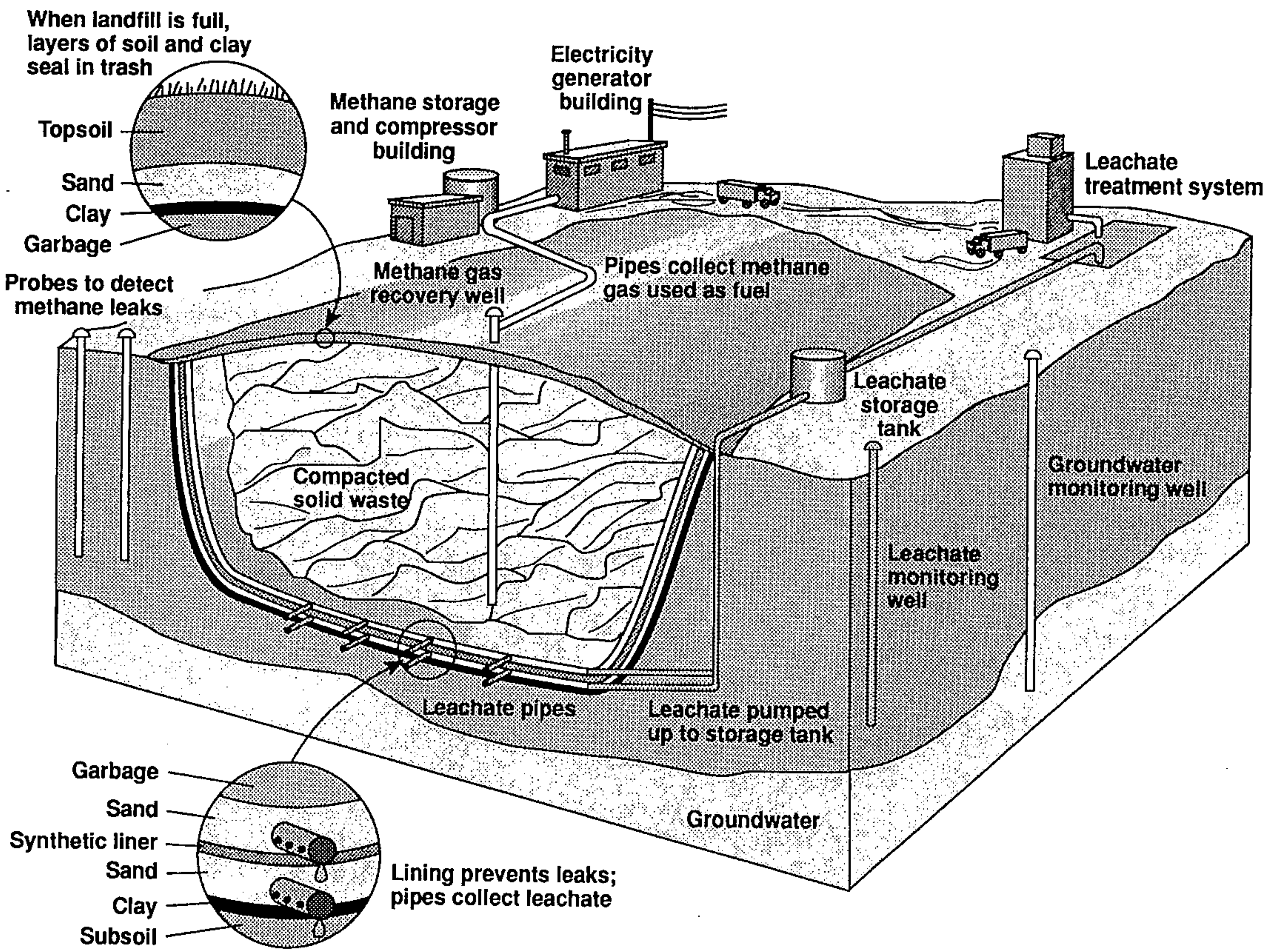

State-of-the-art sanitary landfill.

BOX 2

SCIENCE AND LANDFILL TECHNOLOGY

Science has contributed to improving landfill disposal operations in many ways. Scientific research about the movement of methane and the chemical characteristics of leachate within a landfill have helped environmental agencies set specific requirements for landfill construction and operation. Scientific models for the testing of construction materials have enabled environmental engineers to devise reliable pollution control systems for landfills. Theories, tests, models, and experiments related to chemistry, biology, and the physical sciences have been utilized in these endeavors and continue to be part of research and development.

Much of the research and testing that has been conducted applies to transformations of matter in landfills and the generation of toxic substances. Solid waste that is taken to a sanitary landfill initially undergoes physical changes as the waste items are compacted into the ground to make maximum use of available land space. Once buried, inorganic wastes in the form of metals, glass, rubber, and other difficult to degrade materials essentially remain unchanged, depending upon acidic conditions. Organic waste, however, in the form of paper, yard waste, and food scraps, makes up a large portion of municipal solid waste (nearly three-fourths by some estimates) and is capable of undergoing chemical changes to produce carbon dioxide, methane, organic acids, ammonia, water, and other chemicals in the biodegradation process.

Organic waste is broken down most quickly by aerobic bacteria, which are bacteria that require the presence of oxygen. However, in a landfill, oxygen becomes scarce as wastes are compacted and buried. In the reduced-oxygen environment anaerobic bacteria, bacteria which do not require oxygen, take over, and they are much less efficient at decomposing organic waste material than are aerobic bacteria. Therefore, the rate of decomposition in a landfill is slowed down considerably, even discarded food scraps and paper products can remain relatively intact for 20 years or more. The rate of decomposition that does occur depends upon moisture content, Ph, temperature, degree of compaction, and composition of MSW.

Several factors contribute to the potential for leachate to become hazardous in a landfill. Residues and unused portions of household hazardous products, such as cleansers and solvents, motor oil and anti-freeze, are sources of potentially harmful chemicals that mix into leachate. As organic waste breaks down, and as metals eventually oxidize and plastics degrade with all their additives, the potential exists for further contributions of toxic material. However, it is difficult to know the exact nature of chemical changes and the potential for pollution problems without knowing the specific materials and conditions that exist at any given site.

General research, often conducted in laboratories, has provided some insight into the conditions for chemical transformations to take place at landfills. Factors associated with the solubility of various materials (the ability for a substance to dissolve into different chemical elements or compounds in the presence of other substances) is an important element. The more soluble a substance is within a landfill, the more likely it is to become a toxic constituent of leachate. Therefore, from a pollution prevention viewpoint, it is often better for materials not to decompose inside a landfill. This is one drawback to biodegradable plastics, especially those that contain additives.

Laboratory experiments and testing have been conducted to determine the potential of various wastes to leach metallic and organic compounds under acidic conditions similar to those that might exist at a landfill. Some experiments have shown that there is greater potential for metals to break down into toxic substances in leachate after having spent considerable time in the presence of aerobic bacteria, while remaining less soluble under anaerobic conditions. Dioxins and furans have shown little ability to leach, indicting they may be relatively insoluble in water. (OTA, 250-51, 275)

(continued)

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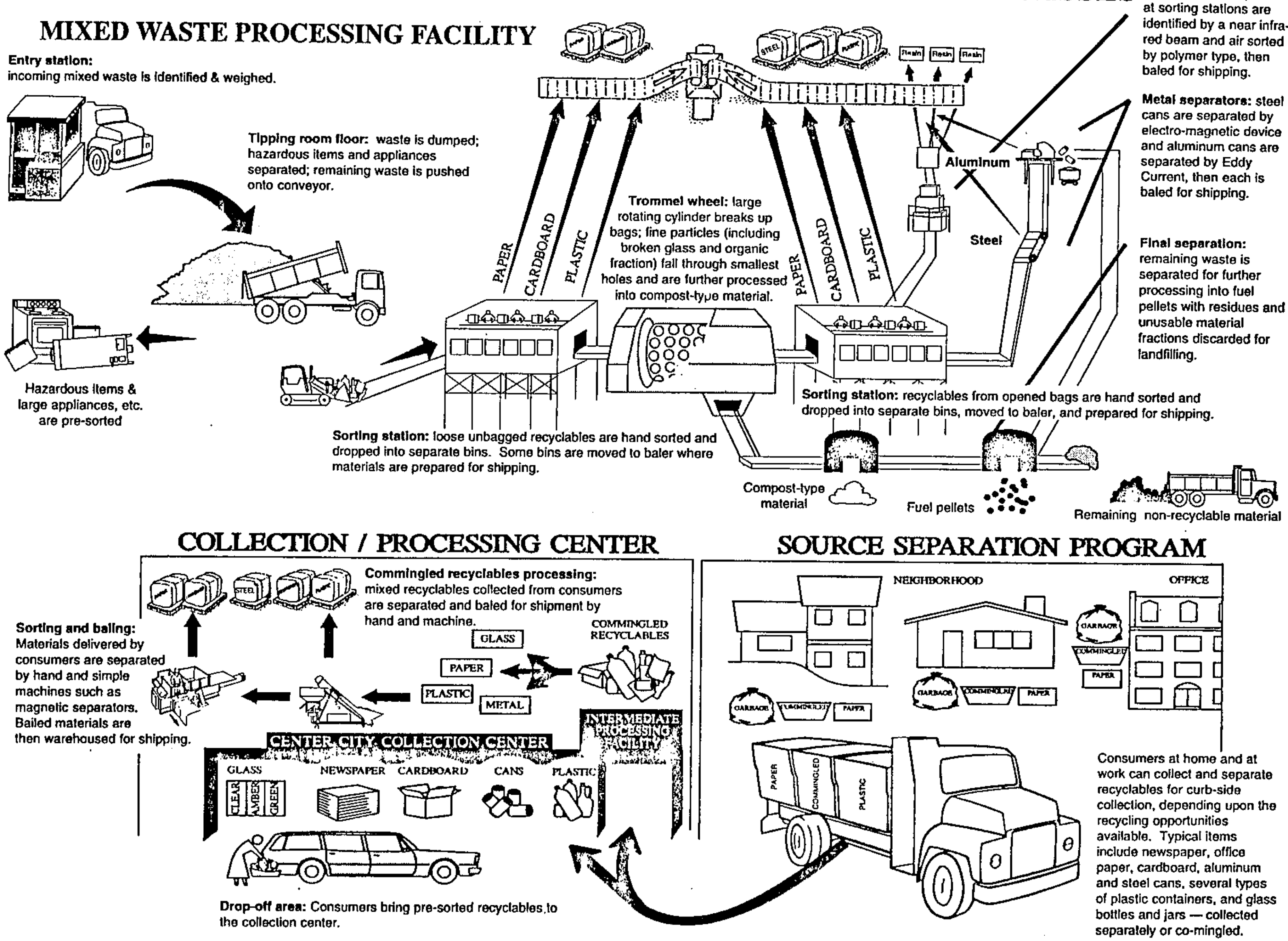
DIAGRAM MODEL 5

TECHNOLOGY AND COMMUNITY RECYCLING PROCESSES



EXPLANATORY MODEL 1
HIERARCHICAL MODEL OF INTEGRATED SOLID WASTE MANAGEMENT

POTENTIAL FOR NEGATIVE IMPACT ON THE ENVIRONMENT INCREASES.

POTENTIAL TO CONSERVE NATURAL RESOURCES INCREASES.

WASTE REDUCTION

Altering manufacturing or consumption practices to diminish the quantity of materials that become solid waste.

Processing and Manufacturing: Modify product design for longevity and to minimize toxicity, and eliminate excess packaging or discontinue production of certain products.

Markets and Purchasing: Buyer purchasing of products with longevity, minimal toxicity, least packaging.

REUSE

The use of a product two or more times.

Processing and Manufacturing: Reuse scrap for materials or energy production or market scrap to recycler.

Markets and Purchasing: Instead of purchasing new products reuse products over again or renovate into a reusable form.

RECYCLING AND RESOURCE RECOVERY

The process of systematically collecting, sorting, decontaminating, processing and returning waste materials to commerce as commodities for use or exchange.

Processing and Manufacturing: Modify product design for recyclability.

Markets and Purchasing: Buyer purchasing of recyclable products and products containing recycled content.

Recycling: Recover waste by-products in the processing of recyclables and process these so that they can be reused or recycled.

Composting: A biological process which involves the natural decomposition of organic waste materials through the action of microorganisms which results in a biologically stable end product -- compost.

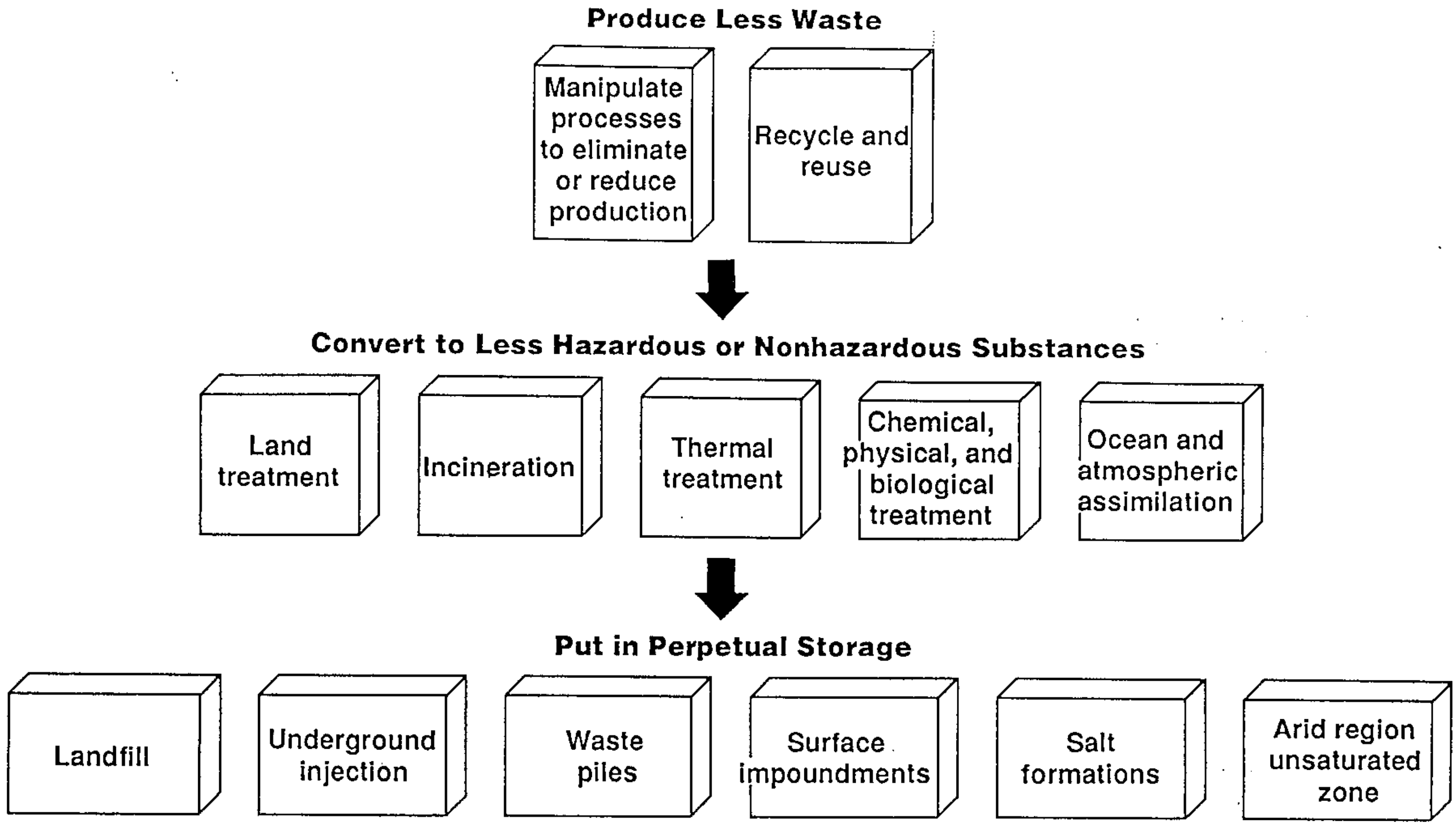
Disposal: Recover energy from the incineration of waste and from the collection of methane at landfills.

DISPOSAL

A process which does not turn waste materials into commodities of value, but can, through chemical transformations of waste extract small quantities of energy which has a one time use only.

Incineration with energy recovery: Reduces the volume of solid waste and helps destroy pathogens and toxic chemicals. Heat released from combustion is converted to steam heat or electricity. (There are potential problems in regard to air pollution and the toxicity of ash that must be landfilled.)

Sanitary Landfill: Solid waste is buried in the ground with potential to recapture methane for energy use. (There are potential problems in regard to atmospheric pollution from methane and ground water pollution from leaching of toxic materials.)



Priorities for dealing with hazardous waste.

National Academy of Sciences.