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WILDLIFE, FURS &
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DRAFT ENVIRONMENTAL GUIDELINES

FOR COMMERCIAL TANNERIES IN THE

NORTHWEST TERRITORIES

prepared by

The Science Institute of the Northwest
Territories

September 1993 (Rev. 3)

Northwest
Territories Renewable Resources

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Draft Guidelines for Tanneries in the Northwest Territories ,

Enclosed for your review and comment are draft *Environmental Guidelines for Commercial Tanneries in the Northwest Territories.*

At the request of Dr. Joe Ahmad, A/Executive Director, Science Institute of the Northwest Territories Science Institute of the Northwest Territories, I have scheduled a Commissioner's Land Review Committee meeting for **Tuesday, November 9th at 9:00 a.m.** in the 6th floor boardroom of the Scotia Centre. The purpose of the meeting will be to discuss elements of the draft guidelines which may be of concern to your agency.

Please call me at 920-6392 if you wish to discuss this initiative.

Carey Ogilvie
Co-chair, Commissioner's
Land Review Committee

c. Stu Lewis, Policy and Planning, Renewable Resources
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Joe Ahmad, Science Institute of the Northwest Territories
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SCIENCE INSTITUTE OF THE NORTHWEST TERRITORIES

NOTE: **This is not an** adopted Standard but is a draft issued for limited circulation and for critical review and comment only.

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The information and data assembled in this report were prepared by Ben Hubert of Hubert and Associates Ltd. of Yellowknife in collaboration with Dr. S.Y. (Joe) Ahmad from the Science Institute of the Northwest Territories. The guidance and advice of the Commissioner's Land Review Committee is gratefully acknowledged. While the information and assistance was helpful, errors and omissions remain the responsibility of the authors.

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The Science Institute also consulted the Canadian Standards Association (CSA) in preparing this document, and their help and guidance is appreciated and acknowledged.

ACRONYMS, ABBREVIATIONS & GLOSSARY

Aerobic:	Associated with oxygen
Anaerobic:	Without oxygen
Bating:	Manufacturing step which follows liming and precedes pickling. The purpose of bating is to delime the hides, reduce swelling, peptize fibres, and remove protein degradation products.
Beamhouse:	That portion of the tannery where the hides are washed, limed, fleshed and unhaired, when necessary, prior to the tanning process.
Biochemical Oxygen Demand **(BOD):**	A measure of the quantity of oxygen which may be consumed while biologically degrading the organic constituents. The test is carried out over five days and the result express as BOD_5.
Chemical Oxygen Demand (COD):	A measure of the quantity of oxygen consumed during chemical oxidation of the constituents of an effluent with potassium bichromate.
CSA :	Canadian Standards Association
Deliming:	Process which removes lime from hides coming from the beamhouse.
Dewatering:	Process of removing a large part of the water content of sludges.
Disposal:	Act of discharging a waste or effluent into the environment.
DS :	Dissolved Solids
Environmental Criteria:	Designate the level of pollutant at which a particular environmental use or quality is substantially unaffected.
Enzyme:	One of a large class of complex proteinaceous substances of high molecular weight formed in and produced by living matter.

ACRONYMS, ABBREVIATIONS & GLOSSARY (Cont' d)

EPA :	Environmental Protection Agency of the United States of America.
EPA Standards:	A legal level of pollutant set by EPA.
GNWT or G. N.W. T. :	Government of the Northwest Territories
Grain:	a) the outer, or hair side, of a hide or skin that has been split into layers; or b) the pattern visible on the outer surface of a hide or skin after the hair or wool has been removed.
H_2S :	Hydrogen sulphide gas or rotten egg gas
INAC :	Indian and Northern Affairs Canada
Leather:	A general term for hide or skin which still retains its original fibrous structure more or less in tact, and which has been treated so as to be non-putrescible even after treatment with water.
N.W. T.	Northwest Territories
pH :	Measures acidity; a pH of 7 is neutral.
Pickling:	The process that follows bating, whereby the skin or hide is immersed in a brine and acid solution to bring it to an acid condition. It prevents precipitation of chromium salts on the hide.
Pollution:	A state that occurs when the natural assimilative capacity of the environment is exceeded, resulting in illness or death or organisms, and undesirable ecological changes.
Putrescible:	Liable to decay and rot.
Proteinaceous or Proteinous:	Adjective of noun "protein".

ACRONYMS, ABBREVIATIONS & GLOSSARY (Cent' d)

Retanning: The process of subjecting a skin, which has been first more or less completely tanned by one process or one kind or blend of tanning materials, to a second tanning process involving similar or, more usually, different tanning agents.

Sammying: Removing moisture and residual tanning solutions.

Syntans: A tanning agent, typically sulphonated products of phenol, cresol and nepthalene, or resins derived from polyurethane or polyacrylic acids.

Total Solids: Refers to both dissolved and suspended solids.

TSS : Total suspended solids

Treatment: Reduction or change in the level of pollutants.

UNEP/IPO : United Nations Environment Program/Industry and Environment Office.

UNIDO : United Nations Industrial Development Organization.

Wet Blue: Term for a hide or skin which has been chrome-tanned and left wet.

1.0 INTRODUCTION

1.1 Objective

The objective of these Guidelines is to provide the Northwest Territories (NWT) tanning industry with an indication of the nature and potential impacts on the environment and the surrounding region from construction and operation of leather skin tanneries.

1.2 Source

One of the principal sources used in preparing these Guidelines is a recent report[1] by the United Nations Environment Programme (UNEP, 1991), entitled "Tanneries and the Environment". Where appropriate, the format of the UNEP guidelines has been followed in order to provide compatibility with International standards. The numerical criteria recommended by the U.S. Environmental protection Agency (EPA) has been adopted as reported in the EPA guidelines by Eidsness et al [2]. Subsidiary EPA document '3), was also extensively consulted. Other documents used in this study are listed under "References".

1.3 Background

The potential for a commercial tannery in the Northwest Territories to provide raw materials for use by local artisans has been recognized for many years. This scenario has also been recognized for many third world countries and with the aid of World Bank capital and United Nations advisors, many of the hides produced from the slaughter of cattle, sheep and goats in the third world have become part of a global leather industry and market that knows no boundaries. These developments on the global stage have produced reports and specifications, some of which were reviewed in preparation of this report.[1] & [4].

In addition to reviewing tannery literature and specifications, waste disposal strategies that are in place for handling mixed waste streams including significant volumes of animal parts were also examined. This examination included the Fraser Valley where domestic wastes from urban and semi-rural suburbs are mixed with effluent from industry and food processing plants and treated to the first and in some cases, the second stage by the Greater Vancouver Regional District. Also reviewed was the relationship between the City of Edmonton and the Province of Alberta where regulations to the provincial Clean Water Act are under revision and have specifically addressed the effluent of Dominion Tanneries Ltd. in Edmonton.

Finally, a thorough examination of the tanning industry practices in the USA were conducted by reviewing the document produced by the U.S. Environmental Protection Agency (EPA) at the conclusion of their review of the leather tanning industry in the U.S. from which it developed national tannery guidelines. '2). Discussions were also held with Dominion Tanneries in Edmonton who have progressively modified their processes with the goal of eliminating all environmentally harmful effluent products from their operations. They are in the final stages of that process now and expect soon to be using only water soluble reagents in all their "tanning" and "finishing" stages of leather production.

This report is a synthesis of findings which are adapted to an NWT setting. In proposing guidelines it is recognized that NWT communities do not have the same municipal infrastructure that was encountered in the course of the research. It is hoped however, that the accommodations proposed in the draft guidelines will receive serious consideration and objective and constructive criticism so that a consensus can be achieved for guidelines to assist proponents of commercial tanneries in the NWT.

This report is organized into the separate stages of the tanning process that produces a stable end product. Each stage is described individually with respect to operations that have implications for environmental quality. Stages that do not involve reagents affecting the effluent receiving environment are not discussed. Environmental guidelines are developed in a separate section .

2.0 OVERVIEW OF TANNING TECHNOLOGY AND PROCESSES

2.1 The Science & Technology of Tanning

Tanning is an ancient technology which uses physical and chemical processes to convert raw animal skins into leather, either with the hair on or clean. Recent advances in producing a variety of leather products have come mainly in the finishing details rather than the basic tanning chemistry, which is the preservation process.

In scientific terms, tanning has been defined as the process by which the putrescible proteinous matter, hide or skin, is made non-putrescible. According to Santappa et al [5], in order to ensure optimum physical and surface characteristics in leather making, several pre-tanning operations which influence the reactions involved in tanning, are as follows:

(a) the dehydration or soaking of the raw skin which had been preserved;

(b) the loosening up of hair and flesh through a liming operation, consisting of a treatment with infusions of calcium hydroxide and other nucleophilic reagents like sodium sulphide to break the disulphide bond, in the hair protein;

(c) neutralization of alkali during a deliming operation by treating with an acidic salt, such as ammonium chloride or ammonium sulphate;

(d) solubilization of unwanted proteinous matter by an enzymatic treatment during bating; and,

(e) pre-conditioning of the acidity for mineral tanning through treatment with a mineral acid like sulphuric acid and a neutral salt (e.g. sodium chloride) in pickling.

The ultimate objective of the tanning process is to convert raw, perishable skin into leather by a chemical preservation process. This is achieved by chemical means in which the preservative is bonded to the collagen fibres in the skin tissue. Depending upon the end use of the leather, tanning or permanent preservation may be affected by one of the following methods:

(1) Chrome tanning using sufficiently basified salts of chromium III for general purpose, light leather. This is the most widely used process in producing commercial leather.

(2) Vegetable tanning using aqueous infusions of polyphenotic type materials of plant origin as the source of mineral salts, needed to preserve the connecting tissues in animal skins. This process is used for especially heavier leather such as saddles and shoe soles.

(3) Tanning with aldehydes or oil tanning using the oxidation products of an unsaturated oil like fish oil for specialty leathers.

(4) Aluminum or zirconium tanning using sufficiently masked salts of aluminum and zirconium for white leathers and pelts with hair on.

(5) Traditional tanning utilizing the natural mineral salts of animal tissue, and in many cases urine, for general purpose leather.

(6) Combination tanning methods in which a judicious combination of the aforementioned methods is used to take advantage of various tanning processes.

After tanning, the hides are usually further processed according to their intended end use, consisting of trimming, dyeing, buffing and surface coating.(l)

2.2 The Process Technology of Tanning

There is no single process for producing leather. Depending on the prevailing circumstances, different options for unit operations are used. Accordingly, different wastes are produced, and different possibilities are encountered in the re-use or conversion of residues.[1]

This report focuses on the chrome tanning process that has become the most widely used process in producing commercial leather. Recent trends in the chemistry and technology of chrome tanning including the modifications in the pre-tanning process are described in an excellent review by Santappa et al '5].

The following sections discuss the major stages of the tanning process and identify the significant chemical inputs and wastes.

The overall process divides naturally into four stages:

Storing raw hides or pelts in a manner to protect these raw materials from putrefaction.

Hide cleaning and preparation for tanning (also known as Beamhouse).

Tanning or converting the hide or skin into leather that should resist putrefaction indefinitely.

Post-tanning activity: re-tanning, fat liquoring, drying and finishing.

Each of these stages are discussed in greater detail below:

2.2.1 Storing Raw Hides and Pelts

Input

Raw material:

The raw hide which in the case of muskox should have had the hair and wool removed for further value added processing and creative effort by a northern artisan. In the case of seal, caribou and moose the hair would be on because it has very little value in a commercial sense. In the case of furbearing species the pelt would be preserved. Several storage strategies are effective in temporary preservation of the raw skin.

Freezing:

Nothing is added to the raw material and care must be taken to ensure the material remains frozen to ensure the final product's overall quality is not diminished.

Drying:

This method has been used traditionally in the N.W.T. since the combination of dry pelts and cold temperatures preserved the pelt sufficiently to get it to market or to the traditional tanning process. Dried untanned skins are at risk of spoiling in the northern summer season. The major drawback of drying is that the process must be reversed during tanning - i.e. dehydrating, which requires large volumes of water.

Salting:

This is the most common storage method used for commercial skins that do not go to tanning from the animal carcass within 24 hours. Normal salt (NaCl) is sPread over the skin which has been drained of blood and other moisture. Salt (50% by weight of the skin) is spread over the flesh side of the skin and successive skins are piled Up for storage. This form of storage can preserve the skins for periods of six months or more depending on environmental conditions.

Process

No processing is involved in storage of skins for the period required to get the skins from the slaughter site to the tannery.

output

Raw skins are either frozen, dried or salted. In the case of salted skins, the storage site may receive bloody brine draining from the pile of skins which may dry and recrystallize. On handling the salted skins for shipping to a tannery, much of the remaining free salt will shake free from the skins and accumulate for local disposal.

Chemicals include: Sodium Chloride - Common Salt.

2.2.2 Hide Cleaning and Preparation for Tanning (Beamhouse)

At this stage the hide is prepared for tanning by cleaning and conditioning and ensuring the correct moisture content. Several steps are involved in preparing the hide or pelt for tanning. Each starts with the same raw material, hides from storage.

Input

Raw material:

Raw hides or pelts that have been stored frozen, dry or salted.

Process

Soaking:

All hides and pelts are soaked in water for a period to remove dirt, blood and salt from the raw material. This is usually done in rotating drums resembling a concrete mixer, in order to rehydrate the skin.

If the final product is to be a fur, the raw pelts are drained and ready for the bating process.

Effluent: Dirty water with blood and salt.

Chemicals include:[1] *0.2-2.0 g/1 of sodium hydroxide, sulphide, up to 1 g/l sodium hypochloride and/or 0.5-2.0 g/1 wetting agents, emulsifiers, surfactants and enzyme preparations.*

Liming, unhairing and fleshing:

If the final product is to be leather, the wet skin with the hair on is immersed in a bath of concentrated hydrated lime, blended with sodium sulphide, which softens the hard outer layer of skin and loosens the hair. It also digests tissues that are not skin like glands and blood vessels which cannot be converted to leather. AS a result, the process opens the fibre structure and “plumps” the hide. After a period of soaking (approximately 18 hours) in a high pH bath, the raw material is removed to a drum for hair and flesh removal. These tissues may also be removed manually. This process is responsible for the major part of the COD load from a tannery.

The fleshing of the limed hides is performed by mechanically removing the adipose tissue from the flesh side of the hide.

In some cases fleshing is carried out immediately after soaking, which is called green fleshing.

Effluent: Hide, hair and fleshing scraps, which should be treated like solid waste. An alkaline slurry with a high calcium concentration containing hair.

Chemicals include:[1] 2-10% calcium chloride (lime), 1-4% sodium sulphide, sodium sulphydrate. Some caustic soda may also be used. Recently, enzymatic preparations have found increasing use.

__Deliming__:

Lime from the hair removal process is washed from the hides with water and ammonium hydroxide in either a pit or in the same rotating drum that have been used for the preceding stages of the process. The removal of lime from the pelt is necessary to avoid interference with the subsequent tanning stages. (Washing requires copious quantities of water). Thorough washing is followed by neutralizing chemicals.

Effluent: A slurry containing hair and tissue scraps. The acidification of liquids still containing sulphide may generate toxic hydrogen sulphide gas. With prior treatment using hydrogen peroxide or sodium bisulphate (which is cheaper) to oxidize the sulphide, this problem can be avoided.[1]

Chemicals include[1]: 0.5-2% acids, (sulphuric, hydrochloride, lactic, formic, boric and mixtures) acidic salts, ammonium chloride or sulphate, sodium bisulphite, hydrogen peroxide. The use of carbon dioxide (CO_2) instead of ammonium salts avoid the release of ammonia in the effluents.

__Bating__:

The drained hide or pelt is immersed in a bath to which a protein digesting enzyme is added to complete the removal of non-collagen tissues that cannot be removed manually or mechanically in the rotating drums. The enzymes used are usually synthetic products which mimic natural enzymes found in digestive systems of carnivores and omnivores.

The enzymatic process has a pronounced effect on the grain of the pelt, and on the general run and stretch of subsequent leathers. Current enzymatic treatment employs 0.5% bating material from 30 minutes to 12 hours.

The bating material is typically composed of('): 50% wood flour or other carrier, 30% deliming agent (ammonium chloride) and 1-5% pancreatic enzyme.

Pickling:

The basic pH of the hide is neutralized and the raw material brought to a slightly acidic state by soaking the clean, hair and flesh free hide in a bath of acid. The hide is then prepared for converting the unstable collagen fibres into leather.

This final pre-tanning operation adjusts the pH of the pelts, thereby sterilizing the skin, ending the bating action, and improving penetration of the subsequent tanning operation.

Effluent: This process neutralizes the alkaline effluent of the previous stage producing a near neutral effluent with a high hair control and stable precipitated salts from mixing acidic and basic solutions.

Chemicals include('): 5-10% common salt *(sodium chloride) or sodium sulphate; 0.6-1.5% acid (sulphuric, hydrochloric c, acetic or formic, or mixtures). Possibly small amounts of fungicide such as thiobenzothiazol.*

2.2.3 Tanning

Tanning is the stabilization of the collagen structure of the hide, using natural or synthetic chemicals. In addition, tanning imparts a particular "feel" to the resulting leather(l). Only one step is involved in the tanning stage of the overall process.

Input

Raw material: Pickled hides are soaked in water, usually in a rotating drum.

Process

Tannins of vegetable or mineral origin are added to the drum. In cases where the end product is hard saddle leather and where small amounts of furs are being tanned, vegetable tannins can be used to preserve the natural fibres in the hide. In commercial tanneries producing leather for a multiplicity of end uses a mineral tanning agent is used, usually chromium. The environmental guidelines will assume that the commercial tanning process intended for the NWT is a mineral based chrome tan process.

The hides are soaked in the rotating drum for a period of up to eight hours. In this stage the tanning agent chromium powder (Cr_2O_3), is added to the bath and absorbed into the hide and chemically bonded to the collagen fibres thereby permanizing them and preserving the leather against natural agents of decay.

output

Product:

Leather called "wet blue" at this stage which fairly describes the raw product. It is a metallic blue colour and very swollen as it has taken on a large volume of water and chrome.

Effluent: A coloured effluent containing unused trivalent chromium. No solid wastes are directly derived from the tanning process. Subsequent washing releases unfixed chemicals from the hide - some effluents may be toxic; all are potentially polluting[1]. Treatment of effluents results in the production of sludges which must be disposed of in a manner that does not create a secondary form of pollution.

Chemicals include}

(a) <u>Chrome tanning</u>: 8-12% of pelt weight of chrome tanning salt, and as little as 5-6% for low chrome processes (basic trivalent chromium sulphate hydrated complexes - 22-25% C_2O_3), 1.0% sodium bicarbonate (basifying agent to adjust pH), 0.1-0.5% masking agent - sodium formate; phthalate or salts of dicarboxylic acids, 0.1% fungicide if product is to be stored/transported in wet blue condition.

(b) <u>Vegetable tanning</u>: Substances used are typically 15-30% of commercial tanning extract (bark or wood *of tree, aqueously extracted), often sulphitated, then spray dried or concentrated.*

(c) *<u>Syntans</u>: 1-25% of pelt weight of syntans are normally employed; materials are typically sulphonated products of phenol, cresol and napthalene, or resins derived from polyurethane or polyacrylic acids. (Note: syntans are employed alone or in association with chrome and vegetable tannins either for retannage or as principal tanning agents for certain specialty leathers).*

(d) *<u>alternative tanning materials</u>: Aluminum, titanium and zirconium salts, cod oil (chamois), glutaraldehyde. Formaldehyde (for chamois) is no longer recommended for use due to its toxicity.*

2.2.4 Post Tanning Activity

This stage determines the final qualities of the leather and the steps in it depend largely on the end product for which the leather is intended. In the wet blue condition the individual hides are drained, smoothed, split into two sheets in the case of heavy hides, and shaved to a consistent thickness before the leather is returned to the drums for further treatment.

Input

"Wet blue" leather or leather with other tanning materials if alternative tanning materials were used.

Process

Following tannage, certain mechanical operations are performed to level the surface of the irregular natural material(l):

Sammying by machine (pressurized rollers) to remove moisture and residual tanning solutions; **splitting** by machine, if not carried out in lime condition; or, shaving whereby substance is levelled, the surplus material yielding a waste of small fragments (rather than the sheet-like material obtain from splitting); and, **trimming**.

Effluent: These operations yield a combination of solids and squeezed out water.

Chemicals include: Unfixed tanning chemicals.

Post -Tanning Wet Work or Retanning:

This involves further processing of the stabilized collagen network and may comprise a further tannage.

Any chemical treatment is mild and precautionary in nature to ensure that any raw hide exposed in the splitting process is tanned before the process of replacing retained water with natural oils is begun. A small amount (compared to the tanning stage) of chrome powder is introduced to the wash for a short period. The remainder of the process is dominated by adding oils, dyes and pigments to the leather. This is done in varying temperature and moisture mediums, depending on the desired quality and colour of the finished leather.

Effluent: Raw solid wastes are produced and the aqueous effluents do not generally contribute significantly to the overall load of pollutants from the tannery. The properties of this effluent are similar to the tanning stage effluent.

Chemicals used (% of shaved weight) include('):

neutralizing: 1% mild alkali or syntan;
retan: a wide range of tanning material, previously discussed
- *dye: 1-6% acid, direct, basic, or specialty dye stuff*
- *fat liquor: 3-10% sulphonated fish, vegetable or animal oils, mineral and synthetic oils.*

Drying and Finishing

The leathers are either sammied or staked to remove moisture, then dried.

This takes the natural stretchiness out of the leather and removes the remaining free moisture from the leather, while under controlled tension, through a heated drying room. The final finishing process includes mechanical treatment of grain and flesh, followed by application of surface finish.

Leather intended for the fine garment, luxury luggage and other up market items is sorted out at this point and subjected to the colouring process. Here colours are sprayed onto the sheets of leather and fixed by the addition of mordants, fixatives and lacquers that impart the permanent colorfast properties to the leather that are expected of it in this market. This process is done in facilities resembling an auto body shop paint booth with sprayers and blowers venting the fumes but on a smaller size scale. From here the sheets of leather may go to a stamping or plating machine where a surface pattern may be pressed into the top grain to impart a desired surface effect onto the leather sheet.

Effluents: The major environmental problem in finishing is undoubtedly air emission of solvents. Some aqueous solutions may be generated. Solid waste may arise from trimmings and buffing dust.

A list of common chemicals used in leather finishing is given *in the following* table(’):

TABLE 2.1

CHEMICALS USED IN LEATHER FINISHING

Butano	Ethylmercaptan
Ethyl acetate	Ethyleneglycol
Butyl acetate	Methylbutylketone
Isobutyl acetate	Methylethylketone
Formic acid	Perchloroethylene
Monochlorobenzene	Toluene
Cyclohexane	Trichloroethylene
Di-isobutylketone	Xylene
Ethylbenzene	

2.3 Summary of the Tanning Process

The major stages of the tanning process are described in the preceding section identifying the significant chemical inputs and wastes.] A summary of the tanning process is illustrated in Figure 1 showing a process flow chart for the major steps in taking raw animal skins to finished leather.

While such a summary is useful to gain an overview of the operations, the process sequence may vary for specific applications resulting in different waste streams. In a typical Northwest Territory tannery, the tanning process and sequence indicating waste streams may follow the schematic shown in Figure 2.

It is to be noted that the major tanning stages shown in Figures 1 and 2 are very similar but there are differences in process sequences. For example, in Figure 1, the fleshing operation is performed after soaking or unhairing by liming. In contrast, in Figure 2 the fleshing is performed ~~before~~ unhairing and liming - known as "green fleshing". Therefore, the tanning process summary described here should be considered as illustrative.

Example:

Stage-by-Stage Description of a Northwest Territory Tannery.

This example describes the water and reagent inputs and effluent outputs for tanning a batch of 100 muskox hides from storage with hair removed by shearing. The data are based on a schedule prepared for tanning cattle hides and is adjusted for muskox by taking a quarter of the materials required for tanning beef hides. For more detail the reader is referred to the titles cited in the references.

EXAMPLE OF MUSKOX TANNERY		
STAGE	INPUTS	OUTPUT
Soaking	2000 litres of warm water 1 kg sodium sulphide 1 kg wetting agent .5 kg disinfectant	Dirty water containing the remnants of inputs
Liming and Fleshing	2000 litres of warm water 40 kg hydrated lime 20 kg sodium sulphide 10 kg salt	Alkaline wash water containing sulphides, calcium and calcium salts, hair and scraps of tissue and hide
Deliming	1000 litres of water 16 kg ammonium sulphate	Alkaline wash water, rich in calcium with some ammonium sulphate
Bating	1000 litres water 8 kg. synthetic bate	Alkaline wash water
Pickling	40 kg salt 4 kg calcium formate 10 kg sulphuric acid diluted in a 10% acid solution	Midly acidic wash water
Chrome Tanning	65 kg chrome powder	Mildly acidic wash water rich in trivalent chromium
At this stage the leather produced is stable and can be stored indefinitely as a "wet blue". Few products are made with this raw material, but rather it is now ready for finishing. The processes involved in finishing depends on the end product that the leather is to become. The sheets of leather are therefore carefully sorted and then dispatched according to the intended end use.		
Retanning, Dyeing and Fatliquoring	2500 litres water 30 kg tanning agents including chrome powder 5 kg various dyes and mordants 25 kg natural oils with additives	Mildly acidic coloured wash water rich in chromium; the oils with their sulphite additives are all taken up in conditioning the leather
Finishing	Various fixatives, solvents and waxes are sprayed onto the leather to help pigments penetrate the leather for permanent colorfast quality	Applied in a vented spray hood similar to a paint shop

2.4 Composition of Tannery Chemicals and Effluents

The major chemicals used in the tanning process are shown in Table 2.2 - adapted from[1] UNIDO (United Nations Industrial Development Organization). Other chemicals used, in more minor quantities, have been mentioned in Section 2.2.

Table 2.2
CHEMICALS USED IN THE TANNING PROCESS
(Source: UNIDO)

		Heavy Leather	Light Leather
		kg per 100 kg of raw hides	
General Purpose Chemicals			
Sodium Sulphide	Na_2S	3.0	3.0
Calcium Hydroxide	$Ca(OH)_2$	4.5	4.5
Hydrochloric Acid (Con)	HCl	0.3	0.3
Ammonium Sulphate	$(NH_4)_2SO_4$	2.0	2.0
Sodium Bisulphate	$NaHSO_3$	1.5	1.5
Sodium Chloride	NaCl	10.0	10.0
Calcium Formate	$Ca(COOH)_2$		2.0
Sulphuric Acid (Con) 96%	H_2SO_4	4.0	4.0
Sodium Carbonate	Na_2CO_3		2.0
Sodium Sulphite	Na_2SO_3		2.0
Basic Tanning Materials			
Chrome Salts	$Cr_2(SO_4)_3$		10.0
Vegetable Taming Materials		12.0	
Performance Chemicals			
Bates		0.8	0.8
Bactericide		0.3	0.3
Syntans			3.0
Fat Liquors			4.0
		kg per 100kg shaved weight	
Dyeing Auxiliaries			3.8
Dyes			0.6
Finishes			4.0

Due to the variety of recipes, and changes in fashions, colours, etc., the actual amounts of chemicals and tanning materials per unit of hide vary within rather wide ranges. The unit values given in the table should be considered as illustrative only.

The composition of a typical, untreated combined effluent is characterized by high oxygen demand and high salt content, and is strongly alkaline. It also contains a high level of suspended solids and possibly a persistent high load of chrome. Levels experienced in an actual tannery will vary to some extent from these values depending for example on water use, etc. The environmental significance of these parameters varies with the circumstances and the environmental sector involved.

Table 2.3 shows the composition of a typical, untreated combined tannery effluent - adapted from UNIDO[1].

Table 2.3

COMPOSITION OF TYPICAL UNTREATED COMBINED TANNERY EFFLUENT.
Units are mg/1 Unless Otherwise Indicated
(Source - UNIDO)

Parameter	Chrome Tannag e	Vegetable Tannage
pH	9	9
Total Solids	10,000	10, 000
Total Ash	5,000	6,000
Suspended Solids	2,500	1,500
Ash in Suspended Solids	1,000	500
Settled Solids (2 h)	100	50
BOD_5	900	1,700
$KMnO_4$ Value	1,000	2,500
COD ($K_2Cr_2O_7$)	2,500	3,000
Sulphide	160	160
Total Nitrogen	120	120
Ammonia Nitrogen	70	70
Chrome (Cr)	70	--
Chloride (Cl-)	2,500	2,500
Sulphate (SO_4)	2,000	2,000
Phosphorus (P)	1	1
Ether Extractable	200	200

Table 2.3 gives an overview of tannery effluent as a whole. While such a table is a useful indication of the orders of magnitude involved, it should not taken as general parameters for a specific plant. The composition of effluent depends in each case on the types of processes employed in the plant, and on the volume of water consumed.

In addition to the strength of effluent, the total mass of pollution produced can be estimated, depending upon the quantity of material processed. Table 2.4 shows the approximate amount of pollution potentially produced per tonne of raw material processed in a typical plant.

Table 2.4

AMOUNTS OF POLLUTION FROM RAW MATERIAL
(kg/t Unless **Otherwise** Specified)
(Salt Weight) (Source - **UNIDO)**

Parameter	Chrome **Tannage**	Vegetable Tannage	Range
Alkalinity (eq/t)	750	750	350-1250
Total Solids	675	675	250-450
Total Ash	375	375	70-200
Suspended Solids	150	75	25-60
Ash in Suspended Solids	60	25	1.5-7.5
Settled Solids (2 h)	6	3	40-100
BOD_5	60	85	
COD	10	10	
COD ($K_2Cr_2O_7$)	220	220	120-280
Sulphide	7	7	
Total Nitrogen	10	10	
Ammonia Nitrogen	3	3	
Chrome	4.5 max		

2.5 The Solid Wastes

The volumes of solid waste generated in a tannery is dependent on the process used. However, an indication of the percentage of solid waste arising from a typical chrome tanning operation at various process stages is shown in Table 2-.5 below.(l)

Table 2.5

SOLID WASTE GENERATION

	Percentage
Trimming	16.7
Fleshing	30.0
Chrome Shavings	13.0
Chrome Split Waste	15.0
Buffing Dust	0.3
Finished Trimmings	4.0
Solids Suspended in Sludge	21.0
Total	100.0%

2.6 Air Emissions

Air emissions for tanneries without incinerators fall into two broad categories:

(a) Odours: are caused by improper control of operations, poor maintenance of treatment plants and decomposing accumulated wastes. The reduction of odours from these sources are achievable by a proper procedure for operational maintenance of the plant.

(b) Solvents: and other vapours from finishing operations depend critically on the types of chemical used - for example see Table 2.1. It is not uncommon to discharge (and emit) up to 30% of the solvent('). Modern processes are able to reduce this emission to 3% in many cases.

3.0 ENVIRONMENTAL ISSUES

3.1 General Considerations

There are two major traditional public concerns over tannery operations. First, unpleasant odours; and second, water pollution from untreated discharges. Both problems can be solved by implementing proper control action - for example biofiltration and effluent treatment.

Other less obvious issues are other pollution, and health and safety issues. They arise from the increasing use of synthetic chemicals and from the use of newer processing chemicals. These substances are frequently toxic and may affect both human health and the environment.[1] The adverse environmental impact of these substances can be avoided by properly designing the tannery process systems.

Finally, the cross-media impact must also be carefully evaluated. It is to be noted that certain simple measures to control pollution can themselves create secondary environmental impacts known as cross-media impacts. These impacts include groundwater pollution, soil contamination, sludge dumping and chemical poisoning.

In the following section, specific impacts at different process stages are discussed.

3.2 Consideration of Some Specific Impacts

The main components of the tanning process effluents are discussed individually for each stage of the overall tanning process.

Storage Stage

For the skins, proper environment and temperature controls are necessary so that the selected storage strategy is effective.

For waste and byproducts, frequent inspection of the storage site should be done to clean up and dispose of salt to prevent corrosion in storage facilities due to the oxidizing of NaCl (common salt) on metal and concrete.

Hide Cleaning and Preparation Stage

Calcium

The main ingredient in the effluent produced in this stage of the overall tanning process is calcium, which is a common element in the natural environment and usually not regulated in effluents. The effects of calcium salts in nature include buffering soils and water against the effects of natural acid sources like newly exposed bedrock and peat bogs.

Sulphates and **Sulphides**

Sulphuric acid is the source of sulphur radicals that may contribute to sulphate and sulphide production which are secondary ingredients in tanning effluent. These are usually regulated in industrial effluent. Sulphur is an essential element in protein synthesis and therefore sulphur compounds can be naturally incorporated and quickly mobilized in biological systems. Synthetic sulphates and sulphides are common end products of aerobic and anaerotic digestion of organic material and so are compounds that are commonly found in the natural environment. At elevated concentrations they are toxic and even lethal as in the case of hydrogen sulphide gas (H_2S) . The most common concern for sulphates and sulphides in the environment is their presence in gaseous forms which combine with water vapour and contribute to acid rain.

In aqueous environments sulphates and sulphides may contribute to increased growth of microbes in sewage systems which are characteristically low on oxygen. At low oxygen concentrations increased biological activity often exhausts all free oxygen and anaerobic activity then starts producing hydrogen sulphide gas which is lethal at low concentrations. This should not be a problem in northern situations where sewage is either pumped into a lagoon or into the natural environment.

The standards established by the US EPA assumed that all tanning effluent would be discharged into a managed environment before being released into a natural water course. They concluded that the "Best Practical Technology" for pretreatment of discharged effluent available to the industry could meet a standard for sulphides of 24 mg/l for a large tannery. Tanneries that processed less than 275 beef hides per day were felt to generate effluent volumes that did not warrant these standards provided they met the standards set by the local authorities.

The rationale in the EPA standards is that a large tannery will contribute a significant portion of the overall effluent that a local sewer system must handle on a daily basis. In such a case the effluent generated by the tannery should be pretreated to ensure that the capacity of the overall sewage system would not be overloaded thereby reducing the probability of excess hydrogen sulphide production. A small tannery does not generate the volumes of effluent that would place a large system at risk provided it meets the other essential requirements of the local system.

In Alberta the regulations to the CLEAN WATER ACT are under revision. These regulations address the characteristics of effluent that can be discharged into natural watercourses in the province and are the standards which municipality waste water treatment systems are expected to meet. In cases where there is no intermediate facility between the waste water generator and the natural receiving waters, the generator is regulated directly. In cases where the generator disposes directly into a sump from which all waters are released by seepage with no surface decant, the effluent is regulated by composition not concentration. That is, if no prohibited substances are used, and all solids are contained in the sump, the leachate from the sump remains unregulated with regard to concentration of the effluent produced by the generator.

A situation similar to that described for Alberta was found in the Fraser Valley of B.C. The individual waste generators were largely unregulated except for large operations which had the potential of disrupting the equilibrium of the primary or secondary treatment facilities operated by the Greater Vancouver Regional District. The operations that had the potential to discharge suspended solids contributing to a high biological oxygen demand (BOD) in the aerobic digestion stage of waste water treatment were regulated and monitored. The EPA standards do not address nor did the development paper propose any precautions on the presence of wetting and bating agents in the effluent from this phase of the tanning process. The other major concern for these systems is the presence of solids in" the waste water stream. These solids are characterised by animal parts in the case of slaughter plants and personal hygiene accessories in the case of domestic sewage.

Chrome Tanning Stage

Chromium

Chromium has long been the most persistent and worrisome substance in tanning effluent. As the chemistry of this ancient technology has become better understood, tanners have abandoned the use of highly toxic hexavelant chrome in favour of the trivalent chromium trioxide. Hexavelant chrome is very reactive having six positive charges available for bonding in order to become chemically stable. It therefore displays the properties of other multivalent heavy metals. Trivalent chrome on the other hand quickly bonds with organic substances to become stable. If this were not the case leather garments would be the cause of serious health problems. Nonetheless, in sufficient concentration, trivalent chrome shows toxic effects on aquatic organisms and so remains a regulated substance in most jurisdictions. It is for this reason that chrome in tannery effluent continues to be under EPA standards in the U.S. "EPA has decided to regulate trivalent chromium in these pretreatment standards because the total quantity of trivalent chromium generated by this industry is nationally significant (2.6 million kg annually) . . . ."[1]

The standards set by the EPA for tanneries processing more than 275 hides per day was 12 mg/l for a daily maximum and a monthly average of 8 mg/l. In examining more than 300 tanneries to set these standards, it was found that much of the chrome in the effluent was tied up in suspended solids. When the effluent was passed through a .040" screen, the total chrome in the effluent was reduced significantly.

In the review conducted by Alberta Environment, "tannery wastes containing trivalent chromium are exempt, provided they do not contain otherwise hazardous waste", from the Hazardous Waste Regulations which are currently in draft (Andrew Cummins, Alberta Environment - personal communications) .

Trivalent chromium is widely encountered in the natural environment and is required for human health as it acts synergistically with insulin in maintaining proper blood sugar levels. The National Academy of Sciences (U.S.) considers an adequate but safe daily intake to be 0.05 to 0.20 mg/day, and assumes that chromium does not bioconcentrate in the food chain.[6]

PH

Waste waters from a chrome tanning process range from strongly acidic to strongly alkaline (pH 3 to 10) . The EPA found that the blended waste water stream from a normal tannery fell in the range of 7 to 10 pH and it is in this context that the standards for tannery effluent were proposed. As mentioned above, the high volume of lime used in the dehairing stage provides a strong buffer which serves to reduce the volatility of chemical reactions *in* the event that a strongly acid stream from the tanning step is released prematurely into the deliming and dehairing effluent.

Retanning to **Finishing**

The remainder of the tanning process is, in the first step, a repeat of the tanning phase; the dyeing to finishing steps are primarily additive in nature. That is, the reagents used are primarily introduced to be taken into the leather to impart special qualities and colour to the final product. The compounds used for finishing were researched and documentedby the EPAbut were not subjected to standards.

3.3 Effluent Disposal Options in the N.W.T.

All the waste water disposal strategies that were examined during this review showed or assumed indirect discharges of waste water. That is, the *waste* water was discharged into a temporary holding or settling facility, or was treated to a second stage of sewage treatment before it was returned to natural water courses. The EPA standards also assume that the tannery effluent would be discharged into waste water treatment systems and so the standards it set are called pretreatment standards. EPA standards that govern tannery waste water before it is introduced to a system that must meet overall standards are set by the U.S. CLEAN WATER ACT.

A cursory review of waste water treatment in the N.W.T. shows that there are no parallels in northern waste water treatment systems to those that were examined in the course of the study. In many communities waste waters are discharged directly into the environment by releasing them into the ocean, an isolated lake or pond, or in some cases onto a remote beach ridge. Few communities have primary treatment plants complemented by a settling lagoon.

In exploring waste water options for a commercial chrome tannery in the N.W.T. it becomes apparent that it may be appropriate to isolate the tannery wastes from the domestic waste water system. This approach would isolate the tannery from the municipality's water use licence and also would not place a burden on the municipal infrastructure where the entire community relies on a vacuum truck service for liquid waste disposal.

This approach is used at Norman Wells by the oil refinery. Wastes not suitable for the municipal sewage system are discharged into a percolating sump. This could also be done for a tannery. Guidelines for sumps in the N.W.T. have been developed by the Department of Indian and Northern Development (INAC) in regulating oil and gas drilling 'activities.[1] The EPA standards for tanneries and the INAC sump guidelines could be combined to safeguard against excessive discharges of substances that may have long term harmful effects in the environment.

It is noteworthy that discharging excessive volumes of reagents in a commercial venture represents unnecessary cost , and therefore for economic reasons alone it is prudent to keep the amount of reagents in the waste stream to a minimum. Appendices One and Two provide graphics showing sumps and sedimentation schematics that may be useful for waste water management.

Another option for consideration is batch pretreatment of waste water where sumps are not practised because of long term land use considerations. A simple procedure for a small tannery that would remedy the long term land use problem and still meet the environmental standards is a batch treatment of effluent before it is released to the municipal *waste* waster handling system.

Effective batch treatment of waste waters has the advantage of producing effluent that could be handled by the municipal waste water handling system, be it a sewage main or a sewage vacuum truck. A small tannery is ideally suited to batch treatment since all phases of the tanning process would be done in batches of 50, 100 or perhaps 200 hides at a time. Successive stages would likely use the same soaking and mixing drums. Such procedures lend themselves to a batch treatment strategy for effluents.

3.4 Effects on Human Health

Direct contact with industrial chemicals are to be avoided, as even relatively minor exposures if they occur frequently, can eventually build up to toxic levels.[1] Another source of exposure are vapours from finishing solvents. Some solvents have relatively high toxicity and should be carefully controlled. Leather dust has been listed by the European Commission (EC) as a potential carcinogen.[1]

4.0 TANNERY ENVIRONMENTAL GUIDELINES

There does not exist any specific legislation on tanneries in the Northwest Territories. However, to allow a tanner to meet the increasingly stringent environmental goals now being laid down by authorities, a set of recommended guidelines are outlined.

A framework of environmental guidelines, if effectively followed, can help ensure that (1) appropriate planning is carried out; (2) the tannery meets certain environmental quality and safety standards; and, (3) its off-site impact on the community at large is within acceptable limits.

The principal environmental requirements which can affect a new tannery operation in the Northwest Territories include[7]

Land-use planning permits and zoning (i.e. siting).

EIA (Environmental Impact Assessment) and Risk Assessment.

Controls in effluent discharges, sludge, solid waste disposal and air emissions.

Limits for occupational exposure and risk to workers.

Standards for storage, transport, labelling and packaging of chemicals.

Environmental Management Plan.

4.1 Land-Use Planning Permits and Siting of Installations

The siting of a tannery is a critical decision that must be thoroughly evaluated. The issue of greatest environmental concerns are the odours frequently associated with tanneries. The guidelines useful in developing land-use planning requirements include the following:

- tanneries should be classed as "potentially offensive" unless very high standards of plant design and operation are adopted. Where lower standards are applied, extensive setbacks from habitation areas are recommended;

- siting permission should ideally be accompanied by an operating permit that allows ongoing control over operation during the life of the plant;

- siting close to sewers, natural bodies of water or evaporation lagoons, is to be preferred;

- odour-free operation to the greatest extent possible should be the objective of plant design;

- all local zoning regulations and criteria are to be complied with and approvals obtained prior to the construction of the plant.

4.2 Environmental Assessments

The prior environmental assessment of a new tannery project is an integral part of land-use planning. It is also useful in evaluating the adequacy of processing technologies to be used. There is no regulatory requirement for a tannery in the Northwest Territories to perform a formal Environmental Impact Assessment (EIA). It is, however, recommended that the checklist given in Table 4.1 be followed for assessing a tannery's environmental impact.

Table 4.1 CHECKLIST FOR ASSESSING A TANNERY'S ENVIRONMENTAL IMPACT[(1)]
Water pollution from uncontrolled storm drainage
water pollution from effluents and waste waters
Water pollution from spills and accidents
Groundwater pollution from ponds, pits, lagoons, holding tanks
Groundwater pollution from effluent disposal to land
Groundwater pollution from waste dumps
Impact on sewage treatment systems
Impact on sewers and drains
Soil pollution from effluents and waste waters
Soil pollution from sludges and residues
Contamination of land from spills
Odours and nuisance from decomposing wastes and chemicals
Toxic gas emission from chemicals, wastes and effluents
Industrial hazards from chemicals - contact, fumes
Hazards from treated hides (handling, effluent)
Public hazards of waste dumps - chemicals, wastes, containers
Noise, smoke, dust
Water consumption
Storage safety of chemicals
Energy consumption
Transport of chemicals, wastes and general materials
Use of land which is ecologically valuable

Each item provides a starting point for a systematic examination of the particular impact, how it might be reduced, and whether alternatives are available that could avoid the impact altogether. The checklist can also be used by plant designers and regulatory authorities.

4.3 Guidelines for Environmental Releases

Tanneries in general are pollution intensive, industrial complexes, generating comparatively large volumes of high concentration waste water. Untreated tannery wastes in surface water can bring about a rapid deterioration of their physical, chemical and biological qualities. Wastes may give rise to noxious odours from the decomposition of organic matters. In order to avoid adverse environmental effects a set of guidelines are recommended for (1) waste water releases; (2) sludge and waste disposal; and, (3) air emission.

The guidelines frequently express concentrations in mg/kg or mg/l. To gain some perspective that how much is a **mg/kg (milligram** per **kilogram)** , consider the following:

> If a person drinks about two quarts of water a day containing 1 **mg/kg** of a metal, **it** would take **over** half a year to consume 500 mg, **which is** the weight of an extra-strength headache tablet.
>
> Note: One **mg/kg** = one part per million **(ppm)** .

4.3.1 Waste Water Releases

Guidelines for three options are outlined below:

OPTION A: Discharge to natural bodies of water or to sewage lagoons.

EPA pretreatment and other quality standards [2] for effluent from a chrome tannery (producing wet blue and finished leather) are recommended for the Northwest Territories. The discharge criteria are given in Table 4.2

Table 4.2

DISCHARGE STANDARDS FOR N.W.T. TANNERY WASTE WATER

PARAMETERS	CONCENTRATION LIMITS NOT TO BE EXCEEDED		*COMMENTS*
pH	**6.0 - 9.0**		EPA Standards[2]
Sulphide	24 mg/l		EPA Standards[2]
	Max. **Per Day**	**Max. Per** Month	
Total Chromium	12 mg/l	8 mg/l	EPA Standards[2]
BOD	6.0	2.7	EPA Standards expressed in kg/1000kg
TSS	**8.7**	**4.0**	EPA Standards expressed in kg/1000kg
Oil & Grease	**2.5**	1.1	EPA Standards expressed in kg/1000kg
Total Chromium	0.16	0.06	EPA Standards expressed in kg/1000kg

Pass all waste water through a 0.4" screen prior to discharge. Recommended by authors.

OPTION B: Discharge to Sumps.

If a chrome tannery is proposed for a community that has no waste water treatment infrastructure, it is recommended that the tannery be sited so that its waste waters can be discharged directly into a percolating sump. The INAC sump guidelines[2] are proposed as a standard to follow. Care should be taken so that the site is in ice poor soils so that progressive permafrost warming does not produce slumping and so threaten the integrity of the sump. Further, care should be taken so that the sump is bermed to avoid spring time flooding of the sump which could result in sump contents decanting into the normal surface drainage waters of the community. The sump guidelines specify water quality properties in the event that a decant is necessary for any reason.

The INAC[7] sump guidelines and EPA[2] tannery guidelines are integrated below in Table 4.3.

Table 4.3

SUMP DISCHARGE STANDARDS FOR N.W.T. TANNERIES' WASTE WATER

PARAMETERS	CONCENTRATION LIMITS NOT TO BE EXCEEDED		COMMENTS
pH	5.5 - 10.0		INAC sump guidelines(7): 5.5-8.5 EPA Standards(2): 7.0 - 10.0
Chloride	1000 mg/l		INAC limits for decant(7)
Sulphate	2000 mg/l		INAC limits for decant(7)
Total Dissolved Solids	4000 mg/l		INAC limits for decant(7)
Sulphide	24 mg/l		EPA Pretreatment Standards(2)
	Max. Per Day	Avg. Max. Per Month	
Total Chromium	12 mg/l	8 mg/l	EPA Standards(2)
BOD	6.0	2.7	EPA Standards expressed in kg/1000 kg
T S S	8.7	4.0	EPA Standards expressed in kg/1000 kg
Oil & Grease	2.5	1.1	EPA Standards expressed in kg/1000 kg
Total Chromium	0.16	0.06	EPA Standards expressed in kg/1000 kg

Pass all waste water through a .0411 screen prior to discharge. Recommended by authors.

A tannery development that adopts this siting and waste water strategy avoids two commonly perceived problems associated with tanneries. It will isolate all waste waters in a way that does not threaten municipal infrastructure nor place waste water volume and quality burdens on the municipal infrastructure.

A serious drawback to the sump disposal option is the long term effects on the soil that may be contaminated with percolating wastes from the sump. Without an expensive hydrological examination of the groundwater drainage patterns emanating from the sump, it is impossible to know, what the ultimate distribution of contaminated soils is likely to be. This may have serious future implications for long term urban development and land use in the community.

OPTION C: Batch Treatment of Waste Water

In cases where long term land-use problems in the community would not permit the sump disposal option, a batch treatment of effluent, prior to its release to the municipal waste water handling system, is recommended.

Chrome Precipitation

The effluent from the chrome tanning stage should be treated with lime to bind all remaining free chromium in a calcium salt precipitate. The alkaline pH of the effluent would also ensure that all remaining greases and fats would be dissolved and so pose no problem to the municipal waste water system. (Note: the precipitated solids remaining as sludge should be contained in drums and disposed of in a manner similar to hazardous wastes like waste lubricating oil) .

Settling

A significant part of the COD load of raw waste water is due to organic solids. If is recommended therefore that all waste water from different streams be discharged to a holding tank and be allowed to settle to remove suspended solids before passing the decant through a .04″ screen.

The shapes and dimensions of tanks and basins are critical in achieving a good settling rate. Horizontal flow tanks, while cheap, have low efficiency. Vertical sedimentation tanks are recommended as they are more efficient and cost-effective (for tanneries) [6] than horizontal tanks,

The settling tanks may be steel or **fibreglass.** For **self-desludging,** 60° angles for the walls are recommended as shown in Figure **4.1**

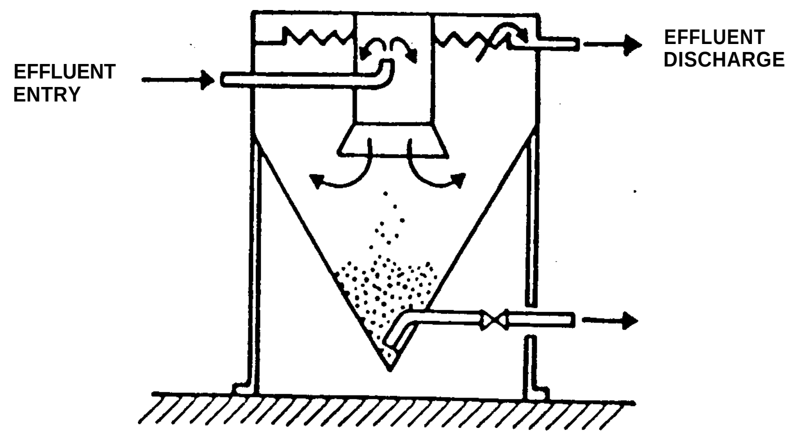

Figure 4.1 Vertical Flow Settling Tank

The basic requirements are for some degree of turbulence at the inlet to ensure **mixing** and encourage flocculation. Turbulence must be avoided in the rest of the unit. The solids settle under gravity and concentrate at the base and removed from the bottom. The clarified effluent is gently drawn off at top at a recommended flow rate in the range of 1.0-1.5 m^3/hr.[1]

Discharge of Effluents

The effluent discharges should meet the standards outlined in Table 4.1. In cases where these standards are not met, dosing with coagulant and **flocculants** are recommended. Coagulation is easily achieved with aluminum **sulphate,** which is cheap, readily available and effective. The efficiency of coagulation can be enhanced by the addition of flocculants, long chain anionic polyelectrolytes, usually at concentrations of 1-10 mg/l.

4.3.2 Disposal of Sludge and Solid Process Waste

Due to the problems of leachate generation, it is recommended that only solids, free of chrome precipitates, be disposed of at landfill sites. The use of "dumpsites" should be avoided as they are uncontrolled landfill sites, usually already suffering from serious local environmental problems. The tanning sludges should be immediately covered with inert material to avoid odour generation and insect infestation.

Chromium sludges in moderate quantities are unlikely to cause serious problems in normal landfills. There has nevertheless been a vigorous debate for some time concerning the environmental hazards of precipitated trivalent chrome, in sludge, disposed to landfill. Much of this debate centers around the possibility of re-conversion to, and leaking of, the more toxic hexavelant form. There is no consensus however of the environmental effects of trivadent chrome(l)

It is, therefore, recommended that the precipitated chrome sludge be contained in a drum and disposed of according to the Northwest Territories' regulations for hazardous wastes like waste lubricating oil.

Landfills which receive other industrial residues, particularly acidic wastes, may not be suitable for receiving tannery wastes. Acidic wastes can react with the tannery wastes, perhaps liberating toxic hydrogen sulphide gas. Similarly, the decomposition of domestic refuse can lead to the formation of acidic conditions in the fill. Periodic monitoring of the leachate is recommended, where such conditions in the landfill exist.

The option of incineration for solid waste disposal in the Northwest Territories is not recommended. Incineration technology is extremely complex and must be performed under controlled conditions by highly trained personnel. Incineration under uncontrolled conditions would lead to unacceptable emissions.

4.3.3 Air Emission Standards

Apart from odour, few serious air impacts are expected outside the tannery. Within the tannery, solvent vapours may be a serious occupational hazard, as is the unintentional generation of hydrogen sulphide (H_2S).

Odour Guidelines:

Tannery odour from biological decomposition of organic materials should be minimized by using biological filters. Currently there are no standards for odour control. The Comporting Council of Canada has proposed qualitative guidelines.

It is recommended by the Science Institute that N.W.T. tanneries should adopt a qualitative guideline as follows:

> The odour emanating from a tannery should not exceed the odour emanating downwind from a sewage truck in a Northwest Territories' community at a distance of 100 metres from the truck.

4.4 Limits for Occupational Exposure and Risk to Workers

A number of tannery processes are capable of posing a hazard to workers. The general Industrial occupational Health and Safety Regulations for the Northwest Territories should be followed.

Limiting exposure to chromium compounds and solvent vapours is also recommended. The guidelines will be issued by the Territorial authorities.

Well planned organizational procedures to maintain safety and health in the Northwest Territories are recommended. Some essential aspects of such procedures are[1]:

- provision by management of safe working conditions and procedures;
- participation by the workforce in ensuring safety at work;

- clear allocation of responsibilities for safety and health services;
- safety training and instruction, both introductory and on-going;
- reporting, investigation and analysis of accidents and working conditions;
- dissemination of information on hazards and risks;
- cooperation with 1abour and safety inspections and reviews.

It should be emphasized that these are not trivial issues. Exposure of tannery workers to chemicals is often insufficiently acknowledged. Their exposure to chrome, solvents and finishing agents leads to well documented illnesses. Accidental poisoning by hydrogen sulphide is also well recorded[2].

4.5 Standards for Storage, Transport, Labelling & Packaging Chemicals

Tanneries in the Northwest Territories, like other industries handling chemicals, must follow specific Canadian Federal and Territorial Government requirements and regulations.

All suppliers of reagents must include a data sheet with the product which sets out the storage and handling requirements for the specific compounds. This requirement is a condition of sale as required by the HAZARDOUS PRODUCTS ACT (Canada) and the CONTROLLED PRODUCTIONS REGULATIONS issued under the Act. The safety labels required of the suppliers advises the user of:

- the name of the product
- the appropriate hazard symbol(s)
- the risk description, (i.e.) flammable, irritant to eye and skin
- precautionary measures for handling and storage
- first aid measures in case of emergency

All tannery employees should be trained in the use, handling and emergency response to accidents with the reagents needed for tanning.

4.6 Environmental Management Plan

The implementation of the environmental guidelines discussed in the previous sections can be effectively carried out by developing a systematically coordinated Environmental Management Plan.

Environmental Audit

A useful management tool is the environmental audit. This should not only review compliance with guidelines but also should look at wider aspects, such as reporting, operation and staff training. Through such techniques tannery management can become more aware of its general ability to achieve a high level of environmental performance in all areas of concern[1]. The following Environmental Awareness Checklist for Management, as shown in Table 4.1, is recommended.

Table 4.1

ENVIRONMENTAL AWARENESS CHECKLIST FOR MANAGEMENT[(1)]

'he items in this checklist concern factors that can .ssist management in systematically achieving high environmental performance. They involve, in particular, :he personal and organizational elements that lead to ›rompt recognition of problems, and to effective action :o correct them.

Eenvironmental ›riorities and ›olicies	Environmental objectives have been clearly defined; Environmental issues of air, water and soil pollution are understood; Environmental impacts of chemicals, wastes and noise are understood; Knowledge of the national and Territorial environmental programme is up-to-date.
⁄ianagement	Environmental and safety responsibilities are clearly allocated; Staff training programmed are defined and carried out; Environmental news updates are received and used; Monitoring results are regularly received and acted upon; Staff incentive schemes exist for safety and environmental performance.
Regulatory Requirements	Pollution regulations - air, waste, and soil standards are known; Health regulations (workPlace) are known; Chemical regulations (handling, transport and labelling) are known.
Operational Information	Waste audits are periodically carried out; Chemical safety data are available; Analytical procedures are understood; Laboratory and trained personnel exist on-site; Monitoring data are compiled and submitted according to a schedule; Monitoring data are checked by personnel with appropriate responsibility.

Waste Audit:

One of the highly recommended tools that pinpoints environmental problem areas within the plant is "Waste Audit". The purpose of the waste audit is to look at specific sources of waste within the plant and develop methodologies for its reduction. The recommended essential steps in carrying out a "waste audit" are shown in Table 4.2.

Table 4.2
STEPS IN CARRYING OUT A WASTE AUDIT

PHASE 1:	**Understand the process in the plant** • List unit processes • Construct a process flow diagram
PHASE 2:	Define the process inputs . Determine resource usage • Check storage and handling losses . Record waste usage . Determine current level of waste reuse
PHASE 3:	Define the process outputs . Quantify the process outputs • Account for waste water flow and strength • Document wastes stored and disposed of
PHASE 4:	Carry out a materials balance study • Summarize process inputs and outputs • Work out materials balance for unit processes • Evaluate the imbalance of materials • Refine the materials balance
PHASE 5:	Identify waste reduction options • List the obvious measures • Examine the problem waste streams . List the long-term options
PHASE 6:	Implement an action plan • Carry out a cost/benefit analysis for options • Select measures for immediate implementation • Start action on long-term measures

Adapted from: "Industrial Waste Audit and Reduction Manual", Ontario Waste Management Corporation

5.0 ENVIRONMENTAL PRINCIPLES

The International Council of Tanners (ICT) has prepared a statement of environmental principles to serve as a model for the tanning industry. It is recommended that the emerging Northwest Territories' industry adopt the ICT principles outlined in Appendix 3.

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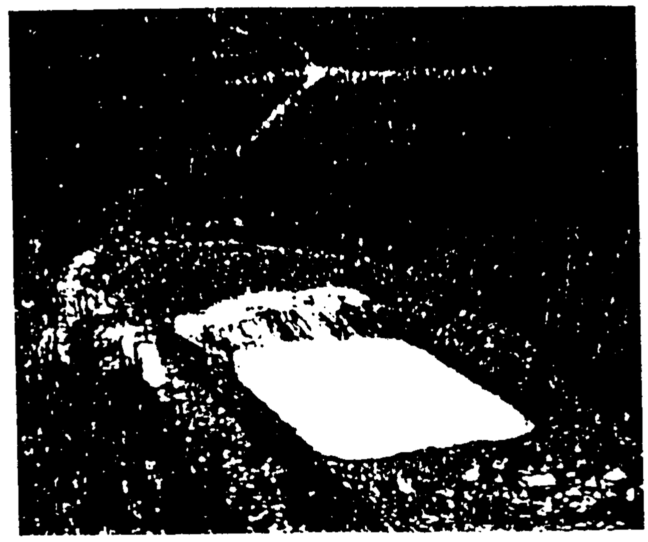
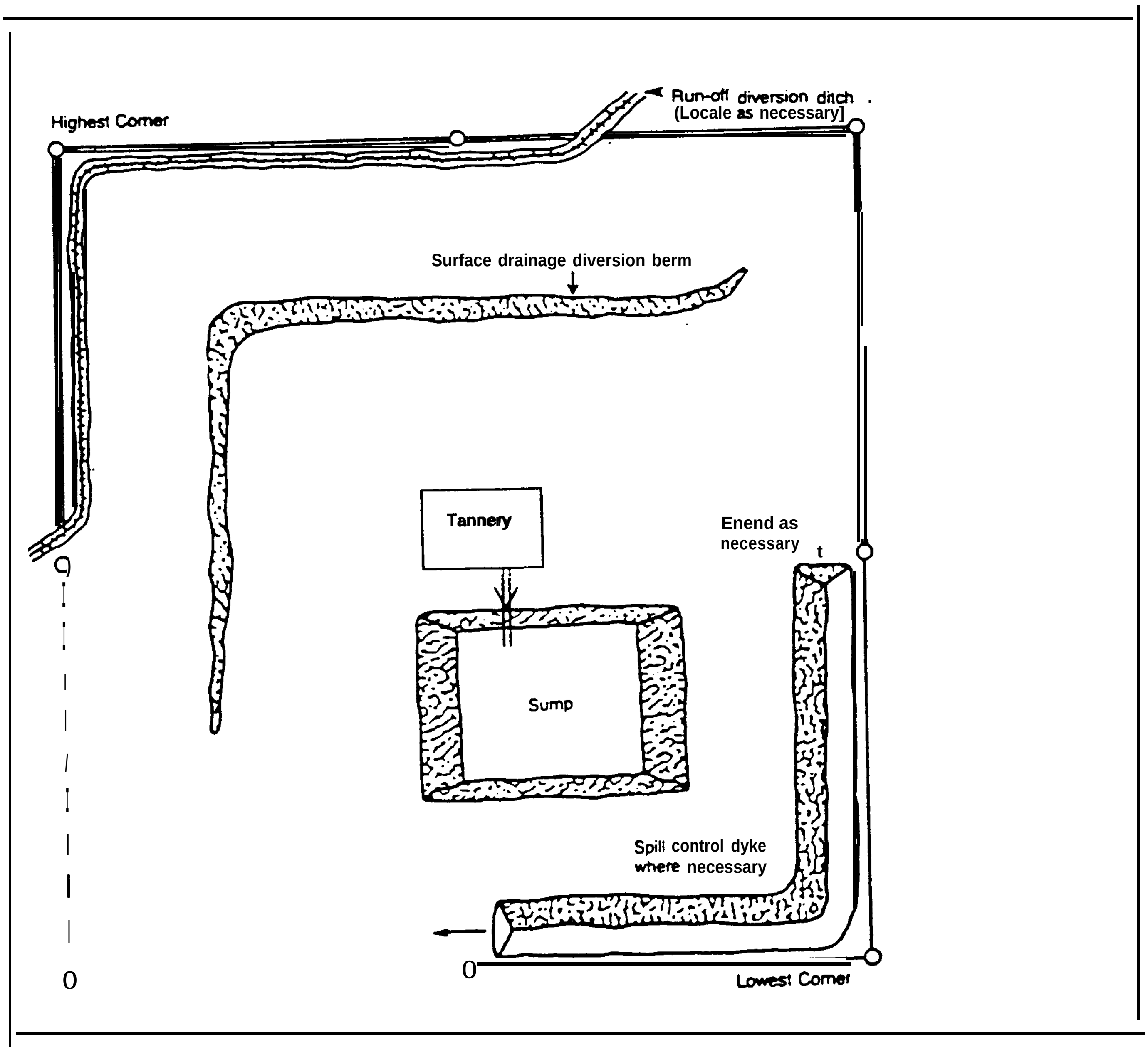
Appendix ONE

Selected illustrations of sumps.

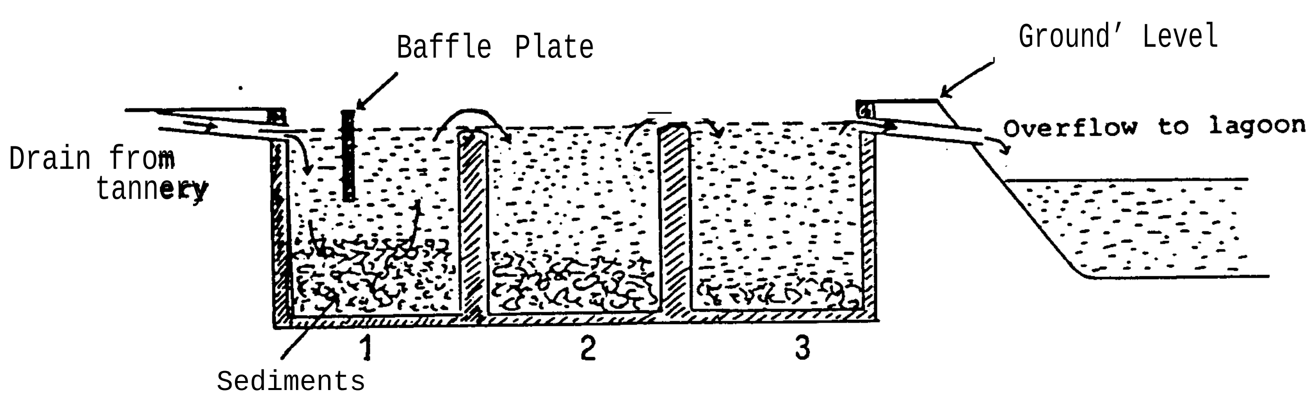
(Adapted from Indian and Northern Affairs Canada 1986)



Remote sump with vacuum truck access



Effluent settling **tanks and lagoon**



International Council of Tanners

Conseil International des Tanneurs
Internationale Gerbervereinigung
Consiglio Internazionale dei Conciatori
Consego Internacional de Curtidores

Operational Secretariat:
186 High Street, Lewes, East Sussex, BN7 2NP England. Telephone & Fax: (0273) 472149 Telex: 878149 Bricen G

STATEMENT OF THE INTERNATIONAL LEATHER INDUSTRY PRINCIPLES . FOR IMPROVED ENVIRONMENTAL, HEALTH AND SAFETY PERFORMANCE

The leather industry accepts responsibility for taking 'its own initiatives to safeguard the environment, health and safety in addition to compliance with the law. It recognises that such initiatives are a civic obligation as well as good business and marketing practice.

The International Council of Tanners has prepared the following statement of principle in order to encourage the industry in the development and implementation of performance improvement programs.

Associations and companies should:-

1. be sensitive and responsive to public concern about pollution and the environmental impact of leather-making processes;
2. promote an individual commitment to protect health, safety and the environment amongst all levels of management and employees;
3. assess adequately the environmental, health and safety implications of new and monitor the effects of existing products, processes and operations at all stages of supply, production and marketing;
4. adopt, use and encourage the supply of processes, operations, chemicals and materials which have low-risk environmental, health and safety impacts;
5. advise all levels of staff on the safe use, storage, handling, transportation and disposal of chemicals and other potentially harmful products;
6. foster cooperation between appropriate trade sectors (hide, skin and leather suppliers and producers at all stages of the supply and production chain, equipment, chemical and other manufacturers and ancillary groups) in order to initiate action on environmental matters where a joint approach may be effective or necessary;
7. conduct and support research to reduce possible damage to people and the environment from leather industry products, processes and waste materials;
8. encourage technological training and education in low waste techniques which are environmentally friendly and reduce the risk of harm to workers, customers and the public;
9. provide information to enable authorities, employees, customers and the public to understand any potential health, safety and environmental effects of tannery operations and processes;
10. cooperate with authorities and others to encourage the development of soundly based practical laws and regulation to safeguard the public, workers and the environment.

6 June 1990

Nominal Headquarters: Leather Trade House, Kings Park Road. Moulton Park. Northampton NN3 IJD

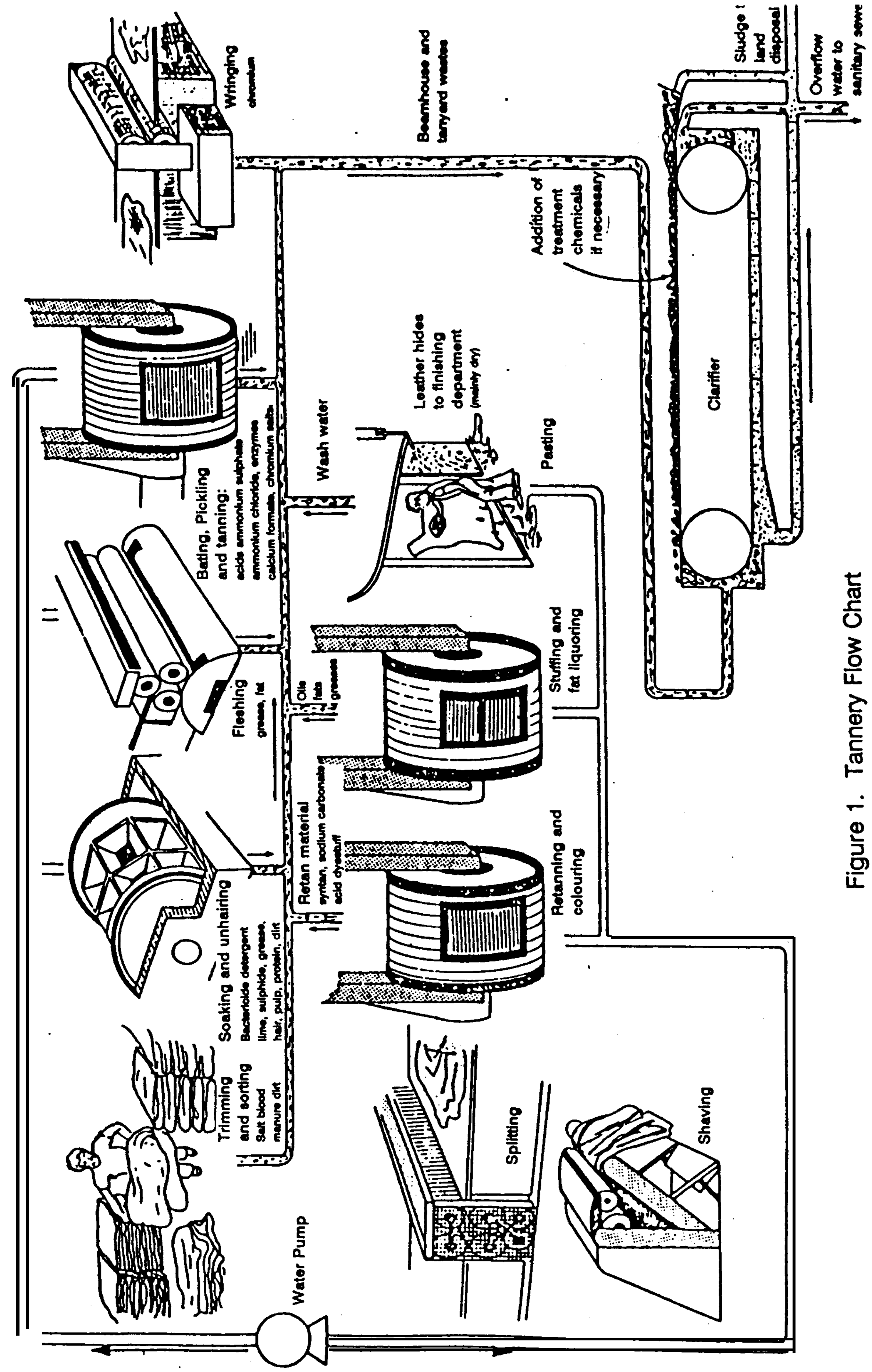


Figure 1. Tannery Flow Chart

FIGURE 2

SCHEMATIC OF THE TANNING PROCESS