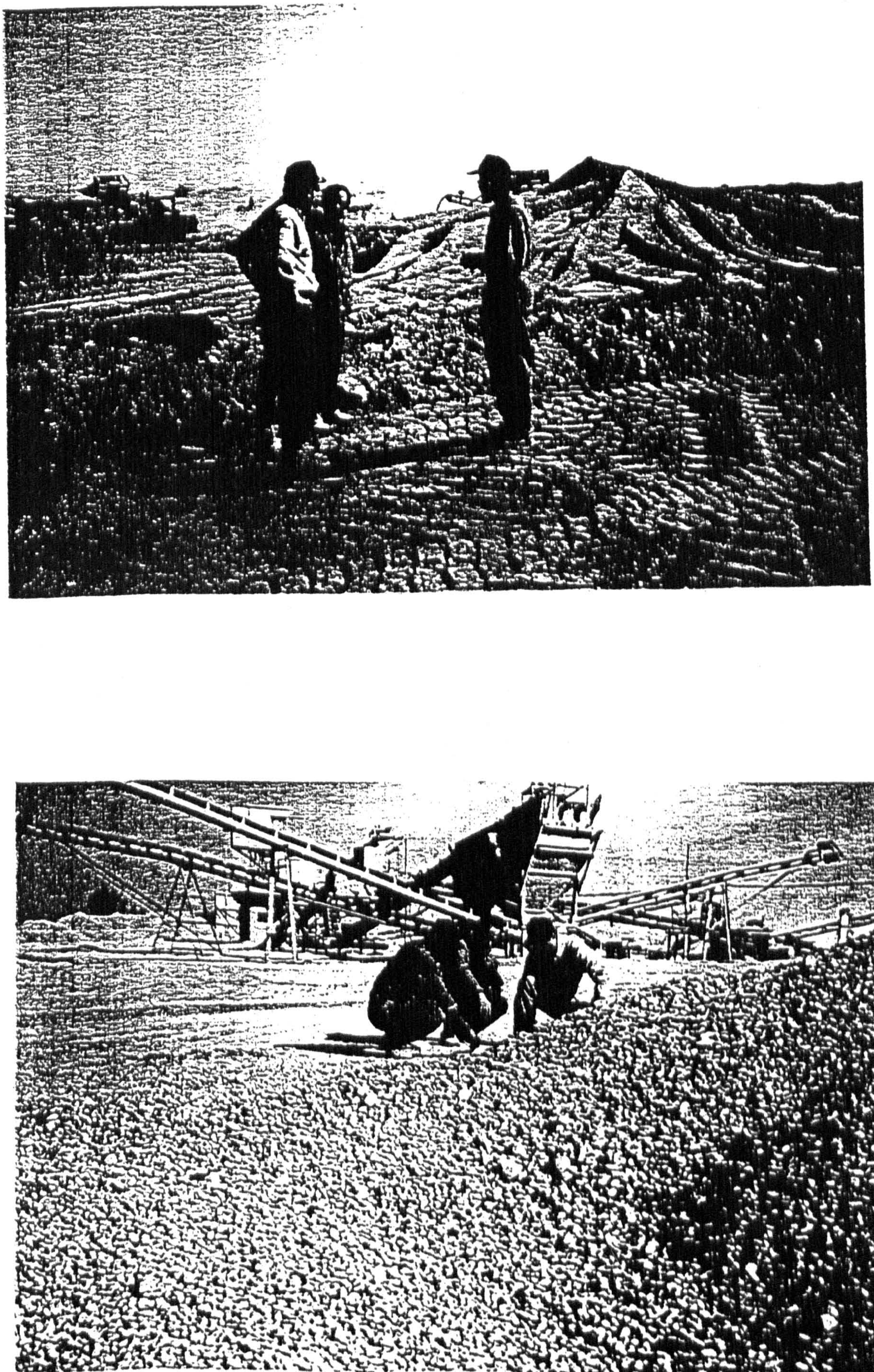
Old tires are also not being recycled



Careless collection crew leaves behind trash scattered around waste bin

A scavenger happen to be a woman in one of Kuwait's residential areas

Aggregates excavation in Kuwait desert up north, the author and the Director of Kuwait EPA are assessing the operation before determining the complete stop of such activities in Kuwait.



Glossary of terms

Glossary of terms

Aeration:

The process of exposing bulk material, such as compost, to air. Forced aeration refers to the use of blowers in compost piles.

Aerobic:

A biochemical process or condition occurring in the presence of oxygen.

Air classification:

A process in which a stream of air is used to separate mixed material according to the size, density, and aerodynamic drag of the pieces.

Algae Bloom:

Population explosion of algae (simple one-celled, usually aquatic plants) in surface waters. Algae bloom is associated with nutrient-rich run-offfrom composting facilities or landfills.

Anaerobic:

A biochemical process or condition occurring in the absence of oxygen.

Baghouse:

A municipal waste combustion facility air emission control device consisting of a series of fabric filters through which MWC flue gases are passed to remove particulate prior to atmosphere, dispersion.

Baler:

A machine used to compress recyclable materials into bundles to reduce volume. Balers are often used on newspaper, plastics, and corrugated cardboard.

Biodegradable Material:

Waste material which is capable of being broken down by micro-organisms into simple, stable compounds such as carbon dioxide and water Most organic wastes, such as food wastes and paper, are biodegradable.

Bottle Bill:

A law requiring deposits on beverage containers (see container Deposit Legislation).

Broker:

An individual or group of individuals that act as an agent or intermediary between the sellers and buyers of recyclable materials.

Btu:

(British Thermal Unit) - Used as a unit of measure for the amount of energy a given material contains (e.g., energy released as heat during combustion measured in Btu's is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

Buffer Zone:

Neutral area, which acts as a protective barrier separating two conflicting forces. For example, a buffer zone is established between a composting facility and neighboring residents to minimize odor problems.

Bulking Agent:

A material used to add volume to another material to make it more porous to airflow. For example, municipal solid waste may act as a bulking agent when mixed with water treatment sludge.

Bulky Waste:

Large items of refuse including, but not limited to, appliances, furniture, large auto parts, non-hazardous construction and demolition material, trees, branches and stumps which cannot be handled by normal solid waste processing, collection and disposal methods.

Buy-Back Center:

A facility where individuals bring recyclable materials in exchange for payment.

Centralized yard Waste Composting:

System utilizing a central facility within a politically defined area with the purpose of composting yard waste.

Co-composting:

Simultaneous composting of two or more diverse waste streams.

Commercial Waste:

Waste materials originating in wholesale, retail, institutional, or service establishments such as office buildings, stores, markets, theaters, hotels and warehouses.

Commingled Recyclable Materials:

A mixture of several recyclable materials stored into one container.

Compactor:

Power-driven device used to compress materials to a smaller volume.

Composting:

The controlled biological decomposition of organic solid waste under aerobic conditions.

Construction and Demolition Waste:

Materials resulting from the construction, remodeling, repair or demolition of buildings, bridges, pavements, and other structures.

Container Deposit Legislation:

Laws that require monetary deposits to be levied on beverage containers. The money is returned to the consumer when the containers are returned to the retailer. Also called "Bottle Bills".

Corrugated Paper:

Paper or cardboard manufactured in a series of wrinkles or folds, or into alternating ridges and grooves.

Cullet:

Clean, generally color-sorted, crushed glass used to make new glass products.

Curbside Collection:

Programs where recyclable materials are collected at the curb, often from special containers, to be brought to various processing facilities.

Decomposition:

Breaking down into component parts or basic elements.

Detinning:

Recovering tin from "tin" cans by a chemical process, which makes the remaining steel more easily recycled.

Diversion Rate:

A measure of the amount of waste material being diverted for recycling compared with the total amount that was previously thrown away.

Drop-off-Center:

A method of collecting recyclable or compositable materials in which the materials are taken by individuals to collection sites and deposited into designated containers.

Electrostatic precipitator:

Device for removing particulate matter from MWC facility air emissions. It works by causing the particles to become electrostatically charged and then attracting them to an oppositely charged plate, where they are precipitated out of the air.

Emission:

Discharge of a gas into atmospheric circulation.

Energy Recovery:

Conversion of waste to energy, generally through the combustion of processed or raw refuse to produce steam. See also "Municipal Waste Combustion," and incineration.

Enterprise Fund:

A fund for a specific purpose that is self-supporting from the revenue it generates.

Ferrous metals:

Metals that are derived from iron. They can be removed using large magnets at separation facilities.

Fly Ash:

Small, solid particles of ash and soot generated when coal, oil, or waste materials are burned. Fly ash is suspended in the flue gas after combustion and is removed by the pollution control equipment.

Flow Control:

A legal or economic means by which waste is directed to particular destinations. For example, An ordinance requiring that certain wastes be sent to a combustion facility is waste flow control.

Garbage:

Spoiled or waste food that is thrown away generally defined as wet food waste. It is used as a general term for all products.

Ground Water:

Water beneath the earth's surface that fills underground pockets (known as aquifers) and moves between soil particles and rock, supplying wells and springs.

Hammermill:

A type of crusher or shredder used to break up waste material into smaller pieces.

Hazardous Waste:

Waste material that may pose a threat to human health or the environment, the disposal and handling of which is regulated by federal law.

Heavy Metals:

Hazardous elements including cadmium, mercury, and lead which may be found in the waste stream as part of discarded items such as batteries, lighting fixtures, colorants and inks.

High Grade Paper:

Relatively valuable types of paper such as computer printout, White ledger, and tab cards. Also used to refer to industrial trimmings at paper mills that are recycled.

Humus:

Organic materials resulting from decay of plant or animal matter. Also referred to as compost.

Hydrogeology:

The study of surface and subsurface wa ter.

Incinerator:

Facility in which the combustion of solid waste takes place.

Incinerator Ash:

The remnants of solid waste after combustion, including non-combustibles (e.g., metals) and soot.

Industrial Waste:

Materials discarded from industrial operations or derived from manufacturing processes.

Inorganic waste:

Waste materials origination in school, hospitals, prisons, research institutions and other public buildings.

Integrated Solid Waste Management:

A practice of using several alternative waste management techniques to manage and dispose of specific components of the municipal solid waste stream. Waste management alternatives include source reduction, recycling, composting, energy recovery and landfill.

In-vessel Composting:

A composting method, in which the compost is continuously and mechanically mixed and aerated in a large, contained area.

IPC:

Intermediate Processing Center - usually refers to the type of materials recovery facility (MRF) that processes residentially collected mixed recyclable materials into new products available for market; often used interchangeably with MRF.

Refractory:

A material that can withstand dramatic heat variations. Used to construct conventional combustion chambers in incinerators.

Refuse-Derived Fuel (RDF)

Product of a mixed waste processing system in which certain recyclable and non-combustible materials are removed, and the remaining combustible material is converted for use as a fuel to create energy.

Residential Waste:

Waste materials generated in single and Multiple-family homes.

Residue:

Materials remaining after processing, incineration, composting, or recycling have been completed. Residues are usually disposed of in landfill.

Resource Recovery:

A term describing the extraction and utilization of materials and energy from the waste stream. The term is sometimes used synonymously with energy recovery.

Retention Basin:

An area designed to retain runoff and prevent erosion and pollution.

Leachate:

Liquid that has percolated through solid waste or another medium and has extracted, dissolved, or suspended materials from it, which may include potentially harmful materials. Leachate collection and treatment is of primary concern at municipal waste landfills.

Magnetic Separation:

A system to recover ferrous metals from other materials in an mixed municipal waste stream, magnets are used to attract the ferrous metals.

Mandatory Recycling:

Programs, which by law require consumers to separate trash so that some or all recyclable materials are not burned or dumped in landfills.

Manual Separation:

The separation of recyclable or compostible materials from waste by hand sorting.

Mass Burn:

A Municipal waste combustion technology in which solid waste is burned in a controlled system without prior sorting or processing.

Mechanical Separation:

The separation of waste into various components using mechanical means, such as cyclones, trommels, and screens.

Methane:

An odorless, colorless, flammable, and explosive gas produced by Municipal solid waste undergoing anaerobic decomposition waste landfills.
Methane is emitted from municipal solid waste landfills.

Micro-Organisms:

Microscopically small living organisms that digest decompostable materials through metabolic activity. Micro-organisms are active in the composting process.

Modular Incinerator:

Smaller-scale waste combustion units prefabricated at a manufacturing facility and transported to the MWC facility site.

MSW Composting:

Municipal Solid Waste Composting - The controlled degradation of Municipal Solid Waste including after some form of preprocessing to remove non-compostible inorganic materials.

Mulch:

Ground or mixed yard wasted placed around plants to prevent evaporation of moisture and freezing of roots and to nourish the soil.

Municipal Solid Waste (MSW):

Includes non-hazardous waste generated in households, commercial and business establishment, institutions, and light industrial process wastes, agricultural wastes, mining waste and sewage sludge. In practice specific definitions vary across jurisdictions.

NIMBY:

Acronym for "Not In My Back Yard" expression of resident opposition to the siting of a solid waste facility based on the particular location proposed.

Organic Waste:

Waste material containing carbon. The organic fraction of Municipal Solid Waste included paper, wood, food wastes, plastics, and yard waste.

Particulate Matter (PM):

Tiny pieces of matter resulting from the combustion process that can have harmful health effects on those who breathe them.

Participation Rate:

A measure of the number of people participating in a recycling program compared to the total number that could be participating.

Pathogen:

An organism capable of causing disease.

Percolate:

To ooze or trickle through a permeable substance. Ground water may percolate into the bottom of an unlined landfill.

Permeable:

Having pores or openings that permit liquids or gasses to pass through.

Post-Consumer Recycling:

The reuse of materials generated from residential and commercial waste, excluding recycling of material from industrial processes that has not reached the consumer such as glass broken in the manufacturing process.

Recyclables:

Materials that still have useful physical or chemical properties after serving their original purpose and that can, therefore, be reused or remanufactured into additional products.

Recycling:

The process by which material otherwise destined for disposal are collected, reprocessed or remanufactured, and reused.

Tipping Floor:

Unloading areas for vehicles that are delivering Municipal solid waste to a transfer station or Municipal waste combustion facility.

Transfer Station:

A permanent where waste materials are taken from smaller collection vehicles and placed in larger vehicles for transport, including truck trailers, railroad cars, or barges. Recycling and some processing may also take place at transfer station.

Trash:

Material considered worthless, unnecessary or offensive that is usually thrown away. Generally defined as dry waste material, but in common usage it is a synonym for garbage, rubbish, or refuse.

Tub Grinder:

Machine to grind or chip wood wastes for mulching, composting or size reduction.

Variable Container Rate:

A charge for solid waste service on the volume of waste generated measured by the number of containers set out for collection.

Volume Reduction:

The processing of waste materials so as to decrease the amount of space the materials occupy, usually by compacting or shredding (mechanical), incineration (thermal), or composting(biological).

Waste Exchange:

A computer and catalog network that redirects waste materials back into the manufacturing or reuse process by matching companies generating specific wastes with companies that use those wastes as manufacturing inputs.

Waste Reduction:

Reducing the amount or type of waste generated. Sometimes used synonymously with Source Reduction.

Whited Goods:

Large household appliances such as refrigerators, Stoves, Air Conditioners, and washing machines.

Windrow:

A large, elongated pile of composting material.

Yard Waste:

Leaves, grass clippings, pruning , and other natural organic matter discarded from yards and gardens. Yard wastes may also include stumps and brush, but materials are not normally handled at composting facilities.

Building Waste:	General term for building waste materials, refuse and rejected building materials arisen from activities within the building and construction industry.
Construction waste:	Building waste arisen from construction work e.g. road construction, bridge construction, construction of airfields, harbors etc.
Controlled landfill:	Landfill run by the local authority e.g. municipality, city council etc.
Demolition waste:	Building waste arisen from demolition of buildings and structures.
Fly-Tipping:	Illegal tipping of building waste outside landfills.
C&D recycling:	Regenerating of basic building materials by a crushing process e.g. crushing of concrete, rubble and broken asphalt.
Repair Waste:	Building waste arisen from repair and maintenance of building and structures.
Reuse:	General term for second use of building waste materials.
Rubble:	Debris of concrete (plain and reinforced) bricks, blocks and tiles.
Selective demolition:	Demolition method with a high degree of sorting materials on site due to reuse and recycling of building materials.

Reuse:

The use of a product more than once in its same form for the same purpose; e.g., a soft-drink bottle is reused when it is refined to the bottling company for refilling.

Roll-off Container:

A large waste container that fits into a tractor trailer that can be dropped off and picked up hydraulically.

Sanitary Landfill:

Land waste disposal site that is located to minimize water pollution from runoff and leaching. Waste is spread in thin layers, compacted, and covered with a fresh layer of soil each day to minimize pest, aesthetic, disease, air pollution and water pollution problems.

Scavenger:

One who illegally removes materials at any point in the solid waste management system.

Scrap:

Discarded or rejected industrial waste material often suitable for recycling.

Scrubber:

Common anti pollution device that used a liquid or slurry spray to remove acid gases and particulates from municipal waste combustion facility flue gases.

Secondary Material:

A material that is used in place of a primary or raw material in manufacturing a product.

Sludge:

A semi-liquid residue remaining from the treatment of Municipal and industrial water and waste water.

Soil Liner:

Landfill liner composed of compacted soil used for the containment of Leachate.

Source Reduction:

The design, Manufacture, acquisition, and reuse of materials so as to minimize the quantity and/or toxicity of waste produced. Source reduction prevents waste either by redesigning products or by otherwise changing societal patterns of consumption, use, and waste generation.

Source Separation:

The Segregation of specific materials at the point of generation for separate collection. Residences source separate recyclables as part of a curbside recycling program.

Special Waste:

Refers to items that require special or separate handling, such as household hazardous wastes, bulky wastes, tires, and used oil.

Stack Emissions:

Air emissions from a combustion facility stacks.

Subtitle C:

The hazardous waste section of the Resource Conservation and Recovery Act (RCRA).

Subtitle D:

The soil, non-hazardous waste section of the Resource Conservation and Recovery Act (RCRA).

Subtitle F:

Section of the Resource Conservation and Recovery Act (RCRA) trwuiring the federal government programs fostering the recovery and use of recycled materials and energy.

Superfund:

Common name for the Comprehensive Environmental Response, Comprehensive and Liability Act (CERCLA) to clean up abandoned or inactive hazardous waste dump sites.

Tipping Fee:

A fee, usually dollars per ton, for the unloading or dumping of waste at a landfill, transfer station, recycling center, or waste-to-energy facility, usually stated in dollars per ton; also called a disposal or service fee.

Appendix I

General Map of the GCC States

A general Map for the GCC States

Appendix II

The GCC States History & Development

"DESCRIPTION OF THE GCC STATES HISTORY AND DEVELOPMENT"

The Kingdom of Saudi Arabia:

Saudi Arabia is in the heart of Arabian peninsula, and is bordered by Jordan, Iraq and Kuwait in the North, Qatar, Bahrain, the United Arab Emirates and Oman in the East, Yemen and Oman in the South, and the Red Sea in the West. Its coast stretches for 1.000 miles along the Red Sea, and for 300 miles along the Arabian Gulf.

It is considered the largest country not only among the GCC countries but also among the other Middle East countries. Saudi Arabia occupies around 4/5 of the land area of the peninsula, and is almost the same size as the whole of western Europe, including the United Kingdom. The Saudi Dynasty established their Kingdom as early as the beginning of the 19th century. This is after a long time of several wars with the various tribes in the peninsula. The Saudis direct their life with the guidance of the Holy Koran.

Nevertheless, Saudi Arabia is considered one of the most progressive countries in the Middle East for its vital concern with domestic infrastructure, diversification of trade, foreign policies and foreign investment.

Oil production and petrochemical industries are the major economic revenues of the Kingdom.

The Saudis have a strong cooperation relations with Britain and the United States of America. These relations based on the mutual agreement on various interests on both sides. There are four main regions in Saudi Arabia. They are the Nejd region in Central Arabia and the largest region of all. Major cities in the region Riyadh is the capital and the political center of the Kingdom covering an area of 1, 600 sq. km., Anaiza and Buraida. Temperature is high during the summer days and comfortable at night. Winter temperature is comfortable. The region is mainly desert. Agriculture is very limited.

The Hejaz region is located along the upper red sea coast, Jeddha, Yanbu, and Medina are the major cities of this region. Mecca is located on the western side of the escarpment dividing the coastal plain from the mountainous interior.

Jedda is the Kingdom's main trade centers and one of the most beautiful cities. It is where the past intermingles with the present.

Asir, located South of the Hejaz, is considered as the most fertile region since it receives upto 300mm of rainfall a year in its western coastline. As a result, this is the most populated area. Mountains rise South East of Mecca with peaks reaching heights of 2,500 meters.

Hasa extends South along the Arabian Gulf from Kuwait. In this region Oil production is the main feature. Ras Tanura, an important Oil port, is the terminal for the pipeline from the Dhahran Oil fields. There is a railroad between Dammam, also on the coast, and Riyadh in the Nejd region. Hasa is rich in its springs and dates.

Saudi Arabia has the largest continuos body of sand in the world which covers an area of 518.000 sq. km. It is known as the Rub Al-khali (The empty quarter). In Saudi Arabia, since there is limited rainfall and limited streams, vegetation is light except in Asir and the Southern Hejaz coastal regions. Trees such as the Tamarisk grow in some regions. Various rare species of animals are found. Gazelles, Wolves, Hyenas, and Foxes.

Birds such as Wild Eagles, Hawks and Falcons are existing. Fishing is performed on a commercial scale.

The total area of the Kingdom of Audi Arabia is approximately 2.250.00 sq. km. And population of approximately 12 millions. The majority of the population are Arabs yet there are some ethnic minorities. The main language is the Arabic, although various Arabic dialects and English are used too.

People are living by the teachings of the Prophet Mohammed (Peace be up on him) and the Holy Koran.

However; there is a large number of illiterate people, many families have to send their girls to private girls schools. This is also a sign of tradition alteration to bring the woman to the proper status, within a progressive society.

Recently, Agriculture is becoming more important for various reasons. One major reason is the Governmental desire to expand cultivation. Increasing green areas within the Cities and Towns is another objective of specially the local authorities (Municipalities) and the Government in

general. Although, the total possible cultivable land within the Kingdom is estimated to be about 15% the actual cultivated land is only 1% of the total land area. A clear indication of the need for composting.

The Government established few programs to encourage the cultivation with the assistance of various foreign companies and agencies. It is obvious that Agricultural produce has no effect on importing foodstuff to the Kingdom.

Date Palm is the most important crop through the Kingdom. The use of date palm stone, spathes, leaves, trunk and fiber in various aspects such as animal fodder and construction as an example gives the date palm crop such an importance.

As a means of transportation, horses and camels are still in use by the Bedouin's who require traveling great distance across the desert. Within the cities and towns there are modern paved highways which also link the different cities centers. There is a railroad which connect the city of Dammam with the city of Riyadh. It has been in operation for more than 40 years.

STATE OF KUWAIT:

Kuwait is ruled by the Amir (Ruler) from the Sabah Family which established Kuwait as early as the 18th century. In November 1962, a constitution was published. By the beginning of 1963, members of the newly created National Assembly were elected by Kuwaitis Male Voters. Kuwait emerged on the international scene during the rule of Sheik Mubarak Al-Sabah from 1896 to 1915. Although Mubarak was the Ottoman Government local representative in Kuwait, he preferred to sign an agreement with the British binding himself and his successors not to alienate any part of his territory without British consent in return for British protection. On June 1961, Kuwait proclaimed its Independence.

The area of Kuwait is approximately (17,818 sq km). The majority of the land is desert, mostly sandy, with scattered low hills and ridges. Summer in Kuwait is very hot. Temperature reaches 49 C. In comparison with other Gulf States, Kuwait has lower humidity. Winter is a pleasant season in Kuwait except for the time when Northern winds blow bringing the temperature to a very low level and sometime creating some sand storms. There is not much rainfall in the winter season in Kuwait.

The recent population estimation was about 1.4 million, Kuwaitis are about 50% of the total population. The other 50% consists of variety of nationalities mainly Arabs from Egypt, Syria, Lebanon and non-Arabs from East Asia's Countries. The most common foreign language used is English. The country language is Arabic, and religion is Islam.

Kuwait economy based Ultimately on Revenue from Oil Production. Moreover petrochemicals and other small scale industries are introduced to decrease the complete dependence on oil. Kuwait foreign investments are one of the most successful Government investments outside its borders. Oil companies, Banks, and Commercial business are few examples of Kuwait foreign investments in Europe and the US

Kuwait City is well designed. Transportation is excellent. Housing and commercial centers are very fine.

STATE OF QATAR:

The British were involved in the conflict between the Bahrain and Qatar in the mid of the 18th century. Britain recognized the Al-Thani family as the Qatar's rulers. A similar treaty to those signed between Britain and the

Arabian Gulf States was signed with Qatar. Britain provided protection to Qatar in return for managing Qatar foreign affairs.

Qatar became independent in 1971. prior to independence, a basic law was promulgated in 1970, which pointed for the formation of a government including a Prime Minister, Cabinet and Advisory Council. Qatar's national income is based on the Oil production since 1940. The discovery of Oil transformed the State of Qatar to the scope of the modern world. Modern infrastructure and medium scale industries have been developed through the years of transformation.

The population in Qatar are mainly Arabs. There are different nationalities living and working in Qatar such as Egyptians, Iraqis, Omanis, Iranians, Indians and Pakistanis.

The major city of Qatar is Doha. It is estimated that about half of the total population live in Doha. Doha has been substantially modernized with various buildings and highways. Port Umm on the east coast receives Oil from Dukhan Oil field.

UNITED ARAB EMIRATES

The United Arab Emirates consists of Seven Emirates. Abu Dhabi, Dubai, Sharajah, Ajman, Fujaira and Umm Al-Quiwan formed the AU Federation in 1971. In 1972 Ras Al-Chime joined the AU Federation. The Emirates are headed by a President and a Vice President whom elected by the Supreme Council which consists of the rulers of the Emirates. Each Emirate has its own policies in taxation and foreign trade. Most of the financial contribution flow from the two wealthiest Emirates, Abu Dhabi and Dubai to the Federal Budget.

The area of the AU is an approximation since its borders are greatly undefined. It is estimated at (83.400 sq. km.). The weather is hot and humid, the rain fall is enough to permit cultivation. In the East mountains rise to about (1.200 meters). The AU had a 1985 census population at 1,622,464. A recent estimation of the total population was 1,800,000.

However, Trading, Fishing, Farming, Herding, Agriculture, limited to date and vegetable growing are sources of revenue, the main sources of revenue are Petroleum, Natural Gas, Aluminum smelting and ship repairing.

The AU imports great protein of its food and consumer goods. Transportation is very fine as well as the housing and public centers.

BAHRAIN:

In 1971 Bahrain declared its independence under the rule of Khalifa dynasty which was established in 1783. The relation between Bahrain and Britain has been established in 1820. When the need for more control on piracy and slave trade was a necessary issue for the British in the East. A treaty of friendship was signed with Bahrain. Britain worked toward the development of Bahrain internal and external affairs. Presently, Bahrain is governed by an hereditary Sheik of the Khalifah Family. The head of the State, heads a council of administration consists of heads of Governmental departments and members of the ruling family.

Besides the Bahraini Population which are Arabs of various origins there are Indians, Pakistanis, Persians, Europeans and Americans. Presently the total population is (436000)..

Bahrain consists of several islands in the Arabian gulf with a total area of (598.2 sq. km.) the major inhabited island in Bahrain are Bahrain,

Muharraq, Sitrah, Nabih Salih, Jida, and Umm Nassar. Manamah is the capital of Bahrain.

It has a deep water anchorage off the port which contains lighterage facilities. It also as a deep water pier which can accommodate six ocean going vessels at the same time.

In Muharraq the second most important city, the International Airport of Bahrain is located.

Bahrain's economy is based on the Oil Industry. Before the discovery of Oil, Bahraini people lived on the income from Pearling. Bahrain imports mostly every item needed in the market. The cities of Bahrain are clean, simple in structure and modern.

SULTANATE OF OMAN:

Until 1970, Sultanate of Oman was called Muscat and Oman. During the 16th century Oman was under the Portuguese control because of its vital geographic location on the Arabian Gulf. Later on the control of shipping in the Arabian Gulf was shifted to the Omanis.

The Omanis controlled parts of what's known as (Pakistan) now-a-days and parts of the African East Coast.

The current dynasty was established in Oman in 1749. Oman's relations with Britain started in the early 19th century. Britain, between 1967-1977, moved out from both the Kuria Muria Islands and Masirah Island. In the mid of the year 1970, Qabus Bin Said the English-educated son of Sultan Said Bin Taimar took over a complete control of the country. Sultan Qabus Bin Said directed his country toward modernization and economic development.

Oman's area is estimated at about 300,000 sq. km. Musqat (Muscat), the capital, and Matrah, the country's commercial center, are the most important cities in Oman. There (North West of Muscat) are also Batinah and Qara mountains (in the southern province of BýDhofar) as the most productive cities for Date Palms, Wheat Sugarcane and Livestock. Presently, the total population of the Sultanate of Oman is Arabs.

Oman's main language is Arabic the total population is estimated at 2 million. The majority of the population are Arabs. Various nationalities

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Appendix III

Unified Economic Agreement (UEA) of the GCC

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The Unified Economic Agreement is an agreement between the governments of the GCC states that contains seven chapters as follows:

- Chapter 1: Trade exchange.
- Chapter 2: The movement of capital and individuals, and the exercise of economic activities.
- Chapter 3: The co-ordination of development.
- Chapter 4: Technical co-operation.
- Chapter 5: Transport and communication.
- Chapter 6: Financial and monetary co-operation.
- Chapter 7: Closing provisions.

I believe that it is important to clarify and comment on this agreement. The comments are based on my belief in the importance of establishing integrated political, economical, and social relationships between the GCC states. It is also based on the necessity of implementing these relationships as practical procedures and complete programmes, which would serve develop co-operation within the GCC in various fields, and consequently bring about in the GCC region effective economic integration.

The GCC would be more effective in implementing the articles of the UEA if its levels of organisation, planning and co-ordination were higher. The articles of the UEA seem to be flexible and general. As a result, the implementation of essential development programs that would gradually convert the GCC region to a viable economically integrated entity may be easier. The success or failure of this agreement depends on the procedures and their execution by the economic and legal experts in the GCC states.

One of the drawbacks of the UEA is the absence of any private sector involvement in its preparation. According to officials in Kuwait's Chamber of Commerce, "The presence of the private sector in forming the practical procedures of the Unified Economic Agreement in its implementation is essential due to their experience and knowledge in business in general."(**Personal communications, Kuwait Chamber of Commerce, 1993).**

The UEA requires no change in its content. However, there is a definite need for specific points to be taken into consideration when the GCC officials prepare the implementation plan for the agreement.

Article 24 in Chapter 7 reads, "Consideration shall be given to differences in the level of development as between member states and the local development priorities of each." The agreement does not mention the implementation stage and the gradual application of its articles.

Through several discussions with GCC officials in the different Chambers of Commerce, an important observation regarding the gradual implementation of the UEA was noticed. Generally, most of the officials indicated that its important that the GCC states apply the articles of the UEA all at once and without attempting a gradual process for such implementation. This is due to the need for more co-operation in several areas between the GCC states. A gradual implementation is not believed to suit the GCC states' aspirations and needs.

Although in the Middle East economic bodies have preferred to develop and implement their policies gradually, this particular body, the GCC, has faced and continues to face great challenges no other organisation has encountered before. This region's politics affect many other parts of the world. As oil producing countries, which contain what is considered to be the world's largest oil reserves, they face several unexpected world changes that may affect their ability to produce or export oil to industrial countries. For example; oil prices fluctuations, political unrest, and military invasion by others.

Social change is also an important challenge for the GCC states as a group. The GCC states' democratic systems are being developed, especially after the Gulf War in 1991; still, there is much more to be done to ensure stability and mutual understanding between the governments of the GCC states and their citizens.

Accordingly, the GCC states should direct their efforts to the immediate implementation of the UEA instead of waiting and probably losing interest in the agreement itself.

In 1973, Kuwait's Chamber of Commerce arranged a meeting between its top officials and representatives of the private sector to discuss implementation of an economic plan for the GCC states. According to the officials of Kuwait's Chamber of Commerce, there was unanimous support for the idea. As a result, a report was presented to the government of Kuwait requesting changes in Kuwait's legislation so that GCC citizens could perform commercial activities in Kuwait as if they were Kuwaiti nationals. The report called for permitting GCC citizens to own shares in Kuwaiti companies, including insurance and banking establishments, and to own property. Moreover, the report from Kuwait's Chamber of Commerce indicated that the economic plan was not a conditioned plan, i.e., it did not call on other GCC states to mutually apply the terms of the plan for the Kuwaitis in their states. In 1975, the government of Kuwait issued Decree No. 33, which allowed the citizens of Saudi Arabia, the UAE and Bahrain to conduct business in Kuwait and receive the same treatment as Kuwaiti citizens. The decree indicated that the citizens of those three Gulf states would have the right to establish and own companies, own real estate and perform all legal commercial activities.

It is important to mention that for such a decree to be successful, the government of Kuwait should encourage projects for local and regional investors. Moreover, GCC states should subsidise the manufacture and sale of products in the GCC markets. It goes without saying that subsidised products should not be exported and should remain within the producing state for local consumption. This would create free competition between the GCC states and enhance the viability of such projects.

The GCC states often joined together in projects long before the GCC was actually established. Yet projects which afforded the private sector the opportunity to join in were almost negligible. Most of the joint projects of the GCC states have been completely owned by the governments themselves. As a result, there is no private sector involvement. Therefore, if the private sector were given the opportunity to be part of the management and ownership such joint governmental projects, the citizens of the GCC would have the opportunity understand and support such projects in the future.

In general, the joint governmental projects are considered to be the best method for achieving co-ordination among the GCC states, as was declared in and is encouraged by the UEA. Yet, such projects, so far, have not received any special treatment from the GCC governments to help them achieve the objective of integration. As a result, the projects continue to be treated as any other local project with the only difference being that the joint projects have

board members from several nationalities representing the different GCC member states. It is essential that the governments of the GCC states open their markets to their joint-projects products. Then and only then will the development and the integration of the GCC states' joint projects be achieved.

The UEA does not cover legislation guiding commercial law, company law, agency law or other important economically related laws. This void in legislation makes it very difficult to implement such an economic plan or agreement. In both Article 12, Item 2, and Article 21, the UEA indicates the need for standardising investment and industrial legislation in the GCC states.

Although the UEA does not mention the stock exchange and money markets in the GCC states, it is important for regional economic co-operation that a central stock exchange house be established for this region with branches in every GCC State. A unified law organising the relations and insuring the proper continuity of work between the main stock exchange house and its branches must be worked out to secure the interest of each of the GCC states in such co-operation.

The following is the full description of the UEA chapters and their articles.

Chapter One

TRADE EXCHANGE

ARTICLE 1

1) The Member States shall permit the importation and exportation of agricultural, animal, industrial and natural resource products that are of national origin. Also, they shall permit exportation thereof to other Member States.

2) All agricultural, animal, industrial and natural resource products that are from Member States shall receive the same treatment as national products.

ARTICLE 2

1) All agricultural, animal, industrial and natural resource products that are of national origin shall be exempted from reciprocal charges.

2) Fees charged for specific services such as demurrage, storage, transportation, freight or unloading, shall not be considered as customs duties when they are levied on domestic products.

ARTICLE 3

1) For products of national origin to qualify as national manufactured products, the value added ensuing from their production in Member States shall not be less that 40% of their final value as at the termination of the production phase. In addition Member States citizens' share in the ownership of the producing plant shall not be less that 51%.

2) Every item enjoying exemption hereby shall be accompanied by a certificate of origin duly authenticated by the appropriate government agency concerned.

ARTICLE 4

1) Member States shall establish a uniform minimum Customs tariff applicable to the products of countries other than GCC Member States.

2) One of the objectives of the uniform Customs tariff shall be the protection of national products from foreign competition.

3) The uniform Customs tariff shall be implemented gradually within five years from the date on which this agreement becomes effective.

Arrangements for its gradual implementation shall be agreed upon within one year from the said date.

ARTICLE 5

Member States shall grant all facilities for the transit of any Member State's goods to other Member States, exempting them from all duties and taxes whatsoever, without prejudice to the provisions of Paragraph 2 of Article 2.

ARTICLE 6

Transit shall be denied to any goods that are barred from entry into the territory of a Member State by its local regulations. Lists of such goods shall be exchanged between the Customs authorities of the Member States.

ARTICLE 7

Member States shall coordinate their commercial policies and relations with other states and regional economic groupings and blocs with a view to creating balanced trade relations and equitable circumstances and terms of trade therewith.

To achieve this goal, the Member States shall make the following arrangements:

1. Coordination of import/export policies and regulations.
2. Coordination of policies for building up strategic food stocks.
3. Conclusion of collective economic agreements in cases where joint benefits to Member States would be realized.
4. Taking of action for the creation of collective negotiating power to strengthen their negotiating position vis-à-vis foreign parties in the field of importation of basic needs and exportation of major products.

CHAPTER TWO

THE MOVEMENT OF CAPITAL AND INDIVIDUALS AND THE EXERCISE OF ECONOMIC ACTIVITIES

ARTICLE 8

The Member States hall agree on executive principles to ensure that each Member State shall grant the citizens of all other Member States the same treatment as is granted to its own citizens without any discrimination of differentiation in the following fields:

1. Freedom of movement, work and residence.

2. Right of ownership, inheritance and bequest.

3. Freedom of exercising economic activity.

4. Free movement of capital.

ARTICLE 9

The Member States shall encourage their respective private sectors to establish joint ventures in order to link their citizens' economic interests in various spheres of activity.

CHAPTER THREE

COORDINATION OF DEVELOPMENT

ARTICLE 10

The Member States shall endeavor to achieve the coordination and harmonization of their respective development plans with a view to achieving integration in economic affairs.

ARTICLE 11

1) The Member States shall endeavor to coordinate their policies with regard to all aspects of the oil industry including extraction, refining, marketing, processing, pricing, the exploitation of natural gas, and development of energy sources.

2) The Member States shall endeavor to formulate united oil policies and adopt common positions vis-à-vis the outside world, and in international and specialized organizations.

ARTICLE 12

To achieve the objectives specified in this Agreement, the Member States shall

1) Coordinate industrial activities, formulate policies and mechanisms which will lead to industrial development and the diversification of their products on an integrated basis.

2) Standardize their industrial legislation and regulations and guide their local production units to meet their needs.

3) Allocate industries between Member States according to relative advantages and economic feasibility, and encourage the establishment of basic as well as ancillary industries.

ARTICLE 13

Within the framework of their coordinating activities, the Member States shall pay special attention to the establishment of joint ventures in the fields of industry, agriculture and services, and shall support them with

public, private or mixed capital in order to achieve economic integration, production interface, and common development on sound economic bases.

CHAPTER FOUR

TECHNICAL COOPERATION

ARTICLE 14

The member states shall collaborate in finding spheres for common technical cooperation aimed at building a genuine local base founded on encouragement and support of research and applied sciences and technology as well as adapting imported technology to meet the needs of the region and to achieve the objectives of progress and development.

ARTICLE 15

Member States shall establish procedures, make arrangement and lay down terms for the transfer of technology, selecting the most suitable or introducing such changes thereto as would serve their various needs. Member States shall also, whenever feasible, conclude uniform

agreements with foreign governments and scientific or commercial organizations to achieve these objectives.

ARTICLE 16

Member States shall formulate policies and implement coordinated programs for technical, vocational and professional training and qualification at all levels and stages. They shall also develop educational curricular at all levels to link education and technology with the development needs of the Member States.

ARTICLE 17

Member States shall coordinate their manpower policies and shall formulate uniform and standardized criteria and classifications for the various categories of occupations and crafts in different sectors in order to avoid harmful competition among themselves and to optimize the utilization of available human resources.

CHAPTER FIVE

TRANSPORT AND COMMUNICATIONS

ARTICLE 18

Member States shall accord passenger and cargo transportation belonging to citizens of the other Member States, when transiting or entering its territory, the same treatment they accord to the means of passenger and cargo transportation belonging to their own citizens, including exemption from all duties and taxes, whatsoever. However, local means of transportation are excluded.

ARTICLE 19

1) Member States shall cooperate in the fields of land and sea transportation, and communications. They shall also coordinate and establish infrastructure projects such as seaports, airports, water and power stations and roads, with a view to realizing joint economic development and the linking of their economic activities with each other.

2) The contracting states shall coordinate aviation and air transport policies among them and promote all areas of joint action at various levels.

ARTICLE 20

Member States shall allow steamers, ships and boats and their cargo's, belonging to any Member State freely to use the various port facilities and grant them the same treatment and privileges granted to their own in docking or calling at the ports as concerns fees, pilotage and docking services, freight, loading and unloading, maintenance, repair, storage of goods and other similar services.

CHAPTER SIX

FINANCIAL AND MONETARY COOPERATION

ARTICLE 21

Member States shall seek to unify investment rules and regulations in order to achieve a joint investment policy aimed at directing their domestic and foreign investments towards serving their interest, and realizing their people's aspirations for development and progress.

ARTICLE 22

Member States shall seek to coordinate their financial, monetary and banking policies and enhance cooperation between monetary agencies and central banks, including the endeavor to establish a joint currency in order to further their desired economy.

ARTICLE 23

Member States shall seek to coordinate their external policies in the sphere of international and regional development aid.

CHAPTER SEVEN

CLOSING PROVISIONS

ARTICLE 24

In the execution of the Agreement and determination of the procedures resulting therefrom, consideration shall be given to differences in the levels of development as between Member States and the local development priorities of each. Any Member States may be temporarily exempted from applying such provisions of this Agreement as may be necessitated by temporary local situations in that state or specific circumstances faced by it. Such exemption shall be for a specified period and shall be decided by the Supreme Council of the Cooperation Council of the Arab States of the Gulf.

ARTICLE 25

No Member State shall grant any non-member state any preferential privilege exceeding that granted herein.

ARTICLE 26

1) This Agreement shall enter into force four months after its approval by the Supreme Council.

2) This Agreement may be amended by consent of the Supreme Council.

ARTICLE 27

In case of conflict with local laws and regulations of Member States, execution of the provisions of this Agreement shall prevail.

ARTICLE 28

Provisions herein shall supersede any similar provisions contained in bilateral agreements. Drawn up at Riyadh on 15 Muharram 1402, corresponding to 11 November 1982.

Appendix IV

Brief Description of the GCC States MSW legislation

Kingdom of Saudi Arabia

In general, the government of the Kingdom of Saudi Arabia emphasize the importance of the cleaning operation, waste treatment and environmental protection. In 1937, when the first act was produced by the capital municipalities secretariat in which the role of the municipalities in regard to public cleaning and waste disposal was developed, many important points were covered in this act such as:

1. Averting the disposal of waste in open land leaving it to cause fire and to be as a home for insects and associated pathogens.

2. It also call on every municipality to select the proper landfill under complete awareness of all associated technical regulations that are needed in operating a sanitary landfill taking into account possible surface water pollution problems, site selection, wind direction, buffer zone and informative signs explaining the steps of waste treatment. Moreover, to make use in the future of these landfill sites after the operation of waste disposal is over (site closure).i.e reclamation.

3. The law also says that municipalities have responsibilities for daily street and market cleaning, inspecting the collection and

transportation of municipal solid waste and liquid wastes, issuing violation tickets to the owners of the buildings and hotels which do not abide by the regulations of proper initial waste disposal.

Since 1937 the government of the Kingdom of Saudi Arabia has been devoting great attention to the development of the environment. The continuous expansion of the cities within the Kingdom have forced the major cities municipalities to subcontract the cleaning operation to so called private cleaning contractors. Each municipality's management is responsible for subcontracting cleaning operation to private companies in accordance with the regulations stated in the act.

State of Kuwait

Act number 15 which was issued in 1972 explained the role of Kuwait municipality in general. Our concerns in this case are the regulations arranging the general cleaning activities (street, highway cleaning ...etc.) and the municipal solid waste collection, handling and treatment or disposal methods. The act pointed to the responsibility of each and every resident and owner of any commercial facility in disposing the daily generated waste in the proper prepared location and at the time of collection set by the municipality, this is to facilitate the cleaning operation of collection, handling and disposing of waste carried out by the municipality. On the other hand, all other sources generating waste such as (cooperatives, markets, hotels, factories, large size residential complexes, public commercial establishments) are to collect and transport their own waste to the disposal sites, outside the urban areas which are assigned by the municipality for such purposes. Kuwait Municipality takes full responsibility in collecting, transporting, and disposing all waste generated by the different ministries and governmental offices. Moreover, the act emphasize keeping the sidewalks, curbs, open areas and roads clean; by avoiding disposing waste in those places. Also, the act prohibits scavenging of waste at the different storage's points. Furthermore; any user of charcoal should not dispose his waste at any initial waste storage point since the

material of such containers is burnable. Producers of consumed oil and tires must not dispose their waste oil into the sewers or on the sidewalk. These wastes should be transported to the specified site under the directions of the municipality. Disposal of all types of municipal solid wastes is free of charge. The municipality endure all costs related to the operation of waste collection transportation and disposal.

State of Qatar

The decree number 8 for the year 1974 regarding the general cleaning including the general regulations to be followed in the cleaning and solid waste disposal, which was a modified version of the decree number 8 for the year 1969, was issued. This decree prohibits the following:

The disposal of waste in the streets, roads, open areas, beaches and any other place private or public. The decree pointed that all the producers of solid wastes should use the proper containers which are specified by the municipality council according to certain requirements and specifications for these containers. The municipality council specifies the time in which the waste producers have to deliver their wastes to the proper location for collection. According to this decree the municipality council is responsible for setting the rules for the collection of wastes and determines the cost and applies the required fees for performing this operation. This decree have assigned some of the policemen and municipality inspectors for the continuos following up of the implementations of the decree articles. In 1988 the minister of municipal and towns affairs had issued a circular number 5, which included an explanation by which the definition of waste was developed. The circular have mentioned that each municipality is responsible for the cleaning operations either by using their own available

resources or by employing a contractor to conduct the cleaning operation. Also; the circular referred to the producers of solid wastes which is more than one cubic meter, as responsible generators for the collection and transportation of their own waste to the municipality landfill sites. The municipality charges the waste generators for collecting and transporting their waste to the landfills.

State of Bahrain

In chapter six of the law number 3 which was issued in 1975 regarding public health protection included the responsibilities of the municipality. The law describes the services performed by the municipality which are summarize as followed:

1. Solid waste collection from residential and commercial premises.
2. Solid waste disposal at the assigned landfill sites.
3. Cleaning of the sewers in the houses .
4. cleaning the public toilets.

In 1977 the municipality issued a municipal order number 5 which explained the implementation procedures of the responsibilities which were not mentioned in the law number 3 dated 1975. The law permits the municipality to start charging the public with municipal fees for the services provided. However; the disposal of municipal solid waste is free of charge.

Sultanate of Oman

The Sultanate decree number 10 dated 1982 was issued regarding the environmental protection and pollution control. Item 6 of the decree mentions that it is not acceptable from any individual, establishment or any other source whether governmental or non-governmental to pollute the Omani environment.

In 1977 the local municipality of the capital issued the order number 2 regarding the protection of the public health, which included in the 5th chapter of it the call for observing and preventing the occurrence of vermin, insects and associated pathogens, also in the same year another order by the capital municipality was issued included the following; all solid wastes should be stored in the proper containers, no storage in the public areas for any scrap materials, cars, or construction derbies. The order mentioned a list of measurements against those who break the regulations.

United Arab Emirates

Municipality of Dubai issued the following local orders number 2, 4, 5 and 6 for the year 1961 which contained the following:

1. It is unacceptable to dispose solid or liquid waste in the public areas, also it is unacceptable to letter along the roadsides.
2. It is not acceptable from any individual to store scrap materials in public areas.
3. All scrap items should be taken to the proper disposal sites.
4. All waste producers such as restaurants, entertainment centers ...etc. should provide the proper containers for initial waste storage.
5. Slaughter shops should collect their waste daily for disposal.
6. Market waste should be collected and stored at the proper assigned initial waste storage centers.
7. Legal measures would be taken against those who break any of the items mentioned in these orders.

Appendix V

Survey Questions and Answers of GCC Municipalities

APPENDIX V

Survey Questions and Answers

Municipality of Jeddah

Q1: Does the Municipality subcontract the waste management operation to private contractors or cleaning companies?

A1: Yes, the Jeddah Municipality does subcontract the waste management operation to contractors from both the international and the local market.

Q2: What is or are the waste management treatment alternatives applied to the MSW generated daily?

A2: Sanitary landfill is the main method of MSW disposal.

Q3: Does the Municipality welcome the idea of regional co-operation in MSW recycling?

A3: Recycling can be developed locally and on a regional level when enough recyclable materials are provided to a central facility.

Municipality of Riyadh

Q1: Does the Municipality subcontract the waste management operation to private contractors or cleaning companies?

A1: Yes, the Riyadh Municipality does subcontract the waste management operation to contractors from both the international and local market.

Q2: What is or are the waste management treatment alternatives applied to the MSW generated daily?

A2: Sanitary landfill is the most applicable method for MSW disposal in view of the geographic and environmental conditions.

Q3: Does the Municipality welcome the idea of regional co-operation in MSW recycling?

A3: Recycling on a regional level is an important step towards the unification of this region and to prevent the throwing away of this region's resources instead of utilising them to the maximum level.

Municipality of Dubai

Q1: Does the municipality subcontract the waste management operation to private contractors or cleaning companies?

A1: The responsibilities of city cleaning and waste management in general are the sole responsibility of the Dubai Municipality through its Waste Services Section, which handles all aspects of waste collection, transportation and disposal. It is an in-house operation.

Q2: What is or are the waste management treatment alternatives applied to the MSW generated daily?

A2: The main waste management treatment alternative applied to the MSW generated in Dubai is landfill disposal. Moreover there are three plants for municipal solid waste treatment and utilisation. These plants are the Dubai Compost Plant, the Paper and Cartons Plant, and Scrap Metal Plant.

Q3: Does the Municipality welcome the idea of regional co-operation in MSW recycling?

A3: It is recommended that co-operation take place in recycling materials that are produced in large quantities. Yet, it would be feasible to recycle MSW generated in small amounts locally.

Municipality of Doha

Q1: Does the Municipality subcontract the waste management operation to private contractors or cleaning companies?

A1: Yes, the Doha Municipality does subcontract the waste management operation to contractors from both the international and local market.

Q2: What is or are the waste management treatment alternatives applied to the MSW generated daily?

A2: Sanitary landfill is the most applicable method for MSW disposal in view of the geographic and environmental conditions.

Q3: Does the Municipality welcome the idea of regional co-operation in MSW recycling?

A3: Recycling on a regional level is an important step towards the unification of this region against the continuous disposal of this region's resources.

Municipality of Dhofar

Q1: Does the Municipality subcontract the waste management operation to private contractors or cleaning companies?

A1: The responsibilities of city cleaning and waste management in general are the sole responsibility of the Dhofar Municipality. The Public Cleaning Department carries the duties of MSW collection and disposal.

Q2: What is or are the waste management treatment alternatives applied to the MSW generated daily?

A2: The main waste management treatment alternative applied to the MSW generated in Dhofar is landfill disposal.

Q3: Does the Municipality welcome the idea of regional co-operation in MSW recycling?

A3: It is recommended that co-operation take place in recycling materials, which are produced in large quantities. Yet it would be feasible to recycle MSW generated in small amounts locally.

CMC of Bahrain

Q1: Does the Municipality subcontract the waste management operation to private contractors or cleaning companies?

A1: Not at this point in time; yet the CMC is studying the possibility of contracting the MSW handling operation to the private sector.

Q2: What is or are the waste management treatment alternatives applied to the MSW generated daily?

A2: Landfill is the main method of MSW disposal. Moreover, a waste reduction plant is in operation in order to minimise the volume of waste arriving at the landfill site.

Q3: Does the Municipality welcome the idea of regional co-operation in MSW recycling?

A3: We suggest that each GCC state have its own composting plant, since compost, as an inexpensive product, has an important, positive effect on this region's soil, and consequently, on agricultural production. Regional co-operation can be achieved by recycling MSW recyclable materials by establishing a plant for each feasible recyclable material.

Appendix VI

Telephone Survey of the Public General knowledge of Waste Management in Kuwait

Telephone Survey of the Public General Knowledge of Waste Management in Kuwait

OBJECTIVE:

This telephone survey was intended to learn the public general knowledge about the waste management issues in Kuwait.

SAMPLE:

A sample of 150 persons living in Kuwait randomly selected from the phone book. Only 100 people responded to the questions.

OBSERVATIONS:

The results indicated the willingness of the public to sort their waste at home. The public sample indicated that to receive money in return for their sorted waste is not an important issue. As a matter of fact the sample hoped for mandatory waste sorting at home. The sample showed little interest in delivering their sorted waste to a central recovery facility.

No.	Question	Number	Percentage
1.	MSW management level of performance is:		
	- Poor	30	30%
	- Acceptable	28	28%
	- Good	42	42%
2.	Do you know the disposal method used by the municipality?		
	- I do not know	52	52%
	- Landfill	8	8%
	- Incineration	38	38%
	- Recycling/incineration	2	2%
	- Composting	0	
3.	Are you welling to sort your waste at home?		
	- Yes	64	64%
	- No	36	36%
4.	Should the municipality provide plastic bags for your sorted waste?		
	- Yes	34	34%
	- No	66	66%
5.	Should the municipality pay you a certain amount of money for your sorted waste?		
	- Yes	13	13%
	- No	87	87%

6.	Are you welling to deliver your sorted waste to a central recovery facility? - Yes - No	 42 58	 42% 58%
7.	Should sorting waste at home be mandatory? - Yes - No	 64 36	 64% 36%
8.	What are your suggestions regarding MSW management in Kuwait? - Municipality should promote recycling - Private companies should promote recycling - Collection of recyclable materials should be once a week - Municipality should provide different color plastic bags for different recyclable materials - More public awareness programs are required - No suggestions	 10 3 1 1 23 62	 10% 3% 1% 1% 23% 62%

Appendix VII
Criteria for Specific Applications of Compost
&
Uses and Application Rates of Compost to Achieve Fertilizer Benefits and Improve Soil

CRITERIA FOR SPECIFIC APPLICATIONS OF COMPOST			
APPLICATION	**COMPOST TYPE**	**FREQUENCY (YR)**	**QUANTITIES (DONUM)**
Grain Crops	Fresh/Mature	2-4	2-6
Root Crops	Fresh/Mature	2-4	4-10
Grassland and Cultivation of fodder plant	Fine fresh/Mature	2-4	2-5
Fruit growing	Fresh/Mature	3	10-20
Vine growing	Fresh/Mature	3-4	5-10 (light soils)
Vegetable (outdoor)	Fresh/Special*	2-4	5-10
Vegetable (greenhouse)	Mature/Special	2-4 10-30	1-1.5
Landscaping slopes	Fresh/Mature	2	2-4
Control of erosion	Fresh	-	up to 30

*Special compost has added minerals or is very fine in texture.

Source: Obeng and Write, 1987, p.40

USES AND APPLICATION RATES OF COMPOST TO ACHIEVE FERTILIZER BENEFITS AND IMPROVE SOIL		
USE	**COMPOST (DONUM)**	**REMARKS**
VEGITABLE CROPS		
Establishment	5-15	Rototill into surface 1-3 weeks before planting or in previous fall. Don't exceed recommended crop Nitrogen rate
Maintenance	5	Rate is for years after initial garden establishment. Rototill into surface 1-2 weeks before planting or in previous fall
FIELD CROPS		
Barley, Oats Rye, Wheat	5-6	Incorporate into soil 1-2 weeks before planting, or in previous fall.
Corn	15-18.5	Incorporate into soil 1-2 weeks before planting. Supplementing Potash may be required depending on soil test.
Legumes		Legumes can be grown in rotation with corn, oats or other Nitrogen-required crops.
FORAGE GRASSES		
Establishment	19.5-34	Incorporate with top 1-.15 of soil. Use lower rate on relatively fertile soil and higher rate coninfertile soil. Supplement during year's growth with 1/2 pound per 1000 square feet (25 pounds per acre) of soluble Nitrogen fertilizer when needed.
Maintenance	50-60	Broadcast uniformaly on surface in fail or early spring one year after incorporated application.
NURSERY CROPS AND ORNAMENTALS		
(Shrubs and trees) Establishment(Soil incorporation)	9-35	Incorporate with top 6-8 inches of soil. Do not use where acid-soil plants (azalea, rhododendron) are to be grown
Maintenance	1-2.5	Broadcast uniformly on surface soil. Can be worked into soil or used as a mulch
POTTING MIXES		
	Equal ratio of material	Throughly, water and drain mixed several times before planting to prevent salt injury to plants.

USE	COMPOST (DONUM)	REMARKS
RECLAMATION		
Conservation planting soil	up to 45	Incorporate with top. 15m of use maximum rate only where months following establishment is desirable. For each inch add 1000 pounds per 1000 square feet onl soil where groundwater Nitrogen will not be increased.
Mulch	1.5-3.5	Broadcast screened or unscreend compost uniformly on surface after seeding, unscreened is more ffective.
TURF GRASSES		
Establishment (soil incorporative)	10-30	Incorporate with top 0.1-0.15m soil. Use lower rate on relatively fertile soil and higher rate on infertile soil.
Surface Mulch	3-3.5	Broadcast uniformly on surface before seeding small seeded species (bluegrass) or after seeding large seeded species (fescue)
Maintenance	2-4	Broadcast uniformly on surface. On cool-season grasses, apply higher rate in fall or lower rate infall and again early spring.
Sod production	15-30	Incorporate with top 0.1-0.15 m with soil.sod production.,
(Unincorporated with Soil)	30-90	

Appendix VIII
Examples of recyclable materials specifications

Scrap Specifications Circular 1996
Guidelines for Paper Stock: PS96

Paper Stock Industries
A National Chapter of Institute of Scrap Recycling Industries Inc.
1325 G Street, NW, Suite 1000, Washington, DC 20005 - 202-737-1770

Grade Definitions

The definitions which follow describe grades as they should be sorted and packed, CONSIDERATION SHOULD BE GIVEN TO THE FACT THAT PAPER STOCK AS SUCH IS A SECONDARY MATERIAL PRODUCED MANUALLY AND MAY NOT BE TECHNICALLY PERFECT. Definitions may not specifically address all types of processes used in the manufacture of, or recycling of, paper products. Specific requirements should be discussed between buyer and seller during negotiations.

Outthrows

The term "**Outthrows**" as used throughout this section is defined as "all papers that are so manufactured or treated or are in such a form as to be unsuitable for consumption as the grade specified."

Prohibitive Materials

The term "**Prohibitive Materials**" as used throughout this section is defined as:

a. Any materials which by their presence in a packing of paper stock, in excess of the amount allowed, will make the packaging unusable as the grade specified.

b. Any materials that may be damaging to equipment.

Note: The maximum quantity of "Outthrows" indicated in connection with the above grade definitions is understood to be the TOTAL of "Outthrows" and "Prohibitive Materials."

A material can be classified as an "Outthrow" in one grade and as a "Prohibitive Material" in another grade. Carbon paper, for instance, is "UNSTABLE" in Mixed Paper and is, therefore, classified as an "Outthrow" whereas it is "UNUSABLE" in White Ledger and in this case classified as a "Prohibitive Material".

Grade	Definition	Prohibitives May not exceed	Total Outthrows May not exceed
(1) Mixed Paper	Consists of a mixture of various qualities of paper not limited as to type of baling or fiber content.	2%	10%
(2) (Grade not currently in use)			
(3) Super Mixed Paper	Consists of a baled clean, sorted mixture of various qualities of paper containing less than 10% of groundwood content.	0.5%	3%
(4) Boxboard Cuttings	Consists of baled new cuttings of paperboard used in the manufacture of folding cartons, set-up boxes and similar boxboard products.	0.5%	2%
(5) Mill Wrappers	Consists of baled paper used as outside wrap for rolls, bundles, or skids of finished paper.	0.5%	3%
(6) News	Consists of baled newspaper as typically generated from newsdrives and curbside collections.	1%	5%
(7) Special News	Consists of baled sorted, fresh newspapers, not sunburned, containing not more than the normal percentage of rotogravure and colored sections.	None permitted	2%
(8) Special News De-Ink Quality	Consists of baled sorted, fresh newspapers, not sunburned, free from magazines, white blank, pressroom over-issues, and paper other than	None permitted	0.25%

	news, containing not more than the normal percentage of rotogravure and colored sections. This grade must tare-free.		
(9) Over-Issue News	Consists of unused, overrun newspapers printed on newsprint, baled or securely tied in bundles, containing not more than the normal percentage of rotogravure and colored sections.	None permitted	None permitted
(10) Magazines	Consists of baled coated magazines, catalogues, and similar printed materials. May contain a small percentage of uncoated news-type paper.	1%	3%
(11) Corrugated Containers	Consists of baled corrugated containers having liners of either test liner, jute or kraft.	1%	5%
(12) Double Sorted Corrugated	Consists of baled, double sorted corrugated containers, generated from supermarkets and/or industrial or commercial facilities, having liners or test liner, jute, or kraft. Material has been specially sorted to be free of boxboard, off-shore corrugated, plastic, and wax,	0.5%	5%
(13) New Double-Lined Kraft Corrugated Cuttings	Consists of baled new corrugated cuttings having liners of either test liner, jute, or kraft. Insoluble adhesives, butt rolls, slabbed or hogged medium, and treated medium or liners are not acceptable in this grade.	None permitted	2%
(14) (Grade not currently in use)			
(15) Used Brown Kraft	Consists of baled brown kraft bags free of objectionable liners and original contents.	None permitted	0.5%
(16) Mixed Kraft Cuttings	Consists of baled new brown kraft cuttings, sheets and bag scrap free of stitched paper.	None permitted	1%
(17) Carrier Stock	Consists of baled printed or unprinted, unbleached new beverage carrier sheets and cuttings. May contain wet strength additives.	None permitted	1%
(18) New Colored Kraft	Consists of baled new colored kraft cuttings, sheets and bag scrap, free of stitched papers.	None permitted	1%
(19) Grocery Bag Scrap	Consists of baled, new brown kraft bag cuttings, sheets and misprint bags.	None permitted	1%
(20) Kraft Multi-Wall Bag Scrap	Consists of new brown kraft multi-wall bag cuttings, sheets, and misprint bags, free of stitched papers.	None permitted	1%
(21) New Brown Kraft Envelope Cuttings	Consists of baled new unprinted brown kraft envelopes, cuttings or sheets.	None permitted	1%
(22) Mixed Groundwood Shavings	Consists of baled trim of magazines, catalogs and similar printed matter, not limited with respect to groundwood or coated stock, and may contain the bleed of cover and insert stock as well as beater-dyed paper and solid color printing.	None permitted	2%
(23) Telephone Directories	Consists of clean telephone directories printed for or by telephone directory publishers.	None permitted	0.5%
(24) White Blank News	Consists of baled unprinted cuttings and sheets of white newsprint or other uncoated white groundwood paper of similar quality.	None permitted	1%
(25) Groundwood Computer Printout	Consists of groundwood papers which are used in forms manufactured for use in data processing machines. This grade may contain colored stripes and impact or nonimpact (e.g., laser) computer printing.	None permitted	2%
(26) Publication Blanks	Consists of baled unprinted cuttings or sheets of white coated or filled groundwood content paper.	None permitted	1%
(27) Flyleaf Shavings	Consists of baled trim from magazines, catalogs and similar printed matter. May contain the bleed of cover and insert stock to a maximum of 10% dark colors. Beater-dyed paper may not exceed 2%. Shavings of novel news or newsprint grades may not be included in this grade	None permitted	1%
(28) Coated Soft White Shavings	Consists of baled unprinted, coated, and uncoated shavings and sheets of white groundwood free printing paper. May contain a small percentage of groundwood.	None permitted	1%
(29) (Grade not currently in use)			
(30) Hard White	Consists of baled shavings or sheets of unprinted, untreated white	None	0.5%

Shavings	groundwood free paper.	permitted	
(31) Hard White Envelope Cuttings	Consists of baled groundwood free cuttings, shavings, or sheets of unprinted, untreated, and uncoated white envelope paper.	None permitted	0.5%
(32) (Grade not currently in use)			
(33) New Colored Envelope Cuttings	Consists of baled groundwood free cuttings, shavings, or sheets of untreated, uncoated bleachable colored envelope paper.	None permitted	2%
(34) (Grade not currently in use)			
(35) Semi Bleached Cuttings	Consists of baled sheets and cuttings of unprinted, untreated, groundwood free paper such as file folder stock, manila tabulating card trim, untreated milk carton stock, or manila tag.	None permitted	2%
(36) Manila Tabulating Cards	Consists of printed groundwood free, bleachable manila-colored cards which have been manufactured for use in tabulating machines. This grade may contain manila-colored tabulating cards with tinted margins.	None permitted	1%
(37) Sorted Office Paper	Consists of baled paper, as typically generated by offices, containing primarily white and colored groundwood free paper, free of unbleached fiber. May include a small percentage of groundwood computer printout and facsimile paper.	2%	5%
(38) Sorted Colored Ledger	Consists of printed or unprinted sheets, shavings, and cuttings of colored or white groundwood free ledger, bond, writing, and other paper which has a similar fiber and filler content. This grade must be free of treated, coated, padded or heavily printed stock.	0.5%	2%
(39) Manifold Colored Ledger	Consists of sheets and trim of new (Industrially generated) printed or unprinted colored or white groundwood free paper used in the manufacture of manifold forms, continuous forms, data forms, and other printed pieces such as sales literature and catalogs. All stock must be uncoated and free of nonimpact printing, A percentage of carbonless paper is allowable.	0.5%	2%
(40) Sorted White Ledger	Consists of printed or unprinted sheets, shavings, guillotined books, and cuttings of white groundwood free ledger, bond, writing, and all other papers which have a similar fiber and filler content. This grade must be free of treated, coated, padded, or heavily printed stock.	0.5%	2%
(41) Manifold White Ledger	Consists of sheets and trim of new (Industrially generated) printed or unprinted white groundwood free paper used in the manufacturing of manifold forms, continuous forms, data forms, and other printed pieces such as sales literature and catalogs. All stock must be uncoated and free of nonimpact printing. A percentage of carbonless paper is allowable.	0.5%	2%
(42) Computer Printout	Consists of white groundwood free paper in forms manufactured for use in data processing machines. This grade may contain colored stripes and impact or non-impact (e.g. laser) computer printing, and may contain no more than 5% groundwood in the pack. All stock must be untreated and uncoated.	None permitted	2%
(43) Coated Book Stock	Consists of coated groundwood free paper, printed or unprinted in sheets, shavings, guillotined books and cuttings. A reasonable percentage of paper containing fine groundwood may be included.	None permitted	2%
(44) Coated Groundwood Sections	Consists of printed, coated groundwood paper in sheets, sections, shavings or guillotined books. This grade may not include news quality groundwood paper.	None permitted	2%
(45) Printed Bleached Board Cuttings	Consists of groundwood free printed bleached board cuttings, free from misprint sheets, cartons, wax, greaseproof lamination, gilt, and inks, adhesives or coatings that are insoluble.	0.5%	2%
46) Misprinted Bleached Board	Consists of groundwood free misprint sheets and cartons of bleached board, free from wax, greaseproof lamination, gilt, and inks, adhesives or coatings that are insoluble.	1%	2%
(47) Unprinted Bleached Board	Consists of groundwood free unprinted, untreated bleached board cuttings, sheets or rolls, free from wax, greaseproof lamination and	None permitted	1%

	adhesives or coatings that are insoluble.		
(48) # 1 Bleached Cup Stock	Consists of baled, untreated cuttings or sheets, of coated or uncoated cup base stock. Cuttings with slight bleed may be included. Must be free of wax, poly, and other coatings that are insoluble.	None permitted	0.5%
(49) # 2 Printed Bleached Cup Stock	Consists of baled printed, untreated formed cups, cup die cuts, and misprint sheets of coated or uncoated cup base stock. Glues must be water soluble. Must be free of wax, poly, and other coatings that are insoluble.	None permitted	1%
(50) Unprinted Bleached Plate Stock	Consists of baled groundwood free bleached coated or uncoated, untreated and unprinted plate cuttings and sheets.	None permitted	0.5%
(51) Printed Bleached Plate Stock	Consists of baled groundwood free bleached coated or uncoated, untreated printed plates and sheets. Must be free of coatings or inks that are insoluble.	None permitted	1%

Specialty Grades

The grades listed below are produced and traded in carload and truckload quantities throughout the United States, and because of certain characteristics (i.e., the presence of wet strength, polycoatings, plastic, foil, carbon paper, hot melt glue), are not included in the regular grades of paper stock. However, it is recognized that many mills have special equipment and are able to utilize large quantities of these grades. Since many paper mills around the world do use those specialty grades, they are being listed with appropriate grade numbers for easy reference.

The Paper Stook Industries Chapter of ISRI is not establishing specific specifications, which would refer to such factors as the type of wet strength agent use, the percentage of wax, the amount of polycoating, whether it is on top of or under the printing, etc. The specification for each grade should be determined between buyer and seller, and it is recommended that purchase be made based on sample.

These specialty grades are as follows:

1-S White Waxed Cup Cuttings
2-S Printed Waxed Cup Cuttings
3-S Plastic Coated Chips
4-S Polycoated Bleached Kraft-Unprinted
5-S Polycoated Bleached Kraft-Printed
6-S Polycoated Milk Carton Stock
7-S Polycoated Diaper Stock
8-S Polycoated Boxboard Cuttings
9-S Waxed Boxboard Cuttings
10-S Printed and/or Unprinted Bleached Sulphate Containing Foil
11-S Waxed Corrugated Cuttings
12-S Wet Strength Corrugated Cuttings
13-S Asphalt Laminated Corrugated Cuttings
14-S Beer Carton Scrap
15-S Contaminated Bag Scrap
16-S Insoluble Glued Free Sheet Paper and/or Board
17-S White Wet Strength Scrap
18-S Brown Wet Strength Scrap
19-S Printed and/or Colored Wet Strength Scrap
20-S File Stock
21-S New Computer Print Out (C.P.O.)
22-S Ruled White
23-S Flyleaf Shavings Containing Hot Melt Glue
24-S Carbon Mix
25-S Books with Covers
26-S Unsorted Tabulating Cards
27-S Colored Tabulating Cards
28-S Carbonless Treated Ledger (N.C.R.)
29-S (Not currently In use)
30-S Plastic Windowed Envelopes
31-S Textile Boxes
32-S Printed TMP
33-S Unprinted TMP

GLASS

CBOT Specifications for Recycled Glass

Grades of Recycled Glass for trading on the Chicago Board of Trade (CBOT)

The following grades of glass have been designated for trading on the CBOT Recyclables Exchange:

Grade	Form	End-Use Application	Color Sort Classification(s)
A	Processed Cullet	Container	Flint, Amber, Green
B	Unprocessed Cullet	Container	Flint, Amber, Green
C	Fine Cullet	Fiberglass	Flint, Amber, Green, Mixed
D	Coarse Cullet	Fiberglass	Flint, Amber, Green, Mixed
E	Unprocessed Cullet	Construction Aggregate	No Color Sort Required
F	Unspecified Cullet	Open	Open
H	Bottles (Whole and/or Broken)	Open	Flint, Amber, Green, Mixed

Grade A: Processed Cullet

This specification is representative of the quality needs of the glass container industry covers glass food and beverage containers (soda-lime-silica) only. Any other types of glass are considered contaminants and may provide justification for load rejection based on agreement between negotiating parties and discretion of buyer. Other types of glass considered to be contaminants include: Pyrex®, crystal, ovenware, plate glass, windows, light bulbs, ceramics, art glass, mirror glass and others.

These specifications establish baseline parameters for Grade A cullet, and a classification scheme for buyer and seller advertising. The allowances and specifications presented herein may be further negotiated between trading parties.

1.0 Size Specification

- Grade A cullet size ranges between 19 mm (3/4 inch) and 10 mm (3/8 inch). 100 weight percent of cullet must pass a 50 mm (2 inch) screen and no more than 10 weight percent shall pass a No. 140 screen.

2.0 Color Specification

2.1 Flint:

95 to 100 percent flint:
0 to 5 percent amber
0 to 1 percent green
0 to 0.5 percent other colors (e.g. blue)

2.2 Amber:

90 to 100 percent amber
0 to 10 percent flint
0 to 10 percent green
0 to 0.5 percent other colors (e.g. blue)

2.3 Green:

70 to 100 percent green
0 to 15 percent amber
0 to 15 percent flint
0 to 0.5 percent other colors (e.g. blue)

Note: Deadleaf green may be sorted and included with green glass or amber glass based on agreement between negotiating parties.

3.0 Moisture Specification

3.1 No visible drainage of liquid when tipped. No visible snow or ice. Material shall be non-caking and free flowing.

4.0 Contamination Limits

4.1 Glass packaging (labels, plastic caps and plastic rings) and other organic material - not to exceed the following quantities for each color:

Flint: 0.2 weight percent
Amber: 0.4 weight percent
Green: 0.4 weight percent

4.2 **Ferrous metal** - not to exceed 0.005 weight percent.
4.3 **Non-ferrous metal** - not to exceed five (5) particles per truck load and two (2) particles per truck load upon initial visual inspection.
4.4 **Other inorganic materials** - upon initial visual inspection, no more than one (1) particle over the size of 12.5 mm (1/2 inch) mesh per truck load and three (3) particles under 12.5 mm (1/2 inch) mesh per truckload.
4.5 **Medical, toxic and/or hazardous materials (Prohibited contaminants)** - any amount present may be justification for load rejection based on discretion of buyer.

Grade B: Unprocessed Cullet

This specification is representative of the quality needs of the glass container industry covers glass food and beverage containers (soda-lime-silica) only. Any other types of glass are considered contaminants and may provide justification for load rejection based on agreement between negotiating parties and discretion of buyer. Other types of glass considered to be contaminants include: Pyrex®, crystal, ovenware, plate glass, windows, light bulbs, ceramics, art glass, mirror glass and others.
These specifications establish baseline parameters for Grade B cullet, and a classification scheme for buyer and seller advertising. The allowances and specifications presented herein may be further negotiated between trading parties.

1.0 Size Specification

- Grade B cullet may be broken but not pulverized. If crushed, no more than 25 weight percent shall pass a 19 mm (3/4 inch) screen.

2.0 Color Specification

2.1 Flint:
95 to 100 percent flint:
0 to 5 percent amber
0 to 1 percent green
0 to 0.5 percent other colors (e.g. blue)

2.2 Amber:
90 to 100 percent amber
0 to 10 percent flint
0 to 10 percent green
0 to 0.5 percent other colors (e.g. blue)

2.3 Green:
70 to 100 percent green
0 to 15 percent amber
0 to 15 percent flint
0 to 0.5 percent other colors (e.g. blue)

Note: Deadleaf green may be sorted and included with green glass or amber glass based on agreement between negotiating parties.

3.0 Moisture Specification

3.1 No visible drainage of liquid when tipped. No visible snow or ice. Material shall be non-caking and free flowing.

4.0 Contamination Limits

4.1 **Organic materials** - only glass packaging material inherent to the glass container (labels, plastic caps and plastic rings) may be present in quantities equivalent to normal amounts of glass packaging. Non-glass packaging materials (wood, paper, rubber, etc.) shall be no greater than 0.5 weight percent.
4.2 **Ferrous and non-ferrous metals** - permitted are those glass packaging materials (closures, foil, etc.) present in quantities equivalent to normal amounts inherent to glass packaging.
4.3 **Other inorganic materials** - upon initial visual inspection, no more than one (1) particle over the size of 12.5 mm (1/2 inch) mesh per truck load and three (3) particles under 12.5 mm (1/2 inch) mesh per truckload.
4.4 **Medical, toxic and/or hazardous materials (Prohibited contaminants)** - any amount present may be justification for load rejection based on discretion of buyer.

5.0 General Acceptability

- the cullet purchased must be in such a condition, that after beneficiation with a conventional cullet processor, the material will be suitable for the production of glass containers.

5.0 Contamination Limits

5.1 Allowable contaminant levels of Grade F glass shall be determined by negotiating parties. Limits should be considered for any or all of the following contamination types as applicable: organic, inorganic, ferrous metal, non-ferrous metal, debris, medical, toxic and/or hazardous materials), and different glass types.

Grade H: Bottles (Whole and/or Broken)

This specification covers post-consumer food/beverage glass containers (soda-lime-silica) only, in the form of whole and/or broken bottles, and is representative of the quality needs of the glass container industry. Any other types of glass are considered contaminants and may provide justification for load rejection based on agreement and discretion of negotiating parties. Other types of glass considered to be contaminants include: Pyrex®, crystal, ovenware, plate glass, windows, light bulbs, ceramics, art glass, mirror glass and others.
These specifications establish baseline parameters for whole or broken bottles, and a classification scheme for buyer and seller advertising. The allowances and specifications presented herein may be further negotiated between trading parties.

1.0 Size Specification

Not applicable.

2.0 Color Specification

2.1 **Flint:** 95 to 100 percent flint 0 to 5 percent amber, 0 to 1 percent green, 0 to 0.5 percent other colors (e.g., blue).
2.2 **Amber:** 90 to 100 percent amber 0 to 10 percent flint, 0 to 10 percent green, 0 to 5 percent other colors (e.g., blue).
2.3 **Green:** 70 to 100 percent green 0 to 15 percent amber, 0 to 15 percent flint, 0 to 10 percent other colors (e.g., blue).
Note: Deadleaf green may be sorted and included with green glass or amber glass based on agreement between negotiating parties. 2.4 Mixed Color: Sorting and mix depends on end-use and may be established by negotiating parties.

3.0 Moisture Specification

3.1 No visible drainage of liquid when tipped. No visible snow or ice. Bottles must be drained and all free moisture removed prior to delivery.

4.0 Contamination Limits

4.1 **Organic materials** - only glass packaging material inherent to the glass container (labels, plastic caps and plastic rings) may be present in quantities equivalent to normal amounts of glass packaging. Non-glass packaging materials (wood, paper, rubber, etc.) shall be no greater than 0.5 weight percent.
4.2 **Ferrous and non-ferrous metals** - permitted are those glass packaging materials (closures, foil, etc.) present in quantities equivalent to normal amounts inherent to glass packaging.
4.3 **Other inorganic materials (rocks, stones, ceramics, vision ware, etc.)** - upon initial visual inspection, no more than one (1) particle over the size of 12.5 mm (1/2 inch) per truck load, and one (1) particle under 12.5 mm (1/2 inch) per truckload.
4.4 **Medical, toxic and/or hazardous materials (Prohibited contaminants)** - any amount present may be justification for load rejection based on discretion of buyer.

Table D-1 - Chemical Compositional Range of Grade D Cullet

Oxide or Chemical	Weight % Range	+/-
SiO2	66-88	1.00
Al203	0-7	0.50
CaO	0-15	0.50
MgO	0-5	0.50
Na2O	8-18	.0.50
K2O	0-4	0.50
Fe2O3	< 0.5	0.05
Cr2O3	< 0.1	0.02
SO3	< 0.2	0.02
All other oxides	< 0.1	0.02
Carbon	< 0.1	0.02

This table has been adapted, in part, from the American Society for Testing and Materials (ASTM) standard D 5359-93, copyright ASTM, 1916 Race Street, Philadelphia, PA 19103-1187. As such, the table has neither been approved nor endorsed by ASTM.

Grade E: Construction Cullet

This specification addresses glass food and beverage containers (soda-lime-silica) only and is representative of the quality needs of the construction aggregate industry.

1.0 Size Specification

Grade E cullet must yield 100 weight percent passing a 19 mm (3/4 inch) screen, with no more than 5 percent weight passing a No. 200 screen.

2.0 Color Specification

Not applicable.

3.0 Moisture Specification

3.1 No visible drainage of liquid when tipped. No visible snow or ice. Material shall be non-caking and free flowing.

4.0 Contamination Limits

4.1 Debris level - maximum debris level of 5 percent by visual examination of the total two-dimensional surface area of a representative test sample.

Debris is defined as any non-container-glass material which may impact the performance of engineered fill, including labels (paper aluminum or tin foil, and plastic) caps and cap fragments (metal and plastic), and organic contents (corks, food residue, etc.).

4.2 Lead - the average of five (5) samples shall not exceed a total lead content of 80 ppm.

4.3 Medical, toxic and/or hazardous materials (Prohibited contaminants) - any amount present may be justification for load rejection based on discretion of buyer.

Grade F: Open (or Proprietary) Specification Glass

1.0 Form and Type Specification

1.1 Form and type of Grade F glass shall be determined by negotiating parties. "Open" glass may include post-consumer or post-industrial glass in any form. Types of glass may include, but are not limited to: containers, Pyrex®, crystal, ovenware, plate glass, light bulbs, ceramics, art glass, and mirror glass.

2.0 Size Specification

2.1 Size of particulate or whole Grade F glass shall be determined by negotiating parties. "Open" glass may range in unit sizes from very fine cullet to whole panes or plates of glass.

3.0 Color Specification

3.1 Color of particulate or whole Grade F glass shall be determined by negotiating parties.

4.0 Moisture Specification

4.1 Allowable moisture content of Grade F glass shall be determined by negotiating parties.

Cr2O3	< 0.1	0.02
SO3	< 0.2	0.02
All other oxides	< 0.1	0.02
Carbon	< 0.1	0.02

This table has been adapted, in part, from the American Society for Testing and Materials (ASTM) standard D 5359-93, copyright ASTM, 1916 Race Street, Philadelphia, PA 19103-1187. As such, the table has neither been approved nor endorsed by ASTM..

Grade D: Coarse Cullet

This specification is representative of the quality needs of the fiberglass industry and covers glass food and beverage containers (soda-lime-silica) only. Any other types of glass are considered contaminants and may provide justification for load rejection based on agreement between negotiating parties and discretion of buyer. Other types of glass considered to be contaminants include: Pyrex®, crystal, ovenware, windows, light bulbs, ceramics, plate glass, art glass, mirror glass and others.
These specifications establish baseline parameters for Grade D cullet, and a classification scheme for buyer and seller advertising. The allowances and specifications presented herein may be further negotiated between trading parties.

1.0 Size Specification

Grade D coarse cullet size must yield 100 weight percent passing a 6.3 mm (1/4 inch) screen with at least 25 weight percent retained on a No. 12 screen and no more than 15 weight percent passing a No. 200 screen.

2.0 Color Specification

In the fiberglass industry, color-sorting is optional and specific color quantities and mixes-may be negotiated between supplier and purchaser. The established color specification will ensure a consistent color mix from shipment to shipment.

2.1 **Flint** - a color distribution with flint as the predominant color. The percent by weight composition of flint and other allowable color(s) will be established by trading parties. This color composition will vary no more than + 3 weight percent for each color from shipment to shipment.
2.2 **Amber** - a color distribution with amber as the predominant color. The percent by weight composition of flint and other allowable color(s) will be established by trading parties. This color composition will vary no more than + 3 weight percent for each color from shipment to shipment.
2.3 **Green** - a color distribution with green as the predominant color. The percent by weight composition of green and other allowable color(s) will be established by trading parties. This color composition will vary no more than + 3 weight percent for each color from shipment to shipment.
2.4 **Mixed color cullet** - a color distribution with up to 25 weight percent amber content allowed, and an established weight percent content for each other color that varies no more than + 3 weight percent from shipment to shipment.

3.0 Moisture Specification

3.1 Moisture not to exceed 0.5 weight percent.

4.0 Contamination Limits

4.1 **Organic material** -not to exceed 0.1 + 0.02 weight percent.
4.2. **Ferrous metal** - not to exceed 0.005 weight percent.
4.3 **Non-ferrous metal** - not to exceed 0.01 weight percent.
4.4 **Other inorganic material** - not to exceed 0.3 weight percent of the entire sample weight, with no inorganic particles retained on a No. 12 screen, and no more than 0.1 weight percent retained on a No. 20 screen, and no more than 0.2 weight percent retained on a No. 20 screen.
4.5 **Medical, toxic and/or hazardous materials (Prohibited contaminants)** - any amount present may be justification for load rejection based on discretion of buyer.

5.0 Chemical Composition of Cullet

5.1 Table D-1 describes the compositional range of oxides and carbon for grade D cullet. Any particular supply of grade D cullet will fall within these compositional ranges if the material contains only glass food and beverage containers.
For long term buying and selling relationships, an average weight percent for each oxide and upper and lower range limits will be established. This compositional range must not vary beyond specified limits from shipment to shipment.

Grade C: Fine Cullet

This specification is representative of the quality needs of the fiberglass industry and covers glass food and beverage containers (soda-lime-silica) only. Any other types of glass are considered contaminants and may provide justification for load rejection based on agreement between negotiating parties and discretion of buyer. Other types of glass considered to be contaminants include: Pyrex®, crystal, ovenware, windows, light bulbs, ceramics, plate glass, art glass, mirror glass and others.
These specifications establish baseline parameters for Grade C cullet, and a classification scheme for buyer and seller advertising. The allowances and specifications presented herein may be further negotiated between trading parties.

1.0 Size Specification

- Grade C fine cullet must yield 100 weight percent passing a 6.3 mm (1/4 inch) screen, with no more than 0.5 weight percent retained on a No. 12 screen, and no more than 15 weight percent passing a No. 200 screen.

2.0 Color Specification

In the fiberglass industry, color-sorting is optional and specific color quantities and mixes-may be negotiated between supplier and purchaser. The established color specification will ensure a consistent color mix from shipment to shipment.

2.1 **Flint** - a color distribution with flint as the predominant color. The percent by weight composition of flint and other allowable color(s) will be established by trading parties. This color composition will vary no more than + 3 weight percent for each color from shipment to shipment.
2.2 **Amber** - a color distribution with amber as the predominant color. The percent by weight composition of flint and other allowable color(s) will be established by trading parties. This color composition will vary no more than + 3 weight percent for each color from shipment to shipment.
2.3 **Green** - a color distribution with green as the predominant color. The percent by weight composition of green and other allowable color(s) will be established by trading parties. This color composition will vary no more than + 3 weight percent for each color from shipment to shipment.
2.4 **Mixed color cullet** - a color distribution with up to 25 weight percent amber content allowed, and an established weight percent content for each other color that varies no more than + 3 weight percent from shipment to shipment.

3.0 Moisture Specification

3.1 Moisture not to exceed 0.5 weight percent.

4.0 Contamination Limits

4.1 **Organic material** -not to exceed 0.1 weight percent.
4.2. **Ferrous metal** - not to exceed 0.005 weight percent.
4.3 **Non-ferrous metal** - not to exceed 0.01 weight percent.
4.4 **Other inorganic material** - not to exceed 0.3 weight percent of the entire sample weight, with no inorganic particles retained on a No. 12 screen, and no more than 0.1 weight percent retained on a No. 20 screen, and no more than 0.2 weight percent retained on a No. 20 screen.
4.5 **Medical, toxic and/or hazardous materials (Prohibited contaminants)** - any amount present may be justification for load rejection based on discretion of buyer.

5.0 Chemical Composition of Cullet

5.1 Table C-1 describes the compositional range of oxides and carbon for grade C cullet. Any particular supply of grade C cullet will fall within these compositional ranges if the material contains only glass food and beverage containers.
For long term buying and selling relationships, an average weight percent for each oxide and upper and lower range limits will be established. This compositional range must not vary beyond specified limits from shipment to shipment.

Table C-1 - Chemical Compositional Range of Grade C Cullet

Oxide or Chemical	Weight % Range	+/-
SiO2	66-88	1.00
Al203	0-7	0.50
CaO	0-15	0.50
MgO	0-5	0.50
Na2O	8-18	.0.50
K2O	0-4	0.50
Fe2O3	< 0.5	0.05

Appendix IX

Statistics of payloads of municipal solid waste during the sampling week

statistical analysis of the sampling weeks

from 6\06\92	from 10\17\92		from 6\13\92	from10\24\92		from 5\23\92	from 11\07\92
to 6\11\92	to 10\22\92		to 6\18\92	to 10\29\92		to 5\28\92	to 11\12\92
6	6.5		6	6.5		6 5	7
7	7		6	5		7	7
6	6		5	5.5		7	6.5
6	7		5.5	6		7	7
6	7		5.5	5		6	6
6.5	6		5.5	5.5		6	6
6.5	6		5	6		6.5	7 5
6	7.5		6	6		6	6
7	7.5		6	6		6.5	7
6.5	8		5	6 5		6.5	6 5
7	6.5		6	5.5		6	6
7.5	6.5		6	5.5		5.5	6
6.5	7		6.5	6.5		6	6
6	7.5		6	6.5		6	6 5
7	7.5		5	6.5		6	5
6	6		6	7		5	6
6.5	7		6	6		6	6.5
6	7		6	6		6.5	6.5
7	6.5		5.5	6.5		6	6
6	6.5		6.5	6.5		5	6.5
6	7		5	6.5		5	6
6.5	7.5		5	6.5		6.5	6
6	7.5		6.5	6		6	6
6	7.5		6.5	6.5		6	6
7	7		6	7		6	7
6	6.5		5.5	6		6	6
6.5	7.5		6	6 5		6	7
6	7.5		6	7		6	5.5
7	7.5		5.5	6.5		6	6
6	6.5		5.5	6		5	6
6.5	7		6 5	6		5.5	6
6	7		6	6		6	5
7	7		6.5	7.5		6	7
6	7		6	6.5		6.5	6.5
7	7.5		6	7		6	7
7	7		6	6		6	6
7	6.5		5.5	6.5		6	6
6	7.5		5	6		6	6
6	7		5	6		6	6
6	6.5		6	6		6	5 5
6	7.5		6	6 5		6	6.5
6	7		6.5	6.5		5.5	6
6.5	7		6.5	7		5.5	6
6.5	7		5.5	7		6	6
6 5	6.5		6	7		6	6 5
6	7.5		6.5	7		6	6
6.5	7.5		6	6.6		5	6
6.5	7.5		6	7		5 5	6
7	7.5		280	302.1	total	287	298
6.5	7		5.83333333	6.29375	average	5.979166667	6.208333333
7	7.5		6.5	7.5	max	7	7.5
7	7		5	5	min	5	5
7.5	7.5		0.48743068	0.57368028	st.d	0.463321105	0 524235343
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7	7						
6.5	7						
6	7						
6	6						
6	7.5						
7	7						
6	7						
539	591.5	total					
6.41666667	7.041666667	average					
7.5	8	max					
6	6	min					
0.46461108	0.479751068	st.d					