Options for the Disposal of Wastewater Effluent In Hanalei, Hawaii

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For purposes of this review, wastewater disposal options are limited to secondary- and tertiary-treated effluent because the disposal of primary-treated effluent via ocean outfall systems, which are utilized elsewhere in Hawaii, is not anticipated to be practical. The advantages of a tertiary-treated wastewater effluent over those of a secondary-treated effluent include a reduction in [1] suspended and dissolved solids, [2] soluble nutrients, [3] degradable organic carbon (BOD_5), and [4] some dissolved metals. Currently, both a conventional wastewater treatment facility (perhaps a large packaged plant) and some type of constructed wetland are under consideration. Given that the populated sections of Hanalei have been classified as a natural wetland, it seems unlikely that a "constructed" wetland system could be permitted. In lieu of constructing treatment ponds in native soils, enclosed structures known as *living machines* could be placed into the ground. Living machines reportedly emulate processes that occur within constructed wetlands and are able to utilize local plants and microorganisms to treat wastewater.

The most obvious option for wastewater effluent is direct discharge into one or more of the surface waters running through the Hanalei watershed. This option would be restricted to the Hanalei River due to intermittent flows in the smaller streams; however, the potential problems with this option are many and varied (e.g., restrictions on NPDES permitting for a "Heritage River" and limitations on effluent disinfection because of the toxicity to aquatic organisms). For environmental, political, aesthetic, and countless other reasons, surface water discharge does not appear to be a viable option.

A second option for treated wastewater disposal is groundwater injection, whereby treated effluent is introduced into saline (and presumably unusable) waters underlying the shallower freshwater lens. Although the USEPA is a decade into the process of banning groundwater injection that disposes both hazardous substances and untreated (or slightly treated) sewage, one of the few remaining permissible uses is the discharge of secondary or tertiary treated wastewater. The EPA refers to these permissible injection wells as *Class V Sewage Treatment Effluent (STE) wells*, which are permitted individually in the state of Hawaii for treatment plants that receive **only** sanitary sewage (i.e., no hazardous wastes). This requirement could be met in Hanalei thanks to the absence of industrial facilities connecting to the proposed sewer system. However, the public often associates groundwater injection wells with unanticipated and undesirable consequences, as was exemplified by two STE wells on Maui that were suspected of contributing to increased nitrate levels in nearby surface waters.

The third option for the discharge of wastewater effluent from small treatment works (either conventional or constructed wetland) is direct land application—preferably on a plot located adjacent to the treatment facility. This option usually incurs relatively low construction and maintenance costs, and the infiltration of effluent through shallow soils essentially adds a polishing step to the treatment process (i.e., filters out suspended solids, adsorbs some metals, reduces nutrients via nitrogen and phosphorus uptake by soil microbes). While land application is optimal for some geographic regions, there are a number of papers in the scientific literature that document the degradation of native soils and biota (both macro and micro) on plots used for the land application of wastewater effluent. A further loss of native vegetation to opportunistic species, a gradual change in the chemistry and permeability of soils, a climate characterized by heavy rainfall events, and a shallow groundwater table could render this option a controversial one for Hanalei.

The final option for the disposal of wastewater effluent is reuse, whereby effluent is used to irrigate lawns, golf courses, or (less frequently) food crops. While there are several locations in Hanalei town that could be irrigated using treated effluent, the costs of constructing a delivery network could be high. Perhaps the effluent network could be laid when the sewer laterals are connected to Hanalei households and businesses. The dominant use of irrigation water in Hanalei is for cultivating taro; hence, taro fields represent the most logical destination for reclaimed effluent. Most studies on the use of reclaimed effluent for crop irrigation have focused on conventional growing techniques (i.e., applying water to the ground surface and permitting it to infiltrate). Because the dominant method of taro cultivation in Hanalei includes flooding the crop (i.e., similar to rice cultivation), human contact with irrigation water is extensive. Consequently, there would have to be a major emphasis on disinfecting the water via ozone, UV, or a similar technique before it was delivered to farmers. On a positive note, the requirement for reducing soluble nutrients and dissolved organic matter (constituting the very ingredients of fertilizers that are used on taro) in the effluent might be reduced. Whether the effluent was used to flood taro fields or to irrigate landscaped areas, one could encounter public resistance if people were uncomfortable with the standards and methods of disinfection.