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18 May 1987
ENGLISH

ASSISTANCE IN COMPOSTING MUNICIPAL WASTES, BAHRAIN

DP/BAH/85/010

Technical report: Composting Plant Bahrain

Prepared for the Government of Bahrain
by the United Nations Industrial Development Organization,
acting as executing agency for the United Nations Development Programme

By: Willibald Lutz
Consultant

United Nations Industrial Development Organization
Vienna

PLACE VISITED: Manama, State of Bahrain

DATES OF MISSION: 9-14 May 1987

PURPOSE OF MISSION: (see Annex 1, job description)

(a) The presentation of the evaluation of pre-qualification proposals for a refuse and sewage sludge composting plant at Tubli, Bahrain was submitted by Mr. Robert O. Williams during the mission from 10 to 13 April 1987.

(b) Additional answers and explanations concerning the differences in the selected processes of the six companies from whom final tenders will be requested. Particularly Messrs. Krüger and deBartolomeis will have to certify their experience in composting in hot climates.

(c) Determine the precise requirements for the proposed compost plant such as:

- present and future status of refuse and sludge management, waste quantities, analysis, etc.
- study the use of the existing pulveriser plant in Tubli,
- cost of energy, man power and others,
- statistics on current use and cost of organic and inorganic fertilizer,
- market for compost.

(d) Additional requirements comming up during the mission such as:

- study the use of the existing pulveriser plant,
- discuss general scheme of the proposed composting plant.

(e) Prepare the study tour to reference plants in Europe and Middle East.

ACHIEVEMENTS:

9 May Flight from Vienna to Bahrain

10 May (1) Visit to the Tubli Water Pollution Control Centre (waste water treatment plant), guided by Mr. Brian Charlesworth, plant manager, Ministry of Works, Power and Water, Directorate of Sewage.

The sludge is generated in the biological treatment step (extended aeration system) and pumped in liquid form to the drying beds where it is dewatered.

Present load of the WWTP and sludge production:

average	daily flow	72000 m³/day
"	BOD load	11000 kg/day
"	waste sludge flow	800 m³/d
"	sludge produced	8000 kg/d

average moisture content in dried sludge	51 %
" volatiles (550 °C)	64 %

(For further sludge data see Annex 2, laboratory analysis report, Jannuary, February and March 1987)

The sewage treatment plant was started up in 1984. Currently the plant is extended double the size. In the future the sludge quantity will amount to 40 TPD with a moisture content of 50-60%. The high salt content of approx. 3% in the dried sludge has to be considered in the composting process.

(2) Visit to the pulveriser plant in Tubli adjacent to the waste water treatment plant, guided by Mr. Brian Walton, plant manager.

The plant is owned by the Central Municipal Council but operated by the private company RMI Development Ltd. since the beginning of 1987. Contrary to previous information, there is no weighing machine installed, but estimates have been made on the existing quantity of waste. Input to the existing facility amounts to 340 TPD refuse. Ten TPD of cardboard material are picked up from the receiving hall by a private company and used for resource recovery. About 25 TPD of bulky material are removed from the tipping floor and hauled directly to the landfill in Askar which is approximately 80 km south of Tubli.

There are two pulveriser lines installed; one has a Tollemache mill 72 A (500 HP) and the other a Tollemache 42 F (250 HP). Iron is recovered by means of two magnetic separators. The shredded waste is compacted and hauled to the landfill. In the future some changes in the waste collecting system will occur. The quantity of refuse will increase to 400 TPD houshold refuse and 200 TPD commercial and trading waste resulting in a total of 600 TPD.

11&12 May Official meetings at the Central Municipal Council in Manama (see Annex 3, minutes of meeting). The compost will be used by the Ministry of Agriculture. (See Annex 4, costs of organic and inorganic fertilizer)

13 May Second visit to the waste water treatment plant and the pulveriser plant to collect additional detailed data.

Final meeting with Mr. Al Sayigh at the Central Municipal Council to discuss the next steps as written in the minutes of meeting (Annex 3) and the function of the pulveriser plant (see Annex 5, pulveriser plant report)

14 May Flight from Bahrain to Vienna.

CONCLUSIONS AND RECOMMENDATIONS:

It is intended to install the composting plant at the same site in Tubli, utilizing the receiving hall and other facilities but ignoring the pulveriser plant. The latter can be used as standby and treatment of rejects from the compost plant.

The high salt content in the dried sludge has to be considered in a potential composting plant. A lower salt content could be achieved by installing a dewatering machine and taking over mechanically dewatered sludge instead of dried sludge. In the final tender, a dewatering machine should be asked for as an additional option.

The six companies from whom final tenders will be requested will be asked to quote for the supply of the attached sheme using their own equipment (see Annex 6, general lay out of the existing facilities and future composting).

Brief description of the proposed composting system:

The houshold refuse is charged from the tipping floor into the receiving hoppers of the handsorting station by front end loaders. There are 2 hand-sorting belts where valuable material such as cardboard, paper, aluminum, glass and others are manually separated. At the end of the picking belts there are two iron separators automatically operated.

The residual material then passes to the rotating drum which is the nucleus of the composting process. The waste is rapidly disintegrated by attrition. Dried (or mechanically dewatered) sludge is mixed in the drum with refuse and due to the long retention time completely homogenized. The proper moisture content in the mixture is adjusted by adding effluent water from the waste water treatment plant.

The treated refuse is moved to the cylindrical screen. Material passing through the holes falls onto the compost conveyor for transfer to the fermentation area. Oversized material is ejected at the open end of the screen onto the rejects conveyor and transported to the compactor unit for ultimate disposal to the landfill.

The raw compost material is deposited in the fermentation hall. Composting can be done by different methods of aeration such as windrowing, static pile aeration or a combination of both.

To achieve complete compost stability after either maturation process it is desirable to place this material in the maturation and storing hall for final curing.

After maturing some compost can be sold for use in land reclaimation. However for most purposes the product is refined by passing it over a fine preparation plant consisting of a second iron separator, fine screen and destoner. For packing in plastic sacks for sale in small quantities a bagging unit is necessary. Most refined compost will be sold in bulk.
For the whole process environmental aspects have to be considered especially odor control by using compostbiofilters.

Revised time schedule: (1987)

mid July: tender invitations to 6 qualified bidders.

mid September: closing date of tender.

end October: completion of evaluation and recommendation.

DATE OF REPORT:

20 May 1987

SIGNATURE:

Dr. Willibald Lutz

ANNEX 1

JOB DESCRIPTION

R. O. Williams/hc
17 March 1987

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

JOB DESCRIPTION

DP/BAH/85/010/11-55

Post title Consultant in Compost Production from Municipal Waste/Sewage Sludge

Duration Ten days (0.3 m/m)

Date required 30 March 1987

Duty station Bahrain and home base

Purpose of project To assist the Government in planning the establishment of a compost plant by providing technical advice on such matters as the most appropriate process of good quality at the most economical cost with sufficient health safeguards, plant design and engineering, capacity, compost pricing and marketing, and administrative and institutional arrangements for the plant's successful operation.

:ies

1. To present, to the authorities in Bahrain, the technical findings of UNIDO's evaluation of thirteen tenders submitted for pre-qualification for the turn-key installation of a compost plant at Tubli, Bahrain.

2. To defend these findings by answering such questions as may be asked by the Bahrain authorities concerning the selected processes and the six companies from whom final tenders will be requested.

3. To determine, through discussions with technical personnel in Bahrain, the precise requirements for the proposed Compost Plant such as:
   - feed rate of both pulverized garbage and sludge
   - manpower and energy availability,
   - standards to be complied with by compost product, and any other appropriate criteria. for inclusion in the final tender request documents.

4. To prepare a report presenting the findings of paragraph 3 (above) and an outline of the contents of the request for final tender.

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Qualifications	Engineer with extensive experience in planning, setting up and operation of plants for compost municipal wastes.
Language	English
Background information	Improved agricultural production in the cultivated areas of Bahrain depends largely on the availability of water and organic matter in the soil. The latter is usually present only in traces under natural conditions and must be added annually in the form of organic manures of various types. Chemical fertilizers can supplement but not replace organic matter because improvements in water economy and soil microbiology can be brought about only by organic fertilizers or soil conditioners. The current use of manure falls short of the economic requirements and a substantial proportion of the cultivated area does not receive annual manuring because of the shortage and high price of manures. Shortage of manure is a contributory factor in the continuous decline of actively cultivated land area. For optimum yields, the current area of actively cultivated land will require around 80,000 tons of organic manure annually, and only about a quarter of this amount is currently available in the form of animal manures. Soils in Bahrain require 30-40 tons/hectare/year of organic manure and such requirements cannot be met through imports. Limited quantitites of organic manure are being imported for special markets, the price varying between 60-220 B.D. per ton. Locally produced manure fetches up to 20 B.D. per ton. In the light of the above-mentioned serious shortage of organic manure, it is sensible to plan for compost production from municipal wastes (refuse and sewage sludge). A refuse pulverization and compaction plant and a sewage treatment plant stand within close proximity at Tubli, which would be the natural site to locate the proposed compost plant.

ANNEX 2

WASTE WATER TREATMENT PLANT TUBLI - LABORATORY ANALYSIS REPORT

LABORATORY ANALYSIS REPORT

MONTHLY ANALYSIS **DATE** January 1987

PARAMETERS	THICKENED SLUDGE	DRY SLUDGE
NITROGEN	64.000 mg/kg dry basis	60,000
PHOSPHATE	19,729	19,866
SODIUM	23.000	23.700
POTASSIUM	4563	3018
COPPER	494	936
NICKEL	133	190
IRON	9866	14000
LEAD	256	366
ZINC	833	1400
% MOISTURE	95.6	74.6
% SOLIDS	4.4	25.4
% VOLATILES	64.5	62.9
TOTAL OILS & GREASES	-	-
CADMIUM	30	18
CALCIUM	-	-
MAGNESIUM	-	-

LABORATORY ANALYSIS REPORT

MONTHLY ANALYSIS **DATE**

February 1987

PARAMETERS	THICKENED SLUDGE	DRY SLUDGE
NITROGEN	49.000	36,000
PHOSPHATE	13,829	18,382
SODIUM	33,723	19,706
POTASSIUM	7234	5294
COPPER	447	579
NICKEL	57	70
IRON	10,212	15,588
LEAD	276	376
ZINC	804	911
% MOISTURE	96.6	59.5
% SOLIDS	3.4	40.5
% VOLATILES	62.5	62.5
TOTAL OILS & GREASES	86,597	-
CADMIUM	9	10
CALCIUM	-	-
MAGNESIUM	-	-

LABORATORY ANALYSIS REPORT

MONTHLY ANALYSIS **DATE** March 1987

PARAMETERS	THICKENED SLUDGE	DRY SLUDGE
NITROGEN	45,000	50,000
PHOSPHATE	5538	11080
SODIUM	33,650	14,120
POTASSIUM	3943	3596
COPPER	340	380
NICKEL	54	54
IRON	9200	10300
LEAD	190	200
ZINC	570	660
% MOISTURE	971	54
% SOLIDS	2.9	36
% VOLATILES	62	63
TOTAL OILS & GREASES	-	-
CADMIUM	4	5
CALCIUM	60740	53920
MAGNESIUM	30700	21250

ANNEX 3

MINUTES OF MEETING

UNIDO - BAH/85/010
Composting plant for the State of Bahrain in Tubli near Manama

MINUTES OF MEETING

1) Place and time:

The Central Municipal Council, Manama
11 May and 12 May 1987.

2) Participants:

- Yusuf Ahmad Al-Sayigh, Director of Environmental Health, The Central Municipal Council.
- Saeed Ali Al-Sairafi, Director of Finance and Legal Affairs, The Central Municipal Council.
- Jaffar Habib, Director of Agriculture Projects, Ministry of Agriculture
- Mohamad Al-Sharif, (partly), Programme Assistant, UN Development Programme
- Willibald Lutz, Consulting Engineer, UNIDO
- Hamad Abdul, Chamber of Commerce
- Hassan Salem, The Central Municipal Council, Parks Directorate

3) Subjects:

a) Study tour to existing composting plants:
- Europe: Austria (Vienna) visiting composting plants using the Voest Alpine, Buhler and Dano system.
France (Paris) visiting a composting plant using the O.T.V. system.
The study tour will start on July 4 and end on July 10, 1987.
Participants are Mr. Al-Sayigh and Mr. Habib representing the State Committee and accompanied by Mr. Lutz.

- Middle East: It is intended to visit the composting plants in Cairo/Egypt (Dano and Buhler) and in Al Ain/U.A.E. (Voest Alpine) in October 1987.

b) It is intended to use sewage sludge in the composting plant. The present quantity amounts to 10 TPD dry substance and it is dewatered on drying beds at the adjacent sewage treatment plant. The dried sludge amounts to 20 TPD and will increase in the future to 40 TPD (50% moisture).

c) The proposed composting plant shall be constructed at the site of the existing pulverizing plant. According to the information received from the operating company RMI Developments Ltd the operation and maintenance of the two shredders is very expensive and many shut downs occur due to explosions and cloggings.

Therefore it is intended to use the pulverizing plant in the future as stand by for the composting plant as well as a compaction facility for the rejects before hauled to the landfill.

The intention of Messrs. RMI to remove the existing pulverizer plant and convert the buildings into workshops is no longer feasable. A brief report on the function of the pulverizer plant will be prepared by Mr. Lutz.

d) The quantity of refuse is estimated to 400 TPD household refuse and 200 TPD commercial and trading waste. Household refuse will be collected on 7 days per week in the near future.

e) The proposed composting plant should be equipped with a handpicking station for resource recovery of cardboards, plastics, bulky wastes, and other materials. In principal the composting plant shall consist of a single treatment line.

f) The quantity of used organic fertilizer amounts presently to 50000 TPY and will increase in the future to 85000 TPY. The organic fertilizer is mainly cattle manure. The quantity of inorganic, chemical fertilizer used in the State amounts to 1000 TPY of NPK and 350 TPY of others.

g) For the final tender UNIDO shall prepare the technical annexes to the model contract of the State of Bahrain.

h) Overall Schedule: (1987 - 1988)

- beginning of July: study tour in Europe, submission of technical annexures for the final tender by UNIDO.
- mid of July: tender invitations to 6 qualified bidders.
- end of October: closing date of tender. (or earlier)
- end of November: tender evaluation
- December 1987: final negotiations and award of contract.

13 May 1987

ANNEX 4

COSTS OF ORGANIC AND INORGANIC FERTILIZER

QUANTITIES AND COSTS OF FERTILIZER

Data received from Mr. Jaffar Habib, Ministry of Agriculture, on 12 May 1987.

1. Organic fertilizer:

Present quantity of organic fertilizer,	50000 t/year
Future " " " " ,	85000 t/year

Costs:

organic fertilizer: mainly cattle manure	20 B.D./load (4 tons)	
	= 5 B.D./ton	
some poultry manure dehydrated	1 B.D./bag (20 kg)	
	= 50 B.D./ton	
imported peat	3 B.D./bag (20 kg)	
	= 150 B.D./ton	

2. Inorganic fertilizer:

present quantity of chemical fertilizer:		costs:
NPK	1000 t/year	92 B.D./ton
urea	200 t/year	85 B.D./ton
superphosphate	50 t/year	100 B.D./ton
foliate spray	50 t/year	16 B.D./bag (50 kg)
		= 320 B.D./ton

3. Application rates:

organic fertilizer (cattle manure)	30-50 t/hectare and year

ANNEX 5

PULVERISER PLANT REPORT

PULVERISER PLANT REPORT

A. COSTS:

1. Power requirement:

shredder 72 A	500 HP	
shredder 42 F	250 HP	
	750 HP	= 552 kW
conveyors, iron seperation, compactors, etc.		168 kW
installed power	approx.	720 kW

required power, 720 kW x 8 h/d x 0,8 = 4608 kWh per day
specific cost for electrical power = 0,016 BD per kWh
daily costs, 4608 kWh x 0,016 BD = 74 BD
specific costs, 74 BD : 305 TPD = 0,243 BD per ton refuse

2. Spare and weir parts:

last order for 4 months 24000 BD
specific costs, 24000 BD : 100 days : 305 TPD = 0,787 BD per ton refuse

3. Personnel costs:

men power for shredder operation only, (total staff 42 men)

14 men x 100 BD	= 1400 BD per month
1 mechanic	= 200 BD
1 electrician	= 200 BD
1 superviser	= 500 BD
summary	2300 BD per month
specific costs, 2300 BD : 25 days : 305 t	= 0,302 BD per ton

4. Miscellaneous, workshop, overheads (without profit) = 0,533 BD per ton

5. Summary: 1,865 BD per ton

annual operation and maintenance costs
(without amortisation), 1,865 BD x 115000 t = 214475 BD per year

B. AVAILIBILITY:

1. regular operation:

   Each day there occur 2 shut downs because of machine clogging.
   It takes 25 minutes to stop the complete treatment line. Blockage removal takes 1 hour for 4 operational people.
   The daily operation time is from 6 a.m. to 2 p.m. (8 hours). Because of the cloggings the actual operation time is shortened to 6 hours. After 2 p.m. maintenance work is ongoing for approx. 4 hours.
   The throughput of refuse is reduced because of short time.

2. Accidents:

   On 29 October 1985 an explosion destroyed the large 72 A shredder and the plant was shut of during 6 months. The throughput dropped down to zero because of safety regulations while repairing the machine.
   Note:
   There is no concrete bunker ceiling the shredders and protecting the staff. Explosions may occur at any time.

3. Summary of availibility:

regular operation availibility	75 % or less
overtime for maintenance personnel	50 % or more
availibility after explosions	0 %

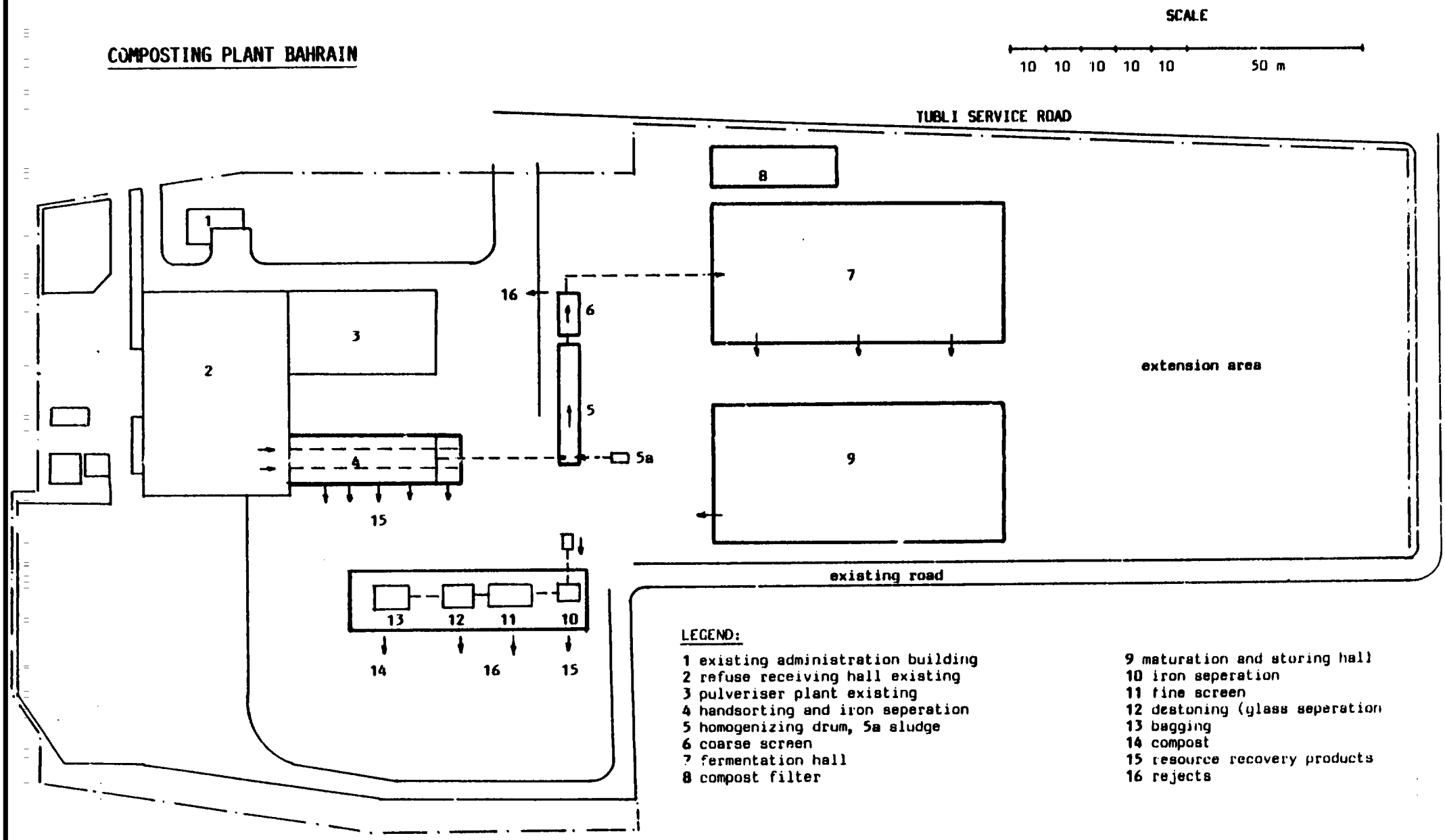
C. RECOMMENDATION:

The plant was started up in 1983. The maintenace costs will increase with the age of the shredders.
It is recommended to use the pulveriser plant as long as the composting plant will start up. Afterwords use the facilities as stand by and back up system wheras the compactors will condense the rejects and screenings before hauled to the landfill. For these rejects a seperate charging unit has to be installed feeding the compactors.

ANNEX 6

GENERAL LAY OUT OF THE EXISTING FACILITIES AND FUTURE COMPOSTING

COMPOSTING PLANT BAHRAIN



LEGEND:

1 existing administration building
2 refuse receiving hall existing
3 pulveriser plant existing
4 handsorting and iron seperation
5 homogenizing drum, 5a sludge
6 coarse screen
7 fermentation hall
8 compost filter
9 maturation and storing hall
10 iron seperation
11 fine screen
12 destoning (glass seperation
13 bagging
14 compost
15 resource recovery products
16 rejects

GENERAL LAY OUT OF THE EXISTING FACILITIES AND FUTURE COMPOSTING