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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

MASTER PLAN FOR SOLID WASTE MANAGEMENT IN KASUR

DP/PAK/93/006

FINAL REPORT

December 05, 1998

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Lahore
December 04, 1998.

Dr. R.G. Gumen
Country Director
UNIDO
2nd Floor, Pak Saudi Tower,
Blue Area, Islamabad

Subject: UNIDO Contract 98/066/Master Plan for Solid Waste Management in Kasur – UNIDO Proj DP/PAK/93/006

Dear Sir:

Enclosed please find five copies of our Final Report on the abovementioned topic as agreed in our meeting with Dr. Schmel at the Pearl Continental on December 02, 1998.

With assurances of our best attention at all times, we remain.

Yours faithfully,
for EMMAY Associates (Pvt) Ltd.

Masood Hasan
Managing Director

Encl. Five copies of Final Report

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ACRONYMS

BOD	Biological Oxygen Demand
CEPTP	Common Effluent Pre-treatment Plant
COD	Chemical Oxygen Demand
CSIRO	Council of Scientific and Industrial Research Organization
DCL	Donkey Cart Load
EA	Environmental Approval
EIA	Environmental Impact Assessment
EPA	Federal Environmental Protection Agency
KTA	Kasur Tanneries Association
KTWMA	Kasur Tanneries Waste Management Agency
PD	Project Director
PEPO	Pakistan Environmental Ordinance (1997)
PM	Project Manager
pa	per annum
pm	per month
RA	Responsible Authority
ST	Survey Team
TL	Team Leader

(Chukram = Staking Wheel)

RACT

: city has a tradition of tanning. Originally vegetable tanning was used in the Dingarh area .e Rohi Nallah. Later tanneries spread over other clusters in Niaz Nagar, Yunus Nagar, Kot \bdul Qadir and Mushtaq Nagar.

otal of 101 tanneries, (23 more than laid down), large, medium and small were surveyed and : results applied to 237 tanneries. Later, discussions with the Tanners Associations and project ıthorities were provided with the implications of optimum production i.e. 75% in excess of ırvey results in regard to quantities of solid waste. Barring a few larger tanneries by and large nost of the tanneries are unaware of quantities of wastes produced. This was a difficulty that the survey had to surmount by quantifying the standard means of removal i.e. the donkey cartload.

Hair, wool, lime fleshings, leather shavings, and trimmings are saleable commodities, whereas stake wheel dust, sodium chloride, insoluble sulphides, insoluble lime and sulphide paint residue, contaminated wool, solidified material waste and lime sludge were non-saleable. Quantities of saleable and non-saleable wastes were worked out.

Further, a master plan including routing along with types of transport has been worked out considering the road widths in transporting material to the landfill site including estimates up till 2010. The associated costs have been included and suggestions made on collection fees.

The use of cleaner technology including chrome recycling has also been covered. Lastly, the impact on the environmental and health conditions in Kasur along with mitigating factors has been included.

1. INTRODUCTION

1.1 The main objective of this study was to quantify the quantities of waste produced by the Tanneries. Both saleable and non-saleable wastes have been identified with their weight / volume ratios and quantities projected till 2010.

1.2 101 Tanneries, as against the agreed 78, were surveyed with the active co-operation of the Tannery Associations. This sample has provided the basis for estimates made. The survey instrument was modified in discussions with the Project Manager and finalized with the Tannery Association (Dingarh) representatives. The results as shown in a spreadsheet, which provides comprehensive information on all aspects of waste production. Further to take care of optimum production a 75% increase in solid wastes was made along with logistic considerations.

1.3 A description of the processes used is given along with suggestions on good housekeeping, which would help reduce wastes, both solids and effluent problems.

1.4 The possible uses of tannery wastes are also described. In fact the saleable wastes are already being put to use and providing tanners financial benefits.

1.5 Currently 237 tanneries are producing a total of 13,192 tons pa of saleable wastes comprising hair, wool, lime fleshing, leather shavings and trimmings representing 53.24% of total wastes. The non-saleable amount to 11,580 tons pa of buffing dust, stake wheel dust, sodium chloride, insoluble sulphide, insoluble lime and sulphide paint residue, contaminated wool, solidified finishing material wastes and lime sludge amounting to 46.76% of the total wastes produced.

1.6 Estimates of both types of wastes have been tabulated. The current gross generation is about 43,350 tons pa, which is expected to increase at 5% pa building up to about 61,000 tons by 2010. The disposal in 1999 is expected to be about 4665 tons (3430m^3) building up to 25640 tons (1885 m^3) by 2010.

1.7 The cumulative landfill disposal volume will be about 155350 m^3 by 2010. Collection vehicles both for solid wastes and sludge removal will be utilised. Since some roads are very narrow (1.5m) the size of the vehicles / trolleys to be used have been adjusted accordingly. Sludge pumps are expected to remove 8% of the generated sludge. Attention in the first instance should be paid to the large and medium sized tanneries. Later the small or domestic should be involved.

1.8 Presently in Kasur city collection of solid wastes is haphazard. Storage points in the form of open heaps exist on wider streets. Collection vehicles transfer their wastes to open dumps around the city. It is preferable tipping type tractors be used. The smaller type, as used by the Lahore Metropolitan Corporation have been recommended.

1.9 Disposal of solid wastes can be done by composting, incineration or sanitary landfilling. The selected method is that of landfill. The site is along the abandoned Ganda Singh Wala railway track and is 80 m wide and 1500 m in length. The approach will be from Dipalpur road on which first the CEPTP will be constructed followed by sludge drying beds. The landfill follows thereafter, as it meets the requirement of the treatment plant and the sludge drying beds along with that of the sanitary landfill.

1.10 Previous reports boring logs show a good clay layer, which can be beneficially used as the landfill bottom (0.5 m) without additional treatment. No problems are expected either from gas movement or leachate.

1.11 For proper operation a landfill office will be required. Estimates have been made for soil required for increasing the width of the abandoned track and for the embankments. It is expected that the volume requirement for landfill is 155350 m^3 up till 2010, in-addition there is another site which could be developed later.

1.12 Manpower and equipment required for storage, collection and disposal for the landfill have been worked out. The management can be the responsibility of KTWM Agency or be contracted out to private contractors/companies who could be engaged area wise by communities/tanneries. The estimated total cost of vehicle equipment, soil / land costs amounts to Rs. 27,050,000. Annual staff salaries amount to Rs. 1,314,000. To work out the collection fee the number of drums has been used as a basis. There are 189, 356 and 127 drums in large, medium and small/domestic tanneries respectively totalling 672. Including depreciation operating and maintenance costs the cost per drum amounts to Rs. 569/drum/month representing as the collection, transportation and landfill costs. This figure appears to be low enough to enable a practicable solution to be found.

1.13 A routing plan for removal of solid wastes from the 237 tanneries has been developed and the concerned trunk roads have been marked out on a sketch map.

1.14 Regarding health and environment, measures as required by PEPO (1997) will have to be followed according to the laid down jurisdiction of various agencies. Both the impact and mitigating factors have been brought out. Because the solid waste will shortly exceed 10000 m^3 pa its disposal will require an EIA.

1.15 Removal of sludge will reduce the incidence of shovelling poisonous matters from choked drain beneficially to both workers and in decreasing downstream hazards. With increasing awareness of the need to take care of the environment both technologically and politically along with the administrations' determination to improve matters along with laws enacted. The local administration headed by the Deputy Commissioner, who is also Project Director of this project, will be a key player in nudging the tanneries in the right direction.

2. SURVEY METHODOLOGY

Keeping in view the requirements of the Terms of Reference, the survey proforma was designed to extract relevant information through an on-site survey so as to have necessary data to assist in:

i) building up design of solid waste collection from tanneries to its final disposal at the landfill site

ii) determining the category of the tanneries as small, medium or large,

iii) chalking out a time table for solid wastes collection from tanneries in various areas and streets for transfer to landfill,

iv) ascertaining tanneries location streetwise and area-wise to facilitate actual work plan and schedule for solid wastes collection from individual tanneries,

v) assessing different types of solid wastes produced monthly, daily and yearly by tanneries along with and their weight to volume ratio to arrive at the capacity of the landfill and requirements of manpower and machinery to lift waste from the site and to plan for the over all basic infrastructure and

vi) estimate capital requirements and operational costs for solid waste management to achieve the desired objectives.

2.1 Survey Proforma - Actual

Keeping in view the requirements of the project and those highlighted in the preceding para, a Survey Proforma was tentatively designed for the parameters to be covered to extract on-site and direct information from individual tanneries. Detailed discussions on the format of the designing of proforma, were held with the Project Manager, KTWMA, Kasur at length considering the entire background of the project requirements. In the light of these discussions, the proforma was suitably modified.

2.2 In order to further improve and refine the proforma for generating data to suit to the requirements of the project, meetings were also held with the following members at the Kasur Tanneries Association (KTA) Dingarh:

- Mr Muhammad Shafiq Pasari, Life Chairman
- Mr Sheikh Allahwasaya, President
- Mr Q M Irshad , Secretary
- Mr Irshad Hussain Joint Secretary
- Mr Mian Ashfaque, Ex-Member

2.3 In consultation with the above members of the KTA, their other colleagues as well as tannery owners who have thorough practical knowledge and long standing experience in the field of leather manufacture, the proforma was improved further and the finally agreed design of the Survey Proforma adopted for the survey (Annex-1).

2.4 **Classification of Tanneries**

Keeping in view the project requirements it was necessary to classify the tanneries into Large, Medium and Small categories. In consultation with above named tanneries representatives and keeping in view the local conditions as to the variation of production capacity in the context of the number of "Drums" installed at each tanning unit, it was agreed through consensus that the following classification be adopted:

Large	6 drums or more
Medium	3 to 5 drums
Small (domestic)	up to 2 drums

Accordingly, the above classification was used in the Survey Proforma.

2.5 **Survey Team**

Keeping in view the technical nature of the survey, a team comprising a Survey Supervisor and 3 other members all having background of tannery operations, and was formed. The Survey Supervisor was experienced with practical exposure relating to tannery surveys. The three team members were provided practical guidance during the survey. The survey of 101 tanneries in all was carried out. Even the senior members of KTA, especially Mian Shafique Pasari, also gave inputs to the 3 team members.

2.5.1 **Actual Survey**

The survey team was fully supported by the KTA through their representative who was immediately available to help them out whenever required by any survey team member. This help facilitated their work. Day to day instructions were also given to the survey team members keeping in view the difficulties experienced during actual survey work.

Number of Tanneries surveyed = 101 (against the requirement of 78)

The break-up of the surveyed tanneries is as follows:

Category	Nos
Large	9
Medium	38
Small/Domestic	54
	101

2.6 **Solid Wastes**

In order to determine the amounts of the variety of tannery solid wastes to be transported to the landfill site, it is important that the daily weight and more so the volume of various types of wastes be assessed through on site investigations. It was mutually agreed by the survey team and the earlier mentioned KTA members that the following wastes being generated at different processing stages in the tanneries, should be assessed during the survey:

- Hair
- Lime, Fleshing
- Shavings
- Lime sludge
- Buffing dust
- Trimmings
- Chakram dust

2.7 In addition to solid waste reported in the survey sheets, some wastes have not been reported which comprise of used salt, contaminated wool, finishing materials waste, insoluble sulphides, insoluble lime and sulphide paint residues. This has been quantified according to the individual tannery processes and the quantity of raw material processed by that tannery. Estimates were made by the Consultant based on their practical experience. Many tanners had no idea of quantities of this waste generation.
Accordingly, these above categories of wastes were included in the survey proforma for assessment as to their weight and volume produced during a definite time.

2.8 **Quantitative Assessment of the Wastes**

During the survey it was noticed that mostly neither the tannery owners nor their staff had any idea of quantities of wastes produced. To overcome this situation information on the sales of the different types of solid wastes was obtained. These sales are conducted mainly on a Donkey Cart Load (DCL) basis. The survey team (ST), therefore, weighed for each waste 7 DCLs to arrive at an average weight. It was found that factory owners' estimate and the ST measurements values were fairly close to each other.

2.9 **Basis of Calculations to Determine the Quantity of Wastes Generated**

The weight of each type of waste produced by the tanneries surveyed was calculated as below:

Weight of a specific type of waste = Number DCLs x Weight of one DCL in kgs

2.10 Determination of Waste Volume & Weight

2.10.1 In order to assess the volumes of solid wastes for the landfill site a bucket was calibrated to determined its volume when full (22 litres) so as to ensure the dry wastes were estimated properly by levelling off the top. Sludge did not present the same problem on account of the quantity of water it held. The tare weight of the bucket was noted.

2.10.2 The bucket was filled with a particular waste to the top and its total weight was determined. Using this procedure the total amount of waste generated in a definite period at a tannery was calculated. For details reference be made to the spreadsheet attached as Annex-2. A summary of this spreadsheet showing the total volume of the wastes generated from each tannery unit from amongst the surveyed tanneries appears in Annex-3. The weights to volume ratios are given in Table 2.1 below.

2.10.3 In order to facilitate the reader, planners, decisions makers and the concerned technical people with the project, details including the name of the tannery, class in which it falls (large, medium or small/domestic), address, phone number, the processes being carried out, type of wastes, the quantities being produced over a definite time, among other particulars, have been included in the Annex-2. The formulae used for various calculations appear in the relevant columns. The information provided therein also helps to further develop technical details and ascertain financial requirements of the project.

2.11 Explanation of the Spread Sheet

2.11.1 Survey of 101 Tanneries was conducted keeping in view of the objective to estimate the total quantity of various types of solid waste generated, both saleable and non-saleable, at different stages of leather manufacturing.

2.11.2 In addition to solid waste reported, part of solid waste is not reported in the survey sheet. These solid wastes comprise of used salt, contaminated wool, finishing materials waste etc. Total solid waste of such types has been quantified according to the individual tannery process stages and the quantity of raw material processed by that tannery. Estimates have been made by the Consultant based on their experience, because many tanners had no idea of quantities thus generated.

2.11.3 Column wise explanation of spreadsheet is as follows:

i) Waste generation in a month is used as the basis for calculation of solid waste generated because most of the tanneries surveyed reported leather production (hence waste generated) on a monthly basis.

ii) Columns 1,2 and 4 are self explanatory.

iii) Category of the tanneries i.e. large, medium and small are given in Column 3.

iv) Installed capacity of tanneries is given in Column 5.

v) Type of raw material (hides or skins) processed is given in Column 6.

vi) Process stages carried are given in Column 7; this varies from tannery to tannery.

vii) Solid wastes generated per lot are classified in Columns 8-14 along with quantity generated.

viii) Production volume per month (in terms of lots) is given in Column 16.

ix) Solid wastes generated per month are given in Columns 17 to 23.

x) Maximum solid waste generated/day, considering a month of twenty-six working days are given in Columns 24-30.

xi) Working days / year total or average are given in Column 32.

xii) Yearly solid waste generation is given in Columns 33-39, by multiplying daily wastage with number of working days/year of a particular tannery.

xiii) Volume of solid waste generated in cubic meters is given in Columns 40-60.

Conversion formula i.e. kgs to cubic meters is as follows:

Volume per kg of waste (m^3) = Volume of waste in litres x 0.001 / (Weight of same volume of waste in kgs)

TABLE 2.1

Weight to Volume Ratio of Wastes

Sr. No.	Solid Wastes	Weight (Kgs.) of 22 Litres	Volume per Kg of Waste (M^3)
1	Hair	2.00	0.011000
2	Lime Sludge	23.760	0.000925
3	Lime Flesh	20.033	0.001100
4	Shaving	3.750	0.005867
5	Buffing Dust	2.250	0.009778
6	Trimmings	6.250	0.003520
7	Chakram Dust	3.400	0.006471

2.12 Reference may be made to Annexes 4 and 5, which summarise the results of the survey of 101 tanneries and gives the estimates for a total of 237. The categorisation of the total tannery population is at Annex 6. The estimates of non-saleable tannery wastes summary are at Annex 7.

3. GOOD HOUSE KEEPING, HEALTH AND ENVIROMENT

Good House Keeping

Environmental protection laws are being made stringent day by day in every part of the world. Tanning like any other chemical industry produces a lot of industrial wastes in different forms and nature. The financial consequences of enforcement of environmental regulations has forced manufacturers rethink to take various steps in the abatement of environmental degradation including tannery waste minimisation by good house keeping. The other ways are through modification of existing processes or adopting cleaner technologies.

This chapter emphasises the impact of Good House Keeping through:

- Recycling of various liquors.
- Reducing chemicals and water consumption
- Improving machine performance.
- In some tanneries minor changes in liquid flows.

3.1 Controlling Water Consumption

The lower the dilution of the effluents the easier it is to handle. Unnecessary and excessive use of water is the main cause of high effluent volume. The remedy lies in

- Lesser floats
- Batch washings and
- Prevention of water leakage from taps and pipelines

3.2 Regulating Chemical Consumption

Leather manufacture involves the use of fairly large quantities of chemicals, including acids, bases as well as toxic compounds. Some of the chemicals like lime used in Beam House are relatively cheap that is why the working staff in this department are careless. Strict enforcement of the following measures will minimise the chemicals load in the effluent.

a. Use of optimum quantity of chemicals
b. Spillage avoidance
c. Proper storage of liquid and powder chemicals.

3.3 Machine Efficiency and Precision

Efficient machinery operations with precision and accuracy, especially precise splitting will result in better yield of split leather and also cut down the quantities of leather shavings with the ultimate result of minimisation of solid waste.

3.4 Proper Tannery Plant Lay-Out Plan

Effluents streams from various process operations must be segregated. Segregation is possible by a properly laid out plant based on separate effluent drains and effluent collection system involving various wet process stages including:

a) Beam House
b) Tanning Chrome and/or Vegetable
c) Re-tanning dyeing and fat liquoring
d) Finishing

3.4.1 Segregated effluents must be filtered through sieves wooden or metal to remove suspended fibrous materials (Hair, Fleshing, Shavings and Coarse hide pieces). Beam House effluent should pass through a three chambered settling tanks including primary settling of sludge in the tannery. This will minimise the effluent treatment plant load, by way of reducing the COD and BOD values, apart from cutting down the operational time cycle and energy cost. Use of coagulants will also increase the sedimentation rate.

3.4.2 The Consultant is of the view that the primary effort should be to ensure all the large tanneries conform to the above. Medium sized tannery owners will have to be educated and helped to understand the need for improvements, as in the final analysis it will help them in the future. Domestic or small tannery owners should be the last group to be tackled with the other two groups conforming to good house keeping pressure can then be brought to bear on them.

3.5 Sources of Discharge of Chromium Compound into Main Tannery Effluent Stream

3.5.1 Primary source of chromium compound in tannery effluent originates from the spent liquor produced by chrome tanning of hides/ skins

3.5.2 Other sources of chrome salts containing liquors are:

a) Drain liquors from wet blue godown
b) Sammying
c) Washing and neutralization of floats
d) Re-tanning and dyeing floats.

These floats contain fairly high amounts of chromium due to weakly bound chromium salts, which re-dissolves in the different processes. Chromium contents in chrome liquors and various floats depend on conditions during processing of chrome tanning and post tanning. Chromium contents in various effluent streams and floats can be minimised by adopting certain measures such as pH and temperature control to attain suitable process conditions so that there is better fixation of chrome in the fibre network and maximum exhaustion of chromium.

3.6 Health & Chemicals

3.6.1 It is clear with increasing awareness of the deleterious effects of toxic chemicals both on the environment and humans that legislation concerning emissions, effluents and solid wastes will progressively become more effective in it's application in Pakistan.

3.6.2 Kasur has a long history of leather production which coupled to a low literarcy level along with the comparatively lower cost of lime, ammonium sulphate (prior to bating for de-liming), sodium sulphate (in de-liming to minimize release of H_2S), sodium chloride (to control acid swelling) before the addition of sulphuric acid (prior to tanning) as compared to sodium sulphide and chrome used later. It takes a low concentration of sodium sulphide to generate an obnoxious toxic sludge as a result of beam house operations, its usage is 3-4% and the reaction with proteins produces the characteristic smell.

3.6.3 Workers come into physical contact with the above chemicals suffer from dermatitis and other diseases. While there is no quantification it is felt that there is a high incidence of cancer and TB in Kasur. There is no doubt with better house keeping and better solid waste management that there will be less damage to human health. Monitoring operations of the solid waste management programs over the years will provide indicators in this line.

3.6.4 An example of the application of standards which has resulted in less hazards to human health has been the very considerable decrease of the in-factory treatment of potassium dichromate reduction with sulfuric acid and sugars to produce basic chromium sulphate. Whether the reduction process was satisfactory or not came to light when Sialkot glove (from sheep and goat skins) manufacturers exports were found to have cancer Inducing hexavalent chromium above the minimum levels, thus curtailing exports, hence Kasur Tannery sales.

3.6.5 Removal of sludge will reduce the incidence of shovelling of matter from choked drains (municipal wastes, chrome, dyes and liquors plus sludge and acids) on to roads, where the toxic matter comes into contact with animals and humans, spreading disease. This contamination will be reduced resulting in lesser disease. It needs to be mentioned the above sludge removed from choked drains also contains some highly toxic finishing chemicals such as glycols, ketones, alcohols, and esters, which also affect health adversely.

3.6.6 Regarding the health risk involved in gas release in the landfill this hazard is not expected to arise because, firstly the solid wastes will be left open to day and secondly the annual precipitation is much less than annual evaporation very minor amounts of gas release may occur.

3.6.7 Since the compacted density of sanitary landfill will be more than 1 ton/m^3 leachate problems through seepage are not expected because of the presence of an impermeable clay liner. The design of the landfill is such that provision has been made through an earthen embankment with an appropriate slope to check any flood water during the

monsoon season. Rain water will be directed to the sides, draining off. When the landfill reaches its design height the surface will with soil cover be suitable to grow grass for sheep and goats grazing.

3.7 Health And Environment

3.7.1 Pakistan Environmental Ordinance (1997)

In February 1997 the Pakistan Environmental Ordinance (PEPO) was signed by the President. It lays down a number of requirements giving environmental assessment a primary place for examination of proposals subject to well-defined procedures for taking care of the government and stakeholder's interests. It is expected over a period of time the solid waste disposal of the tanning and leather finishing industry will build up to more than 10000 m^3 per annum for disposal as landfill and that as provided in the abovementioned Ordinance this disposal will require an Environmental Impact Assessment (EIA).

3.7.2 Jurisdiction

The above operations in regard to landfill will be confined to the Punjab Province hence it can be dealt with provincially. However, the Federal Environmental Agency (EPA) does have overall jurisdiction as all such powers are delegated by the federal government.

3.7.3 Any agency implementing the landfill project is named as "Proponents" in the February 1997 Ordinance, who have to notify the Responsible Authority (RA) before obtaining Environmental Approval (EA) to go ahead. The EA lists conditions for approval allowing the proponents to undertake detailed design, construction and commissioning operations. The RA will inspect the facilities satisfying itself that all their requirements have been met and issue an Operational Approval. This will include a definition of conditions for monitoring and maintenance and a review the Environmental Management Plan developed by the proponent consistent with the Environmental Report for which a predetermined fee will have been paid to the Government for review purposes. The department of Housing Urban Development and Public Health Engineering (HUD & PHE) of the provincial government is the provincial RA.

3.7.4 Assuming the necessary procedures have been implemented and the plan is implemented ensuring Proponents take care of both the environmental policy and sustainability it is expected that benefits will accrue to the community in Kasur including the tanneries, their workers and the population at large. The follow up will be ensured through an annual report made by the proponents to the RA. It may be added that EA is valid for three years

3.8 With time, there will be gradual improvement in the application of the Environmental Protection Ordinance of February 1997 as the government develops expertise in a collaborative effort to ensure that the administrative procedures will encourage public consultation before decisions are made because of two reasons. The first, is that the problem exists and something has to be done about it without generating unemployment.

The second, is that even through the government may help kick off through initial capital contribution, the responsibility of protecting the environment relating to their proposals and carry the costs necessary for environmental protection falls directly in the lap of the proponents of the landfill project.

3.9 Public objections are related generally to the adverse impact to the environment of various nuisances particularly with tannery wastes which can be both poisonous and odiferous. Solid waste management which concerns storage, collection and disposal if handled correctly can help to reduce ill effects resulting in suppressing any outcry from the public.

Environmentally sensitive areas encompass air, land and water. The impact and mitigating factors of the Master Plan leading to a sanitary landfill of Kasur Tannery Wastes is given below:

3.10 STORAGE AND COLLECTION

Littering of Solid Wastes during storage and collection can cause major environmental hazards including.

3.10.1 Choking of Drains and Sewers

This will be mitigated through collection six days of the week. The management of collection will have to be efficient, this will prevent accumulation causing overloading of storage bins resulting in littering of wastes.

3.10.2 Dumping of wastes and even their burning and smoldering with noxious smoke emissions will be avoided by efficient collection. Good public relationing will create community awareness.

3.10.3 Vectors and Rodents Breeding

This will be reduced with an efficient collection service. Storage bins may be sprayed with insecticides and be washed periodically.

3.10.4 Occupational Hazards

Due to direct exposure/contact during manual removal. Waste handling with safety measures (such as gloves) and contrivances (such as hydraulic tipping) will avoid risks.

3.10.5. Dust Raising During Collection/Transportation

Will be taken care of through better road maintenance and water spraying.

3.10.6. Noise During Collection/Transportation

Adequate maintenance of the static and moving facilities will obviate this nuisance.

3.11 Disposal

Sanitary landfill is the disposal method selected for disposal of the solid wastes. The hazards along with mitigating measures are given below:

3.11.1 Surface Water Pollution

Surface water may be polluted through contact with solid wastes. This has been taken care of by providing a slope of 6-7% on the finished fill to prevent ponding.

3.11.2. Ground Water Pollution Through Leachate

This can occur through seepage and biological decomposition and chemical reactions when the leachate finds its way into the acquifier thus polluting the ground water. As brought out in 7.14.7 this aspect has been taken care of.

3.11.3 Morphology

Concerning land settlement, erosion may also occur. However since the solid wastes are mostly inorganics with a small portion of organics, accordingly it is not expected to be confronted with problems on this count.

3.11.4 Odours, Gases and Air Quality

Usually landfill with municipal wastes creates problems. In the landfill no gas vents are needed as the wastes are largely inorganic and no large quantities of biogas will be produced. Odours can be controlled through good maintenance.

3.11.5 Fire Control/Dust

Any fire or dust generation at land fill site can be taken care of with water sprays.

3.11.6. Landscape

To keep the landfill operations out of sight, vegetative screening, earth berms and buffer zone are needed. The landfill in Kasur has been provided with berms on all four sides. Grass plantation on top of the completed landfill will help improve the outlook.

3.11.7 Traffic Hazards

Since there will be minimum but controlled movement the landfill area this hazard will not arise.

3.12 MAINTENANCE

The Consultant understands that their also exists a possibility that the location of the landfill might be changed, looking towards the future some salient features are brought out below:

3.12.1 Ground Water

All solid waste facilities should have a groundwater monitoring facility which must be mainted throughout the active life of the facility and during the closure and post closure operations. Appropriate sampling and analysis programmes be set up. Where necessary

- monitoring wells be installed.
- uppermost aquifer samples obtained from the system should represent the background groundwater quality not affected by the land fill.
- the boreholes should be drilled a minimum of 4 inches larger than casing diameter to allow for sealant and sand emplacement.
- care to be taken no contamination enters the borehole.
- the final design must include the number, spacing, location and well depths. An experienced groundwater professional must approve the design which will include considerations of aquifer thickness, flow rate and direction, seasonal and temporal fluctuations.
- should, at any time, vadose zone (the unsaturated zone of soil beneath the landfill) monitoring be required using a suction lysimeter is indicated.

3.12.2 Modifications

Should modifications be required in the landfill an internal procedure would need to be worked out to obtain the relevant authorities permission.

3.12.3 Operations

Data would need to be recorded including:

- weight/volume of solid waste received.
- record of any deviation of established standard operating procedures.
- post signs to indicate location of facilities, hours of operation, emergency phone numbers, disposal instructions and state that fires and scavenging is prohibited.
- an inspection schedule be set up.
- a written record of inspections be maintained. If unauthorized waste is detected corrective action be taken immediately.
- utilizing the principles of sanitary engineering to confine the working face to the smallest practical area and to compact the solid waste to the smallest practical volume.
- prevent unauthorized access by the public.
- maintain the access roads in good condition.

- the daily compacted solid waste must be covered with an earth layer.

3.13 Annual Reporting

All the operational records need to be presented on an annual basis.

3.14 Contingency Plan

The landfill facility must have a contingency plan for emergencies including fires with a list of who should be contacted.

3.15 Training

All individuals dealing with the landfill including drivers must be trained to do their work including maintenance of records adequately.

3.16 Closure and Post Closure Procedures

The procedures must be recorded for ease of implementation of the same. Finally the procedure for monitoring after closure to ensure no unauthorized disturbances in the area. Annual reports would yet need to be made, such reporting should continue for 20 years after closure.

4. UNHAIRING AND LIMING

4.1 The most common method of un-hairing and liming for cattle hides is hair pulping method or commonly known as sulphide lime system for removing hair from hides. This method is acceptable to almost every tanner due to its simplicity and the quality of end product i.e. the leather produced. Pulping method of depilation is not all that friendly, as it is the main source of pollution in every respect (including high BOD, COD, suspended solids and nitrogen).

4.2 Leather researchers all over the world are working to replace the existing process with a better environment friendly technology, without any adverse effect on the quality of finished leather product.

4.3 CSIRO, Division of Protein Chemistry, Australia worked for over a number of years to develop a rapid hair saving process named "SIROLIME Process" utilising the essentially existing tannery machinery and equipment. SIROLIME process developed in Australia, and this technology was further investigated in depth by TNO (The Netherlands) and suitably modified. It should be kept in mind that as at present this process is not being used in any tannery in Pakistan. It is only logical that one should ascertain the techno commercial viability of the process in all respects, prior to its use in a developing country like Pakistan. Briefly the stages are given in 4.4.

4.4 **The Sirolime Process**

Consists of four stages:

- Impregnation
- Hair Protection
- Hair Loosening and
- Residual hair removal/liming

The drums conditions are carefully controlled along with recycling of liquors leads to both saving in water and chemicals or lower processing costs. More on the Sirolime process is at Annex II.

5 STEPS TO REDUCE CHROMIUM IN TANNERY EFFLUENTS

5.1 There are three different methods to reduce the chromium contents in tannery effluents.

a) To collect and treat the different effluents streams to recover chromium from effluent and recycle the recovered chromium component.

b) Review for adopting any existing proven technology of chrome tanning to maximise uptake of chrome so as to reduce valuable chromium salts lost in the tannery effluents.

c) Examine overall economic viability of using such chrome tanning chemicals having high degree of exhaustion and minimum wastage.

Details of the above mentioned three methods with their relative advantages and disadvantages are given below:

5.1.1. Chrome containing effluent from various process streams are collected and filtered through a fine sieve to remove fine fibres. The filtrate is then agitated thoroughly. Chemical analysis carried out in order to determine the actual quantity of available chromic oxide.

5.1.2 Precipitation of chromium salt is carried out with the addition of some suitable alkali (e.g. sodium hydroxide, magnesium oxide or calcium hydroxide). The precipitate settles to form sludge. Further concentration of sludge is done with the addition of flocculents. Sludge is either filtered by pressure filtration or by settling and decantation of the supernatant layer. Later the sludge is dissolved in 96% sulphuric acid (commercial grade) to adjust the basicity of the solution to the required pH. Chrome recovered from sludge can be blended up to 40% of fresh basic chromium sulphate.

5.1.3 Advantages. The supernatant layer contains Chromium (III) less than 2mg/l which is within the permissible limits.

Disadvantages. Method is lengthy and requires efficient scientific control. An approximate formula to dissolve sludge is as follow (in case no laboratory facilities are available to carry out chrome analysis):

- Precipitate all the chrome in a chrome liquor with the addition of magnesium oxide, so that the pH is adjusted to 9.0
- For precipitation of 1 kg Cr approximately 0.9 kgs of MgO is required
- To calculate Cr_2O_3 the chromium quantity is multiplied by a factor of 1.5.

- For preparing a 33% basic chrome liquor, multiply the quantity of MgO by 2.6 to obtain the quantity of sulphuric acid 96% (commercial grade) needed to adjust to the required pH. Below is an example

Vol. of Chrome Liquor	16 litres
Qty of MgO required to get pH 9.0	370 gms
Cr(III) contents = 1/0.9 x370	411 gms
Cr_2O_3=3/2 x 411	616.5 gms
Qty of Sulphuric Acid reqd to adjust basicity = 370x2.6	960 gms
Analysis of liquor pH=3.1, Basicity = 33% Cr_2O_3	38 gm/l

5.1.4 Look for an up to date commercially proven technology of chrome tanning that ensures increased uptake of chrome. Researchers have developed several processes to improve the uptake of chromium and minimise its discharge in effluent within permissible limits of 2 mg/l. Steps necessary to fix maximum chrome in leather and minimise discharge in effluents are as follows:

- After pickling in normal float, pickle float is drained to a level of 40-60% in the drum, which means that further chrome tanning process is carried out at lower float level.
- Pickle float at pH 2.9-3.1 ensures improved penetration with minimum wastage of acid.
- Basic chromium sulphate is added to the drum in powder form according to conventional process. To avoid knots and grain abrasion slip agents can be added in the drum. Drum rotation is to be kept at 8-9 rpm to avoid drawn grain and overheating in the initial stages of tanning.
- After complete penetration of chrome, basification is done in the normal way and drum kept running for another 5-6 hours. Towards the end of tannage, optimum temperature and pH must be regulated to 40^0C and pH 3.7-3.8 respectively.
- With the adoption of this method of chrome tanning, maximum available chrome quantity can be fixed in the fibres and wastage of chrome which in the conventional process is 6.8 kgs Cr_2O_3/ton of raw hides, can be reduced to 2.72 kgs Cr_2O_3/ ton or even less.

This process without much modification can be conveniently adopted in the existing Kasur Tanneries due to the following reasons

i) No additional/special equipment is required
ii) Nominal investment is needed to regulate the speed of tanning drums
iii) There is no adverse effect on the quality of wet blue leather produced

5.2 Chrome Tanning with Tanning Materials giving High Exhaustion

5.2.1 Keeping in view the problems of recycling and adverse effects on the quality of wet blue produced, research work especially by the renowned manufacturers of tanning chemicals like (Bayer AG) introduced chrome tanning materials with a high degree of exhaustion.

5.2.2 The addition of better chrome tanning chemicals, help in fixing high chrome contents in leather, with almost exhausted (chrome free) float. These materials are organically masked. Sufficient experience has been gained and expertise is available for the commercial application of these chemicals.

5.2.3 Comparison of relative advantages between conventional tanning chemicals Vs high exhausting chrome tanning material is given below. These data have been provided by M/s Bayer AG in their Baychrome C Process.

TABLE 5.1

Conventional Tanning Chemicals Vs High Exhausting Chrome Tanning Materials

	Conventional Chrome Tannage pH	Chrome Oxide content of floats of Cr_2O_3/l	High exhaustion chrome tannage pH	Chrome Oxide content of floats of Cr_2O_3/l
Residual Float Chrome tannage	3.6	6.99	4.15	0.30
Sammying and draining Floats		5.99		0.19
Re-tanning float 1	4.5	1.01	4.6	0.11
Re-tanning float 2	3.8	0.49	4.1	0.09
Wash Float after re-tannage	3.9	0.11	4.1	0.02

6. TANNERY WASTES AND THEIR POSSIBLE USES

Leather industry like any other manufacturing industry is designed to produce a quality product at a competitive price. In general the tanners lay great emphasis on the quality of leather manufactured but have ignored the related vital factor of minimising pollution generated in the form of solid, liquids and gases. Pollution control regulations in force and the limits of contaminants have been fixed in the wastewater effluents, vapour emissions and solid wastes prior to their discharge in river streams and adjoining land areas. During normal chrome/vegetable tanning of leather, solid wastes generated provide a potential source of raw materials for other industries. Presently industries utilizing tannery solid wastes for manufacture are (a) glue, (b) gelatin, (c) animal feed, (d) leather fibre board , (e) hide powder, (f) sausage casing, (g) collagen foams, and sludge in agriculture as manure.

6.1 Tannery Solid Waste Categorisation

The categories are listed below:

- Un-tanned solid wastes
- Tanned solid wastes and
- Sludge

6.2 Constituents of Un-Tanned Solid Wastes

These are produced during cutting and trimming of raw hides in the tannery and in beam house processes from fleshing of hides/skins (comprising of adipose tissues/fats and flesh). Fleshings contain 70% water and are about 15-20% of wet salted weight of raw hides. Both raw hide cuttings and fleshings can be used in the manufacture of:

i) Fats
ii) Glues
iii) Gelatine (edible & industrial)
iv) Protein flour
v) Collagen foam

6.3 Constituents of Tanned Solid Wastes

Tanned solid wastes consist of;

i) **Tanned fibrous tissues.** These are present in tanning liquors and can be separated by sieving the exhausted tan liquors, prior to mixing liquors with other effluents in the tannery.

ii) **Shavings and small split pieces** Produced during adjustment of thickness in splitting and shaving operations.

iii) **Trimmings.** Useless edges of hides/skins trimmed during various stages of leather processing.

iv) **Buffing and wheel staking dust**. Buffing and wheel staking and dry milling are all the sources of dry leather waste of very fine particles size..

6.4 The chrome tanned leather wastes can be used in the manufacture of:

- Leather fibre board - a very useful product for shoe industry
- Building material - heat insulating and sound proofing tiles.

Other possible utilization after de-chroming solid waste by-products, could be useful raw materials for industries listed below:

i) Industrial glue and gelatine, in this connection residual chromium is not a limiting factor

ii) Edible gelatine

iii) Protein flour - for live stock feed

iv) Reconstituted collagen - used in cosmetics

In ii, iii & iv, above the level of chromium is of prime importance and must not exceed the prescribed permissible limits.

6.5 **Sludge**

Sludge's main constituents are proteins (organic matters) and lime (calcium salts) which are useful for agricultural land. As excessive concentration of chlorides, sulphides, chromium and other toxic chemicals are harmful for crops e.g. E.E.C Council has fixed chromium concentrations in soil up to 100-200 mg/kg and in sludge for agricultural land to 1700 mg/kg. Thus the use of sludge as fertilisers is limited. Sludge can also be used in the preparation of composts, provided the chromium contents do not exceed 500 mg/kg on dry basis. Biogas can also be generated.

7. MASTER PLAN

This chapter generates a master plan for transportation of solid wastes from tanneries to the landfill site including current future estimates of quantities up till 2010. The equipment required is identified and costs of operation arrived at. A collection fee is also suggested with alternate ways of management.

7.1 Quantity and Composition of Solid Wastes from Tanneries

Present Generation, Reuse, Collection and Disposal Rates

The data on quantity and composition of solid wastes are the basic requirement to estimate the storage collection and disposal arrangements.

Table 7.1 lists the total quantities to be land filled by the tanneries annually. Future projections are also shown in the same table. This is according to the estimates of P.Rantala (1997). In this report estimates are based on the assumption that while presently only littered components are collected, with proper management, more of the waste will be available in the future for disposal in the landfill.

TABLE 7.1
Solid Waste Collection & Disposal from Tanneries

Year	Tanneries (Wastes (Tons/Year)	Tons/day
1998	3000	10
1999	5000	16
2000	8000	26
2001	10000	32
2002	15000	48

Source: P. Rantala (1997)

7.1.1 The consultant carried out a survey to estimate the quantity and composition of solid wastes generated by the tanneries. Out of a total of 237 tanneries, as given in the KTWMA Tannery registration map 101 tanneries were visited. These data obtained on the quantity and types of wastes generated are shown in Table 7.2 below. These data were then extrapolated to get the estimates for 237 tanneries, and are shown in Table 7.3. The details of the survey conducted are given in the spreadsheet as Annex 2.

7.1.2 However the majority of tanneries visited by the consultants team revealed that the production of Leather was low during the survey period. The consultants, in view of this temporary phase, recommend that planning should be made for optimum scale and the quantities reported in Table 7.3 need to be increased by 75%. KTA fully endorses this view. The estimated quantities obtained in this manner are reported in Table 7.3.A.

TABLE 7.2
Solid Wastes Types, Generation Rates from 101 Tanneries

Sr. #	Types of Wastes	Generation		Saleable/ Non Saleable
		per day (kg)*	per year (tons)**	
1	Hair, Wool	3,412.31	846.67	Saleable
2	Lime Flesh	15,208.27	4,058.86	Saleable
3	Leather Shavings	2,020.58	547.68	Saleable
4	Trimmings	592.19	160.15	Saleable
5	Buffing Dust	178.65	45.98	Non-Saleable
6	Stake Wheel Dust	18.81	4.90	Non-Saleable
7	Sodium Chloride	1,224.15	297.78	Non-Saleable
8	Insoluble Sulphide	122.42	29.78	Non-Saleable
9	Insoluble lime & sulphide paint residue	76.40	18.88	Non-Saleable
10	Contaminated Wool	173.00	37.76	Non-Saleable
11	Sodlidified finishing materials wastes	86.80	7.69	Non-Saleable
12	Lime Sludge ***	18,964.00	4,484.64	Non-Saleable

* *This column represents the maximum generation i.e. if all tanneries operate on a particular day. This is not necessarily so.*

** *This column represents the actual quantities produced annually (as determined through the survey).*

*** *Lime sludge (9% solids) kgs = 1.09 kgs/l x total litres*

7.1.3 According to our study, four types of solid wastes, i.e. wool, lime flesh, leather trimmings, leather shavings are saleable, while buffing dust, stake wheel dust, insoluble sulphide residue, insoluble lime and sulphide paint residue, contaminated wool, and sludge are non-saleable wastes. Total quantities generated per year of saleable wastes are 23,084 tons (53%) while non-saleable make 20,226 tons (47%) as per Table 7.3 A.

7.1.4 The present situation is not as simple as it looks because a part of saleable wastes due to littering, is mixed with the effluent, causing choking of the drains while part of buffing dust and stake wheel dust are also mixed with shavings and sold in the market. The drains are cleaned off and on, and wastes dumped on sides of the streets to dry up with the passage of time. At a later stage such heaps of wastes are manually transferred into a tractor trolley and dumped in the open haphazardly outside the town preferably on the sides of stagnant effluent ponds, 4-5 trips are performed by the trolley per day. Thus the estimates for presently generated, reused, collected and disposed of wastes in the year 1998 are as under:

Total Generation/year (excluding sludge) is	= 24,772-10,539 = 14,233 tons
Total Reused i.e. Total generation less amount mixed in wastes estimated at 5% is	= 95% of 13,192 = 12,532 tons

7.2 Quantity of Solid Waste from Residential Sector

Besides this a portion of solid wastes is also generated by the residential area within the periphery of the tanneries clusters. With an approximate population of 50,000. Solid wastes are estimated to be 15 tons/day or 5475 tons/year. This component is Column 5 in Table 7.4.

7.3 Products made from Recyclable Wastes

Out of the total solid wastes generated, see Table 7.3 below a reasonable amount of 13,192 tons per year (53%) is sold in the market and is used to make by-products like glue, animal feed, leather board and fertiliser. Individuals and small companies making these by-products buy and lift the raw waste materials from tanneries. In this way tanneries also derive financial benefits by selling these solid wastes as raw materials to above named small and domestic scale entrepreneurs without incurring any disposal costs. Logically the saleable solid waste would not form a part of the component of the solid waste to be disposed of in the landfill, except for a minor part, estimated at 5% of the total saleables which is rejected and disposed of with other wastes. This component has been taken care in Table 7.4.

TABLE 7.3

Solid Waste Types, Generation Rates from 237 Tanneries * -

Production as at survey period

Sr. #	Types of Wastes	Generation		%	Saleable or Non Saleable
		Per day (Kg)	per year (tons)		
1	Hair. Wool	8,019	1,990	8.03	Saleable
2	Lime Flesh	35,739	9,538	38.5	Saleable
3	Leather Shavings	4,748	1,287	5.19	Saleable
4	Trimmings	1,392	376	1.52	Saleable
	Total Saleable	**49,898**	**13,192**	**53.24**	
5	Buffing Dust	420	108	0.44	Non-Saleable
6	Stake Wheel Dust	44	12	0.05	Non-Saleable
7	Sodium Chloride	2,877	7	2.82	Non-Saleable
8	Insolubel Sulphide	288	70	0.28	Non-Saleable
9	Insoluble lime & Sulphide paint residue	203	44	0.18	Non-Saleable
10	Contaminated Wool	406	89	0.36	Non-Saleable
11	Solidified finishing materials wastes	204	18	0.07	Non-Saleable
12	Lime sludge **	39,865	10,539	42.55	Non-Saleable
	Total Non Saleable	**44,307**	**11,580**	**46.76**	
	Grand Total	**94,205**	**24,772**	**100**	

* *Waste from 237 tanneries = Wastes from 101 Tanneries x 237/101 (Ref. Table 7.2)*

** *Lime sludge (9% solids) kgs = 1.08 kgs/l x total litres.*

TABLE 7.3A*
Solid Waste Types, Generation Rates from 237 Tanneries
at optimum production rates

Sr. #	Types of Wastes	Generation		
		Per day (kg)	Per year (tons)	%
1	Hair, Wool	14,033	3,482	8.03
2	Lime Flesh	62,543	16,692	38.51
3	Leather Shavings	8,309	2,252	5.19
4	Trimmings	2,436	658	1.52
	Total Saleable	**87,321**	**23,084**	**53.25**
5	Buffing Dust	735	189	0.44
6	Stake Wheel Dust	77	21	0.05
7	Sodium Chloride	5,035	1,225	2.82
8	Insoluble Sulphide	504	123	0.28
9	Insoluble lime & sulphide paint residue	355	77	0.18
10	Contaminated Wool	711	156	0.36
11	Solidified finishing materials wastes	357	32	0.07
12	Lime Sludge	69,764	18,443	42.54
	Total Non-Saleable	**77,538**	**20,266**	**46.75**
	Grand Total	**164,859**	**43,351**	**100**

* *Quantities obtained by multiplying contents of Table 7.3 by 1.75*

7.4 Future Projections of Generation, Collection, Reuse and Disposal Rates

Due to extensive environmental pollution problems, the present policy of the government does not allow any new tannery to be set up in Kasur. May be as and when the anti pollution laws are strictly enforced, some additional capacity can be created say after about five years. Considering only a moderate increase in number and capacity of the present tanneries, the total generation of solid wastes will proportionately increase with the passage of time. Future trends in recycling will match with the activities of collection and disposal rates. Keeping this in view, reasonable estimates have been made to quantify the capacity requirements for collection and disposal of solid wastes. According to a conservative estimate increase in generation rate is about 5% per annum, and reusing activities will increase at the same rate. Working on a collection rate of 80% of net generation and that 90% of all of such wastes which get collected are expected to reach the

landfill site Table 7.4 lists these estimates up to the year 2010, taking daily and yearly generation rate from Table 7.3. A.

Table No. 7.4
Future projection of Generation, Collection, Reuse and Disposal Rates

Year	Generation per day Tons	Gross Generation Per year Tons	Residential Wastes Per Year Tons	* Recycled Per year Tons	Net ** Generation Per Year Tons	*** Collection Per Year Tons	Disposal **** Per Year		Cumulative Landfill Disposal m^3
							Tons	m^3	
1	2	3	4	5	6	7	8	9	10
1999	164.8	43351	4500	21932	25919	5184	4665	3430	3430
2000	164.8	43351	4545	21932	25964	7789	7010	5155	8585
2001	164.8	43351	4590	21932	26009	10403	9363	6885	15470
2002	164.8	43351	4636	21932	26055	15633	14070	10345	25815
2003	164.8	43351	4682	21932	26101	20881	18793	13818	39633
2004	173.0	45519	4729	23026	27222	21778	19600	14412	54045
2005	181.7	47794	4777	24177	28394	22715	20444	15032	69077
2006	190.8	50184	4825	25387	29622	23698	21328	15682	84759
2007	200.3	52693	4873	26656	30910	24728	22255	16364	101123
2008	210.3	55328	5360	27989	32699	26159	23543	17311	118434
2009	220.8	58094	5414	29388	34120	27296	24566	18063	136497
2010	231.9	60999	5467	30858	36608	28486	25638	18851	155348

* *95% of Saleables*
** *Net Generation = Gross Generation + Residential Component - Recycled*
*** *Maximum 80% of net generation*
**** *Maximum 90% of collection*

7.5 An Explanatory Note to Table 7.4

- Estimates of Solid Wastes Generation, collection, disposal and cumulative disposal up to the year 2010 are tabulated in Table No. 7.4.

- Gross generation estimates pa indicates that up to the year 2003 solid waste generation will remain constant thereafter, an increase of 5% per annum is expected. This is related to the expected increase in tanning units or their capacity from the year 2003 onwards.

- Solid waste collection rate per year at the start of project will be around 20% and reach its maximum i.e. 80% by the year 2003.

- Solid waste, which is expected to reach the landfill site is estimated at 90% pa. as of that collected.

- The cumulative waste disposal volume by the year 2010 is thus estimated to be 155,348 m^3.

7.6 Composition of Solid Wastes from Tanneries

Tannery solid wastes in Kasur include, untanned trimmings, fleshing, hair, salt, wet blue trimmings, shavings, buffing dust, finished leather trimmings, empty chemical sacks, containers and usual office wastes.

7.7 Present Storage, Collection and Disposal Practices

As in other areas of the country, the practices for storage, collection and disposal of solid wastes in Kasur are also haphazard. Municipal solid wastes are thrown on to the streets. Sweepers sweep all such wastes along with street litterings and shift them to storage points in the form of open heaps along wider streets. These storage points are then served almost daily by the tractor trolleys, used as collection vehicles. The collection vehicles transfer these wastes to open dumps around the city.

Tannery wastes are mostly used as raw materials for manufacture of different by-products like glue, animal feed, leather board and fertiliser. The portion of solid waste that is not sold is discharged with effluent into street channels/open drains. These channels/open drains usually get choked due to this practice. The cleanings are stacked to dry on the sides of the channels/drains. This dried material is the only waste collected and presently transported to the open dumps located haphazardly around the city. A part of these wastes may also be used as filling material in newly developing residential plots through mutual arrangements between the collection crew and the landowner.

One tractor trolley manually loaded and unloaded takes care of the solid wastes with 4-5 trips/day. It is being managed by KTA. The amounts of wastes being handled at various stages of generation, collection, reuse and disposal have already been given in paras 7.1 and 7.2.

7.8 Proposed Storage and Collection System

As shown in Table 7.3 above the solid wastes from tanneries may be categorised as:

i) saleable and
ii) non - saleable

Saleable are leather trimmings, fleshings, wool, and leather shavings, which are sold in the market and as such they do not pose any problems for storage in a specific manner for collection and disposal except for a minor portion which is rejected by the recycling industry as well as littered during handling. Non-saleable are part of dusts, and mostly sludge produced from the liming process and spent sodium chloride, lime sulphide paint residue and contaminated wool plus any other disposable waste which needs to be stored in containers (plastic drums) located near the tannery entrance. This will make it convenient for the collection crews of KTA or Municipal Corporation to perform efficiently. Provision of such containers for storage will be the responsibility of the tanners.

7.9 Collection of Solid Wastes

Collection vehicles, which may be used for solid waste component from tanneries as well as residences within the industrial clusters are tipping type tractor trolleys of smaller width and if possible, with mechanical or semi-mechanised loading arrangements. The vehicles to be used are manufactured locally and are presently being employed in walled city area of Lahore (photo in Annex 9). The total number of such tractor trolleys required for collection is shown in Annex 12.

7.9.1 Routing for Removal of Solid Wastes

A map had been prepared by KTWMA in which 237 tanneries, large, medium and small had been identified. Unfortunately the key linking tannery registration number to the individual tannery itself was lost in manuscript form (which was the only copy). This map indicates tannery locations and is at Annex 8. The main routes have been shaded yellow for movement of solid wastes to the landfill site. The width of various roads has been indicated on the map. Because it is not possible for normal sized tractor/trolley combinations to negotiate some of the narrow lanes, small tractor trolleys will be employed. Such tractor trolleys are manufactured locally and are currently in use in the walled city area of Lahore. Refer to photographs at Annex 9. In Kasur the main roads to be used will be Mangal Mandi, covering Dingarh, Mushtaq Nagar, Yunus Nagar and Niaz Nagar. Maulvi A. Qadir and Bakkar Mandi Roads will cater to Dingarh, Kot Maulvi A. Qadir and Niaz Nagar. In addition the road parallel to Rohi Nallah in its northerly sector will link with Dingarh Road. The eastern sector of Niaz Nagar will be taken care of by Barat Shah Road and moving southwards from its junction with the District Complex then moving south on the Ganda Singh Wala Road to the proposed landfill site.

Average round-trip distance travelled by tractor trolleys is estimated to be 12 km. With 4 trips it makes 48 km/vehicle. POL costs have been included in Table 7.

7.10 Collection of Tanneries Sludge

The sludge from effluent will be obtained at two stages. One part will be collected with the help of tanker truck fitted with sludge pump to be sucked up from the man holes in the effluent channel/sedimentation tanks in the tanneries and then transported to sludge drying lagoons. Two different sizes of tanker trucks are to be used for this purpose. One with 5900 litre tank (already bought) for wide streets and the other with 2000 litre tank yet to be bought. The dried sludge will also be collected from the Sludge Drying Lagoons with Common Effluent Primary Treatment Plant (CEPTP) to be installed close to the proposed landfill site. The overall quantity of sludge is estimated at 69764 kg dry wt in 717760 litres wet volume per day as derived from Table 7.3A.

Assuming 8% is recovered using sludge pumps from the sedimentation tanks/effluent channels, then the requirement for sludge tankers fitted with sludge pumps is shown in Annex 12 para 1.2.

7.11 Disposal of Tannery Solid Wastes-Alternate Disposal Methods

There are three alternatives, most widely used, to dispose of solid wastes. Selection of the appropriate disposal method depends largely upon the characteristics of solid wastes besides other factors including economics. The three disposal methods alongwith some selection criteria are as under:

7.11.1 Composting

In this method the biodegradable component of solid wastes is converted to compost, which is used as a land conditioner. The non-biodegradable component would yet need to be disposed of in a sanitary landfill. Composting will be adopted, if the solid wastes contain a large biodegradable component (more than 60%), and the product is marketable

7.11.2 Incineration

This method involves the burning of combustible components of solid wastes under controlled conditions. Ashes and residue are about 5-15% of the total solid wastes, which are disposed of in a sanitary landfill. Incineration will be the choice, when wastes contain a high combustible component with low moisture content. Combustion can be self-sustained by the wastes. However, air pollution control costs must be considered. Further, incineration has a tendency to convert chrome wastes to the carcinogenic variety.

7.11.3 Sanitary Landfilling

This method involves the spreading of solid wastes on land in thin layers, compacting and covering with soil after reaching the required height. All types of

solid wastes can be disposed of by this method. Selection of sanitary landfilling is subject to the various factors including the availability of adequate land area at a competitive price and reasonably close to the collection centres to minimise transportation costs. It must also be ensured that there are no significant environmental hazards that may be associated with the process in adjoining areas, considering wind direction and wind speed to avoid offensive odour, which is a nuisance to the general public.

7.12 Selection of Disposal Method

For disposing of solid wastes from tanneries in Kasur, sanitary landfilling method is the best choice due to the following reasons.

Composting process is not applicable in this case as tannery solid wastes contain hazardous and toxic chemicals, such as chromium and various forms of sodium salts, which not only damage the soil, but also can also contaminate food crops and create health hazards, through food chain.

Incineration is also not feasible, as the burning of parts of skins and hides produces smoke and obnoxious odour, and the moisture content is also very high in such wastes.

Sanitary landfill method thus proves to be the best option, discarding the other two waste disposal methods, i.e. composting and incineration. It is also noteworthy sanitary landfilling conforms to the selection criteria, such as availability of land area, reasonable distance from collecting centres, reasonable cost of land, and other related environmental considerations.

7.13 Sanitary Landfill - the Selected Disposal Method

Besides, the selection criteria, details about the site selected such as description of the site, engineering design, and operation plan and management or organisational set up/equipment and manpower requirements with capital and operational costs are given in the following sections.

7.13.1 Selection Criteria and Description of the Selected Site.

The main features which play important part in selection of the site are; sufficient land area, haul distance from the service area, cost of land, and environmental considerations, like wind direction, surfice hydrology, ground water pollution, ground water table depth and ultimate use etc. The site for sanitary land fill has already been selected by the authorities and it conforms to the above mentioned selection critaria.

As shown in Fig 1, the selected landfill site is along the abandoned Ganda Singh Wala railway track, which starts from Dipalpur road on its northern end. Just

after Dipalpur Road, CEPTP will be constructed, which will be followed by sludge drying beds. And after the sludge drying beds a strip of about 1500 meters has been allocated for the landfill. The site is 80 meters wide (60 meters of railways + 20 meters acquired) and 1500 meters long and extends towards Maan village about 2 km away. The filling can be started from the northern end, across the old bridge proceeding southwards. The flood level record is believed to have not exceeded the present abandoned railway track height (maximum 2 meters). This means that access road may be constructed maintaining this level. The soil of the track will be shifted to be used to build access road as shown in Figs 2 and 3

7.13.2 Additional Sanitary Landfill Site

A strip of about 80 meters width with a length of more than 3 km is also available along Kasur–Patti abandoned railway track. This is at an average distance of about 4.5 km from the city. This site may have to be considered after the proposed landfill site gets filled up. It is also indicated in location map (Fig 1).

7.14 Engineering Design of Sanitary Landfill

7.14.1 Access and Service Roads

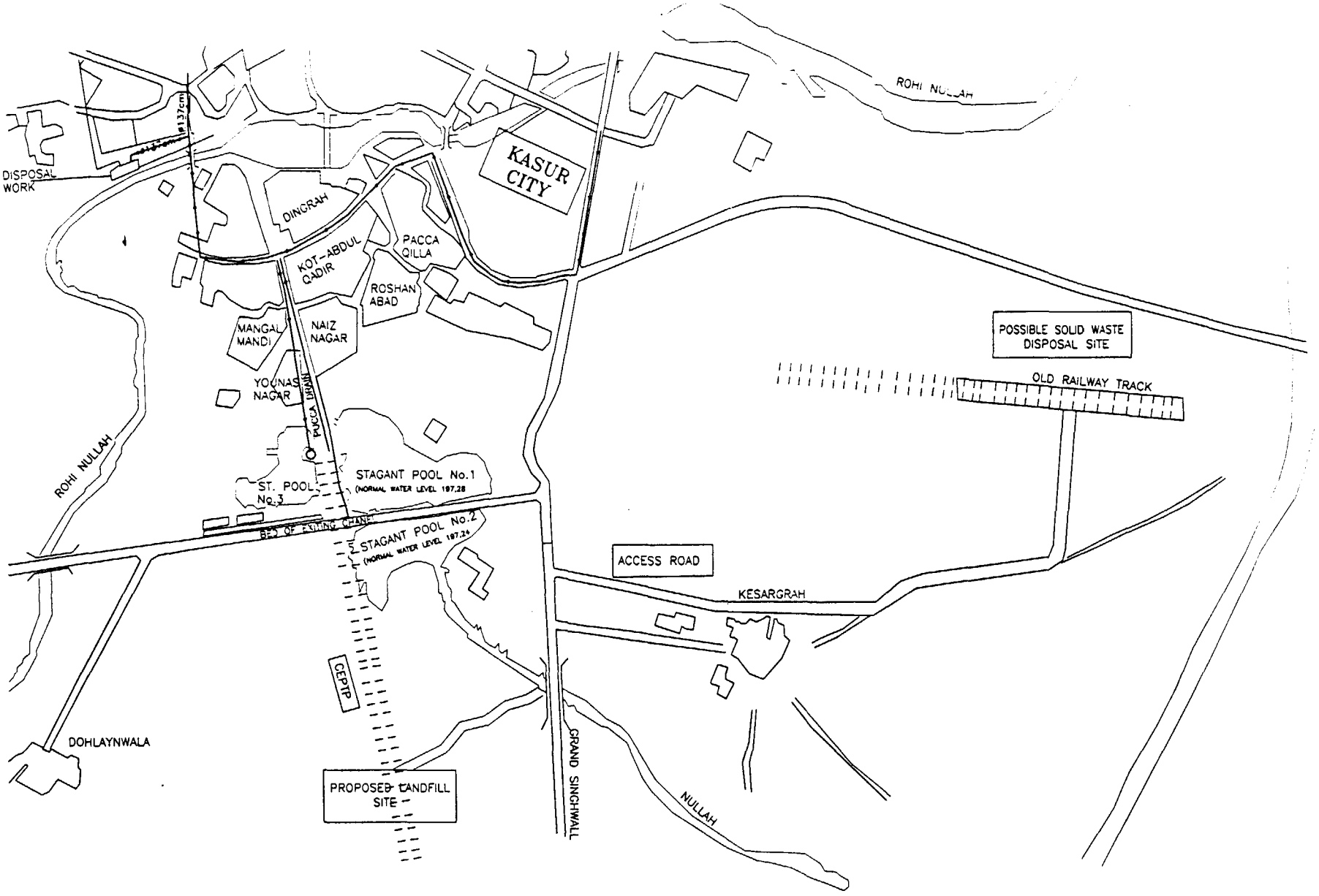
There are two possible approaches to the landfill site.

a) From Dipalpur Road, parallel to the abandoned railway track along the wastewater treatment plant and sludge drying beds

   In this option access road is 7 meters wide (3.6 meter metalled and the rest unpaved shoulders) from Dipalpur road to the end of sludge drying lagoons which makes a length of about 1600 meters besides construction of 30 meter long and 4.5 meter wide bridge on Nallah and 800 meter length of service road along the sanitary landfill.

b) From Ganda Singh Wala road (Fig 1) approaching directly to landfill site at the centre of it, which makes the access road length of one kilometer besides service road on one side of the site with length of about 800 meters according to the requirement. Land needs to be acquired for the excess road of one km length

   The preferred option is that from Dipalpur road, as it meets the requirements of the CEPTP and sludge drying beds also along with the requirements of the sanitary landfill. However it needs the construction of a bridge in place of the damaged one. Also the additional strip of land is already acquired by the authorities in this case.



PROPOSED LANDFILL SITE

FIG - 1

EMMAY ASSOCIATES (PVT) LTD.

7.14.2 Landfill Configuration

According to the availability of strip of land about 80 meters wide, 50 meter on one side and 30 meters on the other side of the abandoned railway track, the proposed landfill site section, and plan are shown in Figs 2 and 3. This has the access road 7 meters wide on one side and earthen embankment of 2 meters width on other three sides of the fill. The heights of both the road and earthen embankment are kept 2 meters above the natural ground level for flood protection. The abandoned railway track will be removed and its soil used to construct the access road.

Fig 2 shows the landfill will be accommodating the waste up to a level of 1.8 meters on the sides and 4.3 meters at the centre, which includes the scraping of ground surface up to depth of 0.3 meters.

7.14.3 Landfilling Method

As the ground water table depth ranges between 6-9 meters round the year, and the boring logs, (as per P. Rantala's report) show a good clay layer existing right from the ground level to a depth of about 1.3 meters ground level may be beneficially used as the sanitary landfill bottom without any additional treatment. The soil of the abandoned railway track can be utilized for access road as well as earthen embankment on one side. So that the wastes are unloaded and spread in thin layers on the surface off ground. Each layer is compacted as the filling progresses until the thickness of the compacted waste reaches the designed height (4.3 meters at the centre and 1.8 meters on the sides). In this method, normally at the end of day's work soil cover is provided, both at the top and at slopes. But as this is a costly option, in Kasur sanitary landfill only cover of about 0.5 meter thick clay and 0.5 meter normal soil will be provided. The arrangements are shown in Fig 2.

Quantities and cost estimates are given in Tables 7.5 and 7.6.

7.14.4 Landfill Cover

The landfill is to be provided with adequate cover to prevent penetration of rainfall as well as plantation of grass for grazing by sheep and goats after completion. A clay liner about 0.5 meters thick will be provided as impermeable liner and 0.5 meters thick soil cover will be provided at the top for plantation of grass. The arrangement is shown in Fig 2.

7.14.5 Capacity and Land Requirement

The capacity and land requirement for the sanitary landfill are calculated in Annex 12 para 3. The land required up to the year 2010 is 6.4 hectares which includes 1.6 hectares of acquired land.

PROPOSED SANITARY LANDFILL SECTION

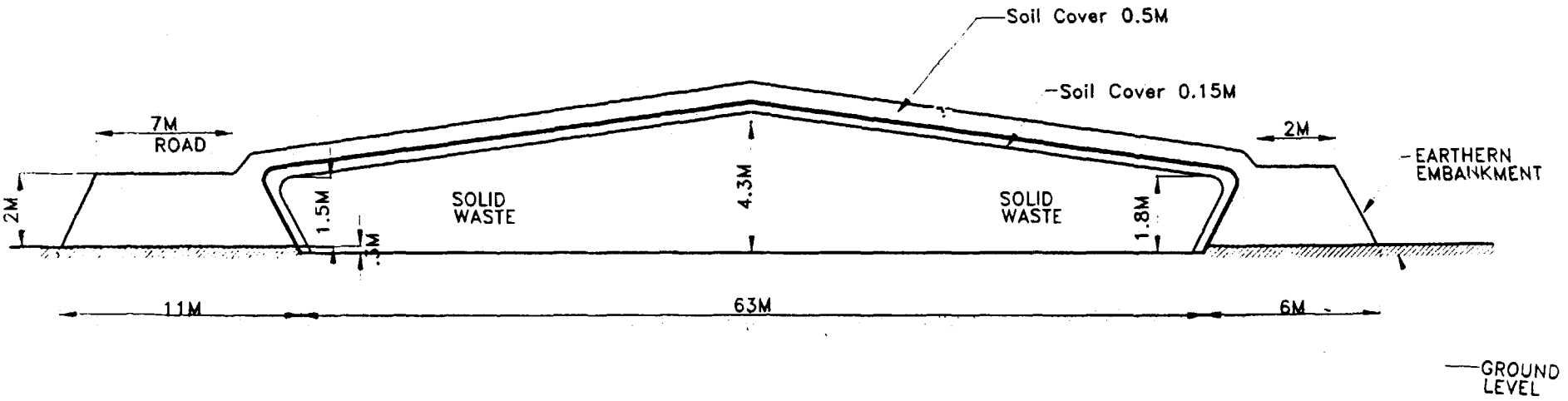


FIG. 2

7.14.6 Gas Movement and Control

While filling the solid wastes in the sanitary landfill it will be left open for some time to dry. This will reduce the moisture content considerably. Further as the filling proceeds, the solid waste will compact to from 1 ton/ m^3 to 1.36 ton/m^3 as is happening in the present open dump site. The evaporation and natural climatological conditions will also enhance the compaction. The evaporation rate of 1530 mm/year in Kasur far exceeds the precipitation rate of 396 mm/year (P.Rantala 1997). This will enable drying of all rainwater and further drying the wastes.

Due to these conditions, very minor amounts of landfill gases will be released, which will easily escape the wastes and soil cover. Therefore, there is no need for providing gas vents.

7.14.7 Leachate Problem

As noted in the preceding paragraph under heading of "Gas Movement and Control" the sanitary landfill will have sufficiently dried solid wastes, compacted to a density of more than 1 ton/m^3. Further seepage of rainwater will be reduced to the minimum by impermeable clay liner (0.5m thick) and vegetation on the top soil with a reasonable grade provided for diverting the rainwater to the adjoining fertile land. With such a scenario it is expected that there will be no problem of leachate production and its penetration into the ground water.

The top soil strata under the landfill is also rich in clay, which is already compacted and will not let the small amount of leachate, if produced, enter the ground water which is at depth of 6-9 meters depending on seasonal variations. The production of leachate due to floodwater is checked by providing earthen embankment with a height of 2 meters and slope 1:1.

7.14.8 Drainage Facilities

Slope of the top of the landfill is maintained such that the rainwater will be directed towards the sides, and will seep into the soil without causing any problem to the landfill.

7.14.9 Office and Ancillary Facilities

For proper operation, site office with facilities of water, lighting and washrooms needs to be provided, according to the needs of the site staff. A garage for bulldozer/tractor with suitable blades is also to be provided.

7.14.10 Ultimate Use

The completed land fill can be used for grazing sheep and goats.

7.15 Site Preparation and Operation Plan for Sanitary Landfill

Following steps will be taken in site preparation and operation plan for the proposed sanitary landfill.

7.15.1 Scraping of soil and leveling the Ground surface.

About 30 cm soil needs to be scraped on an average from the top of the landfill site to use it for building the earthen embankment around the site and the access road on one side. After scraping the surface of landfill site will be levelled before landfilling operation is taken up. The soil of the abandoned sanitary tract will also be removed to be used to build access road.

7.15.2 Access Road, Flood Protection Embankment

Flood levels in the area do not normally exceed the present level of the abandoned railway track, which is about 2 meters higher than normal ground level. So this level will be obtained for the access road and earhten embankment on all the four sides of the site as shown in Figs 2 and 3. The additional site required for the purpose will be obtained from other nearby areas.

7.15.3 Filling Operation

The filling operation will start from the end near the sludge drying lagoons. The wastes will be unloaded near the working face and will be compacted in place in thin layers by the bulldozer or alternately by compactor and front end scraper with a farm tractor, until the thickness of the compacted waste reaches the designed height 4.3 meters at the centre and 1.8 meters on the sides.

7.15.4 Landfill Cover

There is no need for providing daily soil cover. This is because the quantities received daily are in small amounts and provision of daily cover on the face is a costly option. Only final cover will be provided. It may be provided on weekly basis.

7.15.5 Drainage

There is no need to construct any drainage channels as the fields on the side of the landfill site are cultivated and can easily absorb the rainfall.

SANITARY LANDFILL PLAN

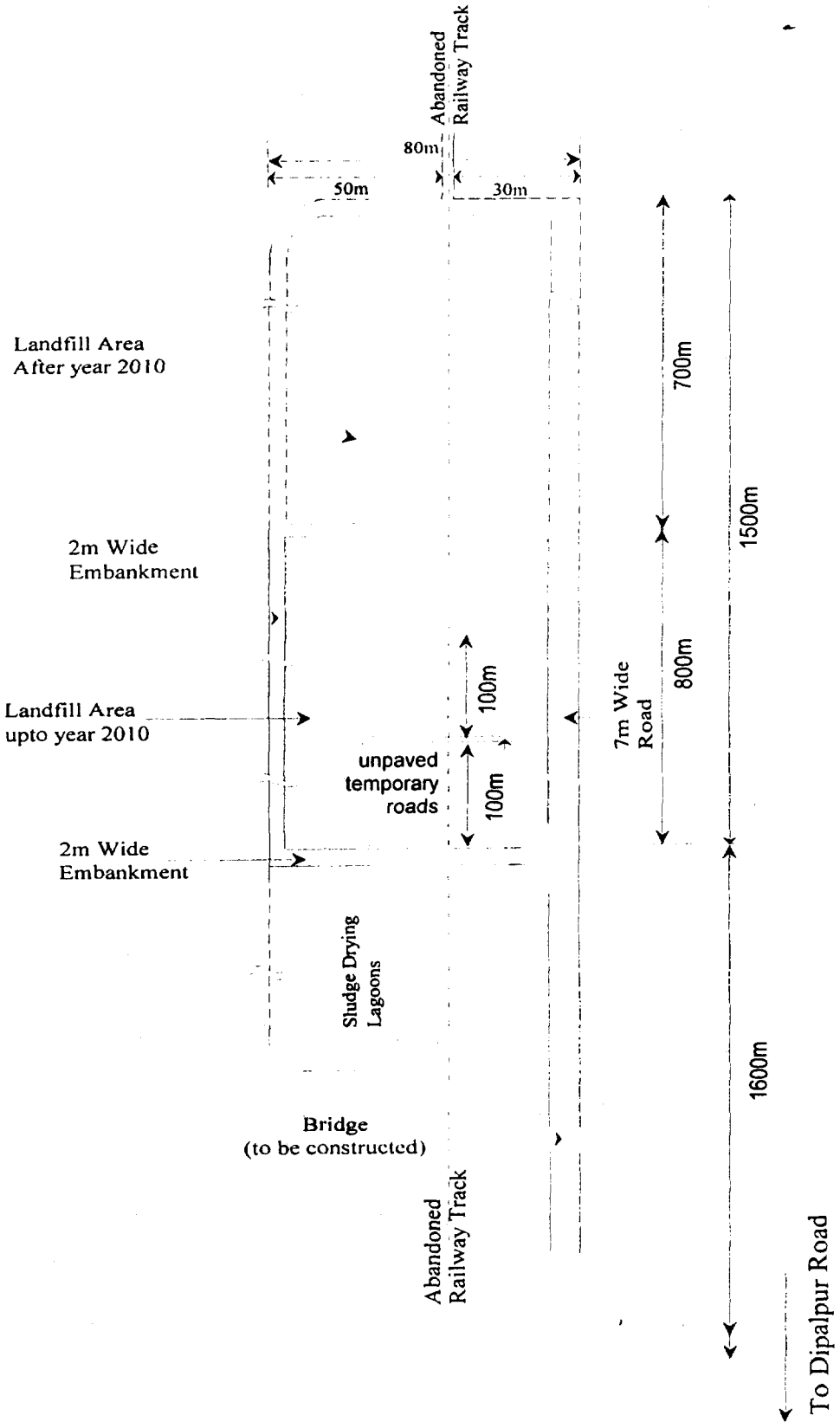


Figure 3

7.15.6 General Precautions during Landfill Operation

- Access to the site must be controlled to keep unauthorised persons out.
- Burning of wastes at landfill site is to be prohibited.
- Blown paper, polythene bags shall be controlled by providing portable fence near the working face.
- Salvaging and scavenging shall not be allowed at working face.
- Measures will be adopted to ensure that there is no pollution of surface or ground water.
- Operational log sheets including recording total amounts of solid wastes received shall be maintained.

Fig 4 indicates schematically filling in progress at the landfill site.

7.16 Physical Requirements (Vehicle, Materials, Manpower) & Cost Estimates

Taking 12 years (i.e. from 1999 to 2010) as the plan period the physical requirements in terms of staff, vehicles, equipment, have been worked out considering future trends. Total number of vehicles, quantities of civil works and land etc. are worked out in Annex 12 and tabulated in Table 7.5. The manpower requirements are given in Table 7.6

Bulldozer with dozer blade, landfill blade and front end loader bucket with a capacity of $2m^3$ is sufficient for spreading compacting and covering the land filled wastes. Manpower requirements are one dozer operator, and one part-time supervisor, and a watchman-cum-helper, at the landfill site.

This section also includes the system costs, capital cost estimates, unit costs and annual operation and maintenance cost estimates. These costs are worked out in Tables 7.5 and 7.6. The total capital and annual cost is estimated to be Rs. 27,050,000 and Rs. 3,281,000 respectively with clay liner (Table 7.5) in sanitary landfill cover.

FILLING IN PROGRESS

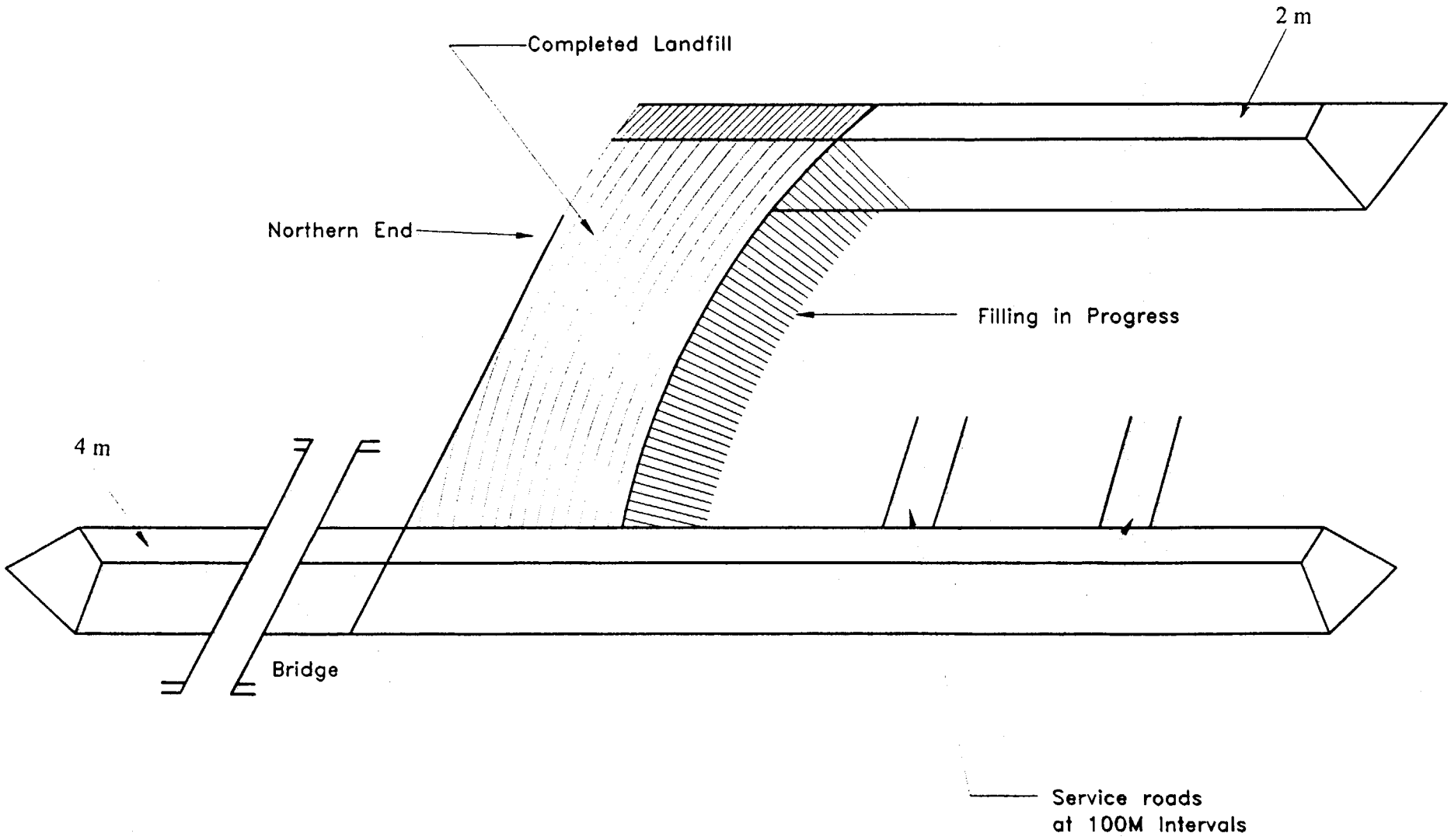


FIG - 4

TABLE 7.5
VEHICLES, CIVIL WORKS, LAND REQUIREMENT AND COSTS

Sr #	EQUIPMENT LAND MATERIAL	CAPACITY/ SIZE (m^3)	EX-PECTED LIFE (YEARS)	NO QTY	UNIT	CAPITAL COST (Rs)		ANNUAL COST (Rs)			
						PER UNIT	TOTAL	DEPRE-CIATION	REPAIR/ MAINTE-NANCE	POL	TOTAL
1	Bulldozer	Medium	15	1	Nos	Purchased		233,000	175,000	60,000	468,000
2	Sludge Tankers	5.9	15	1	Nos	2,400,000	2,400,000	160,000	120,000	60,000	340,000
		5.9	15	1	Nos	Purchased		160,000	120,000	60,000	340,000
		2.0	15	3	Nos	1,200,000	3,600,000	240,000	180,000	75,000	465,000
3	Tractor Trolleys	4	15	6	Nos	600,000	3,600,000	240,000	180,000	360,000	780,000
4	Road Bridge		60	1	Nos	2,500,000	2,500,000	42,000	50,000	-	92,000
5	Road		6	2400	m	1,500	3,600,000	600,000	72,000	-	672,000
6	Site Office		50	1	No	250,000	250,000	5,000	5,000	-	10,000
7	Soil for cover, embankment and road sub base			57000	m^3	100	5,700,000	-	114,000	-	114,000
8	Land (state - acquired)			5.6	Hec-Tares	Already Obtained		-	-	-	-
9	Clay Liner			26800	m^3	200	5,360,000	-	-	-	-
						Total	27,050,000			Total	3,281,000

TABLE 7.6
Annual Staff Salaries

Sr. #	Position	Vacancies	Salary PM Rupees	Salary PA Rupees
1	Supervisor for collection & disposal	2	6,000	144,000
2	Driver (Bulldozer)	1	5000	60,000
3	Drivers (Tankers & trolleys)	11	3,500	462,000
4	Coolies/Loader/Helper	18	3,000	648,000
			Total	1,.314,000

7.17 Cost Recovery for Service, Unit Cost

In Table 7.5 the element of annual depreciation, POL and other costs adds up to Rs. 3,281,000 taking maintenance costs of 5% annually. In Table 7.6 the element of staff salaries adds up to Rs. 1,314,000 pa.

The total is given below:

	Rupees
Depreciation, POL & Other Costs	3,281,000
Staff Salaries/Year	1,314,000
Total	4,595,000

In order to arrive at an apportionment tannery wise the Consultant suggests the basis be that of installed drums. The estimates are give below in Table 7.7:

TABLE 7.7
Drums Installed in Tanneries

Tannery Size	No. of Tanneries	Avg. No. of Drums	Total Drums
Large	21	9	189
Medium	89	4	356
Small	127	1	127
Total	**237**		**672**

Unit Cost

Cost recovery/Drum = 4,595,000/672 = Rs. 6,830 per year
= Rs. 569 per month.

The monthly collection fee arrived at may initially provide an element of subsidy, if the Tanners Association weight the fee in favour of small tanners, even though they do go in for wet blue or vegetable tanning yet may not have other equipment/ machinery barring drums and pits.

The fee per drum would work out to Rs. 6,830 pa or Rs. 569 per month. This indicates that a practicable solution can be found. A good approach would be to target the drums in large and medium tanneries amounting to 545 or over 80% of the total, in the first instance.

Since the administration is well seized of the problem, the Project Director in his capacity of Deputy Commissioner Kasur would be a key player in the success of this endeavour.

7.18 Management for Collection and Disposal

Solid Waste management services may be rendered by KTWMA, by contractor or by private companies individually engaged by the different communities and tanneries.

In case of a contract, only the proper contract mechanism, complete with appropriate operating standards instructions to bidders, and bidders qualification offers the assurance, the KTWMA will need, when relinquishing this vital service to the contractors. Well planned, sophisticated and equitable contract documents must be designed in order to protect the mutual interests of both the communities by the contractor. The vehicles to be purchased under the project can be leased out to facilitate a good operational start for the waste collection and disposal system. Such vehicles should be transferred with ownership to the leaseholders at the termination of the lease. The lease period may be 5 to 8 years. This will be helpful to guarantee a proper maintenance of the equipment during the lease period. However the consultant is of the view in the first instance the involvement of KTWMA and the Tanneries Associations would provide a good beginning.

EPILOGUE

The Consultant was responsible for and accomplished the following:

Collected data on types, characteristics and quantities of wastes produced by tanneries in Kasur. A survey of 101 tanneries, against a requirement of 78 was made and results worked out for a total of 237 tanneries both at time of survey and at optimum production.

Estimating solid wastes through an assessment of volume/weight ratios and projecting the same up to 2010.

Cleaner technologies have been considered, however good housekeeping comes first hence the consultant has given their assessment on this aspect also. Health and environment along with PEPO (1997) has been considered and its implications with reference to solid waste management. Included are the impact and mitigating factors brought about by the solid waste management programme.

Equipment for solid waste handling, its transportation and its volumes have been worked out to estimate landfill area required up till 2010 providing for a 5% increase in tanning activities from 2003 onwards. Sludge removal, using sludge pumps has been recommended which will be sent to a drying bed before being compacted in the landfill.

A master plan is presented including routing. Considering the narrow streets, the need for locally made narrow materials handling equipment (photographs included) are required.

Access road to landfill, the quantities of soil and clay required have been computed and a line plan and cross section of the landfill has been given.

Saleable wastes (by products) have been identified and quantified with indications of their downstream usage.

The estimates of costs, capital and operational have been worked out. Alternate modes of management have been defined. Using the number of drums as a basis a collection fee has been arrived at amounting to Rs. 569.00 per drum. The numbers of drums involved are 672 of which large and medium tanneries account for 545. In co-operation with the Tanners Association the Consultant feels a practicable solution for levying a fee can be arrived at. The small or domestic tanners should be targeted later.

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ANNEXES

Annexes

Annex 1

Date:_____

SURVEY PROFORMA ON TANNERIES
KASUR TANNERY SOLID WASTE MANAGEMENT PROJECT

1 Name and address of the tannery *

Phone/Fax:

2 Contact person and Designation:

3 Category of Industry: Large/Medium/Small (Domestic)

4 Type of Production Activity Tanning/Training-Finishing/Finishing

5 Number of shifts per day

6 Working days/year

7 Production capacity/day

a) Type of raw material processed

Raw:
Hides (Pcs/Kgs)
Skins (Pcs/Kgs)

Wet Blue:
Hides (Pcs/Sft)
Skins (Pcs/Sft)
Skins (Pcs/Sft)

b) Average Number of Drums (Beamhouse) per week
Goat

Other (Specify)

* Please indicate Tannery Registration Map Number, if applicable

SURVEY PROFORMA ON TANNERIES

KASUR TANNERY SOLID WASTE MANAGEMENT PROJECT

8 Solid wastes generated per day:

Type:	Quantity Kg	Type	Quantity Kg
I Hair, lime, organic matter			
II Lime fleshings			
III Lime trimmings			
IV Shavings			
V Buffing Dust			
VI Trimmings (finished)			
VII Any other (Specify)			

9 Solid wastes disposal mode:

a) Just thrown away (where, please specify)

b) Sold

Name of the buyer with address	**Name of the solid waste**	**Quantity/day Kg**	**End use**

SURVEY PROFORMA ON TANNERIES

KASUR TANNERY SOLID WASTE MANAGEMENT PROJECT

10 Expected increase in production during the next:

Period	Percentage
1 Year =	
2 Year =	
5 Year =	
10 Year =	
By the year 2010 =	

11 **Chrome recovery:**

- Is there any chrome recovery system: Yes/No
- If yes, recovery and reuse done
- If not, do you welcome provision of recovery system at your works Yes/No

12 Chemicals and quantity used per day

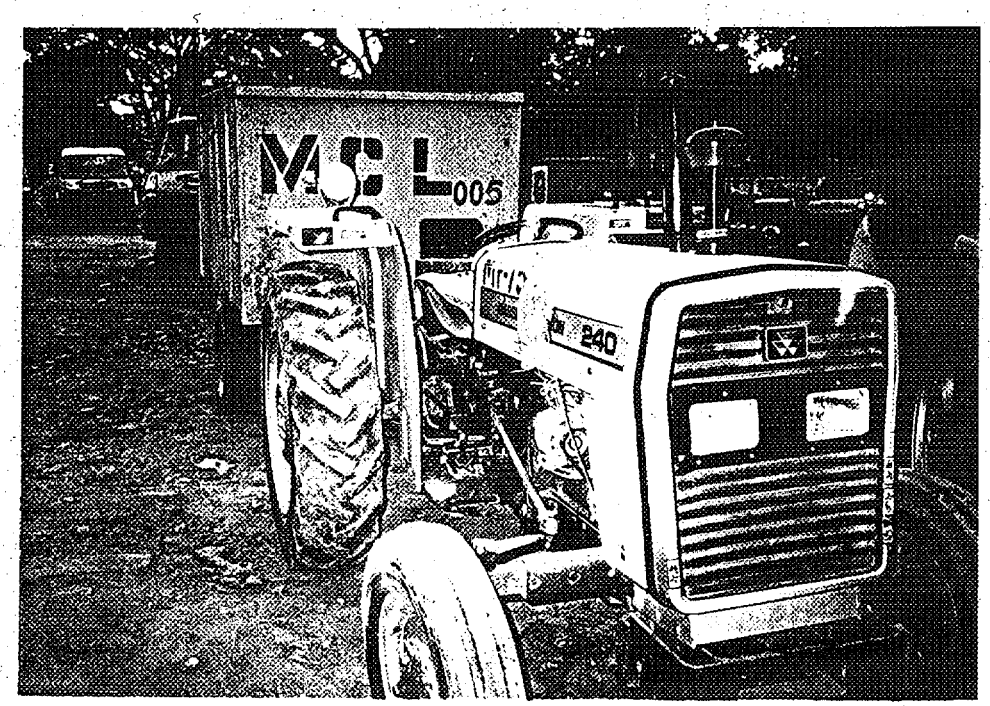
	Name of the Chemical used	Kgs	Name of Chemical	Kgs
I	Sodium sulphide			
II	Lime			
III	Sodium Chloride			
IV	Sulphuric Acid			
V	Dichromate/Basic Chromium Sulphate			

SURVEY PROFORMA ON TANNERIES

KASUR TANNERY SOLID WASTE MANAGEMENT PROJECT

VI	Bating Chemicals	
VII	Ammonium Sulphate	
VIII	Dyes	
IX	Fat Liquors	
X	Finishing Polymers	
XI	Buffering Chemicals	
XII	Others (specify)	
13	Do you have a water meter:	Yes/No
	If yes, water consumption/day	gallons

Signatures of the Factory Owner/Representative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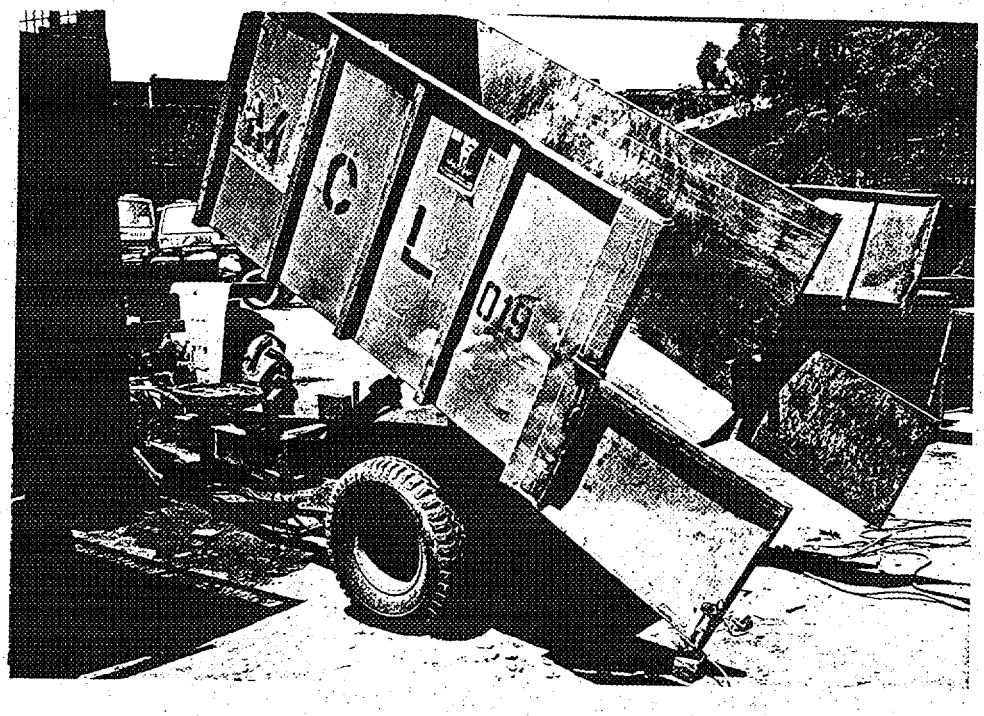
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Annex 3

SUMMARY OF THE WASTE GENERATED BY WEIGHT AND VOLUME

WASTE GENERATED, KGS

TANNERIES SURVEYED		MONTHLY							YEARLY						
		HAIR	LIME SLUDGE	LIME FLESHING	SHAVINGS	BUFFING DUST	TRIMMING	CHUKRAM DUST	HAIR	LIME SLUDGE (L)	LIME FLESHING	SHAVINGS	BUFFING DUST	TRIMMINGS	CHUKRAM DUST
LARGE	9	14,360.00	1,469,520.00	147,835.00	16,080.00	373.00	1,755.00	30.00	165,692.31	16,214,686.27	1,640,365.38	181,707.69	4,137.12	19,528.85	259.62
MEDIUM	38	64,600.00	2,182,099.00	178,755.00	18,359.00	1,674.00	5,583.00	413.00	616,065.38	22,213,882.98	1,848,994.23	182,699.04	17,267.31	58,371.15	4,352.12
SMALL	54	9,760.00	886,110.60	68,825.00	18,096.00	2,598.00	8,059.00	46.00	64,907.69	7,709,756.21	569,505.77	183,272.31	24,579.04	82,250.77	286.54
TOTAL	101	88,720.00	4,537,729.60	395,415.00	52,535.00	4,645.00	15,397.00	489.00	846,665.38	46,138,325.46	4,058,865.38	547,679.04	45,983.47	160,150.77	4,898.28

VOLUME OF WASTE GENERATED, (m3)

TANNERIES SURVEYED		MONTHLY							YEARLY						
		HAIR	LIME SLUDGE	LIME FLESHING	SHAVINGS	BUFFING DUST	TRIMMING	CHUKRAM DUST	HAIR	LIME SLUDGE (L)	LIME FLESHING	SHAVINGS	BUFFING DUST	TRIMMINGS	CHUKRAM DUST
LARGE	9	157.96	1,359.30	162.62	94.34	3.65	6.18	0.19	1,822.62	14,998.58	1,804.40	1,066.08	40.45	68.74	1.68
MEDIUM	38	710.60	2,018.44	196.63	107.71	16.37	19.65	2.67	6,776.72	20,547.84	2,033.89	1,071.90	168.84	205.45	28.16
SMALL	54	107.36	819.65	75.71	106.17	25.40	28.37	0.30	713.98	7,131.52	626.46	1,075.26	240.33	289.52	1.85
TOTAL	101	975.92	4,197.39	434.96	308.22	45.42	54.20	3.16	9,313.32	42,677.94	4,464.75	3,213.24	449.62	563.71	31.69

QUANTITY AND QUALITY OF TANNERY SOLID WASTES ACCORDING TO SURVEY

I	Total No of Tanneries Surveyed		=	101
II	Categorisation of 101 Tanneries (according to installed drum capacity)	Large	=	09
		Medium	=	38
		Small	=	54

III	Segregation of solid waste produced			Qty/day (kgs)
		Hair/Wool	=	3412.31
		Lime Sludge	=	174528.05 (litres) (16964 Kgs Solids)
		Lime Flesh	=	15208.21
		Shavings	=	2020.58
		Buffing dust	=	178.65
		Trimmings	=	592.19
		Chukram Dust	=	18.81

IV Solid Waste	Saleable kgs/day	Non Saleable kgs/day
Hair Wool	3412.31	-
Lime Sludge	-	174528.05 (litres) (16964 kgs solids)*
Lime Flesh	15208.27	-
Leather Shavings	2020.58	-
Buffing Dust	-	178.65
Trimmings	592.19	-
Chukram Dust	-	18.81

* *Lime Sludge (9% solids) in kgs = 1.08 kgs / litre x no of litres)*

QUANTITY AND QUALITY OF TANNERY SOLID WASTES FOR 237 TANNERIES

I Total No of Tanneries in Kasur = 237

II Categorisation of 237 Tanneries on the basis of 101 tanneries surveyed

Large	=	21
Medium	=	89
Small	=	127

III Segregation of solid waste produced

		Qty/day (kgs)
Hair/Wool	=	8019
Lime Sludge	=	410140.9 litres (39865 Kgs Solid)
Lime Flesh	=	35,739
Shavings	=	4,748
Buffing dust	=	420
Trimmings	=	1,392
Chukram Dust	=	44

IV Solid Waste

	Saleable kgs/day	Non Saleable kgs/day
Hair Wool	8019	-
Lime Sludge	-	410141 * (litres) (39,865 Kgs solids)
Lime Flesh	35,739	-
Leather Shavings	4,748	-
Buffing Dust	-	420
Trimmings	1392	-
Chukram Dust	-	44
TOTAL	49,898	40329

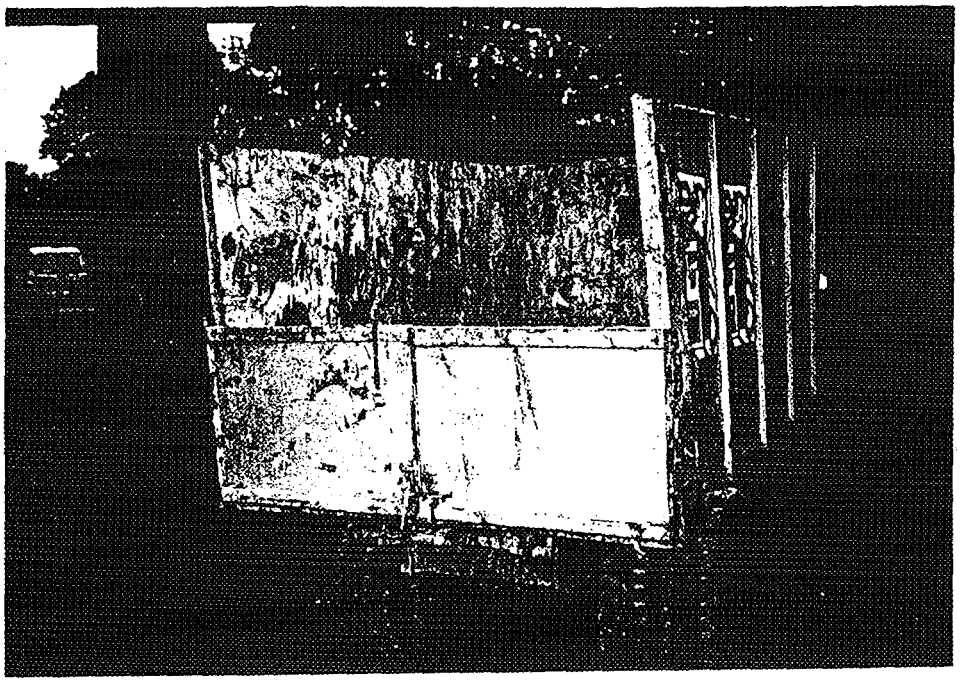
* *Lime Sludge (9% solids) in kgs = 1,08 kgs/litre x no of litres).*

NO. OF TANNERIES AND THEIR CATEGORISATION

Area	Large	Medium	Small	Total
Niaz Nagar	5	49	58	112
Din Garh	16	16	23	55
Younas Nagar	0	5	16	21
Mangal Mondi	0	5	19	24
Kot Molvi Abdul Qadir	0	12	9	21
Mushtaq Nagar	0	2	2	4
Total	21	89	127	237

DATA ON SOLID WASTES GENERATED BY 237 TANNERIES

Sr. No.	Waste	Source	Generation Rate		
			Kgs./Ton of Raw Weight	Daily Kgs.	Yearly Tons
1.	Sodium Chloride	Raw hides & Skins Godown sweepings	15	2877	699.78
2.	Insoluble Sulphide residue	Sulphide dissolving tank for hides and skins	1.5	288	69.98
3.	Insoluble lime and sulphide paint reasidue	Liming paint pits, drums for skins	10	203	44.37
4.	Lime sulphide paint Contaminated wool	De-wooling by painting of skins	20	406	88.74
5.	Solid finishing material waste	Finishing of Hides and skins	2	204	18.07



LIST OF PERSONS INTERVIEWED IN THE COURSE OF THE ASSIGNMENT

Name	Designation
Dr. R. Gumen	CD UNIDO
Mr. S. Mahmood	Project Director and Dy Commissioner, Kasur
Dr. A.R. Siddiqu	Project Manager KTWMA
Dr. B.H. Bashir	Programme Officer UNIDO
Mr. M. Shafiq Pasari	Life Chariman KTA
Mr. Sh. Allawasaya	President KTA
Mr. Q.M. Irshad	Secretary KTA
Mr. I. Hussain	Joint Secretary KTA
Mian Ashfaque	Ex-Member KTA
Mr. Saifullah	SDO KTWMA
Mr. A.S. Khan Lillah	XEN KTWMA
Mr. Abdur Rashid	Sanitary Inspector Kasur
Dr. Pervez	Medical Officer Kasur
Mr. Riaz Bhola	Kasur
Mr. Anfas Yunus	Project Director Institute of Leather Technology, Gujranwala
Mr. Mirza Yunus	President Small Tanners Association

Outline of Sirolime Process

Impregnation Stage

After usual soaking, hides are treated with sodium hydrosulphide in wooden drums. Process starts at 11.2 pH and drops to 8.5 pH during the impregnation. Total time of impregnation is around two hours. Impregnating liquor is drained of and subsequently recycled. A little washing is also carried out to further remove hydrosulphide.

Hairs Protection Stage

External hairs are protected by a short oxidation treatment with calcium hypochlorite. This also destroys hydrosulphide adhering with hairs. Total time of this process is about five minutes.

Hair Loosening Stage

With the addition of lime in the drum, sodium hydrosulphide that has already penetrated the hides is activated. Hair loosening occurs rapidly and most of the hairs are loosened in approximately 1-1.25 hours. Drum liquor is drained off collected and recycled.

Residual Hair Removal and Liming Stage

Residual hairs are removed by conventional lime and sulphide combination, and the approximate time for completion is around sixteen hours.

Requirements for Continuous Removal and Filtering of Hairs and other Debris from Drum

For this purpose the drum must be fitted with precise control instruments for efficient mixing, draining and regulating the quantities of chemical and liquors including a special device as a fixture for taking the liquor out of the drum for filtration of hairs and other solid materials, apart from re-cycling the filtered liquors back to the drum.

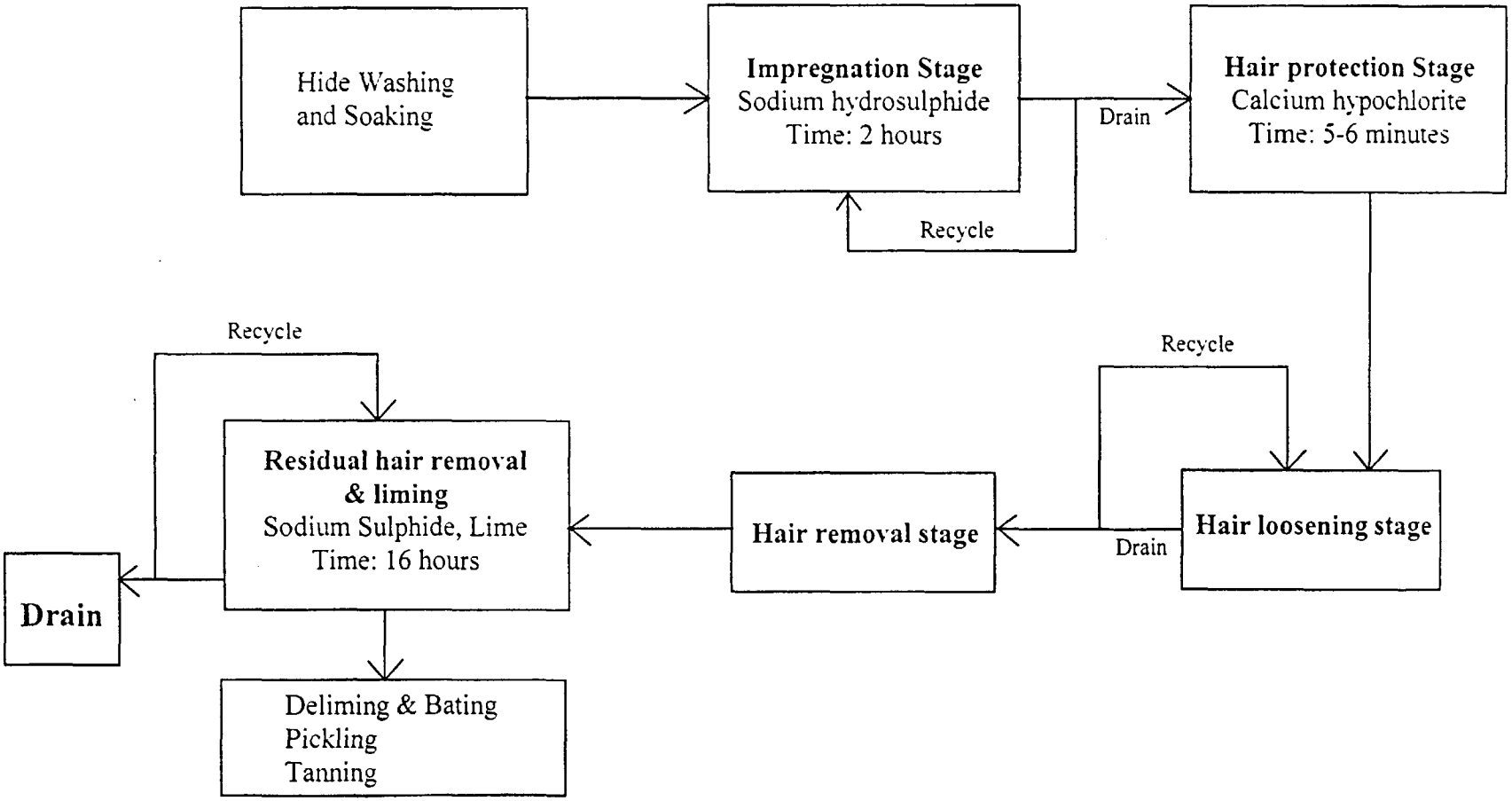
Recycling of Liquors

Further, the advantage of "SIROLIME" process is recycling of partially exhausted liquor at any stage of the process by simply making up of last float with the addition of some fresh water and a small quantity of chemicals. This would ensure conservation of both water and costly chemicals leading to the net result of less input cost, reduced pollution control and production costs of the final finished product. A comparison of both recycling and non recycling of liquors is given below:

PROCESS COMPARISON

	Average SIROLIME (Recycle)	Conventional Hair destroying process (Non recycle)
Input	0.7 lit water /kg hide 0.7% Sodium sulphide (60% Purity) 0.95% Sodium hydro-sulphide (60% Purity) 2-3.0% Lime (depending on method of implementation)	3.5 lit water /Kg hide 2.5-3.0% Sodium sulphide 2-3.0% Lime
Output	0.8 lit effluent/kg hide at total solid level of 15 gm/kg of hide 0.3 lit/kg hide unused liquor (unused wash stage liquor)	1.3 lit effluent/kg at total solid level of 70-gm/kg of hide

SIROLIME PROCESS



NUMBER OF VEHICLES AND QUANTITIES OF CIVIL WORKS AND MATERIALS REQUIRED FOR THE MASTER PLAN.

1 Collection Vehicles

1.1 For component of solid wastes from tanneries (ref. para 7.9).

Total amount of solid wastes to be transported per day (total non-saleable – sludge + 5% of littered saleables + residential components	=	27140 kgs
Bulk Density of waste in vehicles	=	750 kgs/ m^3
Total transportable volume	=	27140/750 = 36 m^3
Volume per vehicle trip	=	3.5 m^3 (87 % utilisation out of 4 m^3)
No. of trips per day (say)	=	36/3.5 = 10
Trips/trolley/day (say)	=	4
No of Vehicles required	=	10/4=3

1.2. For component of dry sludge from lagoons (para 7.10)

Total amount of dry sludge	=	69764 kgs/day (Table 7.3.A)
Density of sludge in vehicle	=	1000 kgs/ m^3
Total volume to be carried/day	=	69.76 m^3
Volume / trolley trip	=	4 m^3

	Total trips/day	=	69.76/4 = 17
	Expected trips per trolley per day	=	6
	Tractor Trolleys required	=	17/6 =3
1.3	Total No. of Tractor Trolleys required (for transportation from tanneries + sludge from lagoons)	=	3+3 =6(1.1 & 1.2 above)

1.4 For component of wet sludge from manholes of wastewater channels (para 7.10)

Total amount of sludge to be transported In wet form	=	57420 litres/day (8% of 1,177,450 liters/day)

60% Collection by 5900 Litre Tanker
40% Collection by 2000 Litre Tanker

a. <u>5900 Litre Tankers</u>

Volume Handle/Day 57420x60/100	=	34452 Litres
Total Trips/Day	=	34452/5900 = 6
Trips/Tanker	=	3
No. of Tankers Required	=	6/3 = 2

b. <u>2000 Litre Tankers</u>

Volume Handled/Day = 57420x40/100	=	22968 Litre
Total Trips/Day	=	22968/2000 = 12
Trips/Tanker	=	4
No. of Tankers required	=	12/4 = 3

2 Vehicles for sanitary landfilling.

For solid waste spreading, compacting and covering with daily inflow of 100 tons requires 1 bulldozer.

3 Land Area required (Table 7.4)

The capacity requirement

upto year 2010	=	155348 m^3
Average design width	=	64 m (Fig 2)
Average design height	=	4.3 m at centre 1.8 m at sides
	=	3 m (average)
The required length	=	155348/64x3=809m
	=	800 m (say)
Land area required up to year 2010	=	800x80=64000 m^2
	=	6.4 hectares
Part of abandoned Railway Track Land	=	800x60=48000 m^2
	=	4.8 hectares
Part of Acquired Land	=	800x20=16000m^2
	=	1.6 hectares

4 **Access Road**
(para 7.14.1)

Length of access road.	=	1600 m
Length of access/service road along sanitary landfill	=	800 m
Total length of Access Road	=	1600+800=2400 m

Width of access road = 7 meters (3.66 meters metalled 3.34 meters unpaved shoulders)

5 **Bridge on Access Road over Nallah (para 7.14.1)**

Length of Bridge	=	30 m
Width of Bridge	=	4.5 m

6 **Soil for Road, embankment and landfill cover (para 7.14)**

6.1 Amount of soil for road and embankment.

i)	Amount of soil required to build access road	=	½(7+11)x2x(1600+ 800)
		=	43200 m^3

ii)	Amount of soil for flood protection embankment on three sides	=	½(2+4)x2x (800+63+63)
		=	5556 m^3
iii)	Amount of soil for landfill cover	=	(80-13) x 0.5 x 800
		=	26800 m^3
iv)	Total amount of soil required	=	(I)+(ii)+(iii) above
		=	75556 m^3

6.2 Amount of soil obtained from the site.

i)	Amount of soil obtained from scraping the ground surface under the landfill	=	0.3x63 x 800
		=	15120 m^3
ii)	Amount of soil obtained from removal of abandoned railway track sub-base	=	1.5x3 x 800
		=	3600 m^3
iii)	Total amount of soil obtained from the site	=	(I)+(ii) above
		=	18720 m^3

6.3 Total amount of soil to be brought from other area {(6.1)-(6.2)}

= 75556 –18720
= 56836
= 57000 m^3 (say)

7. Provision of Clay Liner in landfill cover (para 7.14.4)

Amount of clay liner = (80-13)x0.5x800
= 26800 m^3

TABLE A

COMPARISON BETWEEN PHYSICAL AND STAFF REQUIREMENTS AND COSTS FOR THE PROJECT ON THE BASIS OF PRESENT AND OPTIMUM PRODUCTION SCENARIOS

I. PHYSICAL REQUIREMENTS

SR. #	ITEMS	SIZE/ CAPACITY	UNITS	NO/QUANTITY		REMARKS
				ON PRESENT PRODUCTION RATES	ON OPTIMUM PRODUCTION RATES	
1	Bulldozer	Medium	No.	1	1	Procured
2	Sludge Tankers	5.9 m^3	No.	1	2	One Procured
		2 m^3	No.	1	3	
3	Tractor Trolleys	4 m^3	No	4	6	
4	Road Bridge	30 m Long 4.5 m wide	No	1	1	
5	Road		Meter	2116	2400	
6	Site Office	Small	No	1	1	
7	Soil		m^3	47200	57000	
8	Clay		m^3	17300	26800	
9	Land (strip Length)	 80 m wide	Hectares meter	4.13 516	5.6 800	Procured

2. STAFF

SR #	POSITON	VACANCIES REQUIRED	
		WITH PRESENT PRODUCTION RATE	WITH OPTIMUM PRODUCTION RATE
1	Supervisors	1	2
2	Bulldozer Driver	1	1
3	Other Drivers	6	11
4	Loaders/Helpers	11	18

3. COSTS

SR #	TYPE OF COST	COST WITH PRESENT PRODUCTION RATE (RS)	COST WITH OPTIMUM PRODUCTION RATE (RS)	INCREASE %
1	Capital	15,204,000	27,050,000	78
2	Annual	3,061,900	4,595,000	50
3	Unit Cost/Drum Per Month	380	569	50

TABLE A-1

Scenario Based On Present Production Rates

Future Projection of Generation, Collection, Reuse and Disposal Rates

Year	Generation per day Tons	Gross Generation Per year Tons	Residential Wastes Per Year Tons	* Recycled Per year Tons	Net ** Generation Per Year Tons	*** Collection Per Year Tons	Disposal **** Per Year		Cumulative Landfill Disposal m^3
							Tons	m^3	
1	2	3	4	5	6	7	8	9	10
1999	94.2	24771	4500	12532	16739	3348	3013	2215	2215
2000	94.2	24771	4545	12532	16739	5022	4519	3323	5538
2001	94.2	24771	4590	12532	16739	6696	6026	4031	9551
2002	94.2	24771	4636	12532	16739	10043	9039	6646	16197
2003	94.2	24771	4682	12532	16739	13391	12052	8862	25059
2004	98.9	26010	4729	13157	17582	14065	12659	9308	34367
2005	103.8	27310	4777	13815	18272	14618	13156	9673	4040
2006	109	28676	4825	14506	18995	15196	13676	10056	54096
2007	114.5	30109	4873	15231	19751	15801	14221	10456	64552
2008	120.2	31615	5360	15993	20982	16786	15107	11108	75660
2009	126.2	33196	5414	16793	21817	17454	15708	11550	87210
2010	132.5	34855	5467	17632	22690	18152	16337	12012	99222

* *95% of Saleables*

** *Net Generation = Gross Generation + Residential Component - Recycled*

*** *Maximum 80% of net generation*

**** *Maximum 90% of collection*

TABLE A-2

Vehicles, Civil Works, Land Requirement And Costs *

Sr #	EQUIPMENT/ LAND/ MATERIAL	CAPACITY/ SIZE (m^3)	EX-PECTED LIFE (YEARS)	NO/ QTY	UNIT	CAPITAL COST (Rs)		ANNUAL COST (Rs)			
						PER UNIT	TOTAL	DEPRE-CIATION	REPAIR/ MAINTE-NANCE	POL	TOTAL
1	Bulldozer	Medium	15	1	Nos	Purchased		233,000	175,000	60,000	468,000
2	Sludge Tankers	5.9	15	1	Nos	Already Purchased		160,000	120,000	60,000	340,000
		2.0	15	1	Nos	1,200,000	1,200,000	80,000	60,000	25,000	165,000
3	Tractor Trolleys	4	15	4	Nos		2,400,000	160,000	120,000	240,000	520,000
4	Road Bridge	30 meter	60	1	No	2,500,000	2,500,000	42,000	50,000	-	92,000
5	Road		6	2116	m^3	1,500	3,174,000	529,000	63,500	-	592,500
6	Site office		50	1	No	250,000	250,000	5,000	5,000	-	10,000
7	Soil for cover, embankment and road sub base			47200	m^3	100	4,720,000	-	94,400	-	94,400
8	Land (state + acquired)			5.6	Hec-tares	(Already Obtained)					
9	Clay Liner			17300	m^3	200	3,460,000				
						Total	15,204,000			Total	2,281,900

* *Refer To workwheet for physical requirements details on following pages.*

TABLE . A-3
Staff Requirement and Costs

Sr. #	Position	Vacancies	Salary PM Rupees	Salary PA Rupees
1	Supervisor for collection & disposal	1	6.000	72,000
2	Driver (Bulldozer)	1	5000	60,000
3	Drivers (Tankers & trolleys)	6	3,500	252,000
4	Coolies/Loader/Helper	11	3,000	396,000
			Total	780,000

UNIT COSTS

In Tables A-1, A-2, A-3 physical requirements, staff requirements and their costs have been worked out.

The Capital Costs are Rs. 15,204,000.00 and Annual Cost is Rs. 3,061,900.00 (including cost of physical requirement and staff).

With total drums and tanneries numbering 672, the cost per drum is 3,061,900/672 = Rs. 4556 per annum or Rs. 380 per month

WORK SHEET FOR TABLE A-2
NUMBER OF VEHICLES AND QUANTITIES OF CIVIL WORKS AND MATERIALS REQUIRED FOR THE MASTER PLAN.

1 Collection Vehicles

1.1 For component of solid wastes from tanneries (ref. para 7.9).

Total amount of solid wastes to be transported per day (total non-saleable – sludge + 5% of littered saleables + residential components	=	21937 kgs
Bulk Density of waste in vehicles	=	750 kgs/ m^3
Total transportable volume	=	21937/750 = 29.3 m^3
Volume per vehicle trip	=	3.5 m^3 (87 % utilisation out of 4 m^3)
No. of trips per day (say)	=	29.3/3.5 = 8.4
Trips/trolley/day (say)	=	4
No of Vehicles required	=	8.4/4=2

1.2. For component of dry sludge from lagoons (para 7.10)

Total amount of dry sludge	=	37872 kgs/day (Table 7.3)
Density of sludge in vehicle	=	1000 kgs/ m^3
Total volume to be carried/day	=	37.87 m^3
Volume / trolley trip	=	3.5 m^3

Total trips/day	=	37.87/3.5 = 11
Expected trips per trolley per day	=	6
Tractor Trolleys required	=	11/6 =2
Total No. of Tractor Trolleys required (for transportation from tanneries + sludge from lagoons)	=	2+2=4(1.1 & 1.2 above)

For component of wet sludge from manholes of wastewater channels (para 7.10)

Total amount of sludge to be transported In wet form	=	20507 litres/day (5% of 410,140 liters/day)

a. 5900 Litre Tankers

Volume Handle/Tanker Trip	=	5900 Litres
Total Trips/Day	=	20507/5900 = 3.47
Trips/Tanker	=	4
No. of Tankers Required	=	3.47/4 = 1

b. 2000 Litre Tankers

One 2000 liter tanker required for negotiating narrow streets

2 Vehicles for sanitary landfilling.

For solid waste spreading, compacting and covering with daily inflow of 100 tons requires 1 bulldozer.

3 Land Area required (Table 7.4)

The capacity requirement

upto year 2010	=	99222 m^3
Average design width	=	64 m (Fig 2)
Average design height	=	4.3 m at centre 1.8 m at sides
	=	3 m (average)

	The required length	=	99222/64x3=516m
	Land area required up to year 2010	=	516x80=41280 m^2
		=	4.13 hectares
	Part of abandoned Railway Track Land	=	516x60=30960 m^2
		=	3.1 hectares
	Part of Acquired Land	=	516x20=10320m^2
		=	1.03 hectares

4 **Access Road**
(para 7.14.1)

Length of access road.	=	1600 m
Length of access/service road along sanitary landfill	=	516 m
Total length of Access Road	=	1600+516=2116 m

Width of access road = 7 meters (3.66 meters metalled 3.34 meters unpaved shoulders)

5 **Bridge on Access Road over Nallah (para 7.14.1)**

Length of Bridge	=	30 m
Width of Bridge	=	4.5 m

6 **Soil for Road, embankment and landfill cover (para 7.14)**

6.1 Amount of soil for road and embankment.

i)	Amount of soil required to build access road	=	½(7+11)x2x(1600+516)
		=	38088 m^3
ii)	Amount of soil for flood protection embankment on three sides	=	½(2+4)x2x(516+63+63)
		=	3852 m^3

iii)	Amount of soil for landfill cover	=	(80-13) x 0.5 x 516
		=	17286 m^3
iv)	Total amount of soil required	=	(I)+(ii)+(iii) above
		=	59226 m^3

6.2 Amount of soil obtained from the site.

i)	Amount of soil obtained from scraping the ground surface under the landfill	=	0.3x63 x 516
		=	9752 m^3
ii)	Amount of soil obtained from removal of abandoned railway track sub-base	=	1.5x3 x 516
		=	2322 m^3
iii)	Total amount of soil obtained from the site	=	(I)+(ii) above
		=	12074 m^3

6.3 Total amount of soil to be brought from other area {(5.1)-(5.2)}

= 47152

= 47200 (say)

7. Provision of Clay Liner in landfill cover (para 7.14.4)

Amount of clay liner

= (80-13)x0.5x516

= 17286 m^3

= 17300 (say)