Chapter 5

Environmental Considerations

The primary or direct impacts from desalination are typically associated with the disposal of the waste concentrates produced during desalination and the disposal of sludges from the pretreatment of incoming feed water. Both types of impacts are briefly described in the following paragraphs. It is important to remember that the construction and operation of a desalination facility can create many other secondary or indirect impacts that may be associated with transporting raw water to the plant, generating electric power, etc. Indirect impacts are not covered in this chapter, but should be considered in planning specific projects.

WASTE CONCENTRATES

All desalination processes produce a high-salinity waste concentrate that must be disposed of. The fraction of feedwater that becomes wastewater depends on the desalination process used (table 4), the plant design, the feedwater composition, and the type of concentrate treatment required prior to disposal. The amount of waste concentrate can be minimized by further desalinating the waste concentrate(s) produced from the first stages of desalination. The greater the percentage of feed water recovered, the smaller the amount of concentrate that must be disposed of, but the higher the concentration of salt and other dissolved chemicals in the concentrate. The moderately elevated temperature of waste concentrates may also cause potential ecological changes in the immediate vicinity of concentrate discharges in marine environments. The composition of the waste concentrates generally makes them unsuited for most subsequent industrial, municipal, or agricultural uses.

Waste concentrates from brackish water reverse osmosis (RO) and electrodialysis (ED) plants have been disposed of in a number of ways including: pumping into lined evaporation ponds, injection into underground rock formations, spreading on unusable arid land, or discharging through a pipeline into sewers, rivers, or the ocean. The waste concentrate from seawater RO and distillation plants would probably be discharged into adjacent marine environments. All disposal options require site specific evaluations of costs and potential environmental impacts. To date the problems associated with the disposal of waste concentrates have generally not been significant enough to override a decision to build a desalination plant. However, with increasingly stringent environmental and regulatory programs, the disposal of wrote concentrates could become a primary consideration in siting future plants. Disposal costs could conceivably make some proposed desalination operations uneconomical.

When evaluating several alternatives for increasing supplies of freshwater, it is important to evaluate the potential environmental problems associated with the development of conventional sources of freshwater. For example, diversions from lakes and rivers may reduce natural flows and adversely impact the environment. This may cause interregion-

Table 4.-Waste Concentrate Generation[a]

Process	Percent recovery of feed water	Percent disposed as waste concentrate
Brackish water RO1	50 to 80	20 to 50
Seawater RO	20 to 40	60 to 80
ED	80 to 90	10 to 20
Distillation	25 to 65	5 to 75

[a]In determining the amount of waste concentrate requiring disposal, the percentage of salt rejected during desalination must also be considered. If the salt rejection rate after one pass through the system Is too low, the product water from the first pass may have to be treated again. Sequential processing could Increase the amount of concentrate requiring disposal as well as the overall cost of the desalination operation.

SOURCE: Office of Technology Assessment, 19s7.

al political controversy that effectively limits opportunities to develop additional freshwater supplies for growing metropolitan areas, particularly in the arid and semi-arid West.

Land Disposal

Concentrate disposal can be a very significant problem in inland areas where the disposal options are generally limited to evaporation ponds (lined with an impervious material to prevent seepage), or to deep injection wells. Disposal costs may range from 5 to 33 percent of the total cost of desalination depending on the characteristics of the waste concentrate, the level to which the concentrate must be treated prior to disposal, the means of disposal, and the nature of the disposal environment (64). With any type of land disposal there are risks of groundwater contamination.

Deep well injection of waste concentrates into subsurface strata several thousand feet deep is often used in inland areas. Costs for deep well injection can range from $0.10 to $1.15 per 1,000 gallons (6,37) of desalinated water (in 1985 dollars). These costs are usually cheaper than disposal in properly constructed, lined evaporation ponds (6,64). Concentrate injection wells are currently classified by the Environmental Protection Agency (EPA) as Class V wells (i.e., wells for non-hazardous wastes that do not fall in any of the other four classes of wells), for which there are no Federal restrictions on well location or concentrate concentration. However, most States that regulate Class V wells require a hydrogeological study to prevent contamination of freshwater aquifers.

Concentrate disposal ponds are used typically in climates where evaporation rates are high relative to precipitation, and land costs are low. In Texas, costs for evaporation ponds range from about $0.05 to $0.25 per 1,000 gallon of desalinated water produced (37). In some cases, it maybe advantageous to treat or to further concentrate waste concentrates prior to disposal. Concentrating the waste streams from several percent total dissolved solids to a solid using solar evaporation costs $1.15 to $1.85 per 1,000 gallons of desalinated water (6). If desalination techniques (e. g., VC) are used to further concentrate the waste concentrate, processing costs can be as high as $4 to $5 per 1,000 gallons. Evaporation ponds must comply with Federal and State waste disposal laws. Since concentrate ponds and solid salt deposits are both potential sources of long-term pollution, some contaminants in the waste concentrates may preclude the use of evaporation ponds in some areas.

Some experimental work with waste concentrates suggests that in the future it may be economical to extract minerals from the waste concentrates or to generate electricity in specially constructed concentrate ponds. The technical and economic feasibility of generating electricity in concentrate ponds is being explored by the State of California in conjunction with the Westlands Water District's selenium removal project in the San Joaquin Valley. (See section on desalting irrigation drainage water in ch. 3 on uses.) In another 3-year, $500,000 pilot project located near El Paso, TX, a solar salt gradient pond has been constructed to generate electricity for a 5,000-gpd MSF distillation unit for freshwater production. Project funding has been provided primarily by the Bureau of Reclamation, with added support from the Texas Energy and Natural Resources Advisory Council, and the El Paso Electric Co. (88).

Marine Disposal

Concentrate disposal is generally a less significant problem in coastal, marine environments due largely to the high levels of concentrate dilution that typically occur. However, with seawater RO and distillation, some organisms may be adversely impacted by the increased salinity of the wastewater and/or by higher concentrations of pretreatment chemicals or natural contaminants in the effluent. Moderately elevated temperatures of distillation effluents, which run about 10° to 15° F (i.e., 5° to 8° C) above feed water temperatures, mayor may not be a potential concern depending on the organisms near the point of concentrate discharge. Laboratory bioassays using marine organisms from the proposed discharge area can be used to indicate the potential toxicity of desalination effluents (13,43).

In well-mixed, open marine environments, noticeable impacts are typically restricted to within several hundred feet of the discharge. Environments that are semi-enclosed, or inhabited by sensitive or high-value organisms should be avoided if possible. In many cases potential impacts can be mitigated by using a diffuser at the end of the discharge pipeline to increase mixing of the waste concentrate with surrounding marine waters. Regardless of the potential impacts, direct discharges of waste concentrates into estuaries or the ocean would probably require a National Pollutant Discharge Elimination System (NPDES) under the Clean Water Act and State permits as well. For example, most coastal States require permits for any development in their coastal zones.

Other Disposal Options

In some cases, the waste streams from small desalination plants may be disposed of in adjacent rivers if such disposal practices have insignificant impacts. Such discharges would probably require a NPDES and State permits. Under current regulations, it is unlikely that a permit would be required for waste concentrate disposal in sewers, unless the salt concentrations were high enough to adversely affect either the sewage treatment process or the environment where the treated sewage water was discharged.

PRETREATMENT SLUDGES

Desalination plants that draw their feed water from untreated surface supplies usually have to pretreat the incoming water to remove suspended particulate, colloidal material, and some dissolved minerals. Generally, pretreatment techniques used prior to desalination are the same as those used to treat municipal drinking water supplies. In other words, the pretreatment sludges generated from desalination operations are usually quite similar to the sludges produced by municipal drinking water plants.

The sludges from pretreatment operations may contain chemicals that are classified as hazardous by EPA. Coal-fired boilers used for distillation may also produce fly and bottom ash that might be considered hazardous. Depending on the composition of any wastes, desalination plants may be subject to licensing, monitoring, and reporting requirements under the Resource Conservation and Recovery Act,