CHAPTER 10
WASTE DISPOSAL

10-1. General. Wastes from desalination systems include solids, liquids, and gases. Evaluate each desalination system to determine its particular waste products, then use the appropriate systems to treat or contain these wastes. A waste disposal overview is shown in figure 10-1. The designer shall also refer to TM's 5-813-3 and 5-813-7 for additional guidance.

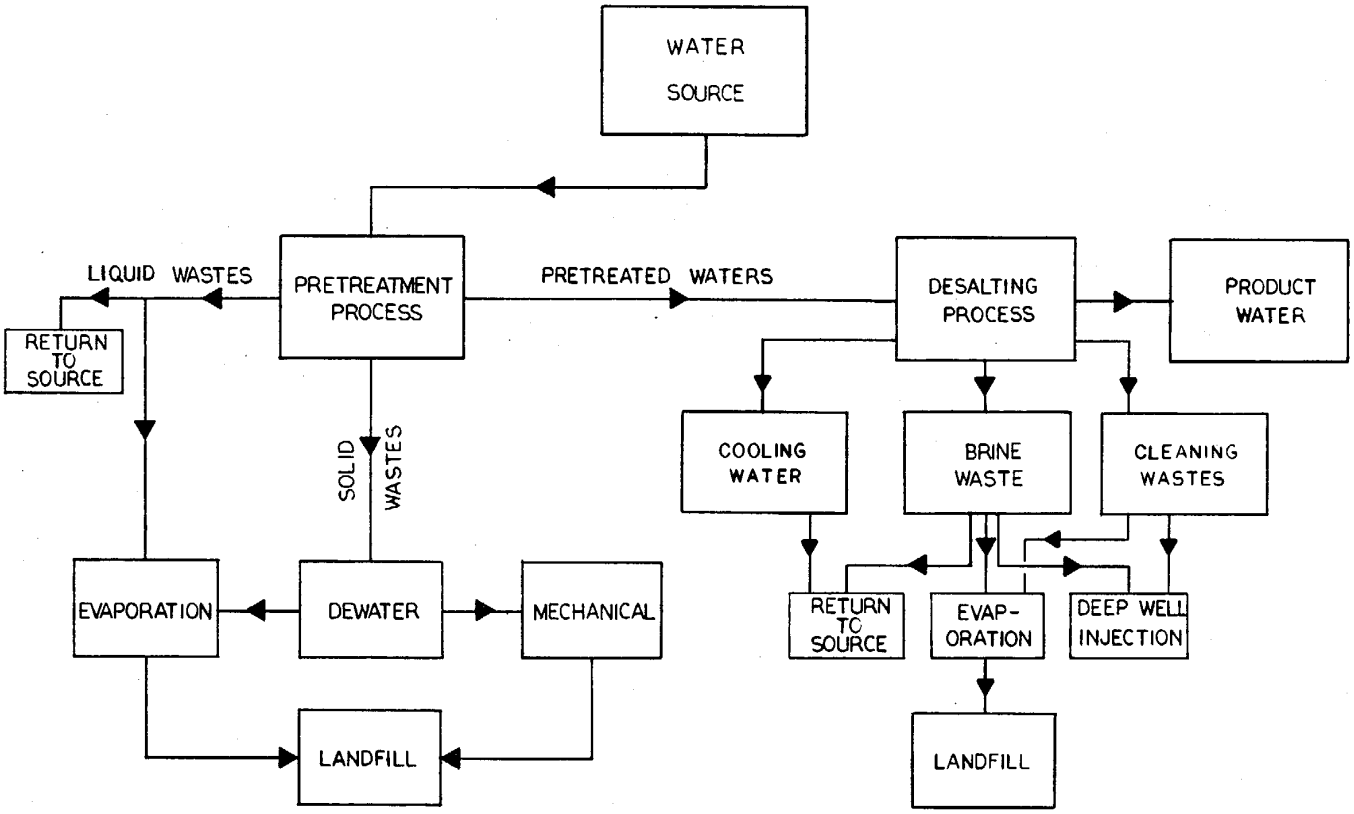


Figure 10-1. Waste disposal overview.

10-2. Pretreatment wastes. Systems that require pretreatment processes produce pretreatment wastes. Solid materials, and the chemicals added to precipitate them, form floc that will be removed from raw water by clarification. The sludges formed must undergo dewatering and are sent to a landfill. Dewatering processes can be mechanical, which are centrifugation or press operations, or evaporative, which are solar beds or lagoon operations. The alternatives for pretreatment sludge disposal are shown in figure 10-2. In addition to solid wastes, pretreatment processes can produce liquid wastes from filter backwash operations. These liquid wastes often can be reclaimed or treated along with other liquid wastes from desalination process.

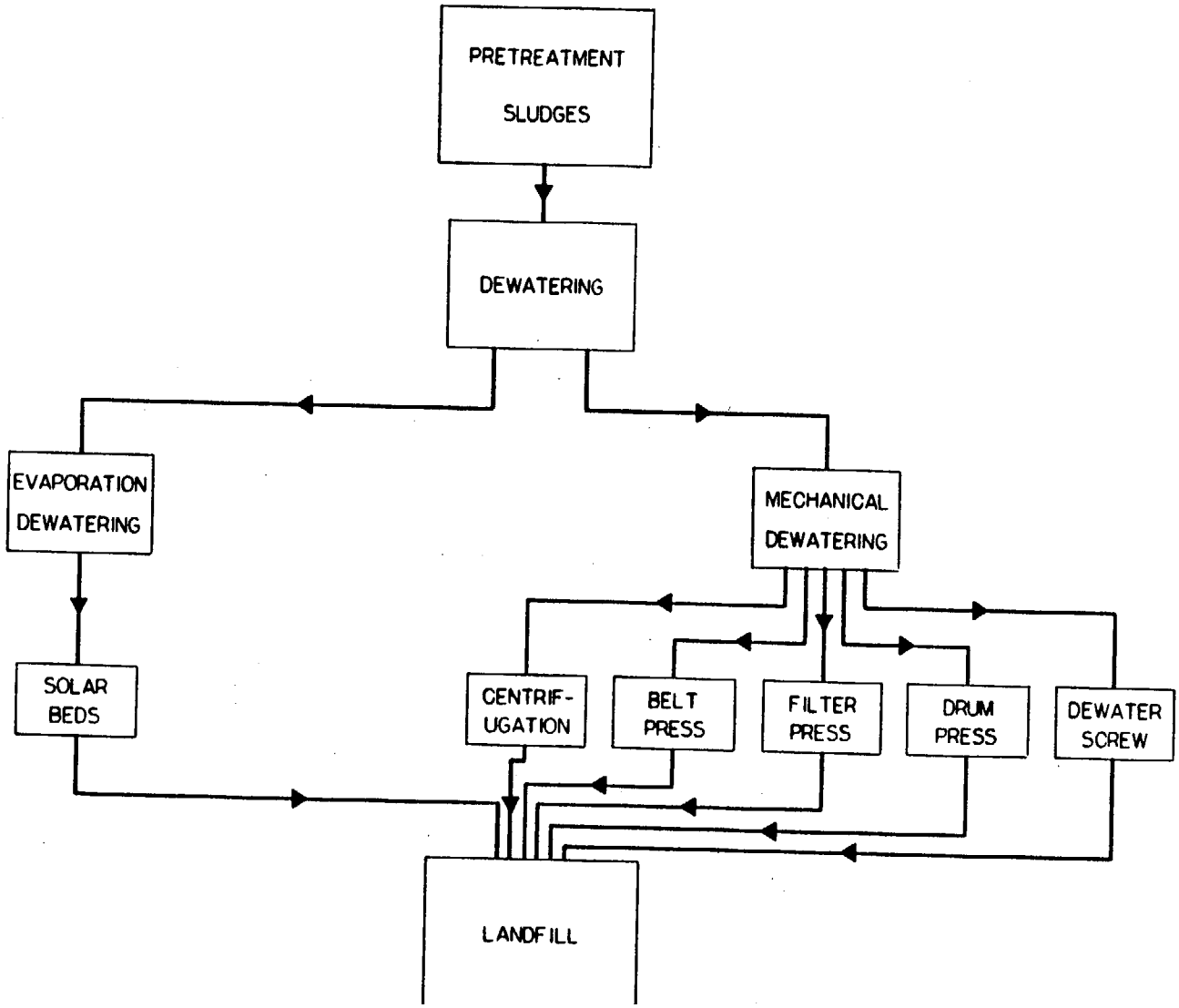


Figure 10-2. Pretreatment sludge disposal.

10-3. Distillation / condensation system wastes. The waste stream volume produced by distillation/condensation systems is usually less than that produced by other desalination processes. The vaporization process yields concentrated brine with a reduced liquid waste loading. The use of less extensive pretreatment requirements for these systems generally results in a reduction of solid wastes. The cooling water discharge produced by many distillation processes does present a separate thermal discharge problem.

a. Brine return to source. The brines from distillation/condensation processes are highly concentrated. For this reason, brines will be discharged where contamination of the intake water will not occur. The liquid brines will be returned to the raw water source if impact studies show there will be no significant environmental impact. Wetlands and estuarian areas that are often used for discharge are usually productive growth sites for many valuable food species. These areas are easily damaged by thermal discharges and require study to ensure that they are acceptable disposal areas for concentrated desalination waste liquids.

b. Brine evaporation. If it is not feasible to return the brines to the raw water source, then consider the use of evaporation ponds to dry the liquid wastes. The thermal nature of the brine from most distillation/condensation systems can aid evaporation of the wastes to dry salts. In areas where the net evaporation rate is low, but thermal energy sources are available, use thermal evaporation. Thermal evaporation has high energy requirements and usually is not cost-effective.

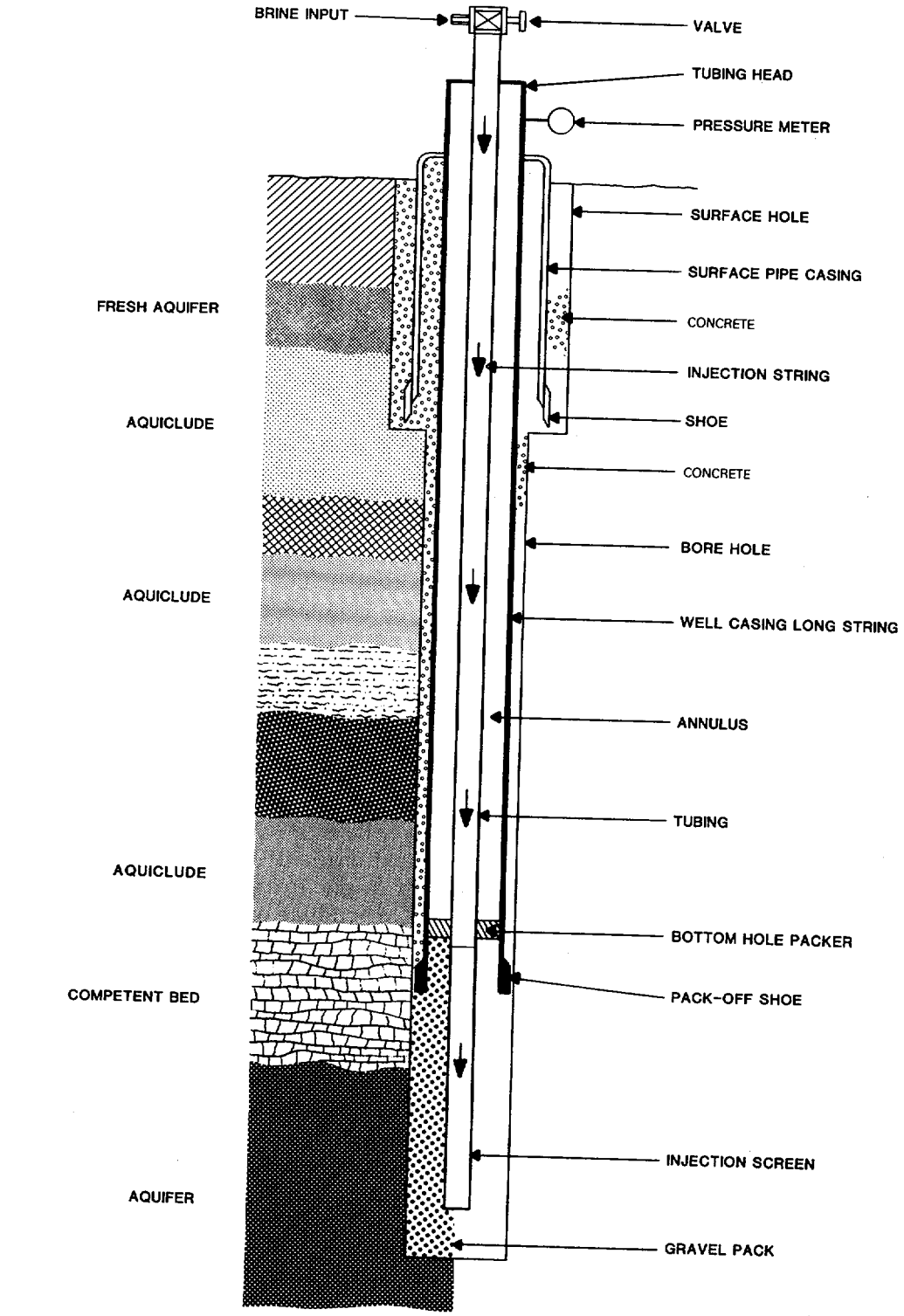
c. Brine deep-well injection. If discharging the brine to a surface water or evaporation is impractical or uneconomical, deep-well injection of brines is possible. The injection of liquid wastes to deep underground formations can provide a disposal alternative where none was previously available. To properly design and install a deep-well injection facility, a complete geologic and geochemical analysis of the reservoir formation is required. Volumes of less than 53 gallons per minute can be disposed of practically in injection wells, while volumes in excess of 264 gallons per minute will be much more difficult to dispose of by use of this method. Compatibility tests must be run between the proposed waste and a sample of the formation water. This test should ensure that the two waters do not react to form precipitates that may clog the receiving formation. The receiving formation must be separated from any fresh water or the desalination source water by an aquiclude that will ensure that the brine will not contaminate them. The area must be checked for geologic faults and any manmade penetrations of the aquiclude. The brine must contain less than 15 milligrams per liter of suspended solids, with a maximum size of 20 microns. Figure 10-3 shows a typical injection well. High construction and operating costs and the potential for serious operational problems usually cause deep-well injection to be the last process selected. If deep-well injection, evaporation, or return-to-source liquid-disposal options are not possible, review the entire facility location.

d. Dried salts. When evaporation processes have reduced the brines to dry salts, make evaluations to determine a market value for these salts, as some salts have a value when dried. A landfill operation must be maintained when no market value can be assigned to the dried salts. An overview of brine wastes disposal is shown in figure 10-4.

e. Use of brine. Desalination evaporation ponds make excellent solar stratification ponds. These ponds can be used to produce a stored thermal energy gradient, which can be harvested with a Rankin cycle engine. Electricity from such a system can be used to electrolytically produce chlorine. The total disposal of brine by chlorine production is not expected to ever be economical for the military. The internal production of chlorine for water disinfection is strategic. Presently, the smallest systems available produce over 22 pounds of chlorine per day. The brine concentration must be greater than above 35,000 milligrams of total dissolved solids to be practical. Any hardness in the brine limits efficiency and causes scaling.

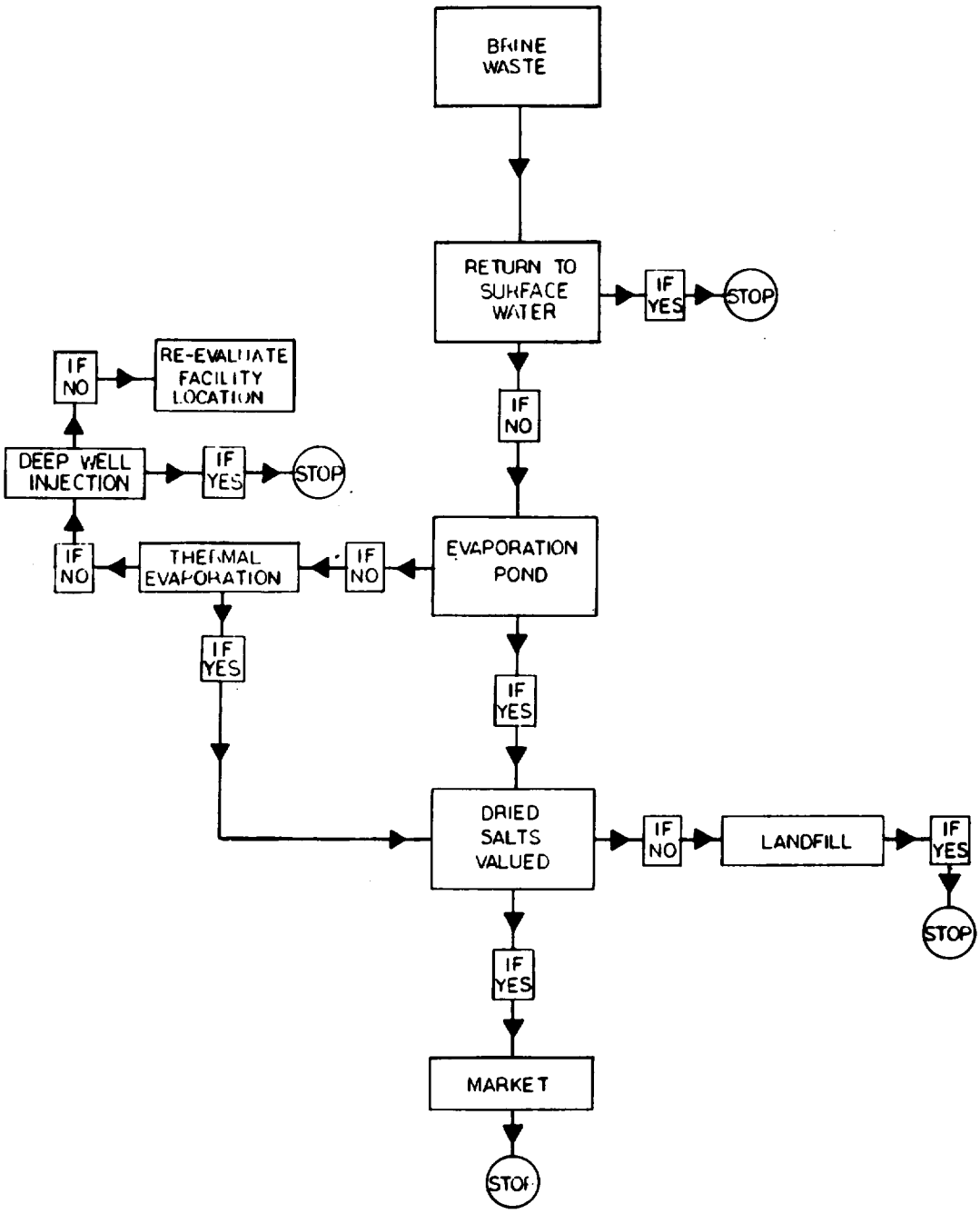
f. Cleaning wastes. At regular intervals, distillation systems must be cleaned. This usually involves strong acid cleaning solutions. These solutions must be neutralized and may require lime precipitation of heavy metals before they can be discharged. These wastes can be dried in evaporation ponds or disposed of in injection wells. The volume of cleaning waste is small enough that transportation of the cleaning wastes to commercial hazardous waste disposal facilities is a third alternative. The operation of pretreatment scale control can reduce the frequency of cleaning.

g. Gases. Gas wastes from desalination processes are removed from the system during deaeration or distillation. These gases include



Source: U.S. Army Corps of Engineers

Figure 10-3. Deep-well disposal unit.



Source U. S. Army Corps of Engineers

Figure 10-4. Brine waste disposal.

carbon dioxide, nitrogen, and oxygen and require no special disposal or monitoring facilities. When hydrogen sulfide gas is removed from raw feed water or toxic and explosive gasses such as methane are generated in waste treatment process, special precautions must be taken for its safe discharge.

10-4. Membrane system wastes.

Membrane desalination systems are the most efficient potable water procedures. However, they produce the most pretreatment wastes, a less concentrated brine waste, and spent membrane modules.

a. Brines. Brines produced from membrane

desalination are usually less concentrated and are at a lower temperature than distillation/ condensation system brines. The concentration and temperature of these membrane brines make them ideal for disposal by return-to-source technology if it is approved by regulatory authorities. Other methods, such as evaporation or injection, can be used.

b. Membrane modules. Membranes can become fouled, compacted, or destroyed during the normal course of membrane desalination operation. None of the membrane systems in current use present health or environmental hazards when disposed in a landfill. It is customary for the membrane manufacturers to dispose of defective membranes and their modules when replacement is necessary.

10-5. Ion-exchange system wastes. Neutralize the acid and caustic solutions from ion-exchange regeneration. Then dispose of wastes as concentrated brines. The only other major waste product from ion-exchange systems is the ion-exchange bed itself. Resins that are spent and not to be regenerated can be placed in a landfill.

10-6. Ultimate disposal. All waste streams from desalination processes must reach a point of ultimate or final disposal. Without adequate waste disposal facilities, site development cannot continue.