RESIDUALS MANAGEMENT: A NATIONAL NEED

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Abstract. Waste generation is a direct consequence of consumption practices. In the United States, consumption levels per capita have reached an almost incredible level. Around $6 \times 10^{9}$ t of materials are consumed yearly—fuels, minerals, foods, timber, and chemicals. That amounts to $28$ t for each man, woman, and child each year or $150$ lb day$^{-1}$. Like some insects, we consume the equivalent of our own weight in "stuff". High consumption rates necessitate high energy consumption to harvest, extract, process, and move about the materials we need. The U.S. per capita energy consumption is twice as high as England’s, the next contender. Waste generation, therefore, has international implications and is not merely a local problem of finding disposal sites.

Six billion tons of consumption result in approximately $4.5 \times 10^{9}$ t of solid wastes and residuals that must be dealt with in some way. Most of the waste is left where it is generated. $2.3 \times 10^{9}$ t of agricultural wastes and $1.7 \times 10^{9}$ t of mining residues fall into this category. These wastes create a variety of problems, but the problems are not generally considered to be acute.

Industrial civilization is urban civilization. More than $60\%$ of the population crowds together on a minute portion of the land area. Here land is in short supply and the absorptive capacities of air, water, and land are limited. The wastes that occur in our urban areas thus represent what people call the solid waste problem.

By urban wastes we mean approximately $2.5 \times 10^{8}$ t of mixed refuse, industrial wastes, and process and sewage sludges. In addition, $10^{9}$ gal of waste oil, $7.5 \times 10^{5}$ abandoned automobiles, $2 \times 10^{8}$ tires, and portions of animal and crop wastes also occur in urban settings.

New types of wastes will also be appearing in the future, largely derived from pollution control processes. For example, $6.2 \times 10^{7}$ t of sulfur oxide sludges will be generated by utilities by around 1980.

The elimination of ocean dumping, intensified water treatment, desalination, atomic power generation and cancellation of toxic chemicals, to name a few new sources, will add to the wastes that will occur in urban areas.

We are definitely not reducing waste generation today. Hard data are not available, but we're guessing that waste generation is growing at a rate of $4\%$ yearly.

The waste problem is greater in the cities than in the countryside; and it is greater in the core cities than in the cities.

The $3 \times 10^{7}$ Americans living in our inner cities share their environment with upwards of $10^{8}$ rats. $4.5 \times 10^{4}$ people are bitten by rats each year—most of them children or the elderly. Disfigurement, sickness, and sometimes even death result from rat bites. The cost of destruction wrought by rats is estimated to be as high as $\$1$ billion yearly. Rat populations continue to thrive on improperly stored solid
wastes. Lackadaisical and infrequent waste collections in the inner city add to this problem.

Another waste-related inner city problem is fire. A million fires in cities of 25000 or higher took the lives of nearly 12000 people and created $2 billion in damage. Based on data from New York, Washington, D.C., and Seattle, it is a safe inference that around 40% of all fires are linked to unacceptable waste accumulations.

Most wastes are deposited on land. Land disposal can have two adverse consequences: (1) air pollution from the sublimation of chemicals or from burning; and (2) water pollution from run-off or leachate intrusions into the aquifers. The most important potential impact is from groundwater pollution. Nearly half the total U.S. population and 95% of the rural population takes its drinking water from water-bearing sub-surface rock formations.

In areas of the country where high rainfall, high water tables, and unsuitable soil types coincide, moisture passing through the waste can pollute groundwater with dissolved and suspended substances. An average-sized (20 acre) land disposal site east of the Mississippi, where such conditions usually exist, discharges roughly 20,000 gal a day of leachate.

The organic matter potentially introduced into ground and surface waters from some 9000 disposal sites east of the Mississippi, measured in BOD, is roughly the same as that from untreated sewage sludges from the same area.

The chemical constituents found in leachate tend to be much higher than levels found acceptable in the Public Health Service Drinking Water Standard. On the average, nitrates, sulphates, chlorides, Fe, Cu, Mn, Zn, Pb, and Cd are encountered in leachate at higher levels than in raw sewage and in significantly higher levels than in acceptable drinking water. Solid waste leachates, fortunately, usually have a foul odor, and drinking water source contamination by leachate is therefore readily detected.

The economic penalties associated with groundwater pollution when it impacts on drinking water supplies, for instance by poisoning a well, are quite severe. Remedial actions such as counter-pumping of the aquifer, relocation of old waste deposits, and diminished pumping from wells may be required.

Infiltration of water into disposal sites can be prevented or minimized, and so can the formation and escape of leachate. Most leachate constituents may be treated by filtration through suitable clay soils - a phenomenon called attenuation. But in this area, far too little work has been done either in the laboratory or in the field. We are not yet talking about a well-established state of the art.

In a very real sense, our ability to control pollution flowing into air and surface waters from point sources like factories has left behind our ability to control pollution from land, and there is at least a presumption that some of these pollutants are reentering the environment through the open escape valve of the land deposit.

Control of land disposal of waste - the last sink - is certain to be instituted legislatively in the near future at the national level. As appropriate control strategies and techniques are developed, only one thing is certain: the management of wastes and residuals will cost more in the future, even discounting inflation.