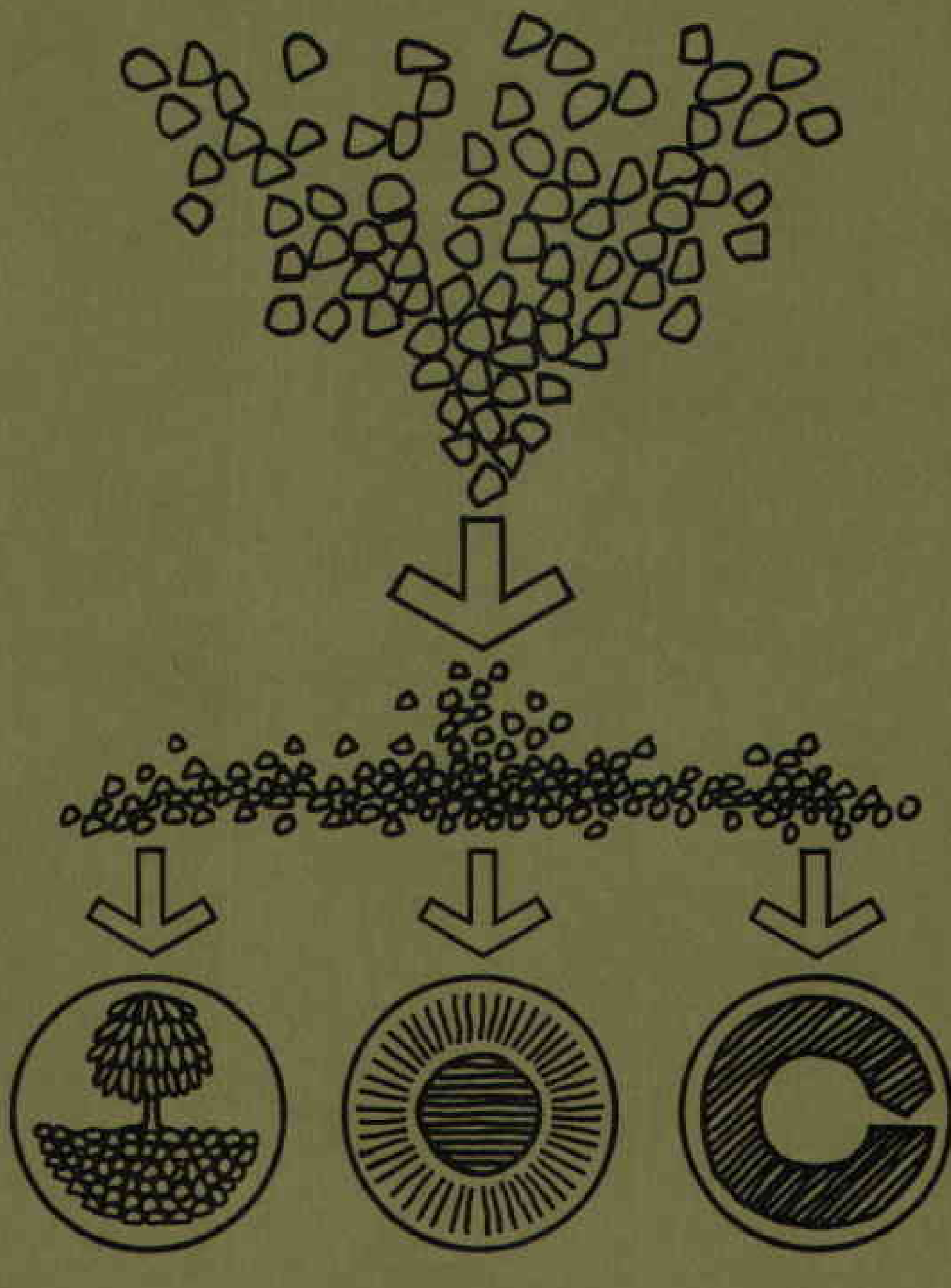
METROPOLITAN SERVICE DISTRICT
Solid Waste Management Action Plan

GREATER PORTLAND AREA, OREGON

COR-MET

III



Effective solid waste management is the responsibility and daily concern of many governmental agencies, officials, and members of the sanitation industry in the greater Portland Metropolitan Area. The co-operation and assistance of the following agencies has been most valuable in preparing this report.

Federal

U.S. Department of Agriculture
U.S. Forest Service, Civil Engineering Department
Soil Conservation Service

State of Oregon

Department of Environmental Quality
Forestry Department
State Engineers Office
State Highway Division

Regional

Columbia Region Association of Governments
Metropolitan Service District

County

Clackamas County Department of Public Works, Solid Waste Division
Clackamas County Planning Department
Columbia County Health Department
Columbia County Organization of Governments
Columbia County Planning Commission
Multnomah City-County Health Department
Multnomah County Department of Public Works
Multnomah County Planning Commission
Washington County Department of Public Works
Washington County Health Department
Washington County Planning Department

Municipal

City of Portland, Bureau of Refuse Disposal
The Municipalities throughout Clackamas, Columbia, Multnomah, and Washington counties

Advisory Groups and Participating Organizations

Clackamas County Solid Waste Commission
Clackamas County Collectors Association
Columbia County Solid Waste Advisory Committee
League of Women Voters
Local Commercial Refuse Collectors and Disposal Site Operators
Metropolitan Service District, Citizens Advisory Committee
Metropolitan Service District, Technical Advisory Committee
Multnomah County Collectors Association
Oregon Recycling Information and Organization Network
Portland Association of Sanitary Service Operators
Sanitary Truck Drivers Union Local Number 220
Washington County Refuse Haulers Association
Washington County Solid Waste Advisory Committee

We wish to express particular appreciation to William B. Culham, Director, Bureau of Refuse Disposal, City of Portland, whose knowledge, interest, and involvement in this project have been an invaluable contribution.

METROPOLITAN SERVICE DISTRICT Solid Waste Management Action Plan III

GREATER PORTLAND AREA, OREGON

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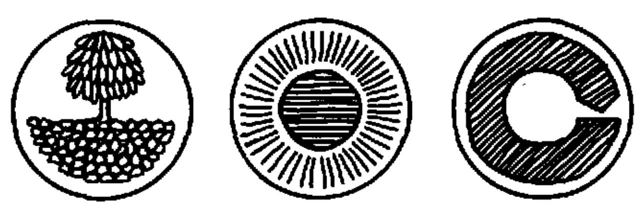
18 April 1974 P7857.0

The cover is a graphical representation of the recommended solid waste management system for the Metropolitan Service District region: mixed refuse is milled to a convenient size to become the source for:



LAND RECLAMATION — ENERGY CONVERSION — MATERIALS RECLAMATION

INTRODUCTION

These appendices contain detailed background information that was used to compile Volume I of this three-volume report. The physical aspects of solid waste management system and selected background information are presented in Volume I, and the financial and legislative aspects are presented in Volume II.

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LIST OF ABBREVIATIONS

ORGANIZATIONS

BPA	Bonneville Power Administration
COR-MET	Joint venture of Cornell, Howland, Hayes & Merryfield and Metcalf & Eddy, Inc., formed to accomplish the engineering portion of this project
MSD	Metropolitan Service District

ABBREVIATIONS

cm - centimeter
cu ft - cubic feet
cy - cubic yard
deg F - degrees Fahrenheit
fbm - board feet
gal. - gallon
gpm - gallons per minute
hr - hour
kV - kilovolt
mph - miles per hour
MSL - mean sea level
sec - second
VRF - volume reduction facility
yr - year

Appendix A

STUDY AREA CHARACTERISTICS

PHYSICAL AND CLIMATOLOGICAL CHARACTERISTICS

Topography

Clackamas County. Clackamas County is generally characterized by a terrain that increases in elevation and ruggedness from west to east. The most westerly portions are relatively flat plains which develop into low rolling hills toward the center of the county. The eastern and southern reaches are sparsely populated mountainous areas of heavy forestation. Drainage generally occurs in a westerly direction and is provided by the Clackamas, Mollala, Salmon, and Sandy rivers. There are flood plains along these rivers near their confluence with the Willamette River, which winds northward away from the county. Elevations in the county range from a low of 50 feet above sea level along the Willamette to a high of 11,245 feet on Mt. Hood in the Cascade Range.

Columbia County. Columbia County is bounded on the north and east by the Columbia River. Most of the county lies within the Coast Range of mountains, although the southeastern portion is part of the Willamette Valley. The Coast Range consists of two moderately hilly ridges with a lower hilly area between. The most easterly of these ridges separates the Columbia River plain from the Nehalem River basin. It also serves to isolate the Vernonia area from the populated Columbia River flood plain on the eastern edge of the county. The westerly series of hills is generally higher than the eastern ridge, but it is composed of the same broad, rounded ridges with medium steep slopes that typify the eastern ridge. For the most part, the county thus has moderately mountainous or low hilly relief, but the eastern and northern fringes of the county consist of the Willamette Valley and the flood plain bordering the Columbia River. As a result of the steepness of the terrain, many county roads are difficult to negotiate in a refuse collection vehicle. Flooding along the Columbia River is controlled by an extensive diking system. The range in elevation for the county is from approximately 20 feet above sea level along the Columbia River to some 2,500 feet in the southwestern part of the county.

Multnomah County. The topography in Multnomah County consists primarily of a relatively flat plain, 100 feet above sea level, with mountainous terrain on the east and west sides. The eastern border of the county is formed by the western slopes of the Cascade Range. The central portions, along the Columbia and Willamette rivers, are flat but become gently rolling to the south. The western end is characterized by a high ridge paralleling the Willamette River. The Tualatin Mountains (Portland West Hills) are part of this ridge. The northern boundary of the county is the Columbia River. Altitudes range from near sea level in the vicinity of downtown Portland to over 4,000 feet on Larch Mountain in the eastern portion of the county.[1*]

Flooding of the lowlands along these rivers is limited by dikes and levies, although the Columbia south shore area and lowlands east of the Sandy River are subject to some flooding.

Washington County. Washington County embraces nearly all of the Tualatin River valley drainage basin. The valley plain is nearly 30 miles long and 10 miles wide and is relatively flat, varying in elevation from 120 to 275 feet. The eastern slope of the Coast Range to the west, the Tualatin Mountains to the

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* Superscript numbers cite references contained in a list at the end of this volume.

north and east, Cooper and Bull mountains to the southeast, and the Chehalem Mountains to the south and west partially enclose the valley floor. Elevations in the foothills range from 1,300 to 2,200 feet and over 3,000 feet in the Coast Range. The Tualatin River, which originates in the Coast Range, meanders through the southern half of the county and finally discharges into the Willamette River. Major tributaries to the Tualatin River include Scoggins Creek, Gales Creek, Dairy Creek, Rock Creek, and Fanno Creek; these streams provide a complete drainage system for the uplands surrounding the valley. The river and lower reaches of its tributaries, which include over 29,000 acres of flood plain, are subject to annual flooding during the winter and spring months.[2]

Geology and Hydrology

Clackamas County. The east side of the Willamette trough forms the western one-quarter of Clackamas County's physiography. The geology is characterized by broad areas of alluvial sediments covering beds of sandstone and siltstone which comprise the Troutdale formation. There are outcrops of the Troutdale formation near Oswego and Clackamas.

Underlying much of the county's more recent soils is Columbia River basalt ranging in thickness from 200 to 2,000 feet.[3] Another basaltic formation consists of the Boring lavas, which were extruded over the Troutdale formation and cover many of the hills near Oregon City. Most other hills west of Boring are capped with wind-blown silts. The Troutdale formation is also overlain with alluvial formations of partially consolidated sands and gravels, particularly on the terraces along the Clackamas and Sandy rivers. Pit mining of these gravel formations is extensive, providing potential solid waste landfill sites.

The hilly and mountainous eastern three-quarters of the county are covered mostly with Boring and Cascan lavas and Troutdale sediments. These are underlain by various formations of basaltic breccia, tuffs, and flows known as the Rhododendron formation.

Groundwater supplies in the county are moderate, as the geologic formations limit the amounts of recoverable groundwater. The basaltic flows contain moderate-yielding permeable zones beneath the regional water table and low-yield perched zones. Sedimentary formations supply limited amounts of groundwater except for the Troutdale formation, which produces moderate to large amounts. Appreciable amounts of water are also available in the older alluvial materials and in younger sand and gravel deposits beneath flood plain areas.[4] Many areas of the county rely almost totally on groundwater for domestic, municipal, and industrial purposes, and increasing demands on these supplies could threaten the recharge capabilities and the water quality.

Columbia County. The dominant geologic feature in Columbia County is the broad uplift of the Coastal Range. Basalt, siltstone, sandstone, shale, and tuff are the major components forming the range. A large portion of the interior lowlands of Columbia County are made up of sedimentary rock, including shale and sandstone. These rock types have generally weathered to varying depths of clay, presenting a nearly impermeable surface. The remaining lowland areas along the Columbia River are composed mainly of various alluvial deposits, which vary in both porosity and permeability. The only major fault line in Columbia County is the Portland fault, which runs northwesterly across the county from the intersection of Highway 30 with the Columbia-Multnomah county line on the south towards the Clatskanie area on the north.

The main mineral resource for Columbia County is the conversion of sand, gravel, and stone into lightweight aggregate products. There is also a wide strip of ferruginous bauxite running across the county, parts of which are under option to a major aluminum producer, but tests show that the ore is of too low a grade to make removal currently feasible. There is also a minor amount of iron ore mining in the county.

Knowledge of the properties of the general soil types in Columbia County is important in determining the potential for landfill use for each type of soil. A brief description of the major soil types follows: (1) The Olympic Series occupies an extensive area of the county, predominantly in the smooth foothills of the Coast Range west of Scappoose, west of St. Helens, and near Clatskanie; (2) the Cascade Series appears mainly in the eastern and northern parts of the county, in a strip between Columbia City and Bradberry; (3) the Aiken Series occurs only in the eastern part of the county, mainly west of Columbia City; (4) the Sauvie Series, which occupies the majority of the area on the Columbia River flood plain, characteristically exhibits poor drainage, high water-table levels, and flooding; (5) the Chehalis Series occurs along the banks of rivers and streams, excluding the Columbia River. The first four soil series listed are all severely limited for use in sanitary landfill operations. The fifth one (Chehalis) is generally above the normal high water level and has moderate to severe restrictions for use in sanitary landfill operations.[5]

Columbia County can be divided into three major drainage areas: (1) the Nehalem River basin drains the southwesterly 40 percent of the county toward the Pacific Ocean; (2) the Clatskanie River and other smaller tributaries of the Columbia River drain the northerly 40 percent of the county; (3) the remaining southeasterly 20 percent of the county drains into the Multnomah slough of the Willamette River which, in turn, empties into the Columbia River.

Columbia County has adequate precipitation to recharge groundwater reserves but lacks major permeable geologic formations capable of absorbing and conducting groundwater. Three major geologic formations can be identified, and their ability to produce water is discussed. Marine Sedimentary rocks make up the major geologic formation in the county. This formation has a history of producing limited amounts of water, usually less than 10 gpm. The Columbia River Basalts have only a limited number of wells and limited history on groundwater flows. The basalt is generally quite dense and impermeable except near the upper and lower edges where the basalt flow is cracked and fractured. Flows vary from less than 10 gpm up to 500 gpm depending on the well location. The Columbia River alluviums lying within the flood plain are the only major geologic formations capable of providing large, consistent flows of from 50 to 600 gpm.

Multnomah County. The lowland area around Portland, as far as the Sandy River, is characterized by broad areas of alluvial and lacustrine sediments consisting of coarse outwash debris mainly from the Columbia River. An extensive stratum of semi-consolidated sediments of the alluvial-fan type, called the Troutdale formation, underlies this area. The Troutdale formation dips westward off the lower slopes of the Cascade Range lying nearly horizontal in the lowland area where it forms the main sedimentary fill. Outcrops of the Troutdale formation exist east of the Sandy River near Troutdale and southwest of Gresham.

Much of the county's more recent soils are underlain by Columbia River basalt ranging in thickness from 200 to 2,000 feet.[6] The formation outcrops along the Columbia River in the east and in the west above the Willamette River lowlands. Another basaltic formation consists of the Boring lavas, which were extruded over the Troutdale formation, and form such prominent features as Rocky Butte, Mount Tabor, Kelly Butte, and Powell Butte in or near the City of Portland.

The hilly and mountainous area east of the Sandy River is covered with Troutdale sediments, and Boring and Cascan lavas. These are underlain by various formations of basaltic breccia, tuffs, and flows known as the Rhododendron formation.

Sand and gravel suitable for road construction and use as concrete aggregate is found in the lacustrine deposits covering the valley floors. The large open pits resulting from the mining of these gravel deposits are potential landfill sites for solid wastes.[7] The pits are primarily located in a strip south of Interstate 80 and north of Division Street between 60th Avenue and Beaver Creek, a few miles east of Gresham.

Groundwater supplies vary depending on the geologic formation. Formations older than the Columbia River basalt are mostly nonpermeable and do not transmit much fresh water. The Columbia River basalt contains moderate amounts of groundwater, mostly in permeable rubble along interflow contacts. Recoverable groundwater occurs in some of the gravel and sand beds in the Troutdale formation. Near large rivers this formation yields water at rates up to 1,000 gpm, but elsewhere few wells yield more than 900 gpm. Large quantities of recoverable water are contained in the alluvial deposits overlying the Troutdale formation.

Washington County. The mountains surrounding the Tualatin River valley reveals extensive outcroppings of Columbia River basalt, a formation underlying much of the Tualatin valley basin.[8] This formation is frequently found in a fractured and jointed state. Its permeability is low, yet it is the principal groundwater acquifer of the basin.

The valley floor is almost entirely Willamette silt, a semi-consolidated clay and silt varying from several feet to 50 feet in depth. Willamette silt contains some fine sand and a few gravel beds, and is very similar to the Troutdale formation. The higher basaltic formations are capped with an upland silt which is similar in texture and composition to the Willamette silt and also has a low permeability.

Lacustrine sand and gravel deposits overlie the Willamette silt formation in the Tualatin-Sherwood area. These soils have a very high permeability and have become excellent borrow pit sources. The deep stream valleys are composed of young alluvium, mainly silty clay and fine sand, which has poor drainage characteristics.

Groundwater occurs quite close to the surface over a significant part of the Tualatin Valley. In much of the Willamette silt, unconfined groundwater exists at a depth of less than 10 feet with surface ponding occurring seasonally. Deep wells located in Columbia River basalt do not benefit from surface recharge in the valley because of low permeability of the soil strata above, and are therefore experiencing gradual declines in the water level.[9] The characteristic high groundwater level and seasonal flooding of the stream valleys present significant limitations to landfill site selection.

Climate

The climate within the study area is generally moderate, with variations in temperature and rainfall largely related to topographic changes.

In the western portion, the climate of Columbia and Washington counties is influenced by proximity (within 23 miles) to the Pacific Ocean and by prevailing westerly winds. The Coast Range acts as a buffer to storms originating in the Pacific, thereby reducing the amount and frequency of precipitation within the area. The resulting temperate marine climate is characterized by mild, wet, cloudy winters and warm, dry, clear summers. Average annual precipitation is about 50 inches, varying from a high of about 110 inches in the west of the two counties to a low of about 36 inches in the east. The majority of the precipitation occurs as rainfall during the 5-month period from November through March. Snowfall is minimal. Temperatures are mild with a very gradual transition from one season to the next. On the average, temperatures fall below freezing only 27 days per year and rise above 90 degrees Fahrenheit only seven days per year. The average annual growing season is about 180 days.

In the eastern portion, the climate of Multnomah and Clackamas counties is also moderate--but with higher precipitation and greater extremes of temperature due to the influence of the Cascade Range to the east. Average annual precipitation across the two counties is about 60 inches, varying from a low of about 40 inches in the west to a high of about 120 inches in the east. Most of the rainfall and snowfall occurs during the 5-month period from November through March. Temperature extremes in the valley portions of the two counties range from -14 degrees Fahrenheit in the winter to 108 degrees Fahrenheit in the summer. In the mountainous areas, the temperatures range from a low of -18 degrees Fahrenheit to a high of 99 degrees Fahrenheit. The prevailing winds are from the northwest in the summer and from the south in the winter, although east winds prevail at times in and near the mouth of the Columbia River Gorge. The frost-free season in the valleys is about 200 days per year, while the higher mountain areas experience frost-free seasons of less than 30 days.

Wildlife and Vegetation

The suburban and rural portions of the study area support a variety of small animal wildlife, including beaver, coyote, fox, mink, muskrat, otter, rabbit, raccoon, skunk, and squirrel. Larger game animals, such as black tail deer and elk, are found in the wooded mountainous areas. Such game birds as dove, grouse, pheasant, and quail can be found throughout the study area, but ducks and other migratory waterfowl generally inhabit the flood plains along the rivers. The Columbia and Willamette rivers are a habitat for trout, steelhead, and salmon. These, along with other rivers and lakes, support a variety of other warm- and cold-water fish.

The moderately heavy rainfall promotes a lush vegetation throughout much of the study area. The vegetation varies from noble fir, beargrass, and rhododendron at the higher elevations to Douglas fir, western hemlock, western red cedar, big leaf maple, Pacific dogwood, and Oregon white oak at the moderate elevations, and to cottonwood, oak trees, and marsh grass along the rivers and the flood plains. Cleared land commonly supports abundant second growths of huckleberry, salal, wild blackberry, fern, and such fast-growing deciduous trees as alder and vine maple.

LAND USE CHARACTERISTICS

Clackamas County

Urban Development. The urban area in Clackamas County is restricted to the northwest corner of the county, which encompasses less than 10 percent of the total county area yet contains about 70 percent of the county population. Even this part of the county is not totally urban, mostly as a result of limitations of water, sewerage, and highway facilities. Present sewerage is confined almost exclusively to the incorporated areas of the northwest portion of the county. Urban growth outside those incorporated areas will depend upon the extension of sewers into those areas. All of the urban area is zoned for residential, commercial, industrial, and recreational land uses.

The Clackamas County Planning Department has developed a comprehensive plan which is awaiting adoption, subject to revisions resulting from public review. The plan calls for only limited high-density residential land use, with most of the future urban sector to be devoted to low-density residential use and scattered areas of medium-density use bordering the existing incorporated areas. Planned heavy industrial areas are concentrated in two locations, one bordering the northwestern boundary of Wilsonville, and the other situated at the intersections of I-205, State Highway 212, and 82nd Avenue. Intensive commercial areas are, and will continue to be, located along the highway corridors of McLoughlin Boulevard and 82nd Avenue. Planning for additional highway commercial strips is limited, with more emphasis on the development of scattered large commercial complexes. The comprehensive plan calls for the development of a countywide zoning ordinance consistent with the guidelines of the plan as a first step in its implementation.[10]

Rural Development. Suburban and agricultural areas are situated south and east of the urban area. These areas comprise about 25 percent of the total land area of the county. Rural residential land is largely farmland; Clackamas County leads all Oregon counties in the number of farms, with approximately 4,000.[4] The most significant rural industrial uses are sand and gravel mining. Current trends indicate a reduction in the number of farming units and an increase in rural population. Sand

and gravel mining is also decreasing in intensity, due to a reduction in available resources. Zoning within the rural areas is confined to those areas surrounding the urban areas and the corridors along the Mt. Hood Highway and the Clackamas and Molalla rivers. Future residential development will be dependent on the availability of utilities, for much of the rural area has soils not conducive to septic tank effluent drainage. No specific county plan for rural development has been formulated.

Forest and Park Lands. Over half the area of Clackamas County is forest land, most of which is contained in the Mt. Hood National Forest. The two major uses of the forest lands are timber harvesting and recreation. Over 23,000 acres of timber land were harvested in 1971, resulting in a lumber production of approximately 335 million fbm. Timber management programs have been developed to promote sustained-yield activities. In addition, the proposed comprehensive county plan suggests that private landowners of subdivided farmland use "idle" acres to cultivate trees for financial benefits to themselves and the community. There is little threat of destroying the forest lands for other uses, for most of the forested areas are too steep and rugged.

Recreation within forested areas is confined to campgrounds and skiing facilities and a major multiple-use sector known as the Mt. Hood Corridor. Future campground development is expected to be minimized, with greater emphasis on backpacking and day-use. Park lands are abundant throughout the county, with about 200 recreational sites of various ownerships.[10] The comprehensive county plan indicates a need, however, for further park development to accommodate the growing permanent and seasonal populations.

Columbia County

Urban Development. The single strongest factor affecting land use patterns in the county is topography. Because of the rugged terrain in most of the county, the major urban areas are concentrated on the narrow Columbia River flood plain, along U.S. Highway 30. Approximately 1.2 percent of the total county area is presently devoted to urban development, primarily in Scappoose, St. Helens, and Columbia City in the southeast part of the county, Clatskanie and Rainier in the northern part, and Vernonia in the central part. The countywide comprehensive plan, completed in 1969, specifies that urban growth should continue in already improved areas in order to economize on utilities and prevent scattered growth. This guideline, combined with the fact that a large portion of the county is held by private timber interests and thus is not available for urban development, will mean that existing urban residential areas will continue to increase at a rate roughly equivalent to the increase in total county population.

Present commercial development is largely in strips along U.S. Highway 30, and the comprehensive county plan indicates that no further commercial areas need be developed. The only major industry in urban Columbia County is a paper mill in St. Helens. Because it is desirable to develop industrial areas that are easily accessible from a major transportation route, any future industrial development can be expected to take place in, or adjacent to, urban areas on the Columbia River flood plain.

Columbia County has recently developed a comprehensive zoning plan and is proceeding with adoption of the plan. The south county zoning plan for the Scappoose and Warren area has recently been adopted. Adoption of the plan in other areas of the county is expected to follow.

Rural Development. The urban containment policy of the comprehensive county plan should help maintain the status of existing acres devoted to rural residential and agricultural uses. Approximately 16 percent of the total county area is presently devoted to nonspecific rural land uses, and 13 percent is devoted to intensive agricultural uses. This agricultural land is located in the south central region of the county and along the foothills of the Columbia flood plain. Use of rural lands for intensive urbanization by future generations will be approved only after suitable study and amendment of the comprehensive plan.

Forest and Park Lands. Approximately 80 percent of the total county area is taken up with forested timber lands. Of this area, approximately 92 percent is held by private timber interests and only 8 percent is owned by public agencies. It is not anticipated that this ownership distribution will change in the future. Existing timber operations are located generally north-northeast of the Vernonia area. The State Department of Forestry reports that in 1971 approximately 69,000 million fbm of lumber were removed from land in Columbia County. Of this total, approximately 64,700 million fbm were harvested from private timber lands. This volume of harvested timber is second only to Clackamas County in the four-county study area.

Columbia County has a wide range of recreational opportunities available in the Hudson, Big Eddy, and Camp Wilkerson county parks and in other smaller parks. The Bureau of Land Management maintains Scaponia, a wooded park, and numerous parks are maintained by private timber interests throughout the county. There are also municipal parks in each urban area offering facilities for outdoor recreational activities. The Columbia County Planning Commission indicates that existing county parks will be improved to a level adequate for their potential use. The commission also suggests that a regional park be established in the vicinity of Pittsburg in the central county region to encourage use of this beautiful area.

Multnomah County

Urban Development. The total land in Multnomah County is about 25 percent urbanized, and most of the urban area is devoted to residential development. The primary residential concentrations are located in Portland proper and in the surrounding communities of Gresham, Fairview, Wood Village, and Troutdale. The present regional planning guidelines stress that new growth should occur within the boundaries of present utility service areas.[11]

The primary commercial center for Multnomah County, and the region as well, is downtown Portland. Major regional shopping centers which serve outlying areas include the Lloyd Center, Mall 205, Gateway, Eastport Plaza, all located east of the Willamette River. Daily shopping needs are served by community shopping centers at various convenient locations. These typically contain a supermarket and a variety of other stores and specialty shops. Strip commercial development extends along a number of the major arterials, such as Union, Halsey, Sandy, Powell, 82nd Avenue, and 122nd Avenue. County and local city plans call for the clustering of future commercial development and discourage any further strip development.

The major industrial areas of Multnomah County are located along the Willamette River, extending for 12 to 14 miles in a band along each bank, and on the south side of the Columbia River, along Columbia Boulevard. The types of industries located in these areas are highly diversified, and no one industry dominates. Electrical equipment, lumber, and wood products, transportation equipment, machinery, fabricated metals, and primary metals are examples of the industries located in the county. Regional, county, and city planning for industrial facilities encourages development in existing industrial areas along the Willamette River and Columbia Boulevard. The Port of Portland owns 3,000 acres at the tip of the North Portland Peninsula, which is being developed into the Rivergate Industrial District. It is estimated that the Rivergate Industrial District can supply about one-half of the 1990 area needed for waterfront-oriented manufacturing industries.[11, 12]

Rural Development. Agricultural lands are limited mainly to the following areas: Sauvie Island and the lowlands along Multnomah Channel; the area south of Johnson Creek to Clackamas County; the south shore of the Columbia River east of 122nd Street to the Sandy River; the area east of the Sandy River to Corbett; and the unurbanized area to the west of the Sandy River lying south of Troutdale and east of Gresham. The agricultural land amounts to about 26 percent of the county's total land area. The main crops are nursery and greenhouse products, vegetables, melons, fruits, nuts, and berries.

The present land use policy, stressing growth within areas of existing utility services, should retard urban growth into agricultural areas. Eventually the pressure for growth is expected to result in urbanization eastward to the Sandy River.[11]

Forest and Park Lands. Forest lands take up about 49 percent of the total county area, with 52 percent of the forest land being in Mt. Hood National Forest. The annual timber harvest from these lands is presently about 16 million fbm. There also are many state, county, and city parks located within the county. The major state parks are Rooster Rock, Lewis and Clark, Dabney, Ainsworth, Benson, Guy W. Talbot, Oak Island, Crown Point, Bonneville, George W. Joseph, John B. Yeon, McLoughlin, and Shepperd's Dell. The major county parks are Oxbow, Blue Lake, and Indian John Island. City parks include East Delta, Mt. Tabor, Powell Butte, Oaks Pioneer, Washington, Macleay, and Forest.[13, 14]

Washington County

Urban Development. Approximately 20 percent of the county area is urban in nature. The existing land use development has been most significantly influenced by vehicular accessibility to the metropolitan Portland area. The communities of the valley are located on three radial highways emanating from Portland. Tigard, Tualatin, and Sherwood in the southeasterly portion of the county are served by the Pacific Highway (Route 99W). Cedar Mill, West Union, North Plains, Banks, and Somerset West have developed in the northerly portion of the valley and are clustered around the Sunset Highway (U.S. Route 26). The central valley communities of Beaverton, Cedar Hills, Hillsboro, Cornelius, and Forest Grove are served by the Tualatin Valley Highway (Route 8). Not far away from these radial highways, the land is still relatively undeveloped. Traveling westerly across the county, the land use changes from urban characteristics to those of suburban sprawl. West of Hillsboro, the valley is still typically rural.[2]

The majority of the population resides in single-family dwellings, most of which are located in the eastern urban portion of the county. Residential development outside of the eastern urban area has been significantly limited by the lack of sanitary sewers.

Commercial development in eastern Washington County consists both of community centers, such as the Tigard and Beaverton central business districts, and of strip commercial development, such as highway oriented activities along the Pacific and Tualatin Valley highways.

Industry within the county is extremely diversified, and is located mostly within the eastern urban sector. Food processing and lumber and wood product industries are the predominant employers, but diversification into electronics, fabricated metals, and other products is increasing.

A firm policy guiding the future development of the county is presently being established by the county planning department. It is anticipated that future policy will provide containment of the presently expanding urban area to avoid the expense of providing utilities for areas of suburban sprawl. Currently 42 percent of the land within the incorporated cities is either in agricultural use or vacant. Future development will include a filling-in of the incorporated cities and of the existing urban corridors, thereby preserving the prime agricultural and conservation lands located outside of the corridors.[9]

The entire land area of the county is zoned, but Washington County is in the process of rezoning the land to adjust residential, commercial, industrial, agricultural, and conservation uses to attain the goals of the future land use plan.

Rural Development. The rural centers, which include Gaston, Banks, North Plains, Buxton, Manning, and Timber, have developed to serve agricultural or forest product activities. Nearly 23 percent of the total county land area is presently used for agricultural purposes. Although agriculture is spread throughout the Tualatin Valley, the most productive farm land is located within, or adjacent to, the Tualatin River flood plain, Pattern Valley, Gales Creek Valley, and from Banks to North Plains north of Forest Grove and Hillsboro. Major crops include hay, wheat, barley, oats, tree fruits and nuts, and small fruits and berries. The trend in future agricultural development appears to be toward fewer and larger farms producing vegetable crops or specialized agricultural and horticultural products. It is anticipated that the outlying rural centers will continue as agricultural service areas with some increasing use as residential communities for those commuting to Portland and the eastern urban area, but residential and commercial activities are not expected to extend beyond the present limits of those rural centers.

Forest and Park Lands. Timbered areas are essentially restricted to the northern and western uplands. Nearly 57 percent of the total county land area is devoted to forest lands. Most of the timber lands are privately owned by large corporations while some are owned by the State of Oregon, the federal government, and the county. Of the 23 million fbm harvested in the county in 1971 over 21.5 million fbm were from privately owned lands.[14]

Washington County does not maintain a county park system. Neither does the state and federal government maintain any recreational facilities within the county, with the exception of a small state operated picnic facility. Nearly every city either maintains a park system or is served by the Tualatin Hills Park and Recreational District or the Aloha Huber Recreational District, which maintain parks located throughout their service districts.

MAJOR TRANSPORTATION NETWORKS

The four counties in the study area are interconnected by a network of federal and state highways. Interstate 5 (I-5) is the major north-south thoroughfare paralleling the Willamette River along the common boundary between Clackamas and Washington counties and continuing northward through Portland across the Columbia River toward Vancouver, Washington. The urban areas of Clackamas County are connected to I-5 by an east-west 6-mile stretch of I-205 which crosses the Willamette at Oregon City and joins State Highway 212/213 leading northward to Multnomah County, where it is also designated 82nd Avenue. Another major thoroughfare east of the Willamette is State Highway 99E, which follows the river from Oregon City through Milwaukie as McLoughlin Boulevard and southeast Portland as Union Avenue, finally joining I-5 near the Columbia River. A major highway connecting Columbia County with the metropolitan area and the coast is U.S. Highway 30, which follows closely along the Columbia River from Astoria to Portland where it divides to serve western Portland on the west side of the Willamette and to north Portland and northern Multnomah County in the east. The northern extension of U.S. 30 is paralleled by Columbia Boulevard, a major street for commercial traffic in Multnomah County.

The most important east-west routes are U.S. Highway 26, or Sunset Highway, and U.S. 80N, called the Banfield Freeway. Forest Grove, Hillsboro, and Beaverton are interconnected by U.S. Highway 26, which extends to southeast Portland. U.S. 26 is also connected to I-5 by State Highway 217 which stretches from Beaverton to Tigard. U.S. 80N begins at the border of northwest and southwest Portland with an interchange with I-5, then extending eastward connecting with U.S. Highway 30 near Fairview and following the Columbia River out of Multnomah County.

The major rail routes are the Southern Pacific lines in the eastern portion of the metropolitan area connecting the cities of Oregon City, Milwaukie, and Portland, and in the western portion joining Lake Oswego, Tigard, and Beaverton. Other important routes are the Burlington Northern, which passes through the major cities of Columbia County along the Columbia River and extending south to Portland, and the Union Pacific, which follows along the city limits of Portland and then parallels U.S. 30 eastward out of Multnomah County.

Barge traffic in the metropolitan area is heavy due to the availability of east-west routes along the Columbia River and north-south access along the Willamette River.

The major airport in the study area is Portland International Airport, which is located near the Columbia River with access provided by State Highway 213. This facility serves the commercial air carrier needs of the entire region.

ECONOMIC CHARACTERISTICS

The greater Portland area has one of the most diverse manufacturing economies of any city in the nation. Typical industrial products throughout the area are wood and wood products, paper and paper products, fabricated metal goods, chemicals, electrical equipment, and precision instruments. Farming and food processing, construction, and wholesale and retail trade also play an important role in the overall economy. The abundance of smaller, diversified firms ensures a stable economic growth for the region, free from the cyclic employment swings that are typical of cities built around a single industry. The Port of Portland is also an economic mainstay of the study area. Although the port is 108 miles up the Columbia River from the ocean, the volume of import and export goods handled through the facility makes it the largest U.S. seaport on the entire Pacific coast.

Of the present industries in the study area, the influence of agriculture is decreasing most while recreation-oriented construction and business is increasing.

Some suburban communities within the study area have no industries of their own but serve as bedroom communities for the industrial areas. Residents generally commute to the greater Portland area or into the State of Washington for employment.

The personal income levels in the study area are generally comparable to state levels, although Multnomah and Washington county residents have higher average incomes than do residents of Clackamas and Columbia counties. The lower income level in Clackamas County is due to the relatively large number of agricultural employees and retired residents. Columbia County, which reflects the lowest income level of all counties in the study area, is affected by a lack of industry to stimulate economic growth. At the present time, however, a major nuclear-powered electrical generating plant is being completed near Rainier, and it is expected that the proximity of available electrical energy to the deep-water transportation route of the Columbia River may encourage industrial growth in Columbia County.

APPENDIX B

Appendix B

POPULATION PROJECTIONS

This appendix contains projected populations for each county in the study region. Counties are divided into refuse generation centers and population projections are presented for each of these centers.

The 1970 populations are taken from the U.S. Bureau of the Census, and projected county populations are based on data supplied by the Columbia Region Association of Governments. Allocation of those county projections among refuse generation centers was accomplished by COR-MET staff based upon land use and growth patterns.

These projected populations have been authorized for use in this study by MSD.

Table B-1

POPULATION PROJECTIONS BY
REFUSE GENERATION CENTERS

Refuse center	1970	1980	1990	2000
Columbia County				
1. Clatskanie	4,821	6,200	7,700	9,500
2. Rainier	4,959	6,600	8,200	9,700
3. Columbia City	1,991	2,300	2,600	2,900
4. St. Helens	6,212	7,500	8,800	10,900
5. Scappoose	8,171	10,700	13,300	16,200
6. Vernonia	2,636	2,700	2,700	2,800
Total	28,790	36,000	43,300	52,000
Washington County				
7. Forest Grove	16,096	20,000	24,400	30,600
8. Hillsboro	19,434	27,500	33,700	42,400
9. Aloha	13,244	22,900	44,100	84,200
10. Cedar Mill	11,244	19,100	28,800	41,000
11. Beaverton	61,910	93,400	123,900	154,700
12. Chehalem Mt.	8,193	9,800	11,500	13,900
13. Tigard	22,380	38,200	51,900	70,300
14. West County	5,419	6,200	7,100	9,600
Total	157,920	237,100	325,400	446,700
Clackamas County				
15. Stafford	4,144	6,400	8,800	11,700
16. Canby	6,197	8,800	12,100	16,700
17. Beaver Creek	9,577	14,100	17,400	20,500
18. Redland	2,526	3,100	3,400	4,000
19. Estacada	7,954	10,500	11,900	13,800
20. Sandy	9,196	11,100	13,000	14,700
21. Boring	6,705	8,600	10,400	12,400
22. Clackamas	12,348	19,100	31,600	42,600
23. Milwaukie	37,731	50,500	63,700	79,500
24. Gladstone	15,875	22,800	34,700	45,400
25. Oregon City	8,488	10,900	12,300	14,200
26. West Linn	7,147	10,500	14,700	21,500
27. Lake Oswego	24,041	37,700	51,600	81,400
28. Molalla	14,159	15,900	17,300	20,500
Total	166,088	230,000	302,900	398,900

Table B-1 (Concluded)

	Refuse center	1970	1980	1990	2000
Multnomah County					
29.	S.W. Barbur	25,650	29,700	33,100	35,000
30.	Hillsdale	20,164	22,800	24,000	29,400
31.	Sylvan	5,270	6,300	7,500	8,800
32.	Portland Heights	5,684	5,800	6,000	6,200
33.	Downtown	14,621	14,600	14,600	14,700
34.	N.W. Residential	16,688	16,000	16,000	16,500
35.	N.W. Industrial	1,873	1,700	1,500	1,300
36.	St. Johns	27,159	29,400	30,500	32,000
37.	Rivergate	967	1,200	1,500	1,700
38.	Swan Island	310	200	200	200
39.	N. Portland	90,914	86,600	87,000	90,000
40.	Portland Airport	1,455	1,300	1,300	1,300
41.	N.E. Portland	58,195	57,600	58,000	58,000
42.	Ladd Addition	28,990	28,600	28,200	28,200
43.	Reed	35,359	36,400	37,500	39,900
44.	Milwaukie	10,221	11,400	12,200	12,700
45.	Mt. Tabor	51,496	53,000	54,200	55,500
46.	S.E. Portland	74,966	87,800	95,900	101,900
47.	Parkrose	50,907	57,600	64,700	70,000
48.	Wood Village	11,842	14,700	18,500	22,800
49.	Gresham	21,207	33,700	45,600	56,400
50.	Corbett	2,729	3,000	3,400	3,900
	Total	556,667	599,400	641,400	686,400
	Regional total	909,465	1,102,500	1,313,000	1,584,000

Sources: 1970 — U.S. Bureau of the Census.
1980-2000 — Columbia Region Association of Governments.
Distribution by refuse centers — COR-MET.

APPENDIX C

Appendix C

EXISTING PROCESSING AND DISPOSAL SITES

CLACKAMAS COUNTY

Lavelle

This demolition landfill, opened in June 1973 on King Road in Milwaukie, is owned by Portland Road and Driveway Company and operated by Harold and Glen Lavelle. The site is a 31-acre gravel pit with a base elevation of about 35 feet below the surrounding land area and is still being mined in the northeast and northwest sectors. Portions of the northeast part were mined below the water table, resulting in depressions of standing water. The location is in a residential and commercial area, and the nearest residence is only about 100 feet from the site. The landfill operation, however, is screened from view by a sight-obscuring fence. The site is zoned for large-lot residential use and the completed landfill is anticipated to be used for a trailer court.

The disposal operation consists of dumping and spreading at the base of the site and compacting with a Caterpillar 988 landfill compactor with support from a D8 bulldozer. The landfill is basically operated by the area method with cover provided by imported excavation. Cell construction consists of cells 8-feet deep and 300 feet long which are spread and compacted in 2-foot layers. Completed cells are covered with 12 inches of soil, and partially completed cells are covered daily with ground wood residues or soils. It is expected that approximately half the imported soil will be purchased at about $0.50 per cubic yard. The site is operated and maintained by five full-time and three part-time employees. Blowing papers are contained by portable screens and policing action by employees. Fire protection is provided by a 3-inch high-pressure water main. Surface water drainage is accomplished by sloping the working areas to drain to the south and east where the water is percolated. The finish grade will be drained by a system of catch-basins leading to dry well sumps outside the fill area.

Limited salvaging of metal items is practiced by an independent salvager.

Rossman

This sanitary landfill, opened in August 1969, is owned by Jack Parker and operated by Rossman's Landfill Inc. It is located on Abernethy Road (17th Street) adjacent to the city limits of Oregon City. The site presently accepts wastes from all of Clackamas County and parts of Multnomah and Washington counties. Approximately one-half of the wastes disposed of at this site come from outside Clackamas County.

The site layout consists of a flat, open area surrounded by dikes for exclusion of flood waters from Abernethy Creek. In the past the dikes were not high enough to prevent winter flooding which caused a cessation of operations. The wastes were then hauled to the Oak Grove disposal site, a temporary landfill in Oregon City. Land use surrounding the Rossman site consists of residential, light industrial, commercial, recreational, and freeway. The distance to the nearest residence is less than one-quarter mile. Abernethy Road passes through an area that is mostly commercial but partly residential. The access road into the site is a short, paved, two-lane road of moderate grade leading up to the final grade where the fee trailer is located. The remaining distance to the working face is covered by a gravel surface. There is also an undeveloped right-of-way at the north end of the site leading directly to I-205. The site is zoned for light industrial use, and it is anticipated that warehouses or other types of light industrial construction will eventually be built upon the fill.

The disposal operation is accomplished with a modified ramp method in which wastes are dumped from the top of the fill and spread and compacted in a direction parallel to the working face. Cells are generally 20 to 25 feet deep, 50 feet wide, and approximately 300 feet long. Daily cover is applied only on top of the cell, and the ramp is left exposed. Consideration is being given to use of wood wastes or other types of material for intermediate cover of the ramp. Cover material is applied by a drag line which excavates the clay soil from the base of the landfill adjacent to the working face. Spreading and compaction is accomplished primarily with a Caterpillar 826 landfill compactor with auxiliary support from two D8 bulldozers. Generally there are eight full-time and two or more part-time employees.

A tire shredding operation has recently been instituted at the site. Tires are stockpiled in the vicinity of the shredder and fed into the machine by hand. The resulting chips are loaded by conveyor into a dump truck which hauls them to the working face of the landfill.

Miscellaneous operations include salvaging and paper cleanup. Limited salvaging is practiced by a part-time employee who collects mostly metal items separated from public dumping or from areas not being worked by compaction equipment. Blowing papers occur on windy days, and when they cannot be contained by portable fences, high school students are employed to police the area.

COLUMBIA COUNTY

Clatskanie

Located in Township 7 North Range 4 West Section 7, the Clatskanie disposal site lies adjacent to the westerly edge of the city limits and about 2 miles southwesterly from the city center. The site was opened in approximately 1940 and operated as an open burning dump until 1970, when the local collector/operator upgraded the disposal operation to that of a modified landfill with an attempt at orderly compaction and cover.

The present operation is situated approximately half way down the side of a moderately sloping hill. Runoff from the hillside drains into Mary's Creek, a minor tributary of the Clatskanie River. The total site encompasses an area of some 19 acres of city property with additional property adjacent to the east edge which now is utilized by a shooting club and a cemetery. There is one residence about one-third of a mile north of the site and a small residential area about 1 mile southwest of the site. A power transmission line runs east-west about one-fourth mile above the site following the ridge of the hill.

Access to the site is over city streets and county roads. The final one-fourth mile stretch of county road climbing up the hill to the site rises at a moderate-to-steep grade. The road has a good oil and gravel surface to the landfill entrance and then continues to the crest of the hill with an improved crushed rock surface. This county road is not maintained on a priority basis, and there are short periods during the winter when the road becomes impassable.

The site is on land owned by the City of Clatskanie but leased to, and operated by, the local collector, Chris Nielsen, through franchised Ordinance No. 336. The site operates under DEQ permit No. 145 and a solid waste disposal franchise from Columbia County.

The dump is open on Saturdays from 9 a.m. to 6 p.m. for public use and is open only to the collector during the week. Of the 19 acres available, the present operation is confined to approximately 5 acres which is fenced. Cover is applied on a regular twice weekly basis throughout the dry part of the summer and as possible during the winter. Equipment used for all dump operations is a Caterpillar D6. Cover material is obtained from the hillside north of the dumping area. A 2- to 3-foot drainage ditch has been dug around the toe of the hill above the landfill area in an attempt to divert surface drainage around the site. Bulky wastes and demolition materials are handled separately at an area just inside the gate on the south face of the filled area.

The estimated quantity disposed of at Clatskanie is 2,059 tons per year. An average of two 16-yard compacted loads are dumped each day, one a mixed commercial and residential load from the City of Clatskanie and one rural residential load. On Saturdays, only one load of commercial refuse from the City of Clatskanie is dumped. An estimated 1,924 tons per year are dumped by the collector. There are presently no large industrial users of the site. In addition, public dumping on Saturdays is estimated to account for an average of 135 tons per year. The service area of the dump encompasses all of northwestern Columbia County.

Mickey

Mickey's landfill is situated in the southwestern portion of Columbia County approximately 4 miles northwesterly from the City of St. Helens. Opened by Mr. R. G. Mickey in 1957, the site is located on Route 1 in a steeply wooded section of Township 5 North Range 2 West Section 24.

Mr. Mickey owns approximately 40 acres of wooded and open land, situated on the side of several steep ravines. There are no major water courses on the site and only one small stream carries the local surface drainage. The local soil is predominantly the characteristic, hard-to-work, Columbia County clay.

The land surrounding the site is presently undeveloped and the nearest residence is approximately one-half mile from the site. The site is well screened, located over the edge of a steep hill in heavy woods. It is expected that the surrounding land use will remain rural throughout the study period.

There are good directional signs on all county access roads. Access to the site from U.S. Highway 30 near St. Helens is over several miles of paved and graveled county roads. The access road into the site is approximately one-quarter mile in length with a gravel surface. This road is extremely steep with a 90-degree corner at the bottom of the road on the site. Maintenance is performed on the road by Mr. Mickey and occasionally by the County in return for free disposal at the site. The maneuvering room at the bottom of the access road is extremely small, and large trucks have difficulty in negotiating the available area. The access road is also impassable for short periods during the winter months.

The site is currently operated under a solid waste disposal franchise from Columbia County and also under DEQ Permit No. 72. It is open 7 days a week, excluding holidays, with winter hours from 9 a.m. to 5 p.m. and summer hours from 8 a.m. to 6 p.m. The costs for disposal are similar to those at other sites in Columbia County. The following items are accepted: garbage and other putrescible items, tires, land clearing and demolition material, junk autos, street sweepings, large appliances, small dead animals, and construction wastes. The site is also approved for the disposal of acids but this type of material is not accepted. Mr. Mickey owns no equipment himself but hires local operators and equipment as needed. The equipment available includes a John Deere 10-10, a Caterpillar D8 tractor, and a small John Deere 450. Mr. Mickey spent approximately $5,000 during the past year for equipment operating time. There is one small office building on the site with no equipment storage or washing facilities available. Tires disposed of at this site have not been covered in any orderly manner, but have simply been spread and covered as needed. Garbage and putrescible wastes are covered twice weekly during the dry summer months and as possible during the winter. The wood wastes are not covered on any orderly schedule. Bulky wastes and junked autos are simply crushed with a caterpillar and buried. Cover material is obtained from the adjacent hillside, and there is a limited supply of cover available.

Mickey's landfill serves the general public in the St. Helens-Columbia City, accepting an estimated 152 tons of residential refuse per year. There are no commercial haulers using the site; they choose to haul to the Santosh disposal site instead. Demolition material is accepted, and the Boise-Cascade Company disposes of an estimated 1,664 tons of wood waste per year. Until May 1973, Mickey's was the major landfill accepting tires in the study area. Large quantities of tires can no longer be accepted because Mr. Mickey has no equipment with which to process them. The total quantity of refuse accepted at the site is estimated as 1,816 tons per year. Of the 40 acres owned by Mr. Mickey, approximately 10 acres have been used to date. With future plans for the construction of downhill refuse retention dikes, Mr. Mickey anticipates that he has 20 usable acres remaining. At the current rate of refuse disposal, he believes this site has an estimated remaining life of approximately 20 years, and he plans to subdivide the completed site for possible residential development.

Santosh

The Santosh disposal site lies in the extreme southeastern quarter of Columbia County, approximately 3 miles northeasterly from the city center of Scappoose. The present 10-acre site is located on Tax Lots 3141-16-1 and 3241-11-1 in Township 4 North Range 1 West.

The site is situated on the flood plain of the Columbia River near the Multnomah Channel. Scappoose Creek runs approximately 200 feet from the westerly edge of the disposal area. There is a dredged canal off of Multnomah Channel, terminating approximately 300 yards from the disposal site, and presently used by an adjacent sand and gravel operation.

Access to the site from U.S. Highway 30 is over approximately 3 miles of City of Scappoose streets and county roads. All roads are well surfaced and maintained with no appreciable gradients. There is not a high ambient level of traffic over any of the access roads. The entrance road is approximately one-quarter mile long with an improved gravel surface from the county road. This road is maintained by the operator of the site with dust control measures practiced during the dry summer months.

There are several residences located approximately a quarter to one-half mile southwesterly of the site along the county road. Land to the north of the site is unimproved flood plain. There is a duck hunting club located beyond the site near the Multnomah Channel with access to this club over the dump access road.

The Sauvie soil type is the predominant soil classification in the area. This soil has severe restrictions for use in a trench type sanitary landfill because of the poor drainage capabilities and a highly fluctuating water table during the winter and early spring months.[1]

The site was first opened in 1969 by a local farmer, under the direction of the Columbia County Organization of Governments, but the operation was poor with no attempt made at orderly cover and compaction. In October 1972, Mr. Phillip Holscheimer, former director of the Columbia County Organization of Governments, assumed direct responsibility for the operation following a series of unsuccessful attempts to improve it as supervisor of dump operations for the Columbia County Organization of Governments.

Mr. Holscheimer leases approximately 10 acres from Santosh Properties out of a total of 290 acres owned by Santosh Properties, including the land on which the sand and gravel operation is situated. The site is operated by Holscheimer under a solid waste disposal franchise from Columbia County and solid waste disposal Permit No. 195 from the DEQ.

The site is currently open every day, excluding Sundays and holidays, from 8:30 a.m. to 5:30 p.m., to both commercial and public haulers. The fees for the disposal of refuse are as follows: $0.75 per compacted cubic yard; $1.00 minimum for 2 loose cubic yards; $0.50 for each additional loose cubic yard;

$0.50 each for bulky wastes. Material accepted includes all putrescible and municipal garbage, land clearing, demolition and construction waste, large appliances, and street sweepings. No tires, oil, sewage sludges, dead animals, or hazardous wastes are accepted at this site. All work at the site is done with either a 1968 International Harvester tractor model TD30, an older model International Harvester tractor TD24, and a John Deere 350. There are no equipment storage or washing facilities on the site. An attempt is made to separate the salvageable and recyclable items to one area of the dump with salvaging practiced and controlled, and no problems noted. No other special handling procedures are practiced.

There is no source of cover material at the site and all cover is imported. Occasionally some gravel tailings from the adjacent sand and gravel operation are used as cover, but more frequently paper pulp sludge from the Boise Cascade paper mill in St. Helens is used as a cover material. The dewatered sludge is spread in thin layers over the compacted refuse; however, the sludge does not compact appreciably. Also the sludge does not dry out and retains much of its initial moisture content under a hard, dry surface. A small amount of sawdust from local mills is also used as cover material.

The diked area currently being filled encompasses an area of approximately 5 acres with an adjacent diked area also encompassing some 5 acres. At the current disposal rate, it is estimated that the two diked areas have adequate volume for approximately 5 to 8 years quantity of refuse. It is anticipated that more land could be leased from Santosh property by Holscheimer to provide for additional site area by constructing additional dikes. At the present time there are no plans for future use of this site.

When Holscheimer assumed operational responsibility of the Santosh site, he instituted a system of ticket receipts to record quantities delivered. These records have been kept for approximately 6 months. Previous to this, there were no records on quantities disposed of at Santosh.

The service area of the Santosh disposal site encompasses the Vernonia and south central county region, the Scappoose-Warren area, the St. Helens and Columbia City area, and the Rainier-Prescott-Goble area. There are presently 7 commercial collectors utilizing the Santosh site; one additional collector, from the City of Rainier, uses the Coal Creek disposal site in Cowlitz County, Washington, only on an interim basis. The collector for the Rainier area had been hauling to the Santosh site subsequent to the closing of the Rainier city dump in 1969.

On the basis of limited records available, the Santosh site accepts the following approximate quantities of refuse per year. The commercial collectors dump approximately 7,300 tons of mixed residential and commercial refuse. The Rainier collector previously dumped approximately 1,100 tons of mixed commercial and residential refuse. The one drop box collector in Columbia County dumps approximately 2,400 tons of predominantly commercial refuse. Public dumping is estimated to account for approximately 1,500 tons. Large industrial users include the Boise Cascade paper mill in St. Helens, disposing of dewatered paper pulp sludge, Friesen Lumber Company disposing of wood waste, and the Kaiser Gypsum fiberboard plant disposing of wood waste--all located in the St. Helens vicinity. The total quantity of the industrial waste disposed of at Santosh is approximately 34,200 tons per year. The overall total estimated quantity disposed of at Santosh disposal site is 46,500 tons per year, excluding the quantities of the Rainier collector.

The rate of residential refuse generation in the Santosh disposal site will increase at the same rate as that for similar areas of the study area. There are no anticipated changes in amounts of industrial waste generated. Hence, the total quantities disposed of at the Santosh site will increase proportionately with the increasing residential population.

MULTNOMAH COUNTY

Lavelle and Yett

The Lavelle and Yett landfill was opened in October 1972 for the disposal of demolition and construction wastes and other nonputrescible materials. The landfill is located in a gravel pit owned by Rose City Sand and Gravel. Some natural screening of the landfill is provided by the depth of the pit, and a surrounding chain link fence with wood slats provides additional screening. Surrounding land use is generally commercial and residential; homes are located near the east and north edges of the pit. The west side is bordered by 82nd Avenue and the south end is still being mined for gravel. The main haul route to the site is 82nd Avenue with nearby connections to Interstate 80 and Columbia and Sandy boulevards. Access to the landfill is provided by 700 feet of two-lane gravel road on a 10 percent slope. Rose City Sand and Gravel does not have a definite use planned for the site.

The landfill is operated by the area method with cover provided from both an on-site stockpile and imported soil. The fill is constructed in 8-foot deep lifts covering an area of about 1 acre surrounded by earth fire dikes and covered with 1 foot of soil. Each lift of the fill is sloped from the periphery toward the center of the site. Solid wastes are placed in the fill in 2-foot layers and are compacted using a Caterpillar 988 landfill compactor. A Caterpillar D8 bulldozer and a Caterpillar 977-1 front loader are also used. A daily cover of ground wood residue is placed on the compacted refuse to prevent papers from blowing and to provide a neat appearance to the fill. Additional control of blowing papers is provided by portable litter screens and policing by employees. Fire protection is provided by a 3-inch high-pressure water line located in the earth fire dikes. During the summer, dust is controlled by watering the gravel access road and by sprinkling the working area of the fill using the fire control hoses. Surface water is drained to dry well sumps located on the site. Limited salvaging is practiced at the site and the salvaged materials are removed daily. The site is operated by eight full-time employees.

Obrist

The Obrist landfill was opened in April 1972 for the disposal of demolition and construction wastes and land-clearing debris delivered by licensed contractors and commercial haulers. Wastes delivered by the public are not accepted. The landfill is located in a hillside gravel excavation owned by Don Obrist Dump Trucking, Inc. The site is well screened from public roads by its topography and location, but houses located along the west side of the excavation have a good view of the landfill operation. Surrounding land use is generally rural residential, but Don Obrist Dump Trucking, Inc., is located at the entrance to the site on Troutdale Road. The main haul route to the site is Troutdale Road with a nearby connection to Stark Street. Site access is provided by about 200 feet of two-lane gravel road on a fairly flat slope. Final use of the site will be as a park for the City of Troutdale.

The landfill is operated by the area method with cover material provided from imported soil. The fill is constructed in 10-foot deep lifts isolated by dikes and covered with 1 foot of soil. Solid wastes are placed in the fill in maximum 2-foot layers and compacted using a Caterpillar D7 bulldozer. An Allis-Chalmers 745 front loader is also available. Because of the limited type of material accepted, daily cover is not required and intermediate soil covering is done on a monthly basis. Fire protection is provided by a 2,500-gallon water truck. Surface water runs off from around the site.

No salvaging is practiced. Operation of the site is done on a part-time basis by employees of Don Obrist Dump Trucking, Inc.

Hidden Valley

The Hidden Valley landfill was first operated in the spring of 1969. Initial operation was generally poor with washout of landfilled waste and underground fires occurring. Land Reclamation, Inc., purchased the property in the spring of 1970, and a new permit was issued in May 1970 for the operation of a demolition landfill. The landfill consists of three steeply sloping canyons that join together in a common drainage basin. Natural vegetation and the height of the area above U.S. Highway 30 make the site very difficult to see from any populated areas. Forest land predominates around the site with Burlington Northern Railroad and U.S. Highway 30 several hundred feet to the north. U.S. Highway 30 provides excellent access to the site at high traveling speeds. Site access is by means of 500 feet of moderately steep two-way gravel road. Final site use has not been determined.

The landfill is operated by the canyon method with cover material excavated from the sides of the canyons. The fill is constructed in 6-foot deep lifts covered with about 1 foot of soil. Solid wastes are placed in the fill in 2-foot layers and compacted using an International TD24 or TD25 bulldozer. Cover material is applied daily over the compacted refuse to prevent blowing litter and to provide a neat appearance to the fill. Drain pipes have been placed under the landfill to drain surface water from above the filled areas. Salvaging is not practiced at the site. One full-time employee operates the landfill.

St. Johns

Operations at St. Johns landfill began in 1932. The landfill was essentially an open dump until the summer of 1969 when covering of the entire top surface of the fill with earth was begun. The landfill is located in a lowland area adjacent to Columbia Slough. Trees around the site provide natural screening with a loss of some efficiency in the winter when the leaves are gone. Surrounding land use is generally commercial and industrial. Rivergate industrial park is located west of the landfill. Bybee Lake and North Portland harbor are to the north, Smith Lake is to the east, and Columbia Slough is to the south. The main haul routes to the site are Columbia and Swift boulevards with site access provided by approximately 2 miles of two-lane paved road from Swift Boulevard. The City of Portland intends to use the completed landfill and Smith and Bybee lakes for a park and open space area, in conformance with the comprehensive plan for the North Portland area.

The landfill is operated by the area method with cover material provided entirely from imported soil at a cost between $0.70 and $1.20 per cubic yard. The fill is constructed in 8-foot deep lifts that are covered with about 6 inches of soil plus wood waste. Solid wastes are placed in the fill in 2-foot layers and compacted. A daily cover of 6 inches of soil plus wood waste is then placed on the compacted refuse. Control of litter is provided by portable fences and policing by employees. Fire protection is provided by portable 6- and 8-inch diameter aluminum irrigation pipe. During the summer, dust is controlled by watering dust-producing areas with the street-flushing trucks. Surface water is drained off the site to nearby sloughs and lakes. Limited salvaging is practiced at the site by several individuals authorized by the city. Salvaged materials are removed daily from the site.

The landfill is operated by about 27 full-time employees as follows:

	Number of Personnel
Director	1
Supervisors	3
Office and clerical	4
Equipment maintenance	5
Equipment operators	6
Laborers	8

WASHINGTON COUNTY

Frank

Frank's Sanitary Service began operation of this 51-acre site in 1962. Of the 40 usable acres, only 4 have been filled to date, because until 1968, this site was operated as an open burning dump. The site is situated on a hillside which slopes down to a flood plain of the Tualatin River. A number of small springs pass through the property, emptying into the Tualatin River. The property has a predominantly silty clay soil. A small wood frame residence located on the property is presently used as a home for the site caretaker. The property and surrounding area are agriculturally sound with farm houses located on either side of the property on Beef Bend Road, the nearest of which is roughly four-tenths of a mile away from the operating face. As the work face is on a hillside separated from the road by a field, the operation is naturally screened. Scholls Ferry Road and Beef Bend Road from 99 W are used as access. The access road into the site is slightly downgrade, gravel surfaced, and approximately four-tenths of a mile long. It is anticipated that the completed fill will be left as open space or possibly returned to an agricultural use.

Frank's Sanitary Service and the subcontracted drop box service to Frank's franchise area are the only users of this site, which is operated from 8:30 to 5:00 p.m. Monday through Friday, year-round. The site foreman-equipment operator is knowledgeable about landfill operation, and has converted the previous open burning dump to a modified landfill during his 5 years of employment. During the summer months an additional man is used to haul cover material from a borrow location on the property. The equipment operator records the number of loads delivered to the site each day. A TD9 crawler tractor or a D7 crawler tractor are regularly used with a TD15 for standby use. Cover material is excavated and stockpiled using a small D4 crawler tractor and tractor-drawn scraper. The working face has recently been moved to the flood plain area in the southern portion of the property. A dike has been constructed on two sides of the flood plain and is separated from the Tualatin River by a 100-foot buffer strip. The operator intends to complete the third and final side of the dike by wintertime when the area is susceptible to flooding. The eastern face of the flood plain is bordered by a slope of the previous working area. Refuse is dumped at the working face, routinely spread into layers 2-feet thick or less and well compacted. Cover is placed at the end of every working day during the summer months when the cover material is workable and at least once per week during the winter and spring months as required by State and County permits. All refuse is handled in the same working face with no separate areas provided for bulky material. The access road and Beef Bend Road are policed for debris twice per week. There is some scattered debris located around the periphery of the site which has accumulated over a number of years.

Grabhorn

The Grabhorn Construction Company has operated this demolition landfill since 1955. The site has been used regularly since then, but at a very low filling rate until the ban on open burning went into effect. This site, 3 to 4 acres in area, is located in a number of small ravines which slope to a manmade water body that is presently used for irrigation and fire-protection purposes. The nearest residence to the landfill is owned by a vineyard operator. Part of the landfill is located on the neighbor's property which is being reclaimed to extend the vineyard. The remaining portions of the landfill will be used to extend a Christmas tree farm which separates the landfill from the property owner's home. The property and surrounding area is agriculturally zoned. Access into the site is a gravel surfaced road which slopes downgrade to the site. The landfill is strictly limited to construction demolition and land clearing debris from the owner's construction business. As this site is privately owned and operated, there are no specific hours of operation. The site is unattended and the equipment consists of a D8 crawler tractor and a tractor-drawn scraper which is housed at the owner's shop located on the property. The waste is spread and compacted when a sufficient quantity has been dumped. Cover material is excavated from a borrow pit, also located on the property. Cover material is applied approximately once per week, depending on the quantity of waste which is disposed. A berm has been constructed on the southern face of the site which slopes to the water body.

Hillsboro

This 92-acre demolition landfill has been in operation since 1963. The present operator began leasing the property in May 1972 and has improved the operation of this site by providing greater compaction and more frequent covering. The present working face is situated on a hillside which slopes down to, and includes, a flood plain of the Tualatin River. The predominant soil type used for cover is a silty clay. The property and surrounding area is agriculturally zoned, with a nursery directly adjacent to the property. The nearest residence is approximately one-half mile from the operating face of the site. The entire operation is naturally screened from Minter Bridge Road by an open field, formerly the working face of the landfill. The primary access from the Tualatin Valley Highway is by Minter Bridge Road. The level access road is gravel surfaced and approximately three-tenths of a mile long.

The landfill accepts demolition, construction, and land-clearing wastes, brush, large appliances, and other bulky wastes from all of Washington County. Most collectors in the county providing drop box service for commercial and industrial non-putrescible wastes use this landfill. This site is open from 8:00 a.m. to 6:00 p.m. Monday through Saturday. There are three full-time employees--a fee-collector, foreman, and two equipment operators. The fee collector records the quantity of each load that is delivered to the site. A Caterpillar 977 track loader and a Caterpillar D9 crawler tractor are regularly used on the working face, with a Caterpillar D9 crawler tractor on-site for standby use. In accordance with the site operating plan, a 15-foot pad has been constructed of clean fill onto the flood plain area. Refuse is dumped, routinely spread into 2-foot thick layers, and well compacted. Cover material, which is excavated on-site, is placed once per week in accordance with State requirements for demolition landfills. Brush and tree limb wastes are segregated in a separate area and left to dry over a period of time. Fire protection is provided by an 1,800-gallon water truck, which is also used for dust control. This site is well isolated from residential areas so that noise from heavy construction equipment is not a problem.

SITES OUTSIDE THE STUDY AREA

Newberg, Yamhill County

The Newberg landfill was opened in June 1965 near the confluence of the Willamette River and Chehalem Creek. Surrounding land use is industrial and agricultural with access to the site passing through residential areas of Newberg. The final site usage has not been determined; however, the Newberg Parks and Recreation District desires to acquire the site for development as a park.

The landfill is operated by the area method with cover provided from on-site sources. The refuse is compacted in 2-foot lifts, and final depth of cells between cover material is 8 feet. Equipment includes a model HD16 crawler tractor with a 15-yard scraper, a TD9 crawler loader, and a D8 bulldozer. Maintenance facilities are provided in an older building near the site. Fire protection consists of a small well and a 55-gallon barrel, with the Newberg fire department nearby. Some salvaging of white goods is practiced with salvaged materials removed to Portland when quantities are adequate.

Woodburn, Marion County

The Woodburn landfill is located on Crosby Road near the City of Woodburn in Marion County. This landfill serves the southwestern portion of Clackamas County, including the Wilsonville area.

The operator estimates that the site will be complete by late 1973, at which time the operation will move to a new site one-half mile north of the existing site, pending DEQ approval. The new site is estimated to have a life of about 12 years at the present rate of refuse disposal of about 125 tons per day. The operations at the existing site are carried out by two bulldozers and one dragline. The site has historically been operated as a sanitary landfill with daily cover, but owing to a recent lack of on-site cover material, the frequency of cover is now only weekly.

Elsie, Clatsop County

The Elsie disposal site is located in the southeast one-quarter of Clatsop County, just north of the Town of Elsie, with access via U.S. Highway 26. The site is operated by Clatsop County for the disposal of mixed refuse. The site serves the Birkenfeld-Vernonia region of Columbia County and the timber region of Washington County.

Operations at the site are consistent with the small quantity of wastes received, with covering of refuse on a twice weekly basis.

Coal Creek, Cowlitz County, Washington

The Coal Creek disposal site is operated by Cowlitz County, Washington, for the disposal of mixed wastes. The site is located on the Coal Creek slough near the Columbia River. Surrounding land use is primarily agricultural with access from Longview via Washington State Highway 4. The site serves the Rainier-Clatskanie region of Columbia County via the Longview Bridge.

The site is operated by the area method with daily imported cover material. Cowlitz County officials estimate that the Coal Creek site will be complete in May or June 1974, at which time operations will move to a new site near I-5, southwest of the Harry Morgan Bridge.

INCINERATION

Incineration of solid waste has decreased in recent years because of the cost of air pollution control equipment needed to meet stringent air pollution regulations. It is expected that as air pollution regulations become stricter in the future even more incinerators will be phased out. Foreseeably only very specialized incinerators such as those used for pathological waste disposal will remain in future years.

The incinerators located throughout the study region are listed in Table C-1, as reported by the Columbia Willamette Air Pollution Authority (CWAPA).

Table C-1

INCINERATOR LOCATIONS

	Company	Location	Type of incinerator[a]	Quantity, tons/yr
1.	Brazier	Mollala	Wigwam burner	--
2.	Publishers Paper	Mollala	Wigwam burner	8,320
3.	Publishers Paper	Mollala	Hog fuel boiler	11,520
4.	Milwaukie Plywood	Milwaukie	Hog fuel boiler	9,117
5.	Western Wood	Lake Oswego	Hog fuel boiler	2,000
6.	Beaver Lumber	Clatskanie	Wigwam burner	20,000
7.	Boise Cascade	St. Helens	Timber wastes	1[b]
8.	Cedar Wood Timber	Vernonia	Wigwam burner	60
9.	Crown Zellerbach	West Linn	Hog fuel boiler	13,500
10.	Multnomah Plywood	St. Helens	Waste burner	250
11.	Mist Shaken Ridge	Mist	Wigwam burner	60
12.	Olympic Forest Products	Mist	Wigwam burner	1,000
13.	Alaska Steel	Portland	Wire reclamation and aluminum sweater	--
14.	Acme Steel	Portland	Wire reclamation and aluminum sweater	--
15.	Brand S Products	Portland	Hog fuel boiler	New
16.	Barker Manufacturing	Portland	Hog fuel boiler	24,000
17.	BP John	Portland	Hog fuel boiler	245
18.	Publishers Papers	Portland Division	Hog fuel boiler	130,115
19.	Fred Meyer	(Stadium)	Double chamber	75
20.	First National Bank of Oregon	Portland	Multiple chamber unit	50
21.	Holiday Park Plaza Apartments	Portland	Multiple chamber unit	124
22.	Lincoln High School	Portland	Multiple chamber unit	230
23.	Multnomah County Hospital	Portland	Multiple chamber unit with pathological side unit	--

Table C-1 (Continued)

	Company	Location	Type of incinerator[a]	Quantity, tons/yr
24.	Nicoli Door Company	Portland	Hog fuel boiler	14,500
25.	Oregon Humane Society	Portland	Pathological unit	350-500[c]
26.	Multnomah County Animal Shelter	Troutdale	Pathological unit	350-500[c]
27.	Owens Illinois	Portland	Glass furnace	90,000
28.	Olympic Forest Products	Portland	Hog fuel boiler	--
29.	Providence Hospital	Portland	Pathological unit	6
30.	Seaport Manufacturing	Portland	Wood waste boiler	4,860
31.	Town & Country Animal Clinic	Portland	Pathological unit	18
32.	United Medical Lab	Portland	Multiple chamber with pathological side unit	--
33.	University of Oregon Medical School	Portland	2 multiple chambers	100 (each)[c]
			1 multiple chamber	350-500[d]
			1 pathological unit	250-350[d]
34.	VA Hospitall	Portland	--	--
35.	Western Wire-Bound Box	Portland	Hog fuel boiler	--
36.	Woodland Park Hospital	--	Pathological unit	1
37.	Siedels Company	Portland	Wire burning unit	1,830
38.	Zusman Company	Portland	Wire burning unit	26
39.	Forest Grove Lumber	Forest Grove	Hog fuel boiler	2,000
40.	Leonetti Furniture	--	Multiple chamber unit	250
41.	Stimson Lumber Company	Forest Grove	Hog fuel boiler	12,960
42.	Tigard School District	--	Multiple chamber unit	180
43.	RTE Corporation	Portland	Multiple chamber unit	NA

Table C-1 (Continued)

	Company	Location	Type of incinerator[a]	Quantity, tons/yr
44.	Westover Tower Apartments	Portland	Multiple chamber unit	NA
45.	U.S. National Bank	Hillsboro	Multiple chamber unit	NA
46.	Milwaukie Schools (4)	Milwaukie	Multiple chamber unit	NA
47.	National Appliance	Tigard	Multiple chamber unit	NA
48.	Hudson Cannery	Hillsboro	Multiple chamber unit	NA
49.	Portland Laurel-hurst School	Portland	Multiple chamber unit	NA
50.	St. Mary's of the Valley	Beaverton	Multiple chamber unit	NA
51.	Mt. Hood Meadows	Mt. Hood	Multiple chamber unit	NA
52.	Multorpor	Mt. Hood	Multiple chamber unit	NA
53.	Alaka Trailer Company	Beaverton	Multiple chamber unit	NA
54.	Frontier Leather	Sherwood	Pathological unit	NA
55.	Alpenrose Dairy	Portland	Multiple chamber unit	NA
56.	12 Mile Animal Clinic	Portland	Pathological unit	NA
57.	Cooper Memorial School	Beaverton	Multiple chamber unit	NA
58.	Linwood Schools	Milwaukie	Multiple chamber unit	NA
59.	Northern Specialties	Portland	Multiple chamber unit	NA
60.	Beaver Acres School	Beaverton	Multiple chamber unit	NA
61.	Bonnie Slope School	Beaverton	Multiple chamber unit	NA
62.	C.E. Mason School	Beaverton	Multiple chamber unit	NA
63.	Firgrove School	Beaverton	Multiple chamber unit	NA
64.	McKinley School	Beaverton	Multiple chamber unit	NA
65.	Merle Davies School	Beaverton	Multiple chamber unit	NA

Table C-1 (Concluded)

	Company	Location	Type of incinerator[a]	Quantity, tons/yr
66.	Raleigh Hills School	Raleigh Hills	Multiple chamber unit	NA
67.	Ridgewood School	Beaverton	Multiple chamber unit	NA
68.	Sunset Valley School	Beaverton	Multiple chamber unit	NA
69.	Cedar Park School	Beaverton	Multiple chamber unit	NA
70.	Highland Park School	Beaverton	Multiple chamber unit	NA
71.	Meadow Park School	Beaverton	Multiple chamber unit	NA
72.	Mountain View School	Beaverton	Multiple chamber unit	NA
73.	Aloha High School	Aloha	Multiple chamber unit	NA

NA = Not available.

a. All of the units listed have at least primary and secondary after-burners, and some of the units have scrubbers.

b. Tons per hour.

c. Pounds per hour.

Source: Columbia-Willamette Air Pollution Authority.

In addition, there are a number of incinerators that have not been investigated by CWAPA to date. The quantities burned at each of these are estimated by the CWAPA as follows:

County	Single-chamber, tons/yr	Double-chamber, tons/yr
Clackamas	414	245
Columbia	18	230
Multnomah	999	456
Washington	45	876

APPENDIX D

Appendix D

INVENTORY OF REFUSE QUANTITIES

In this appendix, data are presented on the refuse weighing and sampling programs and on the rural waste practices survey.

REFUSE WEIGHING PROGRAM

The accumulation and interpretation of the truck weighing data was basic input information needed for many parts of the solid waste management plan and for this reason it was decided to obtain this information in the early stages of the study. The week of March 12, 1973, was selected for the initial weighing period.

A weighing period of one week at each landfill was decided upon in order that the wastes of residences and businesses with once-a-week collection would be weighed at some time during the program.

Weighing Equipment

Since weighing was to be conducted at two separate sites it was necessary to use a scale that could be easily moved from one site to another and re-erected. It was decided that the most economical and reliable method of obtaining weighing data would be to rent a pair of portable truck wheel scales and construct a portable beam axle scale system around these scales. A pair of one-quarter-inch metal pans were fabricated as base pans for the two scales and two side boards were bolted between the pans, essentially forming a four-walled container. The scales were then placed into the steel pans. A wooden beam, 10-feet long and 6- by 16-inches wide, was fabricated from two

10-foot 6-inch by 8-inch beams and placed across the scales. Each end of this beam had a metal bearing plate between the face of the scale and the beam. Four separate ramps were constructed 10 inches deep by 3 feet wide by 5 feet long. Two of these ramps were used on each side of the scale assembly, so that trucks could mount the scale assembly one axle at a time. With the scale assembled and the ramps in place, several loads of coarse gravel were then placed leading up to the assembly and all around the ramp and scale assembly itself to anchor the ramp and the scale assembly and also to provide a solid surface upon which the trucks could drive. Figure D-1 shows the completed scale system. Additional weighing equipment included fluorescent highway traffic cones used to delineate the scale access road, two portable directional signs, and a shovel for maintenance of the access road.

Field Data Sheets

Three forms for recording field data--one interview form and two weighing forms--were drawn up to expedite the weighing and recording process. The truck interview form contained the largest amount of information, including: truck license number, city license number, empty weight, cubic yardage carried, rated compaction, body make and type, geographic area from which the refuse had been collected, and type of refuse source collected from. The truck weighing forms, one for each side of the truck weighed, contained information on the truck license number, the city license number, and a loaded weight for the truck wheel and each rear axle and a total weight column. The date and time of truck weighing was also recorded. These forms were kept in 3-ring notebooks in the field for protection against the weather and for ease of use. At the end of each day the completed forms for each notebook were removed and placed in three separate folders. These forms were then matched at a later date using

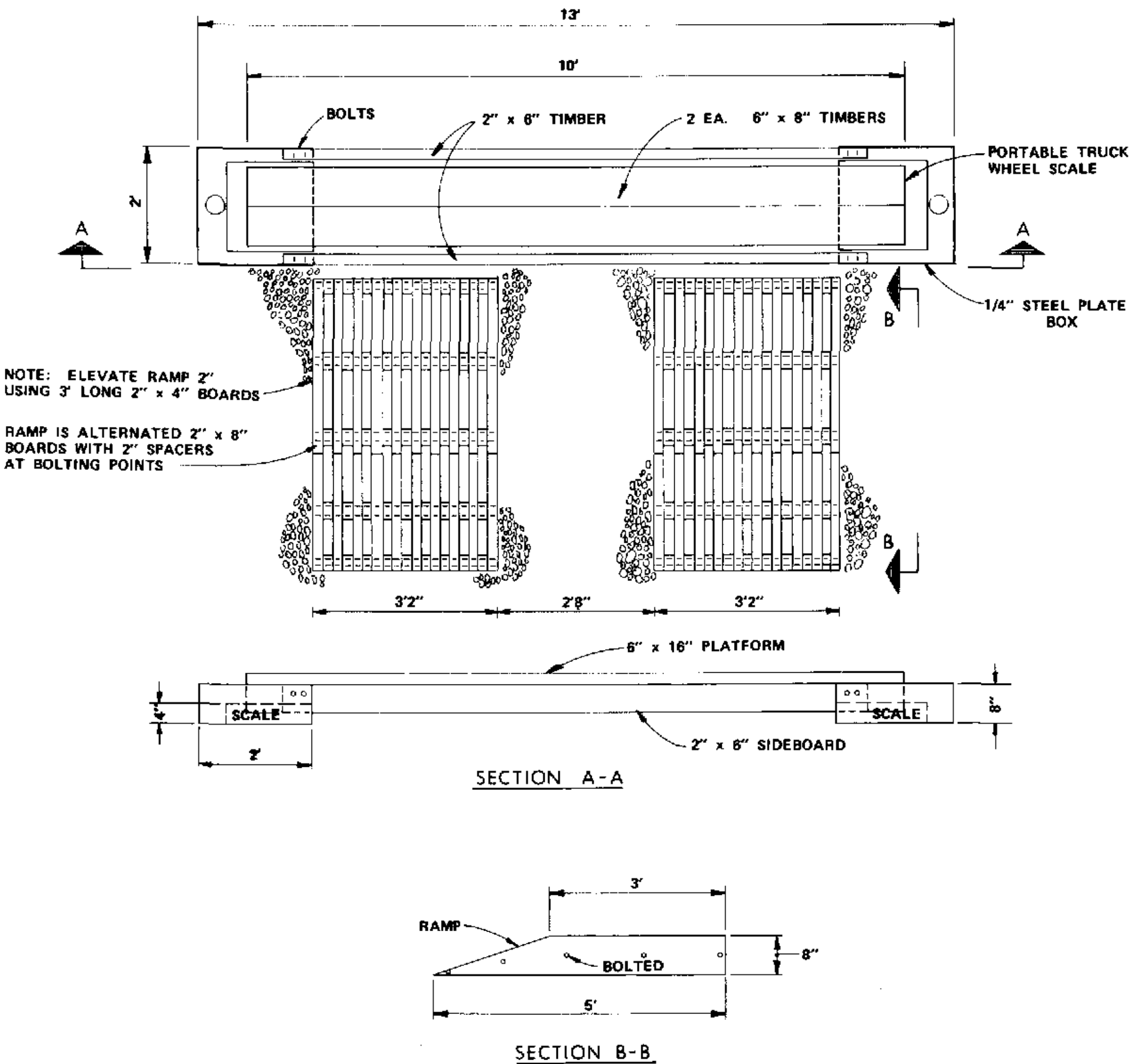


FIGURE D-1
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

PORTABLE TRUCK SCALE

cornell

the information on the truck license number, time, and city license number from each form.

Weighing Procedure

To obtain the greatest amount of cooperation from the private haulers and to inform them of the intentions of this study, the Sanitary Drivers Union Local No. 220 was contacted and a procedure for publicizing the weighing program was established. A letter stating the purpose and time of the weighing program was prepared by the local union representative, COR-MET, and several local haulers. This letter was endorsed by several of the major haulers in the metropolitan area and copies were then distributed to the operators at the two landfills where weighing would be done. These form letters were handed out approximately one week in advance of the weighing program by the toll taker at each landfill site. In this way, each hauler was notified of the impending weighing program. Also, a small article was placed in the teamsters' weekly paper which stated COR-MET's intentions to weigh refuse trucks at specified landfill sites. In addition to this advance publicity, the commercial haulers were able to observe the weighing crew erecting the scales approximately two days ahead of the weighing period.

Daily records kept on volumes discarded at the St. John landfill were analyzed to ascertain the most advantageous time to weigh. From these records it was established that approximately 90 percent of the packer trucks use the site between 6 a.m. and 7 p.m. Consequently, it was decided that refuse weighing would be carried out from 7 a.m. until 6 p.m., hopefully obtaining data on approximately 80 percent of the trucks into the landfill on any given day.

Given the rapid rate of truck arrival at certain times during the day as indicated from landfill records, and the fact that the scale assembly would weigh only one axle at a time, it became essential that the weighing procedure be extremely fast. To ensure speed in the weighing operation, four men were used. One man directed truck traffic over the scales and interviewed the truck driver using the truck interview form to obtain information regarding the truck type and source of refuse carried. Two scale men, one operating each scale, did nothing but weigh each truck axle, one wheel at a time. The fourth man was situated ahead of the entrance to the scale access road on the landfill approach road, and was used as an overflow interviewer. When the number of trucks backed up behind the scale assembly, interfering with traffic on the dump approach road, he directed them past the scales after using the truck interview form to obtain the type of waste and its source. No weights were obtained from these overflow trucks.

Weighing at the St. Johns Landfill. The scale assembly was erected at the St. Johns landfill several days prior to the week of March 12, 1973. On the advice of the landfill supervisor, the scales were placed well inside the entrance of the landfill approximately 500 feet from the working face. The scales were erected to the right of the access road and incoming loaded trucks simply pulled off the road onto a graveled access road up onto the scales, over the scales, and across the access road into the dumping area. The length of the access road to the scales had the capacity to accommodate approximately four or five waiting trucks. Weighing continued from Sunday, March 12 through Saturday, March 18. All trucks leaving the landfill were weighed empty using the scales in reverse on Monday, March 20. These empty weights were used to confirm empty weights provided by some of the drivers and owners. It was desired to weigh each truck entering the landfill during the weighing period;

however, owing to the high volume of truck traffic during certain peak periods of the day, breakdowns, and lack of cooperation among the haulers, approximately 840 trucks were weighed, or about 75 percent of the total number entering the landfill during the week of weighing. No attempt was made to institute a program of weighing for the public dumping, which is done at a separate area on the landfill site. Weather during the weighing period ranged from warm, dry, and sunny with temperatures in the 60's to extremely rainy and wet with temperatures in the 50's and winds of about 15 mph.

Weighing at the Rossman Landfill. On Tuesday, March 12, the scales were disassembled at the Portland landfill and taken to the Rossman landfill in Oregon City. They were placed between the entrance of the site and the toll house, to the right of the entrance road, on a graveled area. The scales were erected and gravel was placed around them to provide a suitable base road for the truck to mount the scale assembly. There was room for approximately three waiting trucks before traffic interfered with the access road. As in Portland, no attempt was made to weigh public dumping and these vehicles were simply routed around the scale assembly by the overflow interviewer. Weighing was begun on Wednesday, March 22, and continued for a period of 6 days until Wednesday, March 28. All trucks leaving the landfill empty on Wednesday, March 28 were weighed using the scales in reverse. Adequate data on empty weights was not obtained on Wednesday so a partial crew weighed empty trucks during the three heaviest traffic hours from 11 a.m. until 2 p.m. on Thursday, March 29.

During the week of weighing approximately 720 trucks were weighed or about 85 percent of the total truck traffic into the Rossman landfill.

Analysis of Data

Upon conclusion of the weighing program, the tabulation and analysis of the raw data was begun. For each truck the completed truck interview form and associated truck weighing forms were matched, and information from these forms was compiled on a daily truck weighing summary sheet. To obtain the weight of the refuse, the empty weight of the truck was subtracted from the gross weight. Those trucks that had no empty weight identified during the weighing program were assigned an average empty weight according to the body size and style. The list of representative average truck empty weights was calculated using the known empty weights from each landfill and information from truck manufacturers.

In-truck densities were computed, using recorded truck volumes and the weights of the refuse. These values were also recorded on the summary sheets. From this information, a summary of the average in-truck densities for each type of refuse carried by each body style of truck was tabulated. Copies of these densities have been returned to the landfill operators and they are in general agreement with the calculated values. This information is summarized in Table 20, Volume I.

The percentage of wastes collected in each type of truck in each of the refuse generation centers is shown on Table D-1.

Scale Accuracy

It was desired to obtain weights within 5 to 10 percent of the true value. To estimate the accuracy of the scale assembly, drivers were asked to provide the empty weights of their trucks and the source of their information. Additionally, several trucks were weighed on the City of Portland incinerator scales.

Table D-1

PERCENT DISTRIBUTION OF REFUSE BY TYPE OF COLLECTION VEHICLE

Refuse generation center	Rear or side loader	Front loader	Drop box	Other
Columbia County				
1. Clatskanie	89	0	0	11
2. Rainier	83	0	0	17
3. Columbia City	85	0	0	15
4. St. Helens	7	0	29	64
5. Scappoose	28	0	42	30
6. Vernonia	99	0	0	1
Total	21	0	26	53
Washington County				
7. Forest Grove	72	0	7	21
8. Hillsboro	56	3	14	27
9. Aloha	66	1	7	25
10. Cedar Mill	45	2	20	33
11. Beaverton	40	3	39	18
12. Chehalem Mt.	79	0	0	21
13. Tigard	51	0	38	11
14. West County	95	0	0	5
Total	50	2	29	19
Clackamas County				
15. Stafford	71	0	19	10
16. Canby	71	0	16	13
17. Beaver Creek	53	0	21	26
18. Redland	90	0	0	10
19. Estacada	89	0	5	6
20. Sandy	44	0	50	6
21. Boring	91	0	0	9
22. Clackamas	47	0	36	17
23. Milwaukie	66	0	18	16
24. Gladstone	68	0	10	22
25. Oregon City	44	0	51	5
26. West Linn	67	0	22	11
27. Lake Oswego	62	0	29	9
28. Molalla	100	0	0	0
Total	61	0	27	12

Table D-1 (Concluded)

	Refuse generation center	Rear or side loader	Front loader	Drop box	Other
Multnomah County					
29.	S. W. Barbur	53	12	22	13
30.	Hillsdale	46	10	35	9
31.	Sylvan	57	6	37	0
32.	Portland Heights	51	3	35	11
33.	Downtown	50	12	21	17
34.	N.W. Residential	30	30	24	16
35.	N.W. Industrial	10	5	55	30
36.	St. Johns	41	5	33	21
37.	Rivergate	4	3	91	2
38.	Swan Island	1	2	96	1
39.	N. Portland	38	5	35	22
40.	Portland Airport	6	7	48	39
41.	N.E. Portland	40	3	20	37
42.	Ladd Addition	39	6	23	32
43.	Reed	42	2	22	34
44.	Milwaukie	28	5	20	47
45.	Mt. Tabor	44	5	20	31
46.	S.E. Portland	49	2	18	32
47.	Parkrose	46	4	16	34
48.	Wood Village	47	0	6	47
49.	Gresham	36	15	11	38
50.	Corbett	44	0	4	52
	Total	38	5	24	33

Note: All percentages are of total refuse collected by commercial haulers.

A graph showing the deviation of COR-MET weighed values from the driver-reported weights is shown in Figure D-2. A graph showing the deviation of COR-MET weighed values from the weights as determined by various certified scales is shown in Figure D-3. In addition, a scale calibration test was conducted by Pacific Scale Company of Portland, and results of this test are presented in Figure D-4. Comparison of COR-MET weighed values with known weights indicates that at least 95 percent of COR-MET scaled weights are within ± 5 percent of the true weight.

REFUSE SAMPLING PROGRAM

In conjunction with the refuse weighing program, a limited refuse sampling program was completed. Sampling of commercial packer truck refuse was carried out at the St. Johns landfill during the week of March 12, 1973. During this time 13 loads of refuse were sampled, of which 6 were residential, 5 were commercial, and 2 were mixed commercial and residential. At the Rossman landfill, sampling was conducted during the week of March 22, 1973. Four loads of refuse were sampled, of which 2 were residential and 2 were commercial.

Sampling Equipment

Equipment used for the sampling program included eleven 32-gallon plastic garbage barrels; one Fairbanks-Morris platform scale with a 500-pound capacity; a solid platform upon which to set the scale assembly, usually salvaged from the dump material; an instamatic camera; gloves for the sampler; and a sampler's notebook in which the sampling forms were kept.

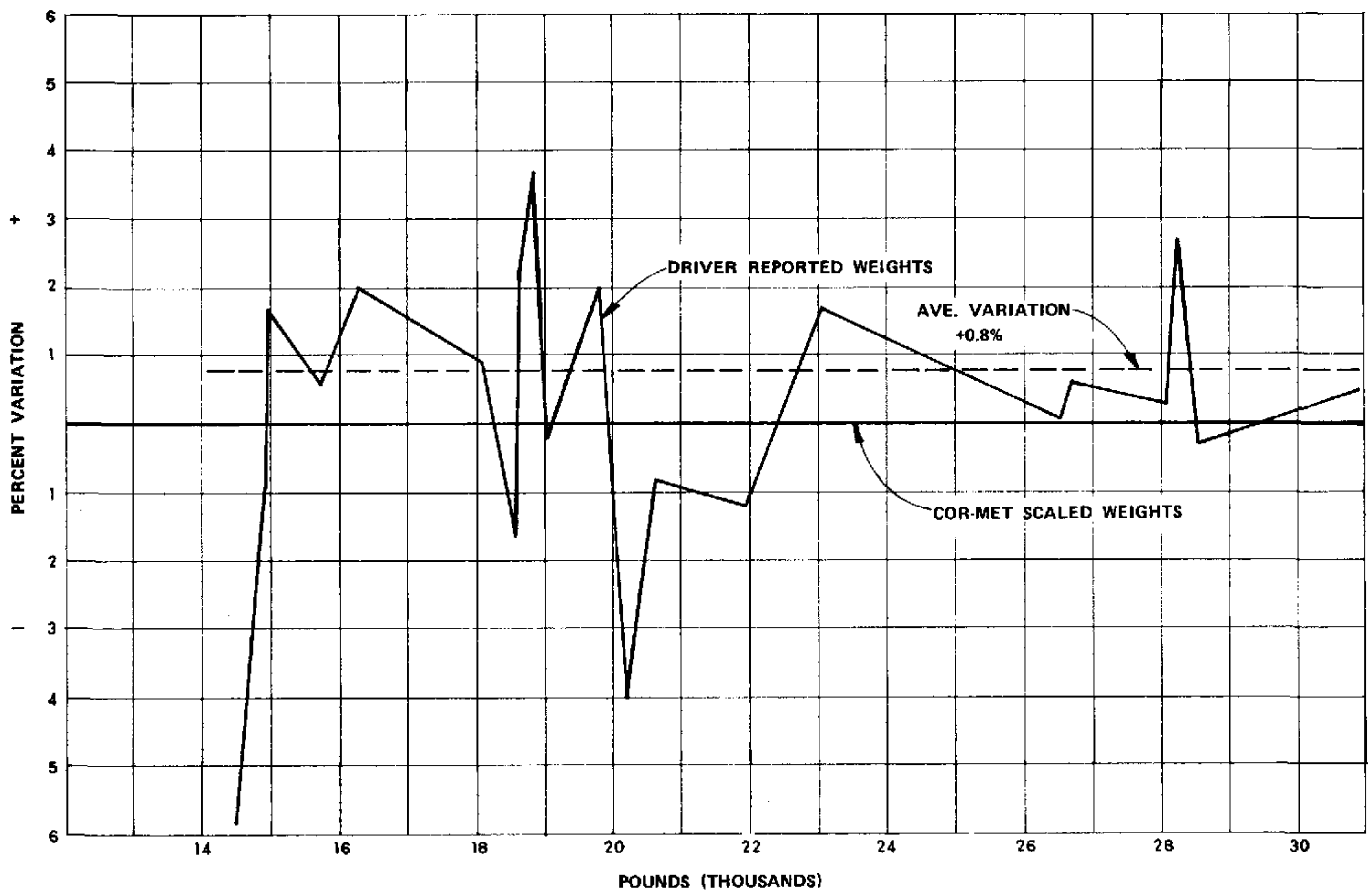


FIGURE D–2
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

COR–MET SCALE ACCURACY

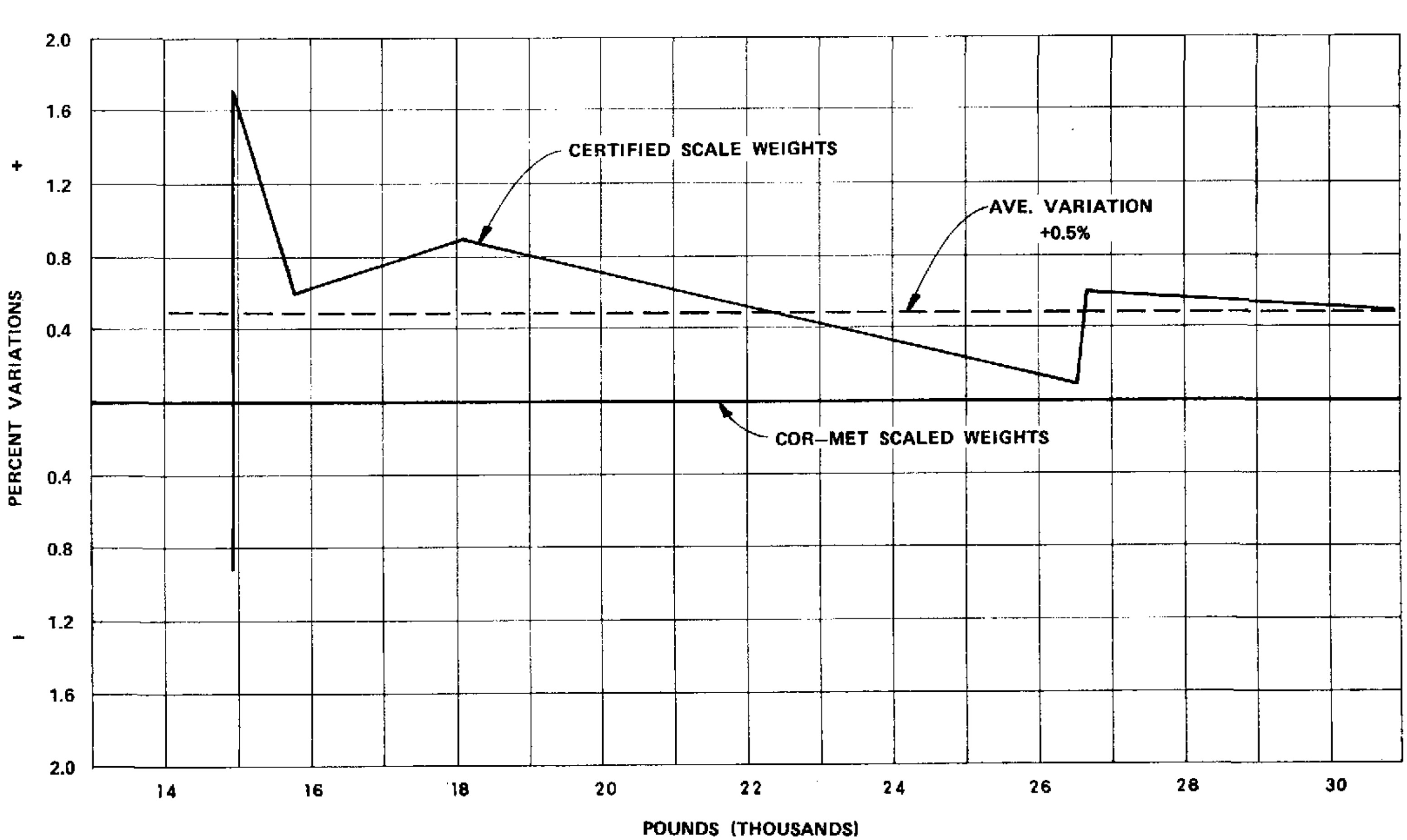


FIGURE D–3
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

COR–MET SCALE ACCURACY
CERTIFIED WEIGHTS

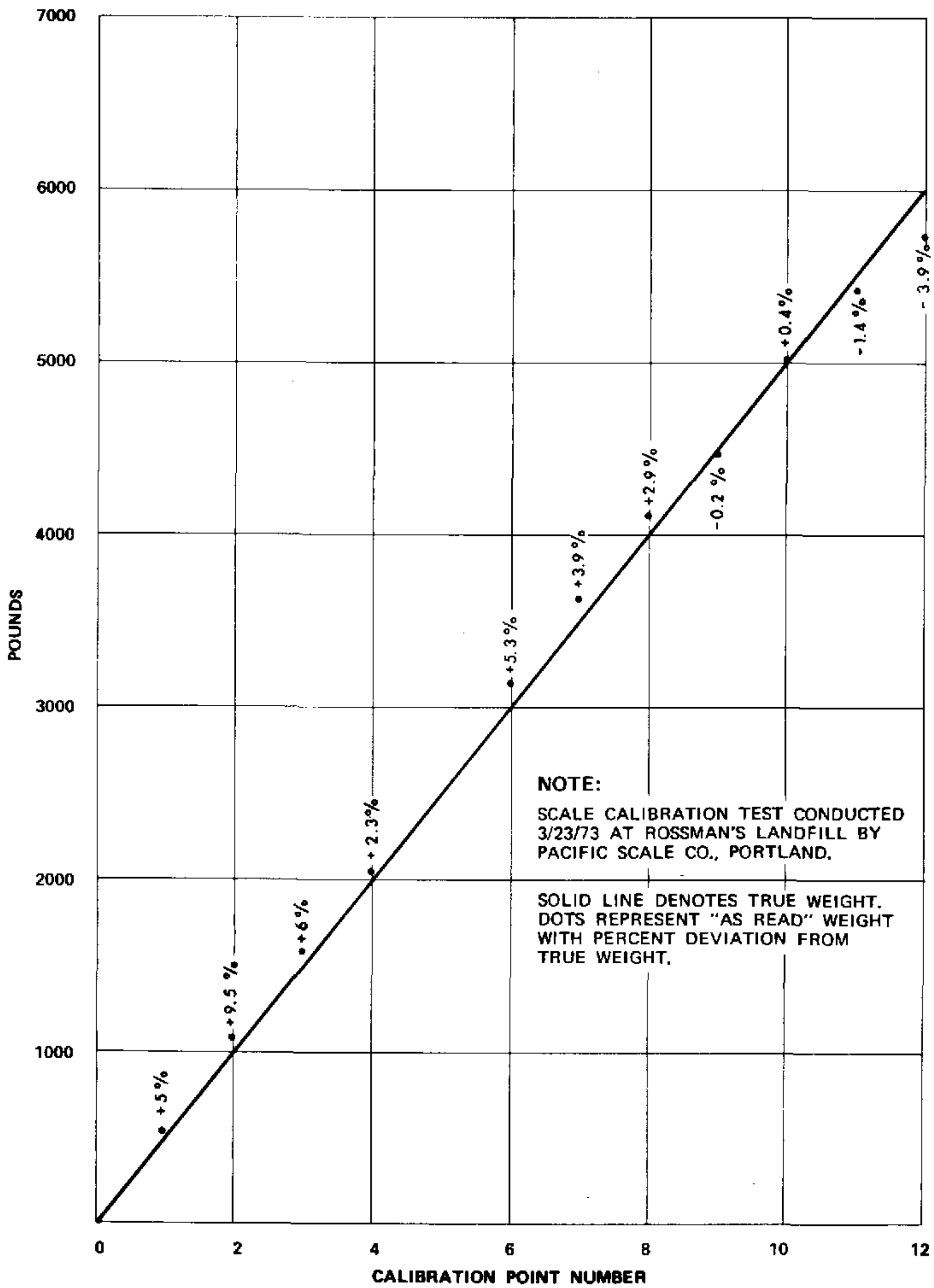


FIGURE D–4
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

SCALE CALIBRATION CURVE

Organization of the Sampling Program

Prior to the field portion of the sampling program, selected commercial haulers and the local sanitary drivers union representative were asked to provide information on the types of refuse collected by the various haulers' trucks, and the areas of the city served by each truck dumping at both landfills. From this basic information, a tentative list of desired trucks for sampling was drawn up. Trucks were selected for this list with the intention of obtaining a well spread geographic sample as well as a desired ratio of two-thirds residential refuse to one-third commercial refuse. In view of the limited amount of time available for sampling, it was considered that this preselection would help to obtain a total sample most representative of the entire municipal area. The desired goal was to sample two trucks per day per sampler. On the basis of a 6-day week, it was anticipated that 12 samples could be obtained at each landfill for a total of 24 samples. The tentative sampling list was drawn up according to these constraints and taken into the field for use by the truck interviewer in selecting trucks during the weighing program.

The various components of municipal refuse were combined into the 11 refuse categories on the following list. The first six categories consist of combustible and organic material that might be incorporated into a municipal incineration program; the remaining five categories are inert and incombustible materials. The separation of returnable bottles from all other glass was intended to investigate the effectiveness of the recently enacted Oregon returnable bottle bill.

1. Food. Food wastes, vegetable trimmings, spoiled or damaged produce, bones, fat.

2. Paper. Paper products, packaging, cardboard boxes, composite packages made mainly of cardboard, books, magazines.

3. Garden wastes. Grass clippings, shrubbery clippings, tree limbs, lawn trimmings, leaves.

4. Timbers and miscellaneous wood. Large timbers and small miscellaneous wood products.

5. Textiles. Clothes, rags, gunnysacks, canvas.

6. Plastics and miscellaneous. Plastic containers, saran wrap, plastic toothpaste tubes, styrofoam, rubber, leather.

7. Ferrous metal. Material composed of iron, tin cans and generally anything that will rust.

8. Nonferrous metal. Aluminum copper, brass, zinc, lead.

9. Returnable bottles. Glass beverage containers requiring a deposit upon purchase.

10. Other glass. Glass products or containers, except returnable bottles.

11. Demolition material (inerts). Asphalt, dirt, rocks, bricks, concrete, ceramics, ashes.

Field Sampling Procedure

At both landfills, a specific work area was designated by the landfill operator where the sampler would sort and separate the refuse using the scale and the 11 separate barrels. Barrels were labeled to indicate the type of refuse to be placed in it. When a preselected truck, or a truck loaded with appropriate material for sampling, crossed the scales, it was sent by the truck interviewer to the designated sampling area to dump its load. The sampler then "surveyed" the contents of the dumped load and selected a quarter section that was representative of the whole load. Only this selected quarter section of the load was sorted and sampled; hopefully, it was composed of the same types of material and in approximately the same proportions as the whole load. It was stressed that great impartiality was to be exercised in selecting the quarter section to be sampled. A camera was assigned to the sampler and pictures of the sample were taken before sorting was begun.

Once the quarter section had been selected, small quantities of mixed waste were separated, sorted, and placed loosely in the appropriate barrels. This continued until the entire quarter section had been sorted. The empty (tare) weight was recorded for each barrel. As the separate barrels became full, they were weighed, the gross (full) weight of the barrels was recorded on the sampling form, and the barrel was emptied to one side. Any barrel weighed when not completely full was noted as a partial weight, and the portion of the barrel filled was estimated. In this way an approximate volume of loose refuse for each category was obtained along with the total net weight. Sampling continued in this manner until either the quarter section was entirely sampled or the sampling time came to an end. If there was not sufficient time to sample the entire quarter section, an estimate was made of the total amount of the load sampled and was noted on the sampling form. Any information pertinent to the sampling program was also noted on the sampling form, including weather conditions, estimated moisture content of the load, and unusual amounts of various items found in the load.

All barrels were emptied and a new form was begun with each separate load.

Sampling at the St. Johns Landfill. The area designated for sampling at the St. Johns landfill was on one corner of the previous day's fill. The refuse to be sampled was dumped from the compactor truck onto the covered fill. There was no barrier placed between the dumped refuse and the ground. Because of the lack of a ground cover and the nature of the surface upon which the sampling was conducted, the sampler was not able to separate out the fine ash, dust, dirt, and other extremely small items that were lost into the cover material. There was a small problem with the wind blowing away the paper while sampling, but if this affected the sample it was noted on the sampling sheets. Since the majority of the trucks would arrive at the landfill between 10 a.m. and 2 p.m., there were some problems in selecting the two desired trucks per day for sampling. Because a suitable truck might not arrive until 11:30 a.m. or noon, there were usually only a few hours left in which to sample. On several days this problem limited the number of trucks sampled to one, and those selected late in the afternoon would have only a partial load sampled because of the lack of time.

Sampling at the Rossman Landfill. It was anticipated that approximately the same number of samples would be obtained at the Oregon City landfill as at the Portland landfill, but this was not the case. One reason was that the truck peak arrival period at the Rossman landfill was even more compressed than at the St. Johns landfill. The sampling team had from about 11 a.m. until 1:30 p.m. to select two trucks for sampling. This highly concentrated period of truck arrivals allowed the selection of only one truck per day on most occasions. A second difficulty was the limited size of the dumping area at Oregon City. The operators of the fill requested that sampling be done only from 8 a.m.

to 11 a.m. and from 2 p.m. until closing at 5 p.m. This time restriction effectively eliminated any sampling during the morning. Dumping at the Rossman site occurs from the top of a previously filled area approximately 30 feet above the present working area. The operators at the site have installed several heavy timber ramps at the edge of the dumping face to support the weight of the loaded commercial compactor trucks. The sampling team was assigned a space for sampling on the edge of the dumping face to the right of the timber ramps, and many of the commercial collectors refused to dump their load on this sampling area, for fear of sliding over the face or of collapsing the fill. Therefore, at the Rossman landfill, it was necessary to find a truck that would (1) satisfy the requirements for geographic area and composition of load; (2) satisfy the timing near enough to 2 p.m. or slightly after 2 p.m. so that the dumping face would be kept clear; and (3) dump on the assigned sampling area. These conditions account for the small number of samples obtained.

Analysis of Data

Each sample was classed as either residential or commercial refuse load, and the data were analyzed for these two general types of refuse. Mixed loads were apportioned on the basis of the drivers' estimates of the ratio of commercial to residential.

The total of eight residential loads were mathematically combined, and a percent by weight and by volume of the total amount of residential refuse sampled for each refuse constituent was computed. The seven commercial loads sampled were similarly combined, and a percent composition by weight and by volume for each refuse constitutent was calculated. Finally, all commercial and residential samples were combined, and the percent composition for each refuse constituent, by weight and by volume, was computed. The percent composition is summarized in Table 21, Volume I. Using the loose volumes and the total weights for each refuse category for all residential and commercial samples, an average loose density for each refuse constituent was computed, as shown in Table D-2.

RURAL SOLID WASTE INVENTORY

To accumulate information on rural waste practices and preferences in the study area, a total of 1,000 questionnaires were mailed randomly throughout the rural areas of the four counties. Approximately 250 questionnaires were mailed to each county, with addresses picked at random from the current rural route address books for each county. A total of 203 completed returns were tabulated and analyzed.

A sample copy of the questionnaire is reprinted on the following pages. The composite summaries of the results for the region and each county are presented in Table D-3.

Table D-2

AVERAGE LOOSE DENSITIES OF REFUSE CONSTITUENTS

(Pounds per Cubic Yard)

Category	Residential	Commercial	Combined
Food	357	317	337
Paper	193	156	173
Garden waste	120	121	120
Timbers and miscellaneous wood	188	250	222
Textiles	160	165	162
Plastics and miscellaneous	130	87	111
Ferrous metal	192	299	283
Nonferrous metal	260	347	293
Returnable bottles	707	783	732
Other glass	987	668	845
Demolition material (inerts)	--	332	332

Source: COR-MET sampling program, March 12-28, 1973. Samples from St. John's and Rossman's landfills combined. Values were derived from a total of 15 samples.

cor-met | CORNELL, HOWLAND, HAYES & MERRYFIELD
METCALF & EDDY
1600 S.W. FOURTH AVENUE, SUITE 601 PORTLAND, OREGON 97204 503/224-9190

18 April 1973

To Rural Residents:

We are looking for better ways to handle garbage and other solid wastes in your area, and we need your help.

The Metropolitan Service District has engaged COR-MET engineers to investigate the transport, processing, and disposal of solid wastes in Clackamas, Columbia, Multnomah, and Washington counties. As part of our project, we want to know how garbage, waste paper, yard trimmings, old appliances, agricultural wastes, and other waste items are handled in the local rural areas.

The enclosed questionnaire will help us to determine the quantities of rural wastes throughout the study area and the ways in which they are presently collected and disposed of. We would like to talk with each of you individually, but the wide scattering of rural residences makes personal contacts very time consuming. So we are asking you to help us by filling out the enclosed questionnaire and returning it to us in the enclosed envelope.

All questionnaires will be treated as confidential information for use by the study consultants only. If you have any questions, please call Mike Kennedy or myself at 224-9190 (collect calls gladly accepted).

Thank you for your assistance. The information that you supply will help us to develop a solid waste management system responsive to your needs.

Sincerely,

COR-MET

Melissa Brown

Melissa Brown
Project Manager

j

Enclosure

COR–MET

MSD PORTLAND SOLID WASTE STUDY

RURAL SOLID WASTE INVENTORY

Refuse is any useless, unused, unwanted or discarded item, including: kitchen garbage, paper, garden wastes and lawn trimmings, wood, cloth, plastics, metal, bottles and broken glass, auto bodies, appliances, dead animals, logging wastes and field wastes.

1. Name

   Address

2. Number of people living at your address: ________

3. How much refuse do you dispose of <u>each week</u>? (Put number in appropriate space.)

   _____ cans of the standard 30-gallon size.

   _____ cans of the 55-gallon drum size.

   _____ containers of ____________ (specify size)

4. How is your refuse presently collected and disposed of?

   Check one: ☐ By commercial garbage collector?

   ☐ By you or one of your family?

   ☐ Other (explain).

5. If you haul your own refuse, where do you take the wastes?

   How far is it from your home? ________ miles

6. Do you separate any portions of your refuse? ☐ Yes ☐ No

   Which items and why?

   What do you do with the separated items?

7. Do you burn any wastes? ☐ Yes ☐ No

If yes, what kind of wastes? (Check as many as apply.)

☐ Food wastes
☐ Paper wastes
☐ Other (explain)
☐ Rubber
☐ Lawn & tree trimmings
☐ Field crop wastes

Where do you burn them?

☐ Indoor fireplace
☐ Outdoor (yards)
☐ Outdoor (fields)
☐ Other (explain)

8. Do you have any special wastes that cause disposal problems?

☐ Yes
☐ No

If yes, what kind of wastes? (Check as many as apply.)

☐ Pesticides
☐ Manure
☐ Tires
☐ Other ____________________
☐ Large appliances
☐ Old cars
☐ Dead animals

What do you do with them now?

9. If there were no one to pick up your refuse and you had to take it yourself to a roadside collection point, what is the longest one-way distance you would drive? (Check one.)

☐ 5 miles
☐ 8 miles
☐ 10 miles
☐ 12 miles
☐ 15 miles
☐ 20 miles

Comments:

10. Please indicate which operating hours would be most convenient for your use if you were taking your refuse to a roadside collection point.

On weekdays, __________ AM to __________ PM

On weekends, __________ AM to __________ PM

Comments:

11. Do you have any other comments on local solid waste problems?

If you have questions or need help in completing this form, call or write:

COR–MET
1600 S.W. Fourth Avenue
Suite 601
Portland, Oregon 97201

Phone: (503) 224-9190
Attn: Mike Kennedy

Table D-3

RURAL SOLID WASTE INVENTORY SUMMARY

	Columbia County	Clackamas County	Multnomah County	Washington County	Region
Total number of questionnaires returned	39	66	46	52	203
Total number of residents on returned questionnaires	126	234	136	186	682
Average number of people per return	3.23	3.55	2.96	3.58	3.36
Unit generation of refuse actually entering collection/disposal stream, lb/capita/day[a]	1.20	1.47	1.65	1.38	1.43
Use of commercial collection service					
% of respondents who do	38	58	91	79	67
% of respondents who do not	62	42	9	21	33
Present one-way haul distance, miles	14	13.1	11.2	13.7	13.1
Desired one-way haul distance, miles	9.2	10.7	8.6	10.0	9.8
Percent of respondents who separate					
Paper	100	70	36	47	61
Glass	36	28	21	26	28
Organic		38		34	36
Of the separated items					
% burned	73	63	33	45	54
% recycled	36	47	63	55	50
% composted	36	45	8	41	35
Problem wastes indicated	Tires, appliances	Tires, appliances, old cars	Tires, appliances, old cars	Appliances, tires, old cars	Tires, appliances, old cars

a. Based on an average density of 200 lb/cy for home garbage containers.

APPENDIX E

Appendix E

SPECIAL WASTE PROJECTIONS

This appendix contains projected agricultural crop waste quantities, present agricultural animal waste quantities, and projected logging waste quantities for each county in the study area, as shown in Table E-1 through E-9.

Agricultural crop acreages are based on projected indexes of change in agricultural production as presented in "The Willamette Basin Comprehensive Study," Appendix C, Economic Base, prepared by the Pacific Northwest River Basins Commission in 1969 and from the Oregon State University Agricultural Experiment Station's Special Report 313, "Agriculture 1980, A Projection for Oregon," dated December 1970. Figure E-1 is a graph showing these projected indexes. It was assumed that the waste production factor would remain constant throughout the study period.

Timber production and associated logging waste projections are also based on information presented in "The Willamette Basin Comprehensive Study."

In the course of the investigations on pathogenic hospital wastes, data on regular hospital waste generation rates were compiled. Figure E-2 shows the total quantity of hospital wastes generated as a function of occupied hospital beds.

Table E-1

ESTIMATED AGRICULTURAL CROP WASTE QUANTITIES CLACKAMAS COUNTY

Crop	1971 Acreage	Waste production factor, tons/acre[a]	Projected waste quantity, tons/yr				
			1971	1975	1980	1990	2000
Tree fruits and nuts	3,100	0.75	2,325	2,516	2,757	3,650	4,464
Sweet corn	2,000	4.00	8,000	9,104	10,480	13,440	17,360
Green peas	--	2.00	--	--	--	--	--
Small fruits and berries	8,860	0.75	6,645	7,190	7,881	10,433	12,758
Snap beans	600	1.50	900	847	780	936	1,188
Fall potatoes	900	1.50	1,350	1,455	1,586	1,890	2,322
Table beets	--	1.50	--	--	--	--	--
Hairy vetch seed	--	1.50	--	--	--	--	--
Ryegrass seed	700	3.00	2,100	2,161	2,239	2,667	3,381
Tall fescue seed	900	3.00	2,700	2,778	2,878	3,429	4,347
Chewings fescue seed	6,000	3.00	18,000	18,522	19,188	22,860	28,980
Red fescue seed	3,300	3.00	9,900	10,187	10,553	12,573	15,939
Bentgrass seed	60	2.00	120	124	128	152	193
Red clover seed	2,000	1.50	3,000	3,087	3,198	3,810	4,830
Crimson clover	1,800	3.00	5,400	5,557	5,756	6,858	8,694
Alfalfa seed	4,400	3.00	13,200	13,583	14,071	16,764	21,252
Merion bluegrass seed	--	2.00	--	--	--	--	--
Wheat	8,600	2.00	17,200	19,574	22,532	28,896	37,324
Barley	4,500	1.50	6,750	7,682	8,843	11,340	14,648
Oats	9,000	1.50	13,500	15,363	17,685	22,680	29,295
Hay	34,200	0.25	8,550	8,892	9,320	11,799	14,706
Feed grains	2,600	4.00	10,400	10,702	11,086	13,208	16,744
Mint	--	0.25	--	--	--	--	--
Other grass and legumes	17,800	1.50	26,700	27,768	29,103	36,846	45,924
Cabbage	285	1.50	428	402	371	445	564
Pumpkin and squash	350	1.50	525	494	455	546	693
All melons	10	1.50	15	14	13	16	20
Total			157,708	168,002	180,903	225,238	285,626

a. Source: Oregon State Board of Health, "Agricultural Solid Wastes Study," 1969.

Table E-2

ESTIMATED AGRICULTURAL CROP WASTE QUANTITIES
COLUMBIA COUNTY

Crop	1971 Acreage	Waste production factor, tons/acre[a]	Projected waste quantity, tons/yr 1971	1975	1980	1990	2000
Tree fruits and nuts	200	0.75	75	162	178	236	288
Sweet corn	--	4.00	--	--	--	--	--
Green peas	--	2.00	--	--	--	--	--
Small fruits and berries	855	0.75	641	694	761	1,007	1,231
Snap beans	5	1.50	8	7	7	8	10
Fall potatoes	240	1.50	360	388	423	504	619
Table beets	--	1.50	--	--	--	--	--
Hairy vetch seed	--	1.50	--	--	--	--	--
Ryegrass seed	--	3.00	--	--	--	--	--
Tall fescue seed	--	3.00	--	--	--	--	--
Chewings fescue seed	--	3.00	--	--	--	--	--
Red fescue seed	--	3.00	--	--	--	--	--
Bentgrass seed	80	2.00	160	165	175	203	258
Red clover seed	600	1.50	900	926	959	1,143	1,449
Crimson clover	--	3.00	--	--	--	--	--
Alfalfa seed	2,000	3.00	6,000	6,174	6,396	7,620	9,660
Merion bluegrass seed	--	2.00	--	--	--	--	--
Wheat	200	2.00	400	455	524	672	868
Barley	1,200	1.50	1,800	2,228	2,358	3,024	3,906
Oats	1,000	1.50	1,500	1,707	1,965	2,520	3,255
Hay	7,700	0.25	1,925	2,002	2,098	2,657	3,311
Feed grains	4,300	4.00	13,200	17,699	18,335	21,844	27,692
Mint	175	0.25	44	47	52	66	84
Other grass and legumes	--	1.50	--	--	--	--	--
Cabbage	150	1.50	225	212	195	234	297
Pumpkin and squash	--	1.50	--	--	--	--	--
All melons	--	1.50	--	--	--	--	--
Total			27,238	32,866	34,244	41,738	52,928

a. Source: Oregon State Board of Health, "Agricultural Solid Wastes Study," 1969.

Table E-3

ESTIMATED AGRICULTURAL CROP WASTE QUANTITIES
MULTNOMAH COUNTY

Crop	Acreage	Waste production factor, tons/acre[a]	Projected waste quantities, tons/yr 1971	1975	1980	1990	2000
Tree fruits and nuts	400	0.75	300	325	356	471	576
Sweet corn	500	4.00	2,000	2,278	2,620	3,360	4,340
Green peas	--	2.00	--	--	--	--	--
Small fruits and berries	3,120	0.75	2,340	2,532	2,775	3,674	4,493
Snap beans	1,000	1.50	1,500	1,412	1,301	1,560	1,980
Fall potatoes	625	1.50	938	1,011	1,102	1,313	1,613
Table beets	--	1.50	--	--	--	--	--
Hairy vetch seed	--	1.50	--	--	--	--	--
Ryegrass seed	50	3.00	150	154	160	191	242
Tall fescue seed	--	3.00	--	--	--	--	--
Chewings fescue seed	--	3.00	--	--	--	--	--
Red fescue seed	--	3.00	--	--	--	--	--
Bentgrass seed	--	2.00	--	--	--	--	--
Red clover seed	150	1.50	225	232	240	286	362
Crimson clover	--	3.00	--	--	--	--	--
Alfalfa seed	5,800	3.00	17,400	17,905	18,548	22,098	28,014
Merion bluegrass seed	--	2.00	--	--	--	--	--
Wheat	400	2.00	800	910	1,048	1,344	1,736
Barley	500	1.50	750	854	983	1,260	1,628
Oats	300	1.50	450	512	590	756	977
Hay	3,100	0.25	775	806	845	1,070	1,333
Feed grains	--	4.00	--	--	--	--	--
Mint	--	0.25	--	--	--	--	--
Other grass and legumes	200	1.50	300	312	327	414	516
Cabbage	620	1.50	930	875	806	967	1,228
Pumpkin and squash	350	1.50	525	494	455	546	693
All melons	--	1.50	--	--	--	--	--
Total			29,383	30,612	32,156	39,310	49,731

a. Source: Oregon State Board of Health, "Agricultural Solid Wastes Study," 1969.

Table E-4

ESTIMATED AGRICULTURAL CROP WASTE QUANTITIES
WASHINGTON COUNTY

Crop	1971 Acreage	Waste production factor, tons/acre[a]	Projected waste qauntity, tons/yr				
			1971	1975	1980	1990	2000
Tree fruits and nuts	1,300	0.75	975	1,055	1,156	1,531	1,872
Sweet corn	750	4.00	3,000	3,414	3,930	5,040	6,510
Green peas	--	2.00	--	--	--	--	--
Small fruits and berries	9,790	0.75	7,343	7,945	8,708	11,528	14,098
Snap beans	900	1.50	1,350	1,270	1,170	1,404	1,782
Fall potatoes	150	1.50	225	241	264	315	387
Table beets	--	1.50	--	--	--	--	--
Hairy vetch seed	1,400	1.50	2,100	2,161	2,239	2,667	3,381
Ryegrass seed	700	3.00	2,100	2,161	2,239	2,667	3,381
Tall fescue seed	20	3.00	60	62	64	76	97
Chewings fescue seed	--	3.00	--	--	--	--	--
Red fescue seed	100	3.00	300	309	320	381	483
Bentgrass seed	100	2.00	200	206	213	254	322
Red clover seed	6,300	1.50	9,450	9,724	10,074	12,002	15,215
Crimson clover	3,000	3.00	9,000	9,261	9,594	11,430	14,490
Alfalfa seed	6,000	3.00	18,000	18,522	19,188	22,860	28,980
Merion bluegrass seed	--	2.00	--	--	--	--	--
Wheat	17,200	2.00	34,400	39,147	45,064	57,792	74,648
Barley	13,500	1.50	20,250	23,045	26,528	34,020	43,943
Oats	13,000	1.50	19,500	22,191	25,545	32,760	42,315
Hay	25,300	0.25	6,325	6,578	6,894	8,729	10,183
Feed grains	2,500	4.00	10,000	10,290	10,660	12,700	16,100
Mint	--	0.25	--	--	--	--	--
Other grass and legumes	14,000	1.50	21,000	21,840	22,890	28,980	36,120
Cabbage	70	1.50	105	99	91	109	139
Pumpkin and squash	400	1.50	600	565	520	624	792
All melons	--	1.50	--	--	--	--	--
Total			166,283	180,086	197,351	247,869	315,238

a. Source: Oregon State Board of Health, "Agricultural Solid Wastes Study," 1969.

Table E-5

ESTIMATED AGRICULTURAL
ANIMAL WASTE QUANTITIES, 1969

Location and animal	Number of head[a]	Waste production factor[b]	Annual waste quantity, tons
Clackamas County			
Cattle	36,126	7.5 tons/head	270,945
Hogs	9,219	1.75 tons/head	16,133
Chickens	892,171	36.5 tons/thousand	32,565
Total			319,643
Columbia County			
Cattle	20,887	7.5 tons/head	156,652
Hogs	1,378	1.75 tons/head	2,411
Chickens	6,057	36.5 tons/thousand	223
Total			159,286
Multnomah County			
Cattle	6,752	7.5 tons/head	50,640
Hogs	1,346	1.75 tons/head	2,356
Chickens	16,734	36.5 tons/thousand	611
Total			53,607
Washington County			
Cattle	23,661	7.5 tons/head	177,457
Hogs	4,780	1.75 tons/head	8,365
Chickens	67,047	36.5 tons/thousand	2,447
Total			188,269
Study area total			720,805

a. Source: U.S. Department of Commerce, "1969 Census of Agriculture, Part 47, Oregon."

b. Source: Oregon State Board of Health, "Agricultural Solid Waste Study," 1971.

Table E-6

ESTIMATED LOGGING WASTE QUANTITIES
CLACKAMAS COUNTY

Land ownership	1971 Acres harvested	Waste production factor,[a] cu ft/acre	Projected waste quantity, millions of cu ft				
			1971	1975	1980	1990	2000
Private	6,823[b]	1,507	10.28	10.33	10.33	10.11	8.29
National forest	14,229[c]	4,511	64.19	64.51	64.51	63.10	51.73
Other public	2,515[c]	2,677	6.73	6.76	6.76	6.62	5.43
Total			81.20	81.60	81.60	79.83	65.45

a. Source: U.S. Department of Agriculture, Forest Service, "Volume of Logging Residues in Oregon, Washington, and California--Initial Results From a 1969-70 Study," Bulletin PNW-163, August 1971.

b. Source: U.S. Department of Agriculture, Forest Service, "1971 Oregon Timber Harvest," Bulletin PNW-43, revised August 1972.

c. Source: Estimated acreage using harvest in thousands of fbm from "Source a" above and average yield of 14,000 fbm/acre. Yield value from U.S. Department of Agriculture, Forest Service, "The Yield of Douglas Fir in the Pacific Northwest," Bulletin 201, revised May 1961.

Table E-7

ESTIMATED LOGGING WASTE QUANTITIES
COLUMBIA COUNTY

Land ownership	1971 Acres harvested	Waste production factor,[a] cu ft/acre	Projected waste quantity, millions of cu ft				
			1971	1975	1980	1990	2000
Private	6,616[b]	1,507	9.97	10.02	10.02	9.80	8.04
National forest	0.5[c]	4,511	0.002	0.002	0.002	0.002	0.002
Other public	298[c]	2,677	0.80	0.80	0.80	0.78	0.64
Total			10.77	10.82	10.82	10.58	8.68

a. Source: U.S. Department of Agriculture, Forest Service, "Volume of Logging Residues in Oregon, Washington, and California--Initial Results From a 1969-70 Study," Bulletin PNW-163, August 1971.

b. Source: U.S. Department of Agriculture, Forest Service, "1971 Oregon Timber Harvest," Bulletin PNW-43, revised August 1972.

c. Source: Estimated acreage using harvest in thousands of fbm from "Source a" above and average yield of 14,000 fbm/acre. Yield value from U.S. Department of Agriculture, Forest Service, "The Yield of Douglas Fir in the Pacific Northwest," Bulletin 201, revised May 1961.

Table E-8

ESTIMATED LOGGING WASTE QUANTITIES
MULTNOMAH COUNTY

Land ownership	1971 Acres harvested	Waste production factor,[a] cu ft/acre	Projected waste quantity, millions of cu ft				
			1971	1975	1980	1990	2000
Private	80[b]	1,507	0.12	0.12	0.12	0.12	0.10
National forest	1,019[c]	4,511	4.60	4.62	4.62	4.52	3.70
Other public	49[c]	2,677	0.13	0.13	0.13	0.13	0.11
Total			4.85	4.87	4.87	4.77	3.91

a. Source: U.S. Department of Agriculture, Forest Service, "Volume of Logging Residues in Oregon, Washington, and California--Initial Results From a 1969-70 Study," Bulletin PNW-163, August 1971.

b. Source: U.S. Department of Agriculture, Forest Service, "1971 Oregon Timber Harvest," Bulletin PNW-43, revised August 1972.

c. Source: Estimated acreage using harvest in thousands of fbm from "Source a" above and average yield of 14,000 fbm/acre. Yield value from U.S. Department of Agriculture, Forest Service, "The Yield of Douglas Fir in the Pacific Northwest," Bulletin 201, revised May 1961.

Table E-9

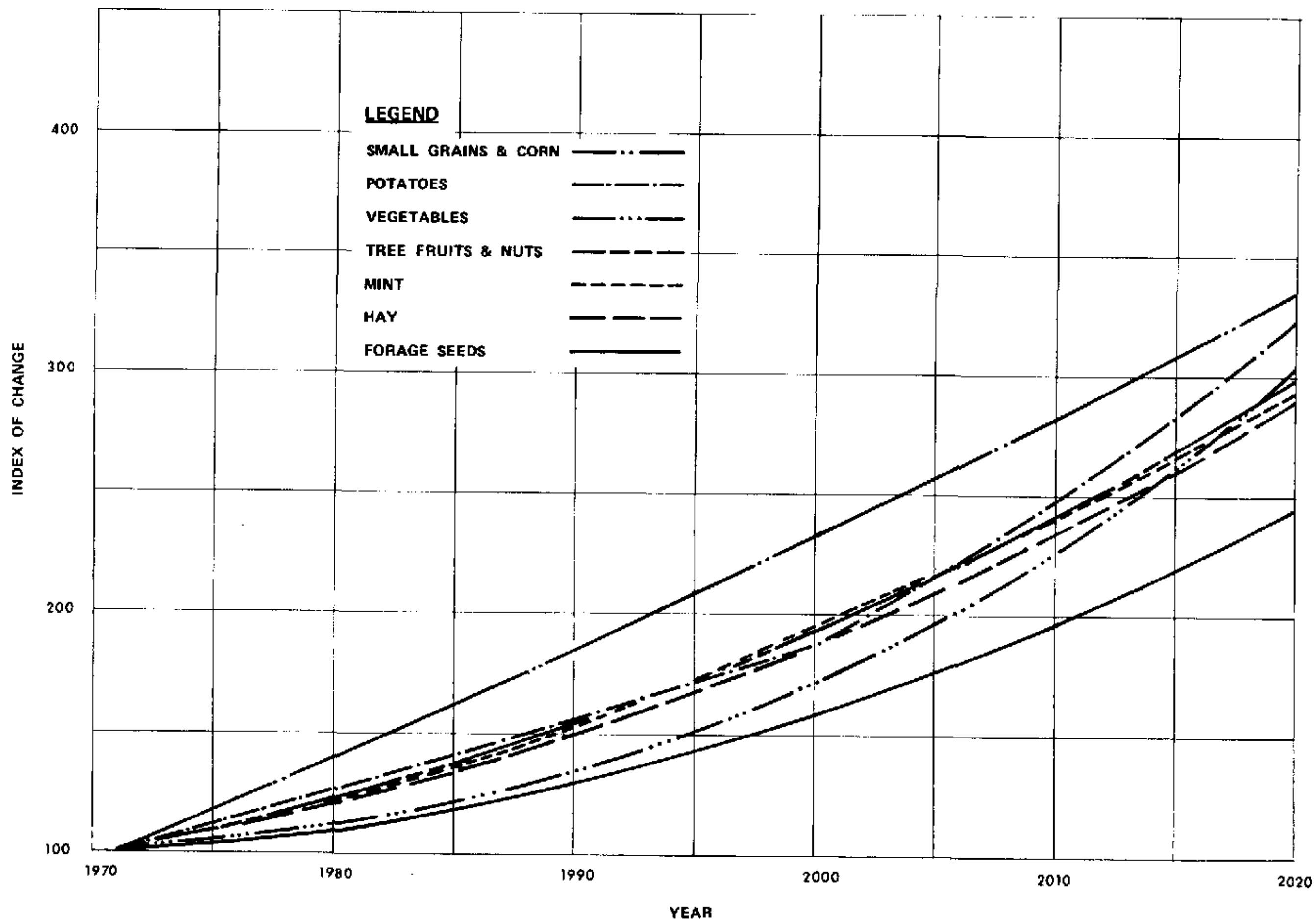
ESTIMATED LOGGING WASTE QUANTITIES
WASHINGTON COUNTY

Land ownership	1971 Acres harvested	Waste production factor,[a] cu ft/acre	Projected waste quantity, millions of cu ft				
			1971	1975	1980	1990	2000
Private	6,195[b]	1,507	9.34	9.38	9.38	9.18	7.52
National forest	--[c]	4,511	--	--	--	--	--
Other public	112[c]	2,677	0.30	0.30	0.30	0.29	0.24
Total			9.64	9.68	9.68	9.47	7.76

a. Source: U.S. Department of Agriculture, Forest Service, "Volume of Logging Residues in Oregon, Washington, and California--Initial Results From a 1969-70 Study," Bulletin PNW-163, August 1971.

b. Source: U.S. Department of Agriculture, Forest Service, "1971 Oregon Timber Harvest," Bulletin PNW-43, revised August 1972.

c. Source: Estimated acreage using harvest in thousands of fbm from "Source a" above and average yield of 14,000 fbm/acre. Yield value from U.S. Department of Agriculture, Forest Service, "The Yield of Douglas Fir in the Pacific Northwest," Bulletin 201, revised May 1961.



SOURCE: PACIFIC NORTHWEST RIVER BASINS COMMISSION, "THE WILLAMETTE BASIN COMPREHENSIVE STUDY," APPENDIX C, ECONOMIC BASE, 1969.

FIGURE E–1
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

AGRICULTURAL CROP PROJECTIONS

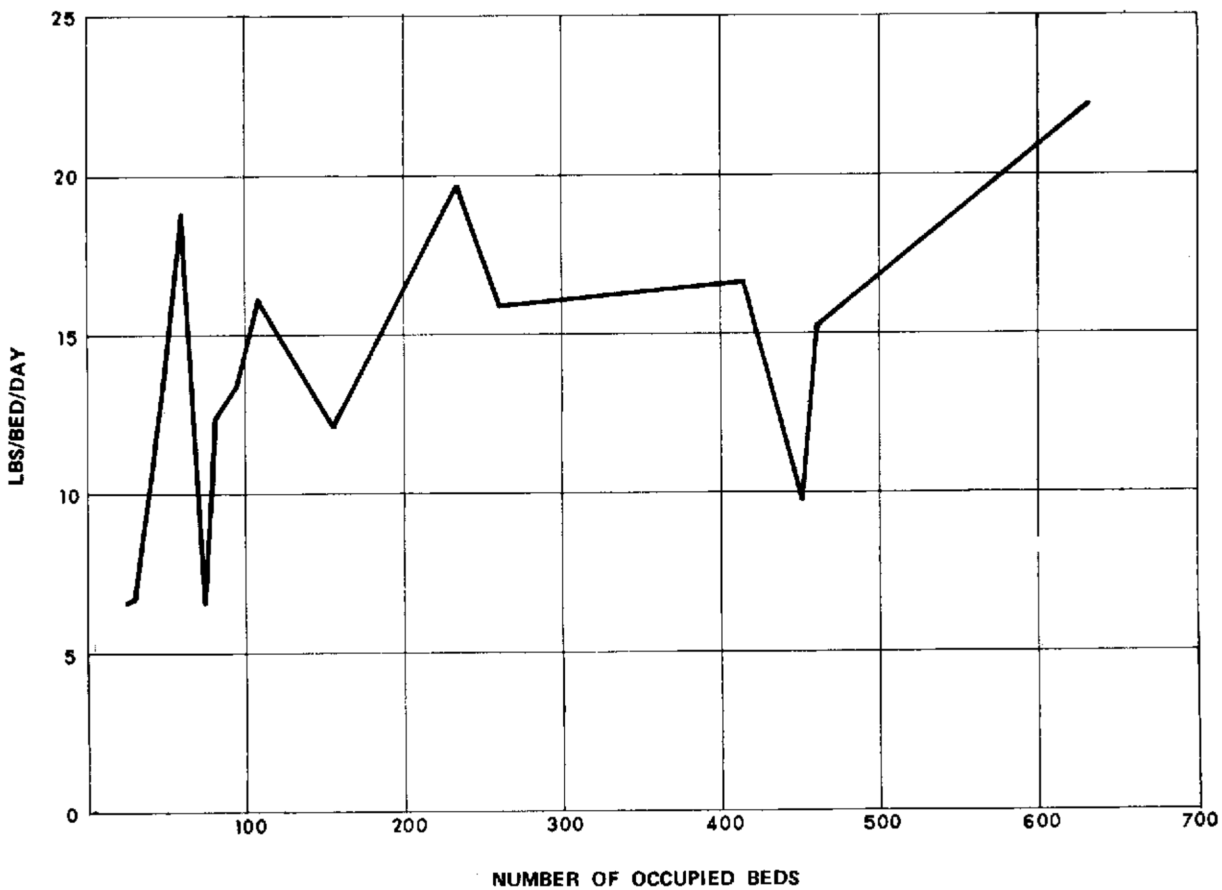


FIGURE E-2
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

HOSPITAL REFUSE GENERATION

APPENDIX F

Appendix F

REFUSE GENERATION PROJECTIONS

This appendix contains study area refuse generation projections, by county, through the year 2000. Refuse generation rates are projected for residential, commercial, and industrial waste sources, expressed in pounds per capita per day, tons per week, and tons per year in Tables F-1 through F-5.

Refuse quantities are also projected for compactible and noncompactible wastes with 5-year averages of compactible and noncompactible wastes presented in tons per week in Tables F-6 through F-10.

A yearly population projection is also presented in each table.

Table F-1

FUTURE SOLID WASTE QUANTITIES
FOUR-COUNTY REGION

		REFUSE GENERATION RATES IN PCD			****************** REFUSE QUANTITY EXPRESSED IN ******************								
					**** TONS PER WEEK *****				***** TONS PER YEAR *****				CUMULATIVE
YEAR	POP	RES.	COM.	IND.	RES.	COM.	IND.	TOTAL	RES.	COM.	IND.	TOTAL	TONS
1975	1005982.	2.49	1.62	1.09	8776.5	5691.9	3841.8	18310.2	456379.	295979.	199774.	952132.	952132.
1976	1025286.	2.52	1.63	1.09	9030.2	5852.1	3896.9	18779.2	469571.	304309.	202637.	976518.	1928649.
1977	1044590.	2.54	1.65	1.08	9288.1	6014.9	3953.3	19256.3	482981.	312776.	205569.	1001327.	2929976.
1978	1063893.	2.56	1.66	1.08	9550.2	6180.4	4011.0	19741.7	496612.	321383.	208572.	1026566.	3956542.
1979	1083197.	2.59	1.67	1.07	9816.7	6348.6	4070.1	20235.5	510467.	330130.	211647.	1052244.	5008786.
1980	1102500.	2.61	1.69	1.07	10087.5	6519.6	4130.7	20737.8	524550.	339020.	214798.	1078367.	6087154.
1981	1123550.	2.64	1.70	1.07	10378.9	6692.6	4192.8	21264.3	539701.	348014.	218026.	1105741.	7192895.
1982	1144600.	2.66	1.71	1.06	10675.0	6868.4	4256.4	21799.9	555102.	357155.	221335.	1133592.	8326487.
1983	1165650.	2.69	1.73	1.06	10976.1	7047.0	4321.7	22344.8	570757.	366444.	224728.	1161929.	9488417.
1984	1186700.	2.72	1.74	1.06	11282.1	7228.5	4388.6	22899.2	586670.	375883.	228208.	1190761.	10679177.
1985	1207750.	2.74	1.75	1.05	11593.2	7413.0	4457.3	23463.4	602844.	385474.	231777.	1220095.	11899272.
1986	1228800.	2.77	1.77	1.05	11909.3	7600.4	4527.7	24037.3	619283.	395219.	235440.	1249942.	13149214.
1987	1249850.	2.80	1.78	1.05	12230.6	7790.8	4600.0	24621.3	635991.	405120.	239199.	1280310.	14429523.
1988	1270900.	2.82	1.79	1.05	12557.1	7984.2	4674.2	25215.6	652970.	415180.	243058.	1311209.	15740732.
1989	1291950.	2.85	1.81	1.05	12889.0	8180.8	4750.4	25820.2	670226.	425401.	247022.	1342648.	17083381.
1990	1313000.	2.88	1.82	1.05	13226.2	8380.5	4828.7	26435.4	687761.	435785.	251093.	1374639.	18458020.
1991	1340100.	2.91	1.84	1.05	13631.0	8609.7	4909.2	27149.9	708813.	447706.	255277.	1411797.	19869816.
1992	1367200.	2.93	1.85	1.04	14042.7	8842.7	4991.9	27877.3	730218.	459823.	259577.	1449618.	21319435.
1993	1394300.	2.96	1.86	1.04	14461.1	9079.6	5076.9	28617.6	751980.	472137.	263999.	1488116.	22807550.
1994	1421400.	2.99	1.87	1.04	14886.6	9320.2	5164.4	29371.2	774104.	484651.	268547.	1527302.	24334853.
1995	1448500.	3.02	1.89	1.04	15319.1	9564.8	5254.4	30138.3	796595.	497369.	273226.	1567190.	25902043.
1996	1475600.	3.05	1.90	1.04	15758.8	9813.3	5347.0	30919.1	819459.	510292.	278042.	1607793.	27509836.
1997	1502700.	3.08	1.91	1.03	16205.8	10065.9	5442.3	31713.9	842700.	523424.	283000.	1649125.	29158961.
1998	1529800.	3.11	1.93	1.03	16660.1	10322.5	5540.5	32523.1	866324.	536768.	288107.	1691199.	30850159.
1999	1556900.	3.14	1.94	1.04	17121.9	10583.2	5641.7	33346.7	890336.	550326.	293368.	1734031.	32584190.
2000	1584000.	3.17	1.96	1.04	17591.2	10848.1	5746.0	34185.3	914742.	564102.	298790.	1777635.	34361825.

Table F-2

FUTURE SOLID WASTE QUANTITIES
CLACKAMAS COUNTY

YEAR	POP	REFUSE GENERATION RATES IN PCD RES.	COM.	IND.	REFUSE QUANTITY TONS PER WEEK RES.	COM.	IND.	TOTAL	REFUSE QUANTITY EXPRESSED IN TONS PER YEAR RES.	COM.	IND.	TOTAL	CUMULATIVE TONS
1975	198044.	2.34	0.84	0.54	1621.2	582.9	375.9	2579.9	84300.	30310.	19547.	134157.	134157.
1976	204436.	2.36	0.85	0.53	1690.8	608.2	381.5	2680.5	87922.	31624.	19839.	139385.	273543.
1977	210827.	2.39	0.86	0.52	1761.7	633.9	387.2	2782.8	91607.	32962.	20137.	144706.	418248.
1978	217218.	2.41	0.87	0.52	1833.8	660.1	393.1	2886.9	95357.	34323.	20439.	150120.	568368.
1979	223609.	2.44	0.88	0.51	1907.2	686.7	399.0	2992.9	99173.	35708.	20747.	155628.	723996.
1980	230000.	2.46	0.89	0.50	1981.8	713.8	405.0	3100.6	103056.	37118.	21060.	161233.	885230.
1981	237290.	2.49	0.90	0.50	2065.9	743.7	411.1	3220.7	107428.	38673.	21378.	167479.	1052708.
1982	244580.	2.51	0.90	0.49	2151.5	774.1	417.3	3343.0	111877.	40256.	21701.	173834.	1226542.
1983	251870.	2.54	0.91	0.48	2238.5	805.1	423.7	3467.3	116404.	41866.	22030.	180300.	1406842.
1984	259160.	2.57	0.92	0.47	2327.1	836.6	430.1	3593.8	121010.	43505.	22365.	186880.	1593722.
1985	266450.	2.59	0.93	0.47	2417.3	868.7	436.6	3722.6	125697.	45172.	22706.	193575.	1787296.
1986	273740.	2.62	0.94	0.46	2509.0	901.3	443.3	3853.6	130466.	46868.	23052.	200386.	1987682.
1987	281030.	2.65	0.95	0.46	2602.2	934.5	450.1	3986.8	135317.	48594.	23404.	207315.	2194997.
1988	288320.	2.67	0.96	0.45	2697.2	968.3	457.0	4122.4	140252.	50349.	23763.	214364.	2409361.
1989	295610.	2.70	0.97	0.45	2793.7	1002.6	464.0	4260.3	145273.	52135.	24127.	221535.	2630896.
1990	302900.	2.73	0.98	0.44	2891.9	1037.5	471.1	4400.6	150380.	53951.	24498.	228829.	2859725.
1991	312500.	2.76	0.99	0.44	3015.6	1082.5	478.4	4576.5	156811.	56291.	24876.	237977.	3097702.
1992	322100.	2.79	1.00	0.43	3141.4	1128.3	485.8	4755.5	163355.	58672.	25260.	247287.	3344989.
1993	331700.	2.82	1.01	0.42	3269.5	1174.9	493.3	4937.7	170015.	61095.	25650.	256761.	3601749.
1994	341300.	2.85	1.02	0.42	3399.8	1222.3	500.9	5123.1	176792.	63561.	26048.	266401.	3868150.
1995	350900.	2.88	1.03	0.41	3532.4	1270.6	508.7	5311.7	183687.	66070.	26452.	276209.	4144359.
1996	360500.	2.91	1.05	0.41	3667.3	1319.7	516.6	5503.6	190702.	68623.	26864.	286189.	4430548.
1997	370100.	2.94	1.06	0.41	3804.6	1369.6	524.7	5698.9	197840.	71220.	27283.	296343.	4726891.
1998	379700.	2.97	1.07	0.40	3944.2	1420.4	532.9	5897.5	205101.	73862.	27709.	306672.	5033563.
1999	389300.	3.00	1.08	0.40	4086.3	1472.1	541.2	6099.6	212487.	76550.	28143.	317181.	5350744.
2000	398900.	3.03	1.09	0.39	4230.8	1524.7	549.7	6305.2	220001.	79285.	28585.	327871.	5678615.

Table F-3

FUTURE SOLID WASTE QUANTITIES
COLUMBIA COUNTY

YEAR	POP	REFUSE GENERATION RATES IN PCD RES.	COM.	IND.	REFUSE QUANTITY TONS PER WEEK RES.	COM.	IND.	TOTAL	REFUSE QUANTITY EXPRESSED IN TONS PER YEAR RES.	COM.	IND.	TOTAL	CUMULATIVE TONS
1975	32395.	2.28	0.86	7.30	259.0	97.0	827.6	1183.6	13470,	5043,	43035,	61548.	61548,
1976	33116.	2.31	0.86	7.21	267.4	100.1	835.8	1203.2	13906,	5203,	43460,	62569.	124117,
1977	33837.	2.33	0.87	7.13	275.9	103.2	844.0	1223.2	14349,	5367,	43888,	63604.	187721,
1978	34558.	2.35	0.88	7.05	284.6	106.4	852.3	1243.3	14800,	5533,	44321,	64654.	252375,
1979	35279.	2.38	0.89	6.97	293.4	109.7	860.7	1263.8	15258,	5702,	44758,	65718.	318093,
1980	36000.	2.40	0.90	6.90	302.4	113.0	869.2	1284.6	15724,	5874,	45200,	66797.	384891,
1981	36730.	2.42	0.91	6.83	311.6	116.4	877.8	1305.7	16201,	6051,	45646,	67898.	452789,
1982	37460.	2.45	0.91	6.76	320.9	119.8	886.5	1327.2	16687,	6232,	46096,	69015.	521804,
1983	38190.	2.47	0.92	6.70	330.4	123.4	895.2	1349.0	17180,	6415,	46551,	70147.	591951,
1984	38920.	2.50	0.93	6.64	340.0	127.0	904.1	1371.0	17682,	6602,	47011,	71294.	663245,
1985	39650.	2.52	0.94	6.58	349.9	130.6	913.0	1393.4	18192,	6791,	47475,	72458.	735703,
1986	40380.	2.55	0.95	6.52	359.8	134.3	922.0	1416.1	18711,	6984,	47943,	73638.	809341,
1987	41110.	2.57	0.96	6.47	370.0	138.1	931.1	1439.1	19238,	7180,	48417,	74834.	884176,
1988	41840.	2.60	0.97	6.42	380.3	141.9	940.3	1462.4	19774,	7379,	48895,	76047.	960223,
1989	42570.	2.62	0.98	6.37	390.7	145.8	949.6	1486.1	20318,	7581,	49378,	77277.	1037500,
1990	43300.	2.65	0.99	6.33	401.4	149.7	958.9	1510.1	20872,	7786,	49865,	78524.	1116023,
1991	44170.	2.68	1.00	6.26	413.6	154.6	968.4	1536.6	21507,	8037,	50358,	79902.	1195925,
1992	45040.	2.70	1.01	6.20	426.0	159.5	978.0	1563.5	22153,	8292,	50855,	81300.	1277225,
1993	45910.	2.73	1.02	6.15	438.6	164.4	987.6	1590.7	22809,	8551,	51357,	82718.	1359943,
1994	46780.	2.76	1.04	6.09	451.5	169.5	997.4	1618.4	23477,	8815,	51865,	84156.	1444099,
1995	47650.	2.79	1.05	6.04	464.5	174.7	1007.3	1646.4	24155,	9083,	52377,	85615.	1529713,
1996	48520.	2.81	1.06	5.99	477.8	179.9	1017.2	1674.9	24845,	9355,	52895,	87094.	1616808,
1997	49390.	2.84	1.07	5.94	491.3	185.2	1027.3	1703.8	25546,	9632,	53417,	88595.	1705403,
1998	50260.	2.87	1.08	5.90	505.0	190.6	1037.4	1733.0	26258,	9914,	53945,	90117.	1795520,
1999	51130.	2.90	1.10	5.85	518.9	196.1	1047.7	1762.7	26983,	10200,	54478,	91661.	1887181,
2000	52000.	2.93	1.11	5.81	533.1	201.7	1058.0	1792.8	27719,	10491,	55017,	93226.	1980407,

Table F-4

FUTURE SOLID WASTE QUANTITIES
MULTNOMAH COUNTY

YEAR	POP	REFUSE GENERATION RATES IN PCD RES.	COM.	IND.	REFUSE QUANTITY EXPRESSED IN TONS PER WEEK RES.	COM.	IND.	TOTAL	TONS PER YEAR RES.	COM.	IND.	TOTAL	CUMULATIVE TONS
1975	578033.	2.57	1.84	1.04	5199.1	3728.1	2105.9	11033.0	270352.	193859.	109507.	573718.	573718.
1976	582306.	2.59	1.86	1.05	5288.1	3793.7	2131.4	11213.3	274983.	197271.	110835.	583089.	1156807.
1977	586580.	2.62	1.88	1.05	5378.5	3860.2	2157.7	11396.3	279680.	200732.	112198.	592610.	1749417.
1978	590853.	2.65	1.90	1.06	5470.1	3927.7	2184.5	11582.3	284443.	204242.	113596.	602281.	2351698.
1979	595127.	2.67	1.92	1.06	5562.9	3996.2	2212.2	11771.3	289273.	207803.	115032.	612108.	2963806.
1980	599400.	2.70	1.94	1.07	5657.1	4065.7	2240.5	11963.3	294172.	211414.	116506.	622092.	3585898.
1981	603600.	2.72	1.96	1.07	5751.9	4131.5	2269.6	12153.1	299099.	214840.	118021.	631960.	4217858.
1982	607800.	2.75	1.97	1.08	5848.0	4198.3	2299.6	12345.9	304095.	218313.	119579.	641986.	4859844.
1983	612000.	2.78	1.99	1.09	5945.4	4266.0	2330.4	12541.8	309161.	221834.	121180.	652175.	5512019.
1984	616200.	2.80	2.01	1.10	6044.2	4334.7	2362.1	12740.9	314298.	225403.	122828.	662529.	6174549.
1985	620400.	2.83	2.03	1.10	6144.4	4404.3	2394.7	12943.3	319507.	229022.	124524.	673053.	6847601.
1986	624600.	2.86	2.05	1.11	6245.9	4474.8	2428.3	13149.0	324788.	232691.	126270.	683749.	7531350.
1987	628800.	2.88	2.07	1.12	6348.9	4546.3	2462.9	13358.1	330144.	236410.	128069.	694623.	8225973.
1988	633000.	2.91	2.08	1.13	6453.3	4618.9	2498.5	13570.7	335574.	240180.	129923.	705677.	8931650.
1989	637200.	2.94	2.10	1.14	6559.2	4692.4	2535.3	13786.9	341079.	244002.	131835.	716916.	9648566.
1990	641400.	2.97	2.12	1.15	6666.6	4766.9	2573.2	14006.6	346661.	247877.	133808.	728345.	10376912.
1991	645900.	3.00	2.14	1.16	6778.7	4841.0	2612.4	14232.0	352492.	251731.	135844.	740066.	11116978.
1992	650400.	3.03	2.16	1.17	6892.4	4916.1	2652.8	14461.3	358404.	255637.	137946.	751987.	11868965.
1993	654900.	3.06	2.18	1.18	7007.7	4992.2	2694.6	14694.5	364399.	259597.	140119.	764115.	12633079.
1994	659400.	3.09	2.20	1.19	7124.6	5069.4	2737.8	14931.8	370479.	263610.	142364.	776453.	13409532.
1995	663900.	3.12	2.22	1.20	7243.1	5147.6	2782.4	15173.2	376643.	267677.	144687.	789007.	14198540.
1996	668400.	3.15	2.23	1.21	7363.3	5226.9	2828.7	15418.9	382894.	271800.	147091.	801784.	15000324.
1997	672900.	3.18	2.25	1.22	7485.2	5307.3	2876.5	15669.0	389232.	275978.	149579.	814789.	15815112.
1998	677400.	3.21	2.27	1.23	7608.8	5388.7	2926.1	15923.6	395658.	280212.	152158.	828028.	16643140.
1999	681900.	3.24	2.29	1.25	7734.1	5471.2	2977.5	16182.8	402175.	284504.	154830.	841508.	17484648.
2000	686400.	3.27	2.31	1.26	7861.2	5554.9	3030.8	16446.8	408781.	288853.	157601.	855235.	18339883.

Table F-5

FUTURE SOLID WASTE QUANTITIES
WASHINGTON COUNTY

YEAR	POP	REFUSE GENERATION RATES IN PCD RES.	COM.	IND.	REFUSE QUANTITY EXPRESSED IN TONS PER WEEK RES.	COM.	IND.	TOTAL	TONS PER YEAR RES.	COM.	IND.	TOTAL	CUMULATIVE TONS
1975	197510.	2.46	1.86	0.77	1697.3	1284.0	532.4	3513.6	88257.	66767.	27685.	182709.	182709.
1976	205428.	2.48	1.88	0.76	1783.9	1350.2	548.1	3682.2	92761.	70210.	28503.	191474.	374183.
1977	213346.	2.51	1.90	0.76	1872.0	1417.6	564.4	3854.0	97345.	73715.	29347.	200407.	574590.
1978	221264.	2.53	1.92	0.75	1961.8	1486.2	581.1	4029.1	102012.	77284.	30215.	209512.	784101.
1979	229182.	2.56	1.94	0.75	2053.1	1556.1	598.3	4207.5	106763.	80916.	31110.	218789.	1002891.
1980	237100.	2.59	1.96	0.74	2146.1	1627.2	616.0	4389.3	111599.	84614.	32031.	228244.	1231135.
1981	245930.	2.61	1.98	0.74	2249.5	1701.0	634.2	4584.7	116973.	88450.	32981.	238404.	1469539.
1982	254760.	2.64	1.99	0.73	2354.7	1776.1	653.1	4783.8	122444.	92355.	33959.	248758.	1718297.
1983	263590.	2.67	2.01	0.73	2461.8	1852.5	672.4	4986.7	128012.	96329.	34966.	259308.	1977604.
1984	272420.	2.70	2.02	0.73	2570.8	1930.2	692.4	5193.4	133680.	100373.	36004.	270057.	2247662.
1985	281250.	2.72	2.04	0.72	2681.7	2009.4	712.9	5404.0	139448.	104488.	37073.	281010.	2528671.
1986	290080.	2.75	2.06	0.72	2794.6	2089.9	734.1	5618.6	145318.	108676.	38174.	292169.	2820840.
1987	298910.	2.78	2.08	0.72	2909.5	2171.9	755.9	5837.3	151292.	112937.	39309.	303538.	3124378.
1988	307740.	2.81	2.09	0.72	3026.4	2255.2	778.4	6060.0	157371.	117272.	40478.	315121.	3439499.
1989	316570.	2.84	2.11	0.72	3145.3	2340.1	801.6	6286.9	163556.	121683.	41682.	326920.	3766419.
1990	325400.	2.87	2.13	0.72	3266.3	2426.4	825.4	6518.1	169848.	126170.	42922.	338941.	4105360.
1991	337530.	2.90	2.14	0.72	3423.2	2531.7	850.0	6804.8	178004.	131647.	44200.	353852.	4459212.
1992	349660.	2.93	2.16	0.72	3582.8	2638.9	875.3	7097.0	186306.	137221.	45516.	369044.	4828256.
1993	361790.	2.96	2.17	0.71	3745.3	2748.0	901.4	7394.7	194756.	142894.	46873.	384523.	5212779.
1994	373920.	2.99	2.18	0.71	3910.7	2859.0	928.3	7697.9	203357.	148666.	48270.	400293.	5613072.
1995	386050.	3.02	2.20	0.71	4079.0	2971.9	956.0	8006.9	212110.	154539.	49709.	416359.	6029430.
1996	398180.	3.05	2.21	0.71	4250.3	3086.8	984.5	8321.6	221018.	160515.	51193.	432725.	6462156.
1997	410310.	3.08	2.23	0.71	4424.7	3203.7	1013.9	8642.3	230083.	166595.	52720.	449398.	6911554.
1998	422440.	3.11	2.25	0.71	4602.1	3322.7	1044.1	8968.9	239307.	172780.	54295.	466382.	7377936.
1999	434570.	3.14	2.26	0.71	4782.5	3443.7	1075.3	9301.6	248692.	179073.	55916.	483681.	7861617.
2000	446700.	3.18	2.28	0.71	4966.2	3566.8	1107.4	9640.4	258241.	185474.	57587.	501303.	8362920.

Table F-6

PROCESSIBLE AND NONPROCESSIBLE WASTES
FOUR-COUNTY REGION

YEAR	POP	QUANTITY IN TONS/WEEK PROCESS.	NONPROCESS.	QUANTITY IN CUMULATIVE TONS PROCESS.	NONPROCESS.	FIVE YEAR AVERAGE TONS/WEEK PROCESS.	NONPROCESS.
1975	1005982.	16355,7	1954,5	850496.	101636.		
1976	1025286.	16800,0	1979.2	1724093.	204556.		
1977	1044590.	17251,9	2004.4	2621190.	308786.		
1978	1063893.	17711,6	2030.1	3542191.	414352.		
1979	1083197.	18179,1	2056.3	4487506.	521280.		
1980	1102500.	18654,8	2083.1	5457555.	629599.	17719.5	2030,6
1981	1123550.	19153,9	2110.4	6453557.	739337.		
1982	1144600.	19661,6	2138.2	7475963.	850524.		
1983	1165650.	20178,1	2166.7	8525226.	963190.		
1984	1186700.	20703,5	2195.7	9601810.	1077367.		
1985	1207750.	21238,0	2225.4	10706186.	1193087.	20187.0	2167,3
1986	1228800.	21781,7	2255.7	11838832.	1310382.		
1987	1249850.	22334,7	2286.7	13000235.	1429288.		
1988	1270900.	22897,2	2318.3	14190892.	1549840.		
1989	1291950.	23469,5	2350.7	15411305.	1672075.		
1990	1313000.	24051,6	2383.8	16661989.	1796031.	22906.9	2319,0
1991	1340100.	24732,3	2417.6	17948070.	1921746.		
1992	1367200.	25425,1	2452.2	19270173.	2049261.		
1993	1394300.	26130,0	2487.6	20628931.	2178619.		
1994	1421400.	26847,3	2523.9	22024991.	2309861.		
1995	1448500.	27577,3	2561.0	23459008.	2443034.	26142.4	2488,5
1996	1475600.	28320,1	2599.0	24931652.	2578184.		
1997	1502700.	29076,0	2638.0	26443603.	2715358.		
1998	1529800.	29845,2	2677.9	27995553.	2854607.		
1999	1556900.	30628,0	2718.7	29588209.	2995981.		
2000	1584000.	31424,6	2760.7	31222290.	3139535.	29858.8	2678,8

Table F-7

PROCESSIBLE AND NONPROCESSIBLE WASTES
CLACKAMAS COUNTY

YEAR	POP	QUANTITY IN TONS/WEEK PROCESS.	NONPROCESS.	QUANTITY IN CUMULATIVE TONS PROCESS.	NONPROCESS.	FIVE YEAR AVERAGE TONS/WEEK PROCESS.	NONPROCESS.
1975	198044.	2400.7	179.3	124835.	9323.		
1976	204436.	2498.8	181.7	254773.	18770.		
1977	210827.	2598.7	184.1	389905.	28343.		
1978	217218.	2700.3	186.6	530323.	38045.		
1979	223609.	2803.8	189.1	676120.	47876.		
1980	230000.	2909.0	191.6	827389.	57840.	2702.1	186.6
1981	237290.	3026.5	194.2	984770.	67938.		
1982	244580.	3146.1	196.8	1148369.	78173.		
1983	251870.	3267.8	199.5	1318296.	88546.		
1984	259160.	3391.7	202.2	1494663.	99059.		
1985	266450.	3517.7	204.9	1677581.	109715.	3270.0	199.5
1986	273740.	3645.9	207.7	1867166.	120516.		
1987	281030.	3776.3	210.5	2063533.	131464.		
1988	288320.	3909.0	213.4	2266799.	142562.		
1989	295610.	4043.9	216.3	2477084.	153811.		
1990	302900.	4181.3	219.3	2694510.	165215.	3911.3	213.5
1991	312500.	4354.2	222.3	2920926.	176776.		
1992	322100.	4530.1	225.4	3156494.	188495.		
1993	331700.	4709.2	228.5	3401373.	200377.		
1994	341300.	4891.4	231.6	3655728.	212422.		
1995	350900.	5076.9	234.9	3919724.	224635.	4712.4	228.5
1996	360500.	5265.5	238.1	4193531.	237017.		
1997	370100.	5457.5	241.4	4477320.	249571.		
1998	379700.	5652.7	244.8	4771262.	262301.		
1999	389300.	5851.4	248.2	5075536.	275208.		
2000	398900.	6053.5	251.7	5390318.	288297.	5656.1	244.9

Table F-8

PROCESSIBLE AND NONPROCESSIBLE WASTES
COLUMBIA COUNTY

YEAR	POP	QUANTITY IN TONS/WEEK PROCESS.	QUANTITY IN TONS/WEEK NONPROCESS.	QUANTITY IN CUMULATIVE TONS PROCESS.	QUANTITY IN CUMULATIVE TONS NONPROCESS.	FIVE YEAR AVERAGE TONS/WEEK PROCESS.	FIVE YEAR AVERAGE TONS/WEEK NONPROCESS.
1975	32395.	673.2	510.4	35008.	26540.		
1976	33116.	687.8	515.4	70774.	53343.		
1977	33837.	702.6	520.5	107310.	80411.		
1978	34558.	717.7	525.7	144628.	107747.		
1979	35279.	732.9	530.9	182740.	135354.		
1980	36000.	748.4	536.1	221657.	163233.	717.9	525.7
1981	36730.	764.3	541.5	261400.	191389.		
1982	37460.	780.4	546.8	301981.	219823.		
1983	38190.	796.7	552.2	343412.	248539.		
1984	38920.	813.4	557.7	385706.	277539.		
1985	39650.	830.2	563.2	428877.	306827.	797.0	552.3
1986	40380.	847.3	568.8	472937.	336404.		
1987	41110.	864.7	574.4	517902.	366274.		
1988	41840.	882.3	580.1	563783.	396440.		
1989	42570.	900.2	585.9	610595.	426905.		
1990	43300.	918.4	591.7	658352.	457671.	882.6	580.2
1991	44170.	939.1	597.5	707183.	488742.		
1992	45040.	960.0	603.4	757104.	520121.		
1993	45910.	981.3	609.4	808132.	551811.		
1994	46780.	1002.9	615.5	860284.	583815.		
1995	47650.	1024.9	621.6	913578.	616136.	981.6	609.5
1996	48520.	1047.2	627.7	968031.	648777.		
1997	49390.	1069.8	633.9	1023662.	681741.		
1998	50260.	1092.8	640.2	1080488.	715032.		
1999	51130.	1116.1	646.6	1138527.	748654.		
2000	52000.	1139.8	653.0	1197799.	782608.	1093.2	640.3

Table F-9

PROCESSIBLE AND NONPROCESSIBLE WASTES
MULTNOMAH COUNTY

YEAR	POP	QUANTITY IN TONS/WEEK PROCESS.	NONPROCESS.	QUANTITY IN CUMULATIVE TONS PROCESS.	NONPROCESS.	FIVE YEAR AVERAGE TONS/WEEK PROCESS.	NONPROCESS.
1975	578033.	9965,9	1067.1	518228.	55490.		
1976	582306.	10134,5	1078.8	1045222.	111585.		
1977	586580.	10305,7	1090.6	1581118.	168299.		
1978	590853.	10479,6	1102.8	2126056.	225643.		
1979	595127.	10656,1	1115.2	2680175.	283631.		
1980	599400.	10835,5	1127.8	3243622.	342277.	10482.3	1103,0
1981	603600.	11012,3	1140.7	3816264.	401595.		
1982	607800.	11192,0	1153.9	4398245.	461599.		
1983	612000.	11374,4	1167.4	4989713.	522306.		
1984	616200.	11559,7	1181.2	5590818.	583731.		
1985	620400.	11748,0	1195.4	6201711.	645890.	11377.3	1167,7
1986	624600.	11939,2	1209.8	6822550.	708801.		
1987	628800.	12133,5	1224.6	7453492.	772481.		
1988	633000.	12330,9	1239.8	8094701.	836948.		
1989	637200.	12531,6	1255.3	8746343.	902223.		
1990	641400.	12735,5	1271.2	9408587.	968325.	12334.1	1240,1
1991	645900.	12944,6	1287.5	10081704.	1035274.		
1992	650400.	13157,1	1304.2	10765873.	1103092.		
1993	654900.	13373,2	1321.3	11461277.	1171802.		
1994	659400.	13592,8	1338.9	12168105.	1241428.		
1995	663900.	13816,2	1357.0	12886547.	1311993.	13376.8	1321,8
1996	668400.	14043,3	1375.6	13616801.	1383523.		
1997	672900.	14274,4	1394.7	14359068.	1456045.		
1998	677400.	14509,3	1414.3	15113553.	1529587.		
1999	681900.	14748,4	1434.4	15880471.	1604177.		
2000	686400.	14991,6	1455.2	16660036.	1679847.	14513.4	1414,8

Table F-10

PROCESSIBLE AND NONPROCESSIBLE WASTES
WASHINGTON COUNTY

YEAR	POP	QUANTITY IN TONS/WEEK PROCESS.	NONPROCESS.	QUANTITY IN CUMULATIVE TONS PROCESS.	NONPROCESS.	FIVE YEAR AVERAGE TONS/WEEK PROCESS.	NONPROCESS.
1975	197510.	3315.9	197.8	172426.	10283.		
1976	205428.	3478.8	203.4	353325.	20858.		
1977	213346.	3644.9	209.1	542857.	31733.		
1978	221264.	3814.0	215.1	741184.	42917.		
1979	229182.	3986.3	221.2	948472.	54419.		
1980	237100.	4161.8	227.5	1164886.	66249.	3817.2	215.3
1981	245930.	4350.7	234.0	1391124.	78415.		
1982	254760.	4543.2	240.6	1627368.	90929.		
1983	263590.	4739.2	247.5	1873805.	103800.		
1984	272420.	4938.8	254.6	2130624.	117038.		
1985	281250.	5142.2	261.9	2398016.	130655.	4742.8	247.7
1986	290080.	5349.3	269.4	2676178.	144662.		
1987	298910.	5560.2	277.1	2965309.	159069.		
1988	307740.	5775.0	285.0	3265608.	173890.		
1989	316570.	5993.7	293.2	3577283.	189136.		
1990	325400.	6216.5	301.6	3900540.	204820.	5778.9	285.2
1991	337530.	6494.6	310.3	4238257.	220954.		
1992	349660.	6777.8	319.2	4590703.	237553.		
1993	361790.	7066.3	328.4	4958150.	254629.		
1994	373920.	7360.1	337.8	5340875.	272197.		
1995	386050.	7659.3	347.6	5739159.	290272.	7071.6	328.7
1996	398180.	7964.0	357.6	6153288.	308868.		
1997	410310.	8274.3	367.9	6583553.	328001.		
1998	422440.	8590.3	378.6	7030249.	347687.		
1999	434570.	8912.0	389.5	7493675.	367942.		
2000	446700.	9239.6	400.8	7974136.	388783.	8596.1	378.9

APPENDIX G

Appendix G

SOLID WASTE QUANTITIES AND PRESENT COSTS

DERIVATION OF LANDFILLED QUANTITIES

The weighing program directly measured slightly less than half of the total quantity of study area wastes taken to disposal during the period of measurement. The procedure for expanding the weighed data into a reasonable estimate of total solid waste quantities is described in the following paragraphs.

The quantities weighed at St. Johns and Rossman's did not represent the total quantities coming into those sites during the one-week weighing periods, since a few drivers had refused to be weighed and a small percentage of trucks had entered the sites outside of the prescribed weighing hours. In addition, there had been no attempt to weigh any private vehicles entering the sites. To make up for this at the St. Johns site, official billing records were reviewed for the nonweighed vehicles. The weight of refuse in each commercial vehicle was estimated from the capacity of the truck and the appropriate, average in-truck density obtained from the weighing program; the wastes were then allocated to refuse generation centers in accordance with the area normally served by the specific collector. The weight of refuse entering the site in private vehicles was estimated from the recorded number of vehicles and from discussions with the site operator as to typical average quantities in the vehicles; the wastes were then allocated to refuse generation centers in accordance with areas generally served by the site. The addition of these estimated quantities to the weighed quantities produced the total quantity of wastes entering St. Johns during the week of March 12 through 18. Of the total, about 69 percent had actually been weighed.

The records available from Rossman's were not sufficiently detailed to supplement the weighed data in the same manner as had been done at St. Johns. Because of this, it was assumed that the percentage of wastes that had not been weighed at Rossman's would be the same as the percentage of wastes that had not been weighed at St. Johns. This percentage was allocated on a population basis to all refuse generation centers served by Rossman's. The weighed and estimated quantities together represent the total quantity of wastes entering Rossman's during the week of March 22 through 28.

For the remaining 14 sites serving the study area, estimates were made of the quantities received. At 6 of the sites, billing records were obtained for either one of the two latter weeks in March (so that the quantities would represent the same time period as the weighed quantities). After discussions with the site operators, the recorded volumes were converted to equivalent weights of refuse by using appropriate in-truck densities obtained in the weighing program. It was determined which private collectors had brought the wastes to the site, and the wastes were allocated on a population basis to the refuse generation centers served by those collectors. At 8 of the sites there were no billing records available, so representative weekly quantities were estimated by on-site observations and by discussions with the site operators. These quantities were then allocated on a population basis to refuse generation centers served by collectors using each site.

When all of the quantities for all 16 disposal sites were added, it was found that 45 percent of the total derived quantity had actually been weighed.

The total quantity of wastes derived for each refuse generation center was summarized in tabular form according to the following categories: (1) quantity of wastes collected in rear or side loaders, front loaders, drop boxes, and other trucks, respectively; and (2) total and per-capita quantity of residential, commercial, and industrial wastes. The quantities by collection truck type were useful in analyzing direct haul costs vs. transfer costs; a summary of the percentage of refuse hauled by each type of vehicle for each refuse generation center is shown in Appendix Table D-1, Volume III. The quantities by land use type (residential, commercial, and industrial) were used to assess the accuracy of the derived data and were fundamental to estimating future quantities since wastes from the three sources increase at different rates. The derived residential, commercial, and industrial quantities are not presented herein because they were further adjusted, as described in the following subsection.

DERIVATION OF TOTAL QUANTITIES

The first adjustment in the derived quantities was made to convert the March data into average annual data. To do this, the recorded volumes for the St. Johns landfill for an entire year were obtained, and the volumes for March were compared against the average volume for the year. It was found that the weekly refuse generation rates in March were about 11 percent below the annual average rates, so all derived quantities for the study area were increased by 11 percent to reflect this.

The residential, commercial, and industrial quantities for each refuse generation center were then compared against one another for consistency and apparent accuracy; and appropriate adjustments were made to eliminate inconsistencies and establish typical per-capita generation rates for the study area. The analysis and adjustment for each type of refuse is discussed in the following paragraphs. The final results for present solid waste quantities in each county are shown in Table 22, Volume I.

Residential

Discussions with refuse haulers and landfill operators revealed that the density of residential refuse ranged from a low in March to a high at the end of the summer, with the range in densities reported to be about 6 percent. The residential densities obtained through the March program of data gathering were therefore increased by 3 percent to reflect an annual average.

The derived per-capita generation rates for residential refuse in each of the 50 refuse generation centers were found to vary from a high of 3.98 pounds per capita per week to a low of 0.45, with no residential wastes at all being inventoried for five of the outlying, sparsely populated areas. The average for the entire study area was 2.18 pounds per capita per week for residential wastes. A comparison of the widely ranging per-capita values showed that the lower values were for very sparsely populated, rural areas where either commercial collection was not provided or the residents did not utilize it.

To eliminate the major discrepancies in per-capita residential generation rates, it was decided to standardize these rates within each of two residential land use types: (1) urban-suburban, typified by dense to moderately dense population; and (2) rural, typified by low population density. Each of the 50 refuse generation centers was classified--26 as urban-suburban and 24 as rural--and a typical residential per-capita generation figure was derived for each of the two classifications. For urban-suburban, the per-capita generation figure was taken as the average of the derived per-capita rates for the 26 refuse generation centers in that classification; the average was then increased slightly to allow for lawn trimmings that are presently being burned. For rural, it was not considered that the figures derived from weighing and landfill records accounted for all wastes from rural residences, so further analysis was considered essential.

As reported in Appendix D, Volume III, a rural questionnaire was sent to a random sampling of a total of 1,000 rural residences throughout the four-county study area. The questionnaire returns were used to determine the total quantity of wastes being generated per household as well as approximate amounts of refuse being burned or buried and thus not presently delivered to disposal sites. It has become evident in other parts of the country that as soon as more convenient solid waste management facilities are provided, wastes previously being burned or buried or illicitly disposed of tend to become a part of the formal solid waste stream. Accordingly, the previously derived average per-capita generation figure for rural residential areas was increased to account for all types of wastes: those already entering the formal waste stream plus those presently being burned, buried, and illicitly disposed of.

The final adjusted figure for present per-capita generation in urban-suburban residences is 2.55 pounds per-capita per day; this figure multiplied by the present population in the 26 urban-suburban refuse generation centers multiplied by 7 days per week yields a total of 6,787 tons per week. The final adjusted figure for present per-capita generation in rural residences is 2.16 pounds per capita per day, or a total of 1,513 tons per week. Total present residential refuse is therefore 8,300 tons per week.

Commercial

In urban-suburban areas, it was assumed that the derived total quantity of residential and commercial wastes (including increases to bring the quantities to an annual average plus the addition of lawn trimmings presently being burned) in each refuse generation center was correct and that any discrepancies in residential quantities had resulted when the wastes were initially categorized as residential or commercial. Therefore, in those refuse centers where the residential quantities had been increased to meet the average of 2.55 pounds per capita per day, commercial quantities were decreased by a like amount. In those refuse centers where the residential quantities had been decreased, the commercial quantities were increased accordingly.

In rural areas, it was assumed that the derived total quantity of commercial wastes (including an increase to bring the quantity to an annual average) was correct and that increases in residential wastes had been required because those extra residential wastes had never been reported at all. Therefore, the derived commercial quantities in rural areas were accepted and not further adjusted.

The total present quantity of commercial wastes in the study area is 5,390 tons per week.

Industrial

It was considered desirable to cross-check the inventoried quantities of industrial wastes as derived from the weighing program and landfill records. The reason for this is twofold: (1) a one-week weighing and monitored program might not reveal all industrial wastes because they do not necessarily follow the weekly pattern of generation that residential and commercial wastes do; and (2) monitoring of public landfills would not identify the quantity of wastes disposed of by industries on their own property. The procedure used to check and adjust the industrial waste quantities is described in the following paragraphs.

The Standard Industrial Code (SIC) listings were obtained from the Oregon State Economic Development Division for all industries within the study area. Included in the listings were type of industry, location, and number of employees. Questionnaires regarding waste types, quantities, and industrial recycling efforts were then mailed to all major industries and to representative smaller industries on the list. Based upon the return from the questionnaires and upon published standard values[1,2] a suitable per-employee waste generation rate was established for each type of industry. It was possible to determine from the Economic Development Commission listings the SIC industries and employees for each refuse generation center. This information, combined with the per-employee waste generation figures, yielded an approximation of the industrial waste quantities that might be expected from each refuse center.

Utilizing information from the weighing and monitoring program, from the industrial questionnaires, and from the SIC per-employee generation data, each refuse generation center was analyzed for industrial waste production. The procedure for comparing the values was as follows. First, individual industrial sources of waste quantities from the weighing and monitoring program were identified wherever possible and checked against the industrial questionnaires from each of those industries. Large discrepancies between inventoried values and results from the industrial questionnaires were rectified by using the value with the most substantiation. In those areas where the two values differed only slightly, the inventoried values were accepted. For those refuse generation centers where there were no industrial quantities indicated from the weighing and monitoring program or from the industrial questionnaires, yet the SIC listings indicated the existence of industries, wastes were allocated on the basis of the number of employees and per-employee waste generation figures.

The total present quantity of industrial wastes as derived for the four-county study area is 3,734 tons per week. This includes an estimated 400 tons per week being disposed of by the industries on their own property. It also includes demolition wastes.

The total industrial waste quantity can be subdivided into wastes that are amenable to compaction and other types of solid waste processing and into those that are not. Of the present 3,734 tons per week of industrial wastes, 1,829 tons are considered processible and 1,905 tons are not.

DERIVATION OF COSTS

Given the scarcity of available cost information, it was decided not to attempt a detailed analysis of costs by agency or by individual disposal site, but rather to determine the estimated overall cost of the present system to the public. For this reason, costs within individual disposal sites were not analyzed but rather the disposal site fees were used, since this represents the cost to the public. Costs were derived only for the operational portion of the existing system; no attempt was made to estimate costs for governmental administrative agencies involved in solid wastes.

Both capital costs and operation and maintenance costs were derived for solid waste operations, as described in the following paragraphs.

Capital Costs

To derive total capital costs for the existing system, it was necessary to inventory all equipment in the area and then to establish a dollar value for it. An inventory of capital equipment in the collection system was compiled from the following sources: (1) the weighing program; (2) information supplied by the Clackamas County Solid Waste Division; (3) questionnaires completed by the Washington County haulers; and (4) information supplied by the Sanitary Truck Drivers Local Union No. 220.

The compiled inventory included number, types, and sizes of collection vehicles in each county. It was not possible, however, to determine the age of each piece of equipment. To obtain an estimate of the amortized annual cost of each vehicle, the following procedure was used: the current new value of each type of vehicle was determined, a 20 percent resale value was assumed, and the balance of the cost was amortized over a 5-year period at 8 percent per year.* The annual amortized capital cost of containers and drop boxes was estimated in a similar manner: using an estimate of the total number of containers and drop boxes in each county, the current new value was determined, a 10 percent resale value was assumed, and the balance of the cost was amortized over a 10-year period at 8 percent per year.

There was no way to determine the investment of the refuse haulers in office and shop facilities, so an increase of 10 percent over the amortized capital value of rolling stock and containers was included to allow for fixed-plant amortization.

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* Some collectors retain their vehicles for a longer period than 5 years, and some replace only the truck chassis and not the body. But the trend is toward 5-year total replacement because maintenance costs usually increase significantly after 5 years of use.

The number of collection vehicles in each county and the estimated wastes collected annually by them are shown in Table G-1. The exceptionally low value of 532 tons per compaction vehicle annually in Columbia County is the result of small collection vehicles and low usage of many of the vehicles. The low value of 1,108 tons per compaction vehicle annually in Clackamas County relates to the small-sized collection vehicles used to accommodate the rural areas. The relatively low value of 1,114 tons per compaction vehicle annually in Multnomah County reflects an inefficient usage of equipment caused by the large number of collectors serving the county. The much higher value of 1,433 tons per compaction vehicle annually in Washington County is a reflection of the vehicle efficiency the collectors there have been forced to develop to offset their generally longer hauls to disposal sites.

Table G-1

QUANTITIES OF WASTES COLLECTED PER VEHICLE

County	Compaction vehicles			Drop box vehicles		
	Number of vehicles	Wastes collected		Number of vehicles	Wastes collected	
		tons/yr	tons/vehicle		tons/yr	tons/vehicle
Clackamas	49	54,265	1,107	9	23,400	2,600
Columbia	14	7,454	532	2	9,078	4,539
Multnomah	235	261,910	1,114	31	141,605	4,568
Washington	50	71,660	1,433	11	36,310	3,301

Note: The vehicles and waste quantities shown are for commercial collectors only. Vehicles used by industries, businesses, and the public for hauling their own wastes are not included.

As may be computed from Table G-1, the percentage of drop box vehicles owned by commercial haulers and the percentage of wastes collected by the drop box vehicles are as follows:

County	Drop Box Vehicles, %	Drop Box Wastes, %
Clackamas	11	30
Columbia	12	55
Multnomah	12	35
Washington	18	34

These high percentages of wastes, compared to the low percentage of drop box vehicles, illustrate the efficiency of utilizing drop box vehicles wherever applicable. Because the vehicle makes only one collection stop for a full load, the vehicle and crew spend less time on the route and thus can make several trips to the disposal site in a single day; in addition, drop box vehicles require only one-man crews instead of the more expensive two-man crews commonly used on compaction trucks.

The unusually high percentage of wastes collected by drop box vehicles in Columbia County is due to the disproportionately high quantity of industrial wastes that are concentrated in one location (St. Helens) and collected in drop boxes. The higher percentage of drop box vehicles required to collect about the same percentage of wastes in Washington County as in Clackamas and Multnomah counties is attributable to an inefficient utilization of vehicles caused by the comparatively large number of drop box collectors serving that county.

Operation and Maintenance Costs

The four main elements of operation and maintenance for the refuse collection system are (1) labor, (2) vehicle fuel and maintenance, (3) disposal fees, and (4) profit. Data from the weighing program and from disposal site records were used to determine the number of trips made to disposal sites by each vehicle each week and thus to aid in estimating weekly disposal fees and vehicle operation and maintenance costs.

Discussions with local collectors as well as the results of the survey conducted by the Sanitary Truck Drivers Local Union No. 220, indicate a wide variation in salaries for collection personnel in the study area. Most of the variation, however, seems to occur with one-man, one-truck operations in which the owner allocates his own salary and in which something less than a 40-hour work week is often evident.* Larger operations appear to have more uniform salaries. For the purpose of this analyses, it was assumed that each compaction vehicle represents a two-man crew, each drop box vehicle represents a one-man crew, and average annual salaries, including fringe benefits, are $13,000 in Clackamas, Multnomah, and Washington counties and $11,000 in Columbia County. The total labor costs obtained from these figures were then increased by 10 percent to allow for office help.

Fuel and maintenance costs for compaction vehicles were estimated from data supplied by private haulers. It was estimated that a collection vehicle would cost $5,750 per year to operate,** based on a utilization of five trips per week and a 25-mile total for collection and round trip to the disposal site. For vehicles making a greater or lesser number of trips than five, the basic cost was increased or decreased proportionately. For vehicles traveling further or less than 25 miles, the cost was increased or decreased at the rate of $0.40 per mile.

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* Disposal site information indicates fewer than five trips per week to a disposal site for some vehicles.

** Includes fuel, oil, parts, repairs, insurance, licenses, and taxes.

Fuel and maintenance costs for drop box vehicles were estimated separately from those of compaction vehicles because the utilization of each is quite different. A basic cost of $1,600 per year was assigned to each drop box vehicle to cover insurance, licenses, and taxes. An additional cost of $0.56 per mile was used to cover fuel, oil, parts, and repairs.

Rates for disposal vary from site to site, as shown in Table 18, Volume I. To estimate the total amount of money spent for disposal, it was necessary to analyze each disposal site separately, determine (from the weighing program and landfill records) the volume of compacted and noncompacted wastes entering that site from each study area county, and then compute the total fee for that quantity from that county.

Profit was assumed as 7 percent of the total annual cost of the system.

APPENDIX H

Appendix H

RECYCLING DATA AND FACTORS AFFECTING MATERIALS REUSE

The information in this appendix is presented in three sections. First, the organizations involved in recycling, current projects, presently recycled materials and quantities, and future trends are described separately for the national, state, and local levels. Second, the separation, sizing, and conversion techniques used in processing for reclamation and reuse are listed. Third, the types and typical costs of transporting secondary materials are identified.

REVIEW OF CURRENT RECYCLING ACTIVITIES

General

Salvage has historically been an economic activity, pursued solely for profit and operating on the fringes of industry and commerce.[1] Materials have value not just intrinsically but largely from the capital and labor invested in processing them to their finished state. Reprocessing used materials has traditionally been less expensive and consumed less energy than extracting and processing virgin raw materials.[1] However, low-cost fossil fuel energy, modern technology, and the consequent exploitation of readily accessible raw materials have dramatically decreased the cost of producing goods from raw materials. Energy-intensive technology has not been applied as readily to reclamation and reuse as it has to raw materials extraction and processing. As a result, the costs of producing goods from virgin materials are generally lower than the costs of producing them from wastes.[1] Thus, rapidly expanding consumption and an even faster proliferation of nonreusable and short-life products have greatly increased the quantity of material disposed of and have steadily decreased the relative rate of reclamation and reuse. The recycling rate in the United States today is lower than at any time in history despite growing public awareness of, and concern for, the environment, enactment of state and federal statutes, and establishment of governmental agencies and programs to protect the environment and increase recycling.

National

Organizations Involved in Recycling. The organizations most actively involved in recycling at the national level are (1) the secondary materials industry trade associations, (2) individual firms and industry trade associations involved in recycling programs for their products (primarily containers), (3) the loose confederation of environmental, conservationist, and civic organizations, and (4) the Environmental Protection Agency (EPA).

A comprehensive list of national agencies and organizations involved in recycling is given in Table H-1. Most of these have literature available and can provide information and answers to specific questions from agencies and organizations involved in recycling.

The most important secondary materials industry trade associations are the National Association of Secondary Materials Industries (NASMI), which represents all secondary materials industries, and the Institute of Scrap Iron and Steel (ISIS), which represents the scrap metals industry. Others include the Rubber Reclaimers Association, the National Tire Dealers and Retreaders Association, and the Association of Petroleum Re-refiners.

Individual packaging and beverage companies, their trade association, and the basic industries manufacturing packaging

Table H-1

ORGANIZATIONS INVOLVED IN RECYCLING - NATIONAL

	Name and address	Description
1.	Environmental Protection Agency (EPA) Office of Solid Waste Management	Department of federal agency charged with recycling
	401 M Street, N.W. Washington, D.C. 20460	National office
	Arcade Plaza 1321 Second Avenue Seattle, Washington 98101	Region X office
	1234 S.W. Morrison Street Portland, Oregon 97205	Local office
	Solid Waste Information Retrieval System Section (SWIRS) P.O. Box 2365 Rockville, Maryland 20852	Data bank and retrieval service
2.	Council on Environmental Quality (CEQ) 722 Jackson Place, N.W. Washington, D.C. 20006	National advisory agency on environmental affairs
3.	Bureau of Mines U.S. Department of the Interior Washington, D.C. 20006	Conducts research on separation and conversion of solid wastes
	Metallurgy Research Center College Park, Maryland	Research center
4.	Forest Products Laboratory U.S. Department of Agriculture P.O. Box 5130 Madison, Wisconsin 53705	Research facility for U.S. Forest Service
5.	National Center for Resource Recovery, Inc. (NCRR) 1211 Connecticut Avenue, N.W. Washington, D.C. 20036	Nonprofit corporation formed by industry and labor to promote recycling
6.	National Association of Secondary Materials Industries, Inc. (NASMI) 330 Madison Avenue New York, New York 10017	Trade association of secondary materials industry
7.	Institute of Scrap Iron and Steel, Inc. (ISIS) 1729 H Street, N.W. Washington, D.C. 20006	Trade association of scrap metal dealers
8.	Rubber Reclaimers Association, Inc. 63 Radnor Avenue Naugatuck, Connecticut 06770	Trade association of rubber reclaimers

Table H-1 (Continued)

	Name and address	Description
9.	National Tire Dealers and Retreaders Association, Inc. 1343 L Street, N.W. Washington, D.C. 20005	Trade association of tire retreaders
10.	Association of Petroleum Re-Refiners Box 7116 Arlington, Virginia 22207	Trade association of waste oil re-refiners
11.	Paper Stock Institute of America	A commodity division of NASMI
12.	National Ash Association 1819 H Street, N.W. Washington, D.C. 20006	National association of fly ash utilizers
13.	American Paper Institute 260 Madison Avenue New York, New York 10016	Manufacturers of pulp, paper, and paperboard
14.	American Iron and Steel Institute 150 East 42nd Street New York, New York 10017	Basic manufacturers in the steel industry
15.	Can Manufacturers Institute, Inc. 821 15th Street, N.W. Washington, D.C. 20005	Manufacturers of metal cans, containers, and packages using tin plate
16.	Fibre Box Association 224 South Michigan Avenue Chicago, Illinois 60604	Manufacturers of corrugated and solid fiber shipping containers
17.	Glass Container Manufacturers Institute 330 Madison Avenue New York, New York 10017	Glass container manufacturers and suppliers
18.	National Canners Association 1133 20th Street, N.W. Washington, D.C. 20036	Packers of food products in hermetically sealed containers
19.	National Soft Drink Association 1101 16th Street, N.W. Washington, D.C. 20036	Manufacturers of soft drinks
20.	Aluminum Association 750 3rd Avenue New York, New York 10017	Producers of aluminum and semi-fabricated aluminum products
21.	Society of the Plastics Industry 250 Park Avenue New York, New York 10017	Manufacturers of plastics and plastic products

Table H-1 (Concluded)

Name and address	Description
22. Packaging Institute 342 Madison Avenue New York, New York 10017	Users and manufacturers of packaging materials, machinery, and services
23. U.S. Brewers Association 1750 K Street, N.W. Washington, D.C. 20036	Brewers of beer
24. National League of Cities/U.S. Conference of Mayors 1612 16th Street, N.W. Washington, D.C. 20036	Cities and mayors
25. Council of State Governments Ironworks Pike Lexington, Kentucky 40505	State commissions on interstate cooperation
26. National Association of Counties 1001 Connecticut Avenue, N.W. Washington, D.C. 20036	County officials
27. Metropolitan Association of Urban Designers (MAUDEP) P.O. Box 722, Church Street Station New York, New York 10008	Association of urban planners that sponsored recent conference on recycling for cities
28. League of Women Voters 1730 M Street, N.W. Washington, D.C. 20036	Women citizens of voting age
29. Izaak Walton League of America 1326 Waukegan Road Glenview, Illinois 60025	Conservationists
30. Sierra Club Mills Tower San Francisco, California 94104	Conservationists and outdoor recreation enthusiasts
31. American Public Works Association 1313 East 60th Street Chicago, Illinois 60637	Public works officials
32. Friends of the Earth 917 15th Street, N.W. Washington, D.C. 20005	Conservationists
33. National Solid Wastes Management Association 1022 15th Street, N.W. Washington, D.C. 20036	Association of solid waste management industry

materials (steel, aluminum, and glass) are involved in recycling programs for their products. Some of the most active are Coors Breweries, Reynolds Aluminum, Continental Can, American Can, Bethlehem Steel, Glass Containers Manufacturers Institute, American Paper Institute, and the Can Manufacturers Institute. In addition, these organizations and others have joined with the secondary materials industry, labor unions, and the solid waste management industry to form the National Center for Resource Recovery (NCRR). NCRR's goal is to coordinate the efforts of industry and labor with those of the federal government and the public to solve the solid waste problem with a total systems approach.

EPA has the primary federal responsibility of environmental protection including recycling. EPA provides funds for demonstration projects and studies, drafts legislation concerning recycling, formulates policy, and publishes and enforces administrative regulations. Other federal agencies involved are the Bureau of Mines, U.S. Department of the Interior, and the Forest Products Laboratory, U.S. Department of Agriculture, which conduct research on resource recovery techniques within their areas of responsibility.

The Council of Environmental Quality is a federal advisory agency charged with developing goals and policy guidelines on all aspects of environmental protection including recycling; however, it has no authority to act or require conformance to these guidelines.

Many civic, environmental, and conservationist organizations are active nationwide in recycling activities, but some are especially involved at a national level. Among these are the National League of Cities, the League of Women Voters, the Izaak Walton League, the National Audubon Society, and the Sierra Club.

Many municipalities, engineering companies, and equipment manufacturing companies have projects or techniques either in operation or under development. These are described under "Current Projects."

Current Projects. The most interesting aspect of currently operating central resource recovery projects and significant source separation programs is that--aside from the traditional activities of the secondary materials industry--there are so few. Most projects are quite new and have been funded, at least partially, by EPA. They are primarily demonstration plants of promising but unperfected techniques. An extensive listing of projects with addresses is given in Table H-2. No special effort was made during this study to make a comprehensive list, and some projects may be of little interest or terminated while many significant projects may have been overlooked. Most of those listed, however, would probably provide limited information on their operations to qualified agencies and organizations.

Some of the projects of special interest, either at the pilot plant stage or with demonstration plants under construction, are (1) the CPU-400 fluid bed combustor and gas turbine of the Combustion Power Company at Menlo Park, California; (2) the pyrolysis units of Garrett Research and Development at San Diego, California, Linde Division of Union Carbide at Tarrytown, New York, and Monsanto Chemical at Baltimore, Maryland; (3) the Bureau of Mines research program and the Lowell, Massachusetts, demonstration plant utilizing minerals enrichment technology; (4) the industrial refuse recovery plant of the Ford Motor Company at Dearborn, Michigan; (5) the proposed hydropulping plants at Hempstead, New York, and Detroit, Michigan; (6) the reported sale of shredded refuse as fuel at Brockton, Massachusetts; and (7) the refuse pelletizing demonstration plant of Sira at Los Gatos, California.

Table H-2

CURRENT PROJECTS - NATIONAL

	Name and address	Description
1.	Ecology Center 2179 Allston Way Berkeley, California 94704	Recycling group
2.	Union Electric Company	Firing of shredded refuse as supplementary fuel in pulverized coal furnace
3.	Black Clawson Company Franklin, Ohio Middletown, Ohio	Hydropulping and fiber reclaiming process
4.	City of Chicago Department of Sanitation	Incineration with heat recovery
5.	Combustion Power Company, Inc. Menlo Park, California	Developers of the CPU-400 fluid bed combustor with turbine generator
6.	Garrett Research and Development San Diego, California	Division of Occidental Petroleum, developers of pyrolysis system
7.	Linde Division of Union Carbide Tarrytown, New York	Developers of pyrolysis unit that converts unshredded refuse to gas
8.	Monsanto Enviro-Chem Systems, Inc. Baltimore, Maryland	Developers of Landgard pyrolytic system using shredded refuse
9.	City of Altoona, Pennsylvania	Municipality operating Fairfield-Hardy compost plant since 1963
10.	Hercules, Inc. New Castle County, Delaware	Developer of Fairfield-Hardy compost system
11.	Ecology, Inc. Brooklyn, New York	Developer of compost plant
12.	Sunset Scavenger Company South San Francisco, California	Operators of transfer station and recovery center
13.	City of Odessa, Texas	Developers of municipal shredding and land disposal system of refuse
14.	Dr. Poo Chow Department of Forestry University of Illinois	Assistant professor of wood science involved in research to make fiberboard from waste cellulose

Table H-2 (Concluded)

Name and address	Description
15. Bowling Green, Ohio Hempstead, New York Irvington, New Jersey Madison, Wisconsin	Municipalities with municipal programs for paper salvage
16. Amarillo, Texas Atlanta, Georgia Chicago, Illinois Franklin, Ohio Houston, Texas Los Gatos, California Madison, Wisconsin Martinez, California Melrose Park, Illinois New Castle County, Delaware Oakland, California Pompano Beach, Florida Sacramento, California St. Louis, Missouri St. Petersburg, Florida Stickney, Illinois Tampa, Florida	Municipalities operating steel can recovery systems
17. Brevard County, Florida Ft. Lauderdale, Florida Framingham, Massachusetts Harrisburg, Pennsylvania Hempstead, New York Milford, Connecticut San Diego, California San Francisco, California Scottsdale, Arizona Vancouver, Washington	Cities planning to install steel can recovery systems in 1972-1973
18. Sira Corporation Los Gatos, California	Developer of pelletizing system to use refuse as fuel
19. Atlanta, Georgia Boston, Massachusetts Braintree, Massachusetts Chicago, Illinois Hempstead, New York Lynn, Massachusetts Miami, Florida Oyster Bay, New York Providence, Rhode Island U.S. Naval Station, Norfolk, Virginia	Municipalities with heat recovery incinerators
20. Boulder, Colorado Gainesville, Florida St. Petersburg, Florida San Juan, Puerto Rico	Municipalities reported to have operating compost plants
21. New Orleans, Louisiana	Full-scale recovery center planned in conjunction with NCRR

New plants and programs are being announced nearly every week. The land disposal of shredded refuse at Odessa, Texas, and the recycling facility sponsored by NCRR at New Orleans, Louisiana, are examples of recent proposed facilities.

Recent Studies and Conferences. Many significant recycling and solid waste management studies and recycling conferences have been conducted recently. Although there have been no immediate results, these are extremely important as they make available information not otherwise readily obtainable.

Some studies are almost entirely devoted to rhetoric and to conceptual systems that are not now implementable. Others give only passing reference to recycling primarily because of its distinctly limited possibilities. Only a few actually recommend limited concepts. A partial list of the most significant reports and other literature utilized in the course of this study is given in Table H-3.

Presently Reclaimed Materials and Quantities. In the 1973 EPA "Report to Congress on Resource Recovery," it is reported that total 1971 U. S. materials consumption was 5.8 billion tons, of which approximately 10 to 15 percent was accumulated in use, and the remainder was either consumed, with the residue discharged to the land, air, or water, or used to replace obsolete goods which in turn became waste.[2] From 1967 to 1968 the major manufactured materials were recycled at a rate of 25 percent of consumption. Recycling rates of materials as a percent of consumption and as a percent of "available waste" are given in Table H-4.

Future Trends. Although it appears that the rate of recycling will increase, statistics are not available to establish a trend. The aforementioned 1973 EPA report concluded

Table H-3

LITERATURE - LOCAL, STATE, AND NATIONAL

1. "Economic and Logistical Aspects of Reuse and Recycling of Solid Waste Materials in the Portland, Oregon Metropolitan Area," Barrett MacDougall, Economic Development Internship Program, PSU Urban Studies Center.
2. "Industrial Solid Waste Survey, Oregon: 1970," State Board of Health.
3. "The Economics of Recycling Waste Materials," Hearings Before the Subcommittee on Fiscal Policy of the Joint Economic Committee, Congress of the United States, 92nd Congress, November 8 and 9, 1971 (70-4220).
4. "Recycling: Assessment and Prospects for Success," Arsen Darnay, EPA SW-81.
5. "Paper Recycling: The Art of the Possible 1970 - 1985," Midwest Research Institute.
6. "Logging Residue," James O. Howard, Pacific Northwest Forest and Range Experiment Station, PNW-44.
7. "Report on Generation of Steam by Incineration of Waste at Southern Oregon College, Ashland," J. Donald Kroeker and Associates, December 1971.
8. "The Report of the Northeast Recycling Pilot Project," Northeast Recycling Pilot Project Committee, June 1972.
9. "Solid Waste," League of Women Voters (Portland), March 1972.
10. "Metropolitan Housewives' Attitudes Toward Solid Waste Disposal," National Analysts, Inc., Environmental Protection Agency, June 1972.
11. "Environmental Quality," League of Women Voters of Portland, December 1970.
12. "Salvage Markets for Materials in Solid Wastes," Arsen Darnay and William Franklin, EPA SW-29c, 1972.
13. "System Energy and Recycling: A Study of the Beverage Industry," Bruce Hannon, Center for Advanced Computation, University of Illinois, March 17, 1973.
14. "Report to Congress on Resource Recovery," Environmental Protection Agency, February 22, 1973.
15. "American Composting Concepts," P. H. McGalihey, EPA SW-2r, 1971.
16. "Sacramento County Solid Waste Reclamation Study Phase I & II," Department of Public Works, March 5, 1973.

Table H-4

U.S. RECYCLING RATES

Material	Consumed, million tons	Recycled[a] Million tons	Recycled[a] % of consumed	Available for recycling, million tons	Recycled[b] Million tons	Recycled[b] % of available
Paper	53.110	10.124	19.0	46.800	11.400	19
Iron and steel	105.900	33.100	31.2	141.000	36.700	26
Aluminum	4.009	0.733	18.3	2.215	1.056	48
Copper	2.913	1.447	49.7	2.456	1.489	61
Lead	1.261	0.625	49.6	1.406	0.585	42
Zinc	1.592	0.201	12.6	1.271	0.182	14
Glass	12.820	0.600	4.2	--	--	--
Textiles	5.672	0.246	4.3	4.700	0.800	17
Rubber	3.943	1.032	26.2	--	--	--
Total	191.220	48.108	25.2[c]	--	--	--
Nickel				0.106	0.042	40
Stainless steel				0.429	0.378	88
Precious metals				105[d]	79[d]	75

a. Arsen Darnay, William Franklin, "Salvage Markets for Materials in Solid Wastes," U.S. Environmental Protection Agency, 1972.

b. Hearings before the Subcommittee on Fiscal Policy of the Joint Economic Committee, 92nd Congress, "The Economics of Recycling Waste Materials," 1971.

c. Average.

d. Million troy ounces.

that "the proportion of the nation's materials requirements satisfied from recycling materials has remained constant or has declined in most instances" and that "recycling should become more economical relative to other solid waste disposal options during the next several years."[2]

State

General. A specific examination of recycling at the state or regional level outside of Oregon was not undertaken during this study; however, several projects and activities at the state level are extremely important to local recycling efforts and some are discussed here.

Reclamation and reuse of waste materials in Oregon differs somewhat from that in the rest of the nation. The isolation from major urban centers, ready access to foreign markets, a generally good supply of hydroelectric power, a local pulp and paper industry, a relatively environmentally concerned public, and progressive state and local government are the primary reasons for differences. Historically, in Oregon as elsewhere, recycling has been inexorably tied to industry. The Willamette Valley's urbanization has resulted in significantly improved opportunities there for recycling of manufactured goods, but the remainder of the state is sparsely populated and cannot support major local recycling programs.

Organizations Involved in Recycling. A list of organizations active in recycling and operating either at the statewide level or locally outside Portland but with significant statewide impact is given in Table H-5. DEQ has been very active in advocating recycling and has established an objective of a recycling rate of 25 percent by 1975 and 90 percent by 1982. In

Table H-5

ORGANIZATIONS INVOLVED IN RECYCLING - STATE

	Name and address	Description
1.	Environmental Quality Commission 1400 S.W. Fifth Portland, Oregon 97205	State pollution control commission
2.	Department of Environmental Quality (DEQ) 1234 S.W. Morrison Street Portland, Oregon 97205 Solid Waste Management Office Recycling Information Office and Recycling Switchboard	Staff of the Environmental Quality Commission
3.	Oregon Recycling Information and Organization Network (ORION) 2637 S.W. Water Portland, Oregon 97201	Recycling clearinghouse and lobbying organization
4.	Pacific Northwest Forest and Range Experiment Station U.S. Department of Agriculture 809 N.E. 6th Portland, Oregon	Local office of federal agency involved in research
5.	Forest Research Laboratory & Food Technology Program Oregon State University Corvallis, Oregon	Basic research on utilization of forest and agricultural wastes
6.	Eugene Salvage and Equipment Company 111 Highway 99 N Eugene, Oregon 97402	Car shredder and scrap metal processor
7.	Rackliff Brothers, Inc. 6543 Cedar Boulevard Newark, California 94560 Merlin Fjarli 515 Lozier Street Medford, Oregon 97501 Walt Thompson c/o White City Disposal Site White City, Oregon 97501 Auto Disposal Services, Inc. 4621 Morriss Hill Road Boise, Idaho 83704	Auto mashers operating in Oregon

Table H-5 (Concluded)

	Name and address	Description
	Contractors and Suppliers, Inc. P.O. Box 37 Goshen, Oregon 97401	
	Johnny's Auto Wreckers 1080 Monmouth Independence, Oregon 97351	
	Stanfield Recycling Center Tum-a-Lum Lumber Yard Stanfield, Oregon 97875	
	Schnitzer Steel Products 100 N. Seneca Road Eugene, Oregon 97401	
	Red's Auto Wrecking Service Brookings, Oregon 97415	
8.	State Solid Waste Management Citizens' Advisory Committee	Advisory group to DEQ
9.	Chemeketa Region Solid Waste Management Program, Recycling Subcommittee Suite 315, 3000 Market Street, N.E. Salem, Oregon 97301	Recycling subcommittee of Chemeketa Council of Governments
10.	Eco-Alliance Memorial Union Oregon State University Corvallis, Oregon 97331	OSU student recycling organization

Note: Table excludes Portland organizations, shown in Table H-7.

addition to the general promotion of recycling, DEQ has funded county and regional solid waste management studies throughout the state that will include examination of recycling. It has also funded a number of feasibility studies, such as the proposals for burning wood waste with municipal refuse for electrical generation at Eugene and at the Port of Umpqua and the recycling possibilities for seed grass straw.

In August 1973, DEQ established a Recycling Information Office with a "Recycling Switchboard" (229-5555) to (1) inform people having questions on recycling and recycling depot locations, (2) assist in field work with recycling projects, (3) distribute information materials, and (4) assist recyclers with their problems. The office also serves as a clearinghouse to collect recycling information, coordinate recycling efforts, and design and produce publicity campaigns for encouraging recycling.

The secondary materials industry has been active in Oregon for many years--especially in Portland. There is a car shredder in Eugene and car mashers operate throughout the state. Individuals and firms use waste oil on dirt roads, and paper dealers and scrap collectors operate in most urban areas. The rendering plants, re-refiners, and other secondary materials firms in Portland also service the entire state and beyond.

As elsewhere, industry is the most important factor in reclamation and reuse of wastes in that industry provides the market for secondary materials. The "Directory of Oregon Manufacturers," published annually by the Oregon Economic Development Division, lists essential data on all manufacturing industries and is a good source of information on possible markets. The directory does not list secondary materials firms as these are normally listed under SIC 5093 as being in wholesale trade. Although some Oregon container manufacturers outside Portland promote litter control projects and many utilize secondary materials in the course of their business, few are very active in recycling. The manufacturer's trade association, Associated Oregon Industries, is interested in the problems of recycling but has no active recyclirj program.

The same civic, environmental, and conservationist groups are active at the state level as nationally. The most significant state organization, Oregon Recycling Information and Organization Network (ORION), headquartered in Portland, promotes recycling projects throughout the state.

Current Projects (Outside Portland). A partial list of projects and industrial waste utilization operations in Oregon is given in Table H-6. There are no known municipally operated resource recovery operations in Oregon other than the incineration with electrical generation at Eugene. Several cities and towns have "recycling centers" and extensive paper collection efforts, but none have a comprehensive program. Essentially, all recycling in Oregon--which is considerable--is conducted by industries either as their primary business or incidental to their operations.

The single most important effort by industry is the utilization by pulp mills of wood residue supplemented with waste paper. The executive secretary of the Northwest Pulp and Paper Association stated that waste paper utilization of Oregon and Washington mills is expected to increase to 269,000 tons, per year by the end of 1973. Seven mills in Oregon now use some form of waste paper (primarily corrugated). These mills are identified in Appendix I. Further increases will most likely be tied to continued paper shortages, high prices, and possibly to effects of the new Oregon tax credit for recycling facilities. The major constraint on increased utilization of corrugated and

Table H-6

PARTIAL LIST OF RECYCLING PROJECTS AND INDUSTRIAL WASTE UTILIZATION OPERATIONS

Industry	Utilization
Crown Zellerbach, West Linn	Paper mill using waste paper
International Paper, Gardiner	Paper mill using waste paper
Georgia Pacific, Toledo	Paper mill using waste paper
Menasha, North Bend	Paper mill using waste paper
Publisher's Paper, Oregon City	Paper mill using waste paper
Western Kraft, Albany	Paper mill using waste paper
Weyerhauser, Springfield	Paper mill using waste paper
McGraw-Edison, Corvallis	Asphalt-impregnated conduit from shredded newspaper
Tuf-Board, Hood River	Composition board from waste paper and papermill sludge
Bohemia Inc., Medford area	Wax and low density particle board from bark
Cascade Steel Rolling Mills, McMinnville	Scrap steel use
Boise Cascade, Salem	Fermentation of spent sulfide liquor for protein

fine grade paper is lack of supply. In fact, local brokers in corrugated paper are having difficulty in meeting their commitments because export brokers are taking part of the supply. Future increases in waste paper usage will very likely be tied to assurance of adequate supplies.

Legislation. Three recent statutes are especially important for recycling activities. These are the Oregon Bottle Bill, House Joint Resolution 53, and Senate Bill 661. The Oregon Bottle Bill eliminated nonreturnable carbonated beverage containers. Whereas nonreturnable containers previously comprised over 50 percent of sales, now all carbonated beverages are sold in returnable containers.

House Joint Resolution 53, passed by the recent legislature, gave the governor authority to develop and publish regulations and recommendations that will encourage state agency recycling. This bill should have a major impact on state agency purchasing practices and on waste generation and salvage by state agencies.

Senate Bill 661, which became effective in October 1973, establishes tax credits for industries installing recycling facilities. This bill can be expected to have a significant effect on recycling efforts by industry.

Presently Recycled Materials and Quantities. Quantities recycled on a statewide level were not examined; however, with the exception of pulp and particle plants and efforts in Corvallis, Eugene, Salem, and Albany, widespread recycling is not done. Those quantities salvaged are processed either in Portland or possibly in one of the major Willamette Valley communities.

Future Trends. In addition to legislation and continued public and industrial interest in recycling, the major forces shaping state recycling trends are (1) the energy shortage, (2) energy cost increases, and (3) the booming export market. The current energy shortage should cause major reassessment of industrial policies toward energy-intensive raw materials manufacturing. The increased costs for whatever energy is available (an increase from less than 4 mills per kwh from BPA to 7 mills for generation from the privately owned and operated Trojan Nuclear Plant) should have an equally important effect, especially on the economics of incineration of refuse with heat recovery. If the export market demand continues, it also should increase recycling rates provided that federal export restrictions are not detrimental.

The major observed statewide trend is toward increased utilization of corrugated paper by pulp mills. Trends in utilization of other materials were not clearly discernible from the rather superficial review of statewide activity; however, it is expected that state trends would be similar to local Portland trends.

Local

General. Local industries and export demand provide the markets for reuse of secondary materials. Except for charitable and service organizations collecting newspapers, clothing, and household goods, the traditional secondary materials industry is the only group involved in significant reclamation of wastes. However, the private sector of the solid waste management industry is becoming active in reclamation of corrugated paper. The recycling efforts of individuals and environmental groups, although important in terms of public involvement, are insignificant in terms of quantities recycled. Portland area public agencies are not actively involved in recycling. The major local industries involved in recycling are Continental Can Company (tin cans), Owens-Illinois (glass), and Reynolds Aluminum (aluminum).

Organizations Involved in Recycling

A partial list of local secondary materials firms would include shipwreckers, ferrous and nonferrous scrap metal processors, rendering plants, waste oil re-refiners, an oil water settling plant, wiping rag processors, retreaders, tire splitters, paper stock dealers, demolition firms, auto wreckers, auto parts rebuilders, salvage brokers, and junk collectors. Besides a glass cullet dealer (handled by the manufacturer), the only significant secondary materials activities not noted in the local area were rubber reclaiming, detinning, and feeding of garbage to hogs.

Portland has a large number of service and charitable organizations involved in the collection of goods. Their primary purpose is to raise funds, but some organizations operate sheltered workshops to train the disadvantaged. These organizations are the key agencies involved in the reclamation of newspapers, textiles, clothing, and household goods.

ORION is a statewide recycling organization with headquarters in Portland. It publishes a periodic bulletin and other information on recycling and is also involved in aiding recyclers and lobbying for state legislation favorable to recycling. The Portland Recycling Team was formed by a group of Portland State University students and is the largest recycling organization in Portland. In addition to operating its own depot, this organization aids other recycling groups by transporting salvaged materials and providing equipment. The League of Women Voters has been the most active civic group in recycling and has published several informative pamphlets on recycling. The DEQ Recycling Information Office has a list of approximately 200 firms, organizations, and individuals--both profit and nonprofit--that either collect or process secondary materials. Table H-7 lists the three major local organizations responsible for recycling information.

Table H-7

ORGANIZATIONS INVOLVED IN RECYCLING - LOCAL

	Name and address	Description
1.	League of Women Voters of Portland 308 Senator Building 732 S.W. Third Avenue Portland, Oregon 97204	Recycling information and education
2.	Portland Recycling Team 1207 S.W. Montgomery Portland, Oregon 97201	Recycling center
3.	Recycling Information Office Department of Environmental Quality Portland, Oregon (229-5555)	Information on locations and hours of current local recycling operations.

The private sector of the solid waste management industry has been marginally involved in salvage for many years. Most collection crews occasionally pick up usable items and scrap metals. Many of the privately owned disposal sites (and even the City-owned St. John disposal site) have private salvagers operating on contract. This practice is declining because it is generally uneconomical and interferes with disposal. The only major effort by the industry is the new corrugated paper recovery plant on North Columbia Boulevard operated by Resource Recovery

Byproducts Company. Other collectors have been interested in corrugated paper recovery and periodically have salvaged some material, but they have not made a major effort.

Special Projects. The Northeast Recycling Pilot Project was initiated by several Portland housewives and aided by the Sanitary Truck Drivers Local Union No. 220. Cans and bottles were collected from November 1971 to April 1972 in northeast Portland, and although the project was economically unsuccessful it provided valuable information on costs and the response of homeowners.

Resource Recovery Byproducts, Inc., is a privately owned firm with a plant in north Portland to salvage corrugated paper from commercial and industrial refuse. If successful, the firm will later install additional facilities to pulp both corrugated paper and wood pallets and will eventually manufacture a particle board.

The City of Portland, in conjunction with DEQ, is participating in the pyrolysis demonstration plant in San Diego that is being constructed by Garrett Research and Development. In addition, the City and the Western Interstate Commission for Higher Education jointly sponsored a recycling study by Barrett MacDougall in 1971. The report, entitled "Economic and Logistical Aspects of Refuse and Recycling of Solid Waste Materials in the Portland, Oregon, Metropolitan Area," contained an analysis of the local situation and a number of recommendations to increase recycling.

Presently Recycled Materials and Quantities. Sufficient data were not available for an accurate determination of either quantities recycled or the rate of recycling. The estimates that were made are presented in Table H-8.

Table H-8

LOCAL ANNUAL RECYCLING QUANTITIES

Commodity	Estimated quantity recycled or processed	Comments
Glass cullet	6,200 tons	--
Newspapers	30,000 tons	--
Corrugated paper	40,000 tons	Not all local material
Fine grade paper	36,000 tons	Mostly process wastes, rather than local post-consumer wastes
Mixed paper	10,000 tons	--
Iron and steel	300,000-400,000 tons	Not all local material
Nonferrous	12,000-18,000 tons	--
Tires	25,000 tons	Retreaded
Crankcase oil	2,000,000 gal.	Rerefined
Bunker oil	1,600,000 gal.	Road oil
Rags	3,000 tons	Wiping cloths and roofing felt
Animal fat	45,000 tons	Rendered in Portland; not all local material

Future Trends. Available data on the expansion of local recycling efforts are limited. From conversations with individuals in the industry and from projections based on the planned installation of new or additional facilities, it appears that, although recycling of paper will significantly increase, waste generation in general will probably increase more rapidly than recycling--at least for the short term. A reversal of this trend might take place if an installation is completed for the separation and sale of light combustibles as an industrial fuel. Although not extremely efficient in terms of material utilization, this facility would productively utilize a significant portion of the wastes.

A more complete description of promising future recycling facilities is presented the subsection entitled "Feasible Systems and Concepts," Chapter 12, Volume I.

For the long term, the recycling potential appears very hopeful. Because costs for energy and virgin materials are rapidly increasing, technological development programs are rapidly culminating in economically viable processes and systems.

PROCESSING FOR RECLAMATION AND REUSE

General

Collection and transporting of wastes to a concentration point are of no value to recycling if the material cannot then be economically processed into a commodity with value to be used in manufacturing. The objectives of processing are thus either direct salvage of a material or production of a new manufactured byproduct.[3]

The essential steps in processing are (1) separation, (2) sizing, and (3) conversion. All current techniques except heat recovery and composting are essentially adaptations of existing technology from other industries--primarily minerals enrichment, food processing, chemical processing, and pulp and paper industries.[3] Serious problems--some as yet unresolved--have been encountered in applying existing technology to solid wastes because of the heterogeneity of solid wastes, the lack of unique properties of waste components, and the diversity of possible recovery methods.[3]

Serious deficiencies were found in the available literature concerning performance and cost data for existing and developing processes. The scarcity of operating facilities, unreliability and scarcity of data published, and the proprietary nature of many techniques make it extremely difficult to derive reliable data. The information that was accumulated is presented in the following subsections.

Separation Techniques

General. The essential qualitative shortcoming of secondary materials is contamination by unwanted substances. Separation is therefore of crucial importance in materials recovery. It is also used in most energy recovery or other chemical conversion processes to remove salvageable material or undesirable contaminants.

Separation techniques are adapted primarily from the minerals enrichment industry. Mechanical separation is based on various properties of wastes, such as magnetic attraction, particle size, particle shape, specific gravity, or a combination of the latter three.

Source Separation. Separation at the source is the most common method now being used by the secondary materials industry. The American Paper Stock Institute promotes source separation as the only feasible means of recovery for high quality paper stock. Separation is usually effected by placing materials in special bins which are often provided by the scrap processor. Efficient separation of residential refuse is limited to stacking and bundling of newspapers for collection or delivery to service clubs' "recycling depots"; source separation of other residential wastes is costly and low in efficiency.

Handpicking and Sorting. As of 1968, handpicking and sorting was the primary commercial means of salvaging materials.[3] It is employed at essentially all composting plants and at some incinerators to remove newspapers, corrugated paper, rags, metals, glass, and plastics and by paper stock dealers; it is expensive, however, and generally unsatisfactory due to a lack of quality control.[3] Published figures indicate that one man can pick from 1/2 to 3/4 ton per hour of newspapers and corrugated paper from mixed municipal refuse on conveyors.[3] No information was found on handpicking from conveyors of corrugated paper from industrial-commercial refuse, but the rate is expected to be over 1 ton per hour.

Magnetic Separation. Magnetic separation is the only common mechanical means of separating materials. It can be accomplished at incinerators, compost plants, milling plants, and landfills. An American Iron and Steel Institute survey indicated that an estimated 115,000 tons per year of ferrous metals were salvaged from municipal refuse and an estimated 86,000 tons per year of capacity was scheduled to be installed in 1972-1973.[1]

Efficient magnetic separation requires prior shredding and size reduction to approximately 6 inches or less in order to facilitate removal of ferrous materials without entrapment of contaminants.

High Intensity Magnetism. This technique is used to separate clear from colored glass at the Bureau of Mines research laboratory in College Park, Maryland.[1] No detailed information was obtained.

Screening. Vibrating, stationary, or rotating screens have been utilized to effect size classification. Very little information is available on the success of any screening methods with solid wastes, and no reliable data were obtained during the course of the study. It is reported that compost plants at Houston, Texas (now closed), and Altoona, Pennsylvania, have used vibrating screens.[3] One equipment manufacturer reported the development of a rotating screen that is apparently successful in the separation of light combustibles from shredded refuse.

Flotation. Existing flotation technology was developed by the mining industry for finely divided material.[3] The only successful application to waste separation is the Garrett system which reportedly removes over 99 plus percent clean glass by flotation.

Heavy Media Separation. Heavy media separation has been primarily used by the mining industry. Applications for waste utilization have been developed by the Bureau of Mines.[3] Some of the scrap metal dealers have reportedly developed heavy media separators for removal of nonferrous scrap from car shredders.

Stoners. Stoners separate materials on the basis of specific gravity, particle size, and shape. They have been used primarily for removal of shells from nuts, seeds, and grains, but they have recently been used at compost plants to remove glass from the compost.[3] Stoners apparently work well with uniform particles such as pelletized compost.

Optical Sorting. Optical sorting was developed for the agricultural and food processing industries and has recently been applied to separating glass cullet by color at Franklin, Ohio. To date, it has not achieved sufficient accuracy for application.

Inertial Separation. Although reportedly successful in Europe, inertial separation has not yet been successfully applied in the United States.[3]

Air Separation. Air separation has been utilized for years in the wood industry. An air separator has been installed at the Union Electric facility in St. Louis and, if successful, could be used to prepare shredded refuse for use as an industrial fuel.

Black Clawson Hydrasposal and Fibreclaim Systems. These systems are based on pulp and paper technology. Solid wastes are pulped and then fibrous materials are reclaimed by special filtering and screening. Black Clawson has a plant in operation at Franklin, Ohio, and is planning two additional plants. The products are paper pulp, combustible pulp, ferrous metals, and reject material.

Corrugated Paper Separation by Spaced Belts. Waste Reclamation Corporation of Los Angeles has developed a system of mechanically separating corrugated boxes from industrial-commercial refuse. The system consists of a series of separate belts which reportedly salvage 80 percent of the corrugated paper in a load and result in a product that is 90 percent corrugated.[1]

Sizing Techniques

Milling (shredding) is a means to effect particle size reduction and uniformity. It is used in waste disposal to facilitate handling and to reduce the total volume for transport and disposal. Except for handpicking, it is essential to all currently proposed reclamation techniques.

Milling is primarily an adaptation from the minerals enrichment industry. Hammermills are the most commonly used type of equipment. Other types of basic equipment are crushers, shears, shredders and chippers, rasp mills, drum pulverizers, and wet pulpers.[3]

Besides costs and reliability, the major aspects of milling performance affecting subsequent recovery processes are (1) particle size, (2) particle gradation, and (3) condition of particles--such as balling of tin cans which prevents detinning.

Conversion Techniques

General. Conversion involves the chemical, biological, or physical processing of waste components to produce new by-products.[3] Conversion techniques that were investigated include (1) composting, (2) heat recovery, (3) pyrolysis, (4) hydrolysis, (5) biological conversion to protein, (6) general chemical conversion, and (7) manufacture of fiberboard.

Information on conversion methods, equipment performance, and cost data was even more difficult to obtain than separation and milling data. Except for a few composting plants and conventional incinerators with heat recovery, there are no commercially operating conversion facilities involved in reclamation of municipal refuse. In addition, many companies with new methods and equipment prefer to sell a complete disposal service rather than equipment or design services and consider performance and cost data as trade secrets.

Composting. Compost is a humus-like material resulting from the biological stabilization of the organic components of solid wastes.[3] It is an excellent mulch or soil conditioner and as such will (1) improve soil structure and workability, (2) increase moisture-holding capacity, (3) reduce leaching of soluble inorganic nitrogen, (4) increase resistance to compaction and erosion, (5) increase phosphorus availability, and (6) increase the buffering capacity of the soil.[3, 4] It is not a fertilizer and contains only 1 percent of the major fertilizer nutrients--nitrogen, phosphorus, and potassium.[3]

Most of the technical problems of compost production have been resolved. The only technical questions not adequately resolved are the following: (1) most composting methods cannot compost paper, which must be removed; (2) plant uptake of toxic metals from refuse and (3) incomplete destruction of pathogens and parasites from raw or improperly digested sewage sludge.

The essential shortcoming of composting is lack of adequate markets. Although economical for specialty farming, nurseries, and home gardening, compost (as well as other soil conditioners) is not economical for general agriculture. Chemical conditioners are far cheaper to purchase, transport, and apply, and they yield entirely satisfactory results.[4] Eastern Oregon farmers indicate that their agriculture is basically hydrophonic and soil conditioners are not needed except for wind erosion control.

The market for specialty farming, nurseries, and home gardening is not very promising because of the strong competition from (1) bark, (2) animal manure, (3) on-premise plant matter, and (4) peat moss. The total U.S. consumption of peat moss (the major form of soil conditioners) was approximately 600,000 tons in 1966,[3] which is equivalent to the compost produced by a city of only 800,000 people.[3] In California, there are enough steers to provide two bags of manure per year for every person.[4] Local supplies of bark are more than sufficient to supply the need for soil conditioner or mulch.

Heat Recovery. *Conventional Incineration with Steam Generation.* Conventional incineration is common in Europe and has been utilized in several U.S. locations.[3] Most incinerators require shredding prior to incineration. Two exceptions are the Northwest Chicago incinerator and a facility proposed, but not adopted, for Southern Oregon College at Ashland. The steam that is generated is used either for heating or for electrical generation, but heating is far more economical. A number of incinerator plants in the United States sell steam at prices ranging from $0.20 to $0.70 per 1,000 pounds. They generate approximately 3.4 pounds of steam per pound of refuse.[3] It is noted that Pacific Power and Light sells heating steam for a minimum high-use rate of $1.21 per 1,000 pounds of steam in downtown Portland. Other locations for significant markets for steam are limited to institutions (hospitals, colleges, etc.) and large industrial steam users (pulp and paper mills). The opportunities for development of such a market are limited.

Fluid Bed Combustor with Gas Turbine Operation. Combustion and heat transfer in a fluid bed is a new concept being developed. The hot gases from combustion are passed through a gas turbine to generate power. It is reported that the prototype, the CPU 400 in Menlo Park, California, has not yet proven economical.

Direct Heating with Vortex Waste Heat Recovery Units. The Energex Company has a vortex firing waste heat recovery unit that has been operating at a veneer line in southern Oregon for approximately 5 years. The most serious operating restrictions on this unit are the requirements for extremely low moisture content and fine particle size. The use of this unit would require extensive refuse preparation prior to burning, thereby increasing costs.

Supplementary Fuel in Existing Boilers. The concept of this system is to fire shredded refuse as a supplementary fuel in existing pulverized coal boilers generating electricity. Portland does not have coal-fired electrical generators and recent studies have revealed that rail-haul to Centralia, Washington, where such boilers exist, would be uneconomical. However, a preferable alternative does exist: local industrial utilization in hog fuel boilers. This concept is described more fully in Chapter 12, Volume I.

Pyrolysis. Pyrolysis is a process of destructive distillation in an atmosphere of limited or no xygen. The result is a breakdown of the wastes into (1) a combustible gas, (2) a heavy oil, and (3) a char of carbon and inerts.

One of the most interesting projects is the Garrett Research and Development operation. This process involves generation of a low-BTU oil (10,600 BTU/lb and 23 percent by weight), a char (9,000 BTU/lb and 5 percent), ferrous metals (7 percent), finely ground color mixed glass (6 percent), water (12 percent), and inert residue (43 percent). The oil has a heat content equivalent of about 56 percent by weight of fuel oil.

Although approximately half of the heat content of refuse is lost in the conversion to oil, this resulting fuel is much more valuable as a fuel than is raw refuse because it can be stored, easily transported, and readily fired (either separately or mixed with petroleum-based fuel oils) in existing furnaces. In view of the absence of Oregon supplies of petroleum, this factor could be significant. On the basis of heat content, it is estimated that the yearly refuse of the four-county study area would produce oil with a heat content equivalent to 193,000 tons of petroleum. Current projections are that the Garrett system will be ready for implementation in 1976.

Hydrolysis. Hydrolysis of cellulose, the major constituent of refuse, to form glucose and fermentation of the glucose to produce ethyl alcohol is one of the most interesting and economically promising concepts yet developed for recovery of solid wastes.[3] Yet, no current tests or projects are being conducted based on this concept.

The hydrolysis of wood, known as the "Madison Wood Sugar Process" was accomplished at Madison, Wisconsin, and Springfield, Oregon, during World War II.[3] The Springfield plant hydrolyzed 221 tons per day of sawmill waste and produced 50,000 gallons of ethyl alcohol at an estimated cost of $0.30 to $0.35 per gallon (1947).[3] Commercial grade ethyl alcohol currently sells for $0.52 per gallon.[3]

Production of ethyl alcohol appears to be not only economical, in comparison with disposal of organic waste, but even likely to yield profit.[3] Georgia Pacific is reported to be operating a wood waste hydrolysis plant in Everett, Washington.

Biological Conversion to Protein. Biological conversion of refuse to animal feed protein, either directly or after initial hydrolysis to glucose, is being examined and tested but is not yet at the demonstration plant stage. Boise Cascade is fermenting spent sulfide liquors to produce protein in Salem.

General Chemical Conversion. Chemical conversion of refuse to usable products is not yet feasible, although some analysis has been done and some laboratory experiments have been conducted.[3]

Manufacture of Fiberboard. Both industry and researchers have been examining the possibilities of manufacturing board from refuse or other cellulose waste. Dr. Chen Poo at the University of Illinois has conducted extensive experiments. Tufboard of Hood River, Oregon, has reportedly developed a process for making one-way shipping pallets from waste pulp sludges, paper stock, and other cellulose material, and is currently modifying a plant for this process.

TRANSPORTATION OF SECONDARY MATERIALS

General

Transportation is a major cost factor for the secondary materials industry and generally limits markets to the immediate geographical area. Almost all secondary materials are therefore utilized within 500 miles of where they are salvaged, although high-value materials may be shipped up to 1,000 miles and some low-value materials may only be shipped a maximum of 75 miles.[1]

To reduce transportation costs, the secondary materials dealer usually accumulates sufficient materials to qualify for the lowest possible commercial carrier rate. Whenever possible, waste materials are shipped "back-haul" as part of the round trip where the vehicle would otherwise return empty.

Types of Transportation

The *private passenger vehicle* is most commonly used for household recycleables with materials being carried as part of another trip or a short direct trip to a nearby depot. A recent survey at a Portland depot indicated that 73 percent of the participants questioned came from less than 1 mile away and carried an average load of 70 pounds.

The *company-owned truck* is probably the most common means of shipment for most secondary materials, except for metals which are normally shipped by *rail*. The most serious problem with rail shipment is the lack of gondola cars. *Barge* shipment is not extensively used locally for secondary materials because most materials are not generated in sufficiently large quantities and loading and unloading are so expensive in relation to movement. Loading costs for ocean shipping are also high, but movement costs are so low that export costs are relatively competitive with rail shipment. Except for large scrap steel shipments, essentially all secondary materials shipped overseas are in containers.

Costs

Since costs are such an important part of secondary materials market economics, commercial freight rates can be expected to be an item of considerable controversy. Although the scrap metal industry is adamant about freight discrimination against secondary materials, no statistics were found (during a rather cursory search) to substantiate any discrimination on the basis of costs to the carrier. Virgin iron ore is shipped much cheaper than scrap iron, but iron ore is generated regularly, in immense quantities, and at one point while scrap iron is generated in small quantities at diffuse locations.

COR-MET calculations indicate that typical compactor trucks collect urban residential refuse for about $21 per ton and haul it for about $0.15 to $0.20 per ton-mile (each way). The cost of separate collection of recycleables, derived for the City of Los Angeles as a function of pounds per collection point, are given in Table H-9. Typical calculated haul costs by agency-owned vehicles are given in Table H-10. Commercial carrier rates for various secondary materials to selected destinations are given in Table H-11. Typical energy costs for intercity freight transport are listed in Table H-12.

Table H-9

COST OF SEPARATE COLLECTION OF RECYCLABLES

Pounds per collection point	Collection cost per ton, $
20	24.70
40	19.00
60	15.90
80	14.10
100	13.20
120	12.20
140	11.60
160	11.10

Source: Sacramento County, Department of Public Works, "Solid Waste Reclamation Study, Phase I & II," 1973.

Table H-10

TYPICAL TRANSPORTATION COSTS USING AGENCY-OWNED VEHICLES

	¢/ton-mile			
Mode, conditions	5 mi., 35 mph[a]	10 mi., 35 mph	50 mi., 50 mph	75 mi., 50 mph
Drop boxes: 45-cy box, at 250 lb/cy, 5.5 ton load	23.5	17.0	9.5	9.0
Drop boxes: 20-cy box, steel, 15-ton load	9.0	6.0	3.5	3.5
Tractor-trailer: flat bed, 23-ton load, bales	7.0	5.5	3.25	3.0
Tractor-trailer: 65-cy trailer, 15-ton load, compacted	11.5	5.5	3.25	3.0

a. One-way distance, average speed.

Table H-11

TYPICAL COMMERCIAL FREIGHT RATES FOR SECONDARY MATERIALS FROM PORTLAND

Material	Destination	Mode	Estimated cost, $/ton	Minimum quantity for shipping
Glass cullet	Portland area	Truck	NA	--
Shredded refuse	Portland area	Truck	NA	--
Chipped rubber	Portland area	Truck	NA	--
	Japan	Ship	NA	--
Baled steel	Portland area	Truck	5.28	20 tons
Loose steel	Portland area	Rail gondola	0.80-1.11	60 tons
	McMinnville, Oregon	Rail gondola	3.00	--
	Seattle	Rail	6.80	40 tons
	Seattle	Rail	6.40	50 tons
	Japan	Ship	22.00	--
Baled paper	Portland and 5-mile area	Truck	5.28	20 tons
	Vancouver, Washington	Truck	3.40	20 tons
	Albany, Oregon	Truck	8.20	20 tons
	Seattle	Truck	15.20	10 tons
	San Francisco	Truck	30.00	20 tons
	Vancouver, Washington	Rail	4.40	20 tons
	Albany, Oregon	Rail	4.20	35 tons
	Seattle	Rail	7.00	40 tons
	San Francisco	Rail	16.80	23 tons
	Japan	Ship	31.00-36.00	--
Waste oil	Tacoma	Tanker truck	9.70	25 tons
	Seattle	Tanker truck	11.30	25 tons
	Seattle/Tacoma	Rail tanker car	5.20	66 tons
	Portland area	Tanker truck	NA	--
Baled rags	San Francisco/Sacramento	Rail	20.40	20 tons

NA = Not available.

Source: Portland Freight Traffic Association.

Table H-12

ENERGY COSTS OF TRANSPORTATION

Mode	Ton-miles/gal.	BTU/ton-mile
Pipeline	300.0	450
Waterways	250.0	540
Railroads	200.0	680
Trucks	58.0	2,340
Airways	3.7	37,000
Passenger cars	0.5	273,000

Source: Committee on Interior and Insular Affairs, U.S. Senate, "Conservation of Energy," 1972.

APPENDIX I

Appendix I

SECONDARY MATERIALS MARKETS

FERROUS METALS

General

Ferrous metals constitute approximately 7 percent of municipal solid waste. The average household discards 0.57 pound of ferrous metals per day--most of which is tin cans.

The three major sectors of the iron and steel industry are: (1) the integrated steel companies that convert iron ore to pig iron in blast furnaces, convert pig iron into steel in steel furnaces, and process steel into intermediate steel products in rolling mills; (2) steel producers that produce steel and intermediate steel products from purchased pig iron and scrap; and (3) iron and steel foundries that produce iron and steel castings by melting pig iron and scrap iron and steel.[1] Other sectors of the industry are: (1) the mines; (2) fabricators and manufacturers that process and convert steel into products; and (3) scrap iron and steel junkmen, dealers, processors, and brokers that salvage, process, and sell both "prompt industrial" and "obsolete" (post consumer) scrap.

National Recycling

Total U.S. ferrous inputs in 1967 were 86 million tons of iron ore, 10 million tons net imports, and 29 million tons salvaged from obsolete scrap. Output was 106 million tons of product to consumers, 8 million tons of scrap export, and 11 million tons lost in processing. In addition, 64 million tons of "home" and prompt industrial scrap circulated within the system. The rate of total scrap use, including export, to total ferrous use was 52 percent.[1] The rate of obsolete scrap salvaged to the estimated "available" obsolete scrap was between 43 and 56 percent. The estimated "possible" recovery rate of obsolete scrap was from 65 to 85 percent.[1]

The American Iron and Steel Institute estimates that the annual U.S. recovery of tinplate from municipal refuse is 160,000 tons and that an addition 120,000 tons per year will be recovered by new facilities planned to start operation in 1972-1973. Some of the 28 municipalities listed as recovering ferrous metals, however, are not in reality actually recovering ferrous scrap. The scrap being recovered is primarily used as copper precipitate iron although some is reportedly used for steelmaking.

Existing Local Recycling

The following data were obtained on the total quantities of ferrous metals salvaged or processed locally. Port of Portland export statistics indicate that steel scrap exports were 212,000 tons in 1972 and 290,000 tons for the first 8 months of 1973. Local annual scrap use is estimated to vary from 100,000 to over 200,000 tons depending on economic conditions.

Estimated sources of scrap are as follows:

	Tons/yr
Shredded automobiles	50,000
Shredded appliances	1,000
Ship dismantling	120,000
Industrial scrap and shipment into area	20,000

The primary local market is the export market. It is expected that this market will be reduced by recent export restrictions. Schnitzer Industries and Zidell Inc. process the majority of the scrap steel handled in Portland and export to Japan, Korea, and Taiwan in company-owned or chartered bulk scrap ships. The scrap is melted there, fabricated into structural steel or pipe, and shipped back to the United States. The demand in Japan is reportedly so high now, however, that reinforcing steel is selling for twice what it was delivered for to the United States 2 years ago and some may be sold overseas.

A secondary local market is Oregon Steel Mill where ferrous scrap is used in their Front Avenue and Rivergate plants, Cascade Steel Rolling Mill's McMinnville plant and the numerous local foundries use the remainder. Much of the material the foundries use, however, is high grade prompt industrial scrap, such as stainless steel, some of which is shipped in from the Midwest and East.

A small quantity of tinplate from local can companies is shipped to detinners in Utah and from there to the copper mines in the Southwest.

Two of the traditional problem scrap materials--junked autos and appliances--have an adequate market at the Schnitzer Industries shredder in Northwest Portland. Car bodies bring $12 to $15 per ton and appliances bring $8 to $12 per ton stripped or approximately $3 per ton if the motors and pulleys are not stripped. Although there are some nuisance problems from abandoned automobiles and junked appliances on private property, the market for autos is generally adequate to bring junked cars in from as far away as eastern Oregon.

Materials without adequate markets are: buckets, banding, wire, tin cans, metal turnings and nonreturnable barrels.

Potential for Increased Recycling. The primary factor affecting local markets is the change in scrap use by Oregon Steel Mill. This company is switching to pelletized iron ore which is apparently easier to handle, metallurgically superior, and in today's market, cheaper than scrap. Although the company will continue to use some scrap in charging its furances, its total consumption is expected to decrease. Cascade Steel Rolling Mills in McMinnville uses scrap exclusively and has purchased some scrap from the Portland area. The company staff projects an increase in scrap use but this is not expected to offset the decreased usage by Oregon Steel Mills. Overall the use of scrap by foundries will probably remain constant.

The market for most grades of ferrous scrap were found to be relatively high. For the moment at least, the problem appears to be lack of adequate supply and excessively high scrap prices which has caused economic problems for local scrap users. Current prices for scrap are as high as $80 per ton for "number 1 prepared." The unstable market price and fluctuating availability form the basis for the steel industry's view of scrap as an undependable and undesirable input material.

There is a need to stabilize scrap markets to prevent wide fluctuations in scrap prices, for it is these fluctuations that prevent a high rate of scrap utilization except during the very highest markets. The federal restrictions on exports are intended to stabilize local scrap prices. This is at best a short term remedy, and is disruptive of existing business patterns. Apparently, the federal government's policy in the sale of surplus ships for dismantling is to stabilize scrap prices as ship sales are at the limit of local processors' capacity to dismantle. Generators of scrap metal and processors also tend to level out price fluctuations as much scrap is stockpiled during low markets and sold during high markets. Another possible means to stabilize the scrap market is to provide additional steady sources of high grade scrap. Even though this would initially displace marginal grades of scrap, it would increase use of these marginal grades over the long run by creating a larger scrap-oriented market.

The single largest untapped ferrous scrap source is the tin can and miscellaneous scrap in municipal refuse. If recovered, this would represent a significant increase in local scrap supplies and would practically eliminate waste of ferrous metals within the study area. An average of 350,000 tons of scrap processed in Portland annually would represent a 20 percent increase in supply.

As indicated in the review of current recycling projects and existing equipment and techniques for processing solid wastes, it is technically feasible to separate practically all ferrous metals from municipal refuse *if the refuse is shredded.* Although none of the ferrous separation facilities visited during this study were operating at full capacity and reliability, it is believed that an acceptable operation could be constructed with a minimum of equipment testing and investment.

The markets for municipal ferrous salvage have been limited because of the high proportion of tinplate. Tinplate has traditionally been unacceptable for steelmaking unless it is detinned. During World War II tin cans from residences were detinned but food residue and labels had to be removed by the homeowner. Markets have developed for tin cans from municipal refuse as precipitation iron in copper mines in the Southwest. Also, there is a limited market for undetinned cans in steel furnaces although a great deal of industry resistance to the use of tin cans still exists.

Literature references and initial conversations with people in the scrap metals industry and steel can manufacturers indicated that markets for municipal ferrous salvage were excellent with a projected price of $20 per ton. In answer to correspondence, however, one major detinner who had been promoting the economic benefits of can recovery quoted a price only $3.60 per ton over the minimum freight cost for shipment. Although this is probably sufficient to give an adequate return on the investment for ferrous separation equipment only, it would contribute little to the overall costs of milling. A major scrap processor who had earlier been optimistic responded--after a detailed analysis--that there was no market for salvaged municipal ferrous scrap. Although most other scrap processors expressed an interest, none were interested in further investigation until material would be available for examination.

A major effort was subsequently undertaken to find adequate markets for municipal ferrous salvage. Contacts regarding possible interest in the purchase of Portland's ferrous salvage were made with the local steel mills and foundries; Bethlehem Steel in Seattle; local scrap processors and export brokers; the trade associations of Japan, Korea, Taiwan, and Singapore; the Port of Portland; and the processors using copper precipitate tinplate. In addition, several U.S. detinners were contacted about the possible installation of a detinning facility in Portland.

Both local steel mills expressed an interest in salvaged municipal ferrous scrap for direct charging into their furnaces but were unable to make any commitment or undertake any investigation. Bethlehem Steel is committed to utilize up to 3 percent tin cans without detinning, and a representative stated that the price would probably be $20 to $25 per ton. The quantity used, however, would not be significant in relation to the scrap available from Portland. The local foundries generally use high grade scrap, and more often high alloy scrap, and could not use significant quantities of low grade scrap.

Vulcan Materials, one of the largest U.S. detinners, recently indicated an interest in discussing construction of a detinning facility in Portland. On the basis of the salvage from the study area refuse alone, there would be sufficient tinplate to support a detinning facility. Moreover, the available salvage from the major Willamette Valley communities and the many Oregon food canners would probably double this quantity.

A representative of Vulcan indicated that detinned tinplate sells for a slight premium over "number 1 heavy melting scrap", the highest grade of mild steel scrap. They were interested in a contract to purchase municipal ferrous salvage either at a price fixed a certain amount below the quoted Seattle price for number 1 heavy melting scrap, or, if a firm price and quantity commitment would be obtainable from the local steel mills, at a fixed price. Although an explicit projection of probable price received was not made, it was indicated that under current market conditions the price would be considerably higher than $20 per ton.

Potential for Increased Recycling

Construction of a local detinning facility is considered to be the optimum solution to the problem of a lack of adequate markets for municipal ferrous salvage. Such a facility not only would return the metal to its original use but also would probably result in the highest return on investment, increase local employment; stabilize local markets for ferrous scrap, and aid the local steel mill industry by providing a guaranteed supply of material at more or less guaranteed prices.

Suggested Action

- The Metropolitan Service District should continue discussions with representatives of the detinning industry regarding construction of a detinning facility in Portland.
- The Metropolitan Service District should incorporate magnetic separation equipment in all milling-transfer station designs.
- The Metropolitan Service District should select a refuse mill that will not ball or crumple tin cans in the milling process.
- The Department of Environmental Quality should discourage the use of aluminum lids on steel cans, due to the difficulty of detinning these composite containers.
- The Department of Environmental Quality should require all metal barrels to be a minimum thickness of 18 gauge to discourage the use of one-way barrels.

NONFERROUS METALS

General

Nonferrous metals constitute approximately 2 percent of the study area refuse, which is unexpectedly high in view of the small number of aluminum cans.[1] Most of the metal was aluminum and the remainder was copper, zinc, lead, tin, and the compounds bronze and brass. The exotic and precious nonferrous metals such as nickel, cobalt, chromium, gold, and silver occur only in minute quantities and then usually in combination with other materials or as alloys.

National Recycling

Nonferrous metals have a fairly high recovery rate. Precise quantities were not determined. Most recovery efforts are primarily of industrial process and fabrication waste and are not of major concern of the municipal solid waste management system. The most publicized recycling effort of nonferrous metals is the aluminum can recovery programs in a few large cities. Most of the material, however, is recovered as part of the traditional secondary materials industry's efforts.

Existing Local Recycling

One industry source estimates that from 12,000 to 18,000 tons of nonferrous metals are processed in Portland annually. An estimated 80 percent of this material is exported--primarily to Japan and Korea plus some to Europe. The rest is shipped elsewhere in the United States; very little is used locally.

An in-depth survey was not made of local nonferrous foundries but conversations with nonferrous scrap processors indicated there is little local use.

Scrap *aluminum* is resmelted in secondary smelters. Thus, although there are two nearby aluminum smelters, the nearest markets for scrap aluminum are the two secondary smelters in Seattle. Most of the aluminum salvaged is believed to be exported.

Scrap *copper* is one of the major nonferrous metals handled locally. The nearest smelter is in Tacoma, Washington. At times, however, the aluminum smelters use copper scrap when making alloy aluminum. Most of the copper salvaged is from wiring and from electrical motor windings.

The very little *zinc* that is salvaged locally goes to Torrance, California, or for export.

National Lead (Morris P. Kird & Son) in Portland was until August 1973 a major reclaimer of *lead* and processed 7,000 to 10,000 tons per year. Their primary production was battery plates which supplied two of the three major local battery companies. They also made low tin-base lead alloy, lead shot, boat keels, and sheet lead for noise and radiation insulation. Now, their only production is lead oxide. Apparently, they closed down in order to consolidate operations in Los Angeles and because of air pollution problems locally. The nearest smelter is Quemetco in Seattle. National Lead still collects lead, however, and ships it to Los Angeles for resmelting.

The nearest detinner is M & T Chemical in Seattle. This company does take some tinplate from Portland but it is entirely process waste and no municipal *tin* cans.

Although some *brass* is used by local foundries, most of it is reportedly shipped to San Francisco, Los Angeles, and Chicago, or exported.

Potential for Increased Recycling

Most recovery of nonferrous metals is from industrial waste and is done by dismantling and handpicking. The nonferrous salvage from automobile scrap shredding is sent to Oakland, California, where Schnitzer Industries has a heavy media separator. No other information was available on this operation. It appears that local recycling will continue at existing levels.

In the course of the literature review, no information was found on equipment that satisfactorily separated nonferrous metals from combined municipal refuse. At any time, however, equipment and techniques may be developed that can satisfactorily separate the nonferrous metals from municipal refuse. Until that time the nonferrous portion of refuse will be of little value and the potential for increased recycling is very low.

Although the proportion of nonferrous metals in municipal refuse is relatively high, no reasonable means was found to recover this material or to further reduce the quantity disposed. The most important factor preventing a higher rate of disposal is the Bottle Bill which effectively limits the use of aluminum cans and ensures that those used are recovered.

TEXTILE WASTE

General

The 1968 per-capita consumption of textiles was 57.4 pounds, composed of 40 percent clothing, 30 percent furnishing, 11 percent other consumer items, and 18 percent industrial use such as tire carcasses and seat upholstery. In addition, an estimated 5.3 pounds per capita of textile mill waste was used as export, in paper and board plants, or as stuffings. The fibers used in textile were 46 percent synthetics, 35 percent cotton, 4 percent wool, and 15 percent other material.[1]

National Recycling

In addition to the textile mill waste utilization, 1.6 pounds per capita of textiles were obtained from the apparel manufacturers, and from 7.8 to 18.6 pounds per capita of used clothing and furnishing textiles were collected by charitable agencies.[1] These agencies sold about 45 percent as used clothing and the remainder as rags to secondary textile dealers. The secondary textiles industry sold only about 5.3 pounds per capita and discarded the remainder as unusable. The rate of recycling, including export and reuse, of clothing and fabric furnishings discarded (or given to charitable organizations) is approximately 21 to 48 percent. The rate of recycling, excluding reuse, of all textiles was approximately 5 percent.[1]

The final disposition of textiles recycled was 28 percent wiping cloths, 44 percent paper and board, 24 percent export, and 4 percent reprocessing.[1]

Existing Local Recycling

Textiles compose approximately 2 percent of residential refuse, 1 percent of commercial refuse, and less than 1 percent of industrial refuse. This is approximately 27 pounds per capita per year. An estimated 3,000 tons per year of rags are salvaged in Portland, or an average of 6.3 pounds per capita. The apparent recycling rate is therefore 19 percent of the available waste and 11 percent of total theoretical consumption.

Portland has a large textile and apparel industry which includes three major national brands (White Stag, Jantzen, and Pendleton Woolen Mills). These firms generate a large quantity of scrap textiles, much of which is reprocessed or utilized as stuffings. Most synthetic materials, including blends with a large portion of synthetic, are discarded.

Most salvage of textiles is done by local charitable organizations. Goodwill, Salvation Army, Volunteers of America, and St. Vincent de Paul obtain most of the textiles as rejects from their clothing collections. This material is sold either to the local wiping cloth manufacturer--Pioneer Sterilized Wiping Cloth--or shipped to Seattle or California. The price paid by the wiping cloth manufacturer is from $0.02 to $0.04

per pound. The manufacturer grades the material, washes, and sterilizes it, cuts off buttons and seams and cuts to size, then packages by color and type in 25- and 50-pound cartons and sells to local industry. Much of the material is unusable, however, or of such low value that the price paid does not cover handling but is cheaper than disposal. Much of the low value material is used by Voleny Roofing Co. to manufacture roofing paper.

Potential for Increased Recycling

There is a lot of competition from disposable cloth and paper wipers, but the demand for quality wiping cloths exceeds the supply. The problem is the vast quantity of synthetic material for which no adequate markets are known to exist.

A brief survey of paper and board plants indicated that there was no local market for rags with either industry.

Suggested Action

- The Port of Portland should inventory the foreign markets for synthetic textiles.
- The Oregon State University Forest Products Laboratory should research the possibility of using synthetic textiles in particle board.
- The Department of Environmental Quality should encourage the local roofing paper mills to utilize synthetic textiles in their product.

WASTE OIL

General

The National Petroleum News magazine indicates that the 1966 U.S. petroleum refinery production was 185 billion gallons and that the products were 85.5 percent fuels, 1 percent lubricants, and 13.5 percent asphalt, waxes, or miscellaneous chemicals. The 2.06 billion gallons of lubricants were one-third industrial lubricants (hydraulic fluid, gear oil, cutting oil, etc.) and two-thirds engine (crankcase) lubricants. Average annual per-capita consumption was therefore 7 gallons of crankcase oil and 3.5 gallons of industrial lubricating oil.

Major sources of waste oils are oily ship bilge water, contaminated fuels, fuel oil sludges, and used or contaminated lubricating oil. These oils are reclaimed and burned as fuel, used as road oil, legally or illegally disposed, or--in the case of lubricating oils--re-refined and reused.

National Recycling

The Association of Petroleum Re-Refiners estimates that annual U.S. lubricating oil drainage is over 1 billion gallons (5 gallons per capita), of which only 25 percent is utilized.[3] The Association also estimates that 120 million gallons of lubricating oil is re-refined. No statistics were available on utilization of waste fuel oils.

Existing Local Recycling

Local waste oil industry people indicate that typical annual waste crankcase oil collection is 1 gallon per capita.

During the course of the study one waste oil reclaimer stated that the quantities available and markets for waste oil in Portland were "very confused." Although the quantity re-refined is believed to be reasonably accurate, it was not possible to obtain adequate statistics on collection of oil, use of oil on roads, and especially on disposal, either legal or illegal. Some organizations were very reluctant to discuss disposal or road oil utilization.

Based on federal lubricating oil excise tax receipts and state motor vehicle registrations, 1971 crankcase oil sales for highway vehicles were 10.8 million gallons for Oregon and 4.5 million gallons for the study area. A survey of Portland-based waste oil collectors indicated that their annual state-wide collections were 2.2 million gallons of crankcase and industrial lubricating oil and 1.6 million gallons of contaminated fuel oil and fuel oil sludges. Over 2 million gallons of lubricating oil are re-refined in Portland and the remainder is used as road oil in the study area and nearby national forests. Very little waste oil is burned as fuel in Portland. Much of the crankcase oil is never handled by waste oil collectors but is used by farmers and other rural property owners as road oil. Some highly contaminated oils and the sludges from the re-refineries are disposed on roads and in pits in eastern Oregon and Washington.

Waste oil collectors charge $0.05 per gallon for a minimum 50- or 100-gallon pickup of crankcase and industrial lubricating oil, and they receive $0.01 to $0.02 per gallon for delivery to the re-refinery. The re-refinery removes carbon, water, and other contaminants and sells the oil to a jobber. The jobbers make all types of industrial and automotive lubricating oil from the same base stock by blending in new oil to change viscosity and additives to improve performance, or to make different types of industrial lubricating oil. The oil is then packaged and marketed through wholesalers.

Most re-refined oil is sold under private labels or local labels within Oregon and does not have to be marked "re-refined." Although one jobber reportedly sells re-refined nondetergent oil for $0.45 a gallon (bulk purchase), only one of eight retailers contacted stated that they sold re-refined oil and it was marked at 60 percent of the cheapest new oil price. One re-refiner stated that he would do custom batch runs of 2,700 gallon minimum and that the price would be about $0.30 per gallon to re-refine and $0.20 or more per gallon for additives and blending, depending upon the requirements.

The quality problem of re-refined oil is not the quality of the re-refined base stock (which is equal to, or better than, new oil) but rather: (1) customer discrimination, (2) poor quality work by some re-refined oil blenders, and (3) an absence of performance standards for lubricating oils. The key to the problem is lack of adequate performance standards. Most lubricating oils are retailed on the basis of advertising claims, not on performance criteria. The small local re-refined oil jobber cannot compete with the major oil companies in advertising. The military services reportedly prohibit use of re-refined oil even though it can meet their specifications. Testing required by some specifications, although no problem to major oil companies, is an excessive burden on local re-refiners.

In addition to the difficulties in marketing, the re-refiners have a problem with pollution control standards. A re-refiner in Salem was forced out of business by pollution control requirements. The two remaining re-refineries in Oregon still have some problems meeting standards, especially in the disposal of the acid sludge left from cleaning the oil. This is apparently a major cost problem. One re-refinery reportedly developed a process to solidify this sludge for landfill disposal but it was not accepted by regulatory agencies.

The Port of Portland ship repair yard recently constructed a waste oil reclamation facility which is processing about 850,000 gallons per month with 2 to 30 percent oil content. The process breaks the oil-water bond with chemicals and heat. The oil is skimmed off while dirt and other particulate contaminants settle out and the clean water is discharged into the city sewers. The plant handles tanker sludge primarily but also processes ships' bilge water and pickup from oil spills. The facility was built as a result of recent federal legislation forbidding jettisoning of oily bilge water. This had caused Portland's repair yard to lose tanker repair business to Seattle and Los Angeles where oily water treatment facilities were available. The Port charges for accepting oil and sells the reclaimed oil to contractors as a road oil. The $50,000 plant can handle up to 65,000 gallons per day of waste oil and water. Although suitable as a road oil, it is apparently not suitable as a fuel since the Port does not utilize it in its own boilers.

<u>Potential for Increased Recycling</u>

During the course of the survey, several firms indicated an interest in, or even tentative plans for, a waste oil reclamation facility that would reclaim fuel oil and sludge for use either as a road oil or fuel.

Burning as a fuel is the most prevalent means of waste oil utilization in the Seattle area. It is also used in Oregon by Tri-Met, the Oregon State University heating plant, and an operation in Albany. A Portland firm makes firelogs from used crankcase oil and shredded newspapers. According to one firm, lubricating oil burns well at up to 25 percent content mixed with fuel oil. In Seattle a reclaimed fuel oil-lubricating oil mixture is sold for about 80 percent of the price of new fuel oil. Seattle fuel oil (No. 6 Grade) prices have increased from about $0.07 a gallon in April 1973 to about $0.15 a gallon in September 1973 if obtainable for barge load lots. A recent quote in Portland was $0.104 per gallon for tank car lots.

The firm reclaiming fuel oils in Seattle reports that its fuel is comparable to new fuel. The Association of Petroleum Re-Refiners states that burning lubricating oil releases over 1,000 pounds of metallic oxides to the atmosphere per 10,000 gallons burned. This represents a significant pollution potential.[3] No figures were available at either DEQ or EPA to confirm or deny these statistics, nor was any information available on possible health hazards.

Spreading contaminated fuel oil and sludges onto temporary logging roads is presently the most common means of utilization in the Portland area. This practice is expected to continue in the future. It appears to be very competitive with emulsified asphalt for temporary roads but not for permanent roads. In addition, the majority of crankcase oil drained in rural areas and much of that drained during the summer in urban areas is picked up by farmers and rural property owners and spread on privately owned roads. There are apparently no regulations on procedures for spreading road oil or on prohibited contaminants in the oil. Until such time as adverse effects are documented and regulations are set, spreading on roads should continue as a viable use of contaminated oils.

Suggested Action

- The Department of Environmental Quality should regulate the utilization of waste lubricating oil for dust control on the roads to encourage re-refining the oil.
- The Department of Environmental Quality should research the possibility of health hazards resulting from the burning of waste lubricating oil and publish guidelines or regulations as required.
- All governmental agencies and local industry should specify re-refined oil when tested comparable in quality to new oil.
- The Department of Environmental Quality should compile accurate data on waste oil sources and quantities.

GLASS

General

The COR-MET weighing program indicated that glass constitutes approximately 5 percent of municipal solid waste and that most of it came from residences.[1] The average study area household discards an estimated 3.9 pounds of glass per week versus a national average of 7.8 pounds per week.[4] Glass industry statistics indicate that U.S. glass production in 1970 was 15 percent flat glass (windows), 12 percent blown and pressed glass (ashtrays, drinking glasses, etc.), and 73 percent containers.[1] The national annual average glass container use was 250 units per capita, consisting of the following:[1]

	Percent		Percent
Food	31.5	Soft drinks	26.5
Liquor	4.8	Medical	8.5
Wine	2.6	Toiletries	4.5
Beer	20.2	Chemicals	1.4

The Northeast Portland Pilot Recycling Project indicated that the color composition of the glass collected was 60 percent clear, 23 percent green, and 17 percent brown.[4] This was before the Oregon Bottle Bill was passed, and the percentage of clear glass has greatly increased since the nonreturnable beer and soft drink bottles, which are green and amber, were eliminated.

The raw materials for glass manufacture are primarily very pure silica sand, soda ash, and limestone, plus small quantities of feldspar and other materials. In addition, some broken glass (cullet) is used to facilitate melting and improve the quality of the product. The amount of cullet can vary from about 8 percent to 100 percent and is primarily process waste or actually made for use as cullet. Cullet purchased from bottlers and recycling groups is not normally used or desired because of the slight differences in chemical composition of the purchased cullet and the possibility of contamination.

Existing Local Recycling

There are three local organizations involved in recycling glass. The Owens-Illinois Company operates a glass container plant in Portland and purchases cullet from bottlers, the general public and recycling groups. United Glass and Bottle Co. purchases gallon and half-gallon jugs and jars and washes these for sale and reuse by syrup, cider, and wine bottlers. Pharmaceutical bottles are handwashed on a contract basis by the Center Workshop for two local pharmaceutical laboratories. However, the Oregon Bottle Bill has had the only significant impact on recycling and reuse of glass by forcing each carbonated beverage bottler to use returnable bottles and forcing the public to return these bottles in order to reclaim deposits.

Industry figures indicate that Oregon soft drink sales amount to approximately 12 million cases annually. Prior to the Oregon Bottle Bill, 60 percent was in returnable glass, 25 percent was in nonreturnable glass and 15 percent was in cans. Now, essentially all is in returnable bottles. Similar figures were not obtained for beer, but beer sales in cans have dropped from 42 percent to 4 percent.

Owens-Illinois annually processes approximately 3,900 tons of cullet from individuals and recycling groups and 2,300 tons of cullet from bottlers; however, this is only a small fraction of the company's production. No estimate was available from the bottle washing operations but both are quite small.

No instance was found locally of recycling flat or pressed and blown glass. These operations do not occur in significant concentrations except for flat glass in the manufacture of buildings, trailers, and campers. Although one firm generated 3 tons per month, there probably is not enough generated in Portland to justify pooling the quantities and shipping to the nearest flat glass plant in Stockton, California.

All cullet now being used in glass-making is source-separated either at the glass plant, at bottlers', or in homes. This has been the traditional method of obtaining relatively uncontaminated glass. It is a rather limited means, however, and in the case of home separation, it is rather uneconomical in terms of energy consumption as most of the glass taken to Owens-Illinois is taken in 200- to 500-pound lots.

Owens-Illinois pays $20 a ton to individuals and recycling groups and $15 a ton to commercial accounts. In view of the excessive handling requirements and the small quantities handled in each transaction, this is probably a cost item to the firm.

Plant representatives did indicate that if the volume would warrant the investment, they would install more efficient facilities to cut costs.

Potential for Increase Recycling

There are as yet no operating facilities that satisfactorily separate and color-sort glass cullet. The primary problem is color sorting as the glass industry has traditionally insisted on both freedom from contamination and off-color glass. There are indications, however, that the color sorting requirement could be waived. Both Owens-Illinois and the Glass Container Manufacturers' Institute reportedly are testing the properties of an unseparated color glass, but no indications of the results were found during the literature review. One of the problems of using unsorted glass is a tendency to foam which causes inclusions in the glass. No industry spokesman has said, however, that making glass from unsorted cullet is not feasible.

Garrett Research and Development has developed a flotation system for removing glass from mixed solid waste. The material is very fine--too fine for use as cullet, but the company claims that it can be substituted for raw materials although the glass manufacturers do not agree. The Garrett estimate is that glass can be removed and concentrated for approximately $4 a ton. As yet, however, there is no market for this material.

Color sorting of glass is the key to mechanical recovery and sale to the traditional glass cullet market. Sortex of North America, Ltd. is developing an optical sorting procedure.

Northwestern Glass in Seattle reportedly has developed a simple mechanical system for crushing glass containers and removing the aluminum closures by bouncing the crushed material. This type of system could facilitate source separation by not requiring hand removal of aluminum closure rings.

Discussion with Owens-Illinois personnel indicated that the probable market price for larger quantities of glass salvaged from municipal refuse would be $12 to $16 per ton depending on the degree of segregation. The color segregation requirement is the most difficult although Northwestern Glass can use amber cullet with as much as 4 to 6 percent green cullet contamination.

A major bottler indicated that returnable bottles are vastly more economical than nonreturnable bottles. This firm even buys back nonreturnable bottles at the distributor for $0.50 per case and gives the distributor $0.13 per case for handling. They can wash a case for about $0.21 and save $0.08 a case over buying new bottles. They bottle in excess of 1 million bottles per week and this operation is not representative. Local wholesalers of glass containers indicate that gallon jugs sell for $0.30 to $0.40 each in lots of 3,600, and quart jars sell for approximately $0.11 to $0.14 each. This compares to the value of $0.03 for gallon jugs and approximately $0.01 for quart jars as cullet. The value as a container therefore is vastly greater than the value as cullet. A detailed economic analysis was not made but discussions with equipment manufacturers indicate that it should be possible to handle and wash quart bottles for less than $0.05 each.

Inquiry was made of the manufacturers of bottle washing machines. One firm, Niagara Bottle Washer Manufacturing Company, specializes in flexible machines that can wash any size container from 4-ounce bottles to 5-gallon jugs. It is believed that one of this company's machines or a similar machine, would be ideal for contract washing for industry. Such a facility could be owned either by private industry or a certified sheltered workshop and should yield an adequate return on investment both washing on contract and purchasing, washing, and selling certain standard glass containers.

A brief analysis was made on the available market. Although soft drink and beer bottlers have their own bottling facilities, few other bottlers do. Oregon has a large cider industry which primarily packs in gallon jugs. United Glass and Bottle now serves this industry, but it is believed that much of the market is not now served. In addition, Portland is a major food packing center, and many firms pack in glass containers. It is also believed that some of these firms would purchase standardized recycled containers and that the local public would purchase these products by preference and recycle the containers as containers. This same washer can also wash molds, totes, and pans from meat packing houses; laboratory test bottles and vials; pharmaceutical bottles; electronics industry glass products, and, of course, all types of food containers.

The cost of an automatic bottle washer would be in the range of $15,000, and accessory equipment would cost an equal amount depending on the desire to cut labor costs.

The Oregon wine industry presents another possible market. It is estimated that the typical small vineyard purchases from 40,000 to 60,000 bottles per year. There are problems in such a program, the primary ones being collection and handling of bulky containers and the lack of standardization by the packing industry.

No health problem is presented by reused bottles, according to the Oregon Public Health Service. Occasionally, washing does not remove all foreign material and there are customer complaints, but this is reported to be very infrequent. Glass does not absorb chemicals but plastics do, and any line that washes used plastic containers has a hydrocarbon sniffer to detect and reject any containers with traces of hydrocarbon, such as petroleum or pesticides.

A great deal of publicity has accompanied efforts to find additional markets for glass, the most well known being glasphalt. Glasphalt was tried locally but without success; the glass worked its way up to the surface of the pavement. It is believed that the costs of recoverying glass would not justify its use as a substitute for gravel until gravel became far more expensive. Other proposals, such as foam glass blocks, reflective signs, or glass wool, either are not well developed or have limited markets. The glass wool process has reportedly been developed in Poland and may eventually provide a good use for unsorted waste glass.

No attempt was made to analyze the success of the Oregon Bottle Bill. On the basis of a comparison of local glass disposal with the national average, there has apparently been a significant decrease in the disposal of glass. Also, according to the paper by Bruce Hanson of the University of Illinois, a returnable bottle uses approximately one-fourth of the energy of a nonreturnable bottle. The only negative aspect appears to be a great decrease in business for container manufacturers, especially can manufacturers. According to Bruce Hanson's report, however, the jobs lost in these industries should be compensated for by increased employment at the retail and wholesale beverage distribution level.

There have been some problems. The returnable beer bottle is about 10 percent heavier than the nonreturnable, and the returnable soft drink container is approximately twice as heavy as the nonreturnable. This does create some difficulties when beverages are shipped long distances. The other problem is increased handling by retailers.

On the basis of both energy and dollar cost, it appears that returnable glass containers are much cheaper than nonreturnable containers. Beer and soft drink containers (covered under the Oregon Bottle Bill) make up approximately 46.7 percent of all glass use. The only other major use is for food containers. Although food industry containers could never be made returnable because of the great diversity of products, it should be possible to establish some standard sizes and to promote the use of these sizes by industry and the salvage of these containers by the public. No analysis of the dollar and energy costs of recoverying these containers was made. It is noted that these containers and newspapers, along with the returnable beverage bottles, could be taken to central depots or collected periodically. Such a program could concentrate on just a few sizes and shapes and probably could obtain enough containers to support a moderate-sized contract bottle washer.

Suggested Action

- Local industries generating flat glass cullet should assess the possibility of pooling quantities of flat glass cullet for shipment to the nearest reuser in Stockton, California.
- The glass container industry and the local Owens-Illinois plant should continue their efforts to utilize unsorted cullet in glassmaking.

- The Oregon Winegrowers Association should adopt a minimum number of standard bottle sizes to facilitate salvage and reuse.
- The Oregon food processing industry should adopt a standard one-quart size to facilitate salvage and reuse.
- The Department of Environmental Quality should support the continuation of the "Oregon Bottle Bill" as an effective solid waste management measure.
- The Metropolitan Service District should encourage both private industry and local sheltered workshops to do a detailed economic analysis of a bottle washing facility for washing containers on a contract basis for industry and for local recycling groups.

RUBBER

National Recycling

Rubber constitutes approximately 1 percent of municipal solid wastes.[1] Most rubber is synthetic--a byproduct of petroleum processing--and although the energy consumption in rubber and tire manufacture was not examined, it is not expected to be significant. The disposal of rubber tires is, however, a major problem.

U.S. rubber consumption in 1969 was 3.94 million tons, of which 67 percent was in vehicle tires. During that year 179,800 tons of tires and industrial rubber scrap were reclaimed, 752,000 tons of tires were recapped, and 7,000 tons of tires were split for gaskets, mats, and tire boots for an overall recycling rate of 26 percent.[1]

Existing Local Recycling

Because of the low value of rubber scrap and the distance to domestic rubber reclaimers, rubber is not reclaimed from the Portland area. Portland is, however, a major retreading center with tires being brought in from all over the Northwest.

Data on existing reuse of tires in the Portland area in 1972 are as follows:

Tires retreaded	
Passenger vehicle	800,000 tires
Truck	120,000 tires
Earthmover	20,000 tires
Other reuse	
Mats	9 tons
Floats	10 tons
Miscellaneous (dunnage, boat and dock bumpers, riprap, etc.)	Unknown

Nevertheless, it is estimated that a total of 22,000 tons of tires are disposed of in the Portland area each year, as follows:

Passenger vehicle tires	1,400,000
Truck tires	120,000
Earthmover tires	2,400

There are 20 tire retreaders in the Portland area. They vary in size from firms retreading close to a quarter of a million tires a year to small operations handling only a few thousand. Some sell their own brand and others only wholesale.

The salvage rate of retreadable tires is probably close to 100 percent for the local area. Many tires are not retreadable, however, because of damage from abuse, excess tread wear, or accidental damage. Damage to earthmover tires and to truck tires can often be repaired because the value of the carcass is high, but passenger tires are generally not economical to repair.

Local retreaders estimate that approximately 20 to 30 percent of all passenger vehicle tires, 50 to 60 percent of all truck tires, and 80 to 90 percent of all earthmover tires are retreaded. Automobile tires are normally retreaded only once. Truck tires are normally retreaded once and sometimes as often as four times. Earthmover tires are retreaded as often as five times depending on conditions of use.

The retreading situation is changing and some decrease has been experienced. One major firm is reported to be closing, but this will not affect the local salvage rate. Shortages of retreadable carcasses have occured because of (1) changes in tire sizes on new cars from 14 to 15 inches, (2) new types of tires, such as bias and radial, which require different retreading equipment, and (3) new federal regulations. These regulations, which require additional recordkeeping and specifically prohibit use of second grade carcasses, should increase customer confidence in retreads and improve the market situation.

U.S. General Accounting Office statistics indicate that 90 percent of all tire carcass damage occurs in the last 1/16-inch of tread wear.[5] The military services have instituted programs of regular inspection for minor repairable damage and excess tire wear that should increase the retreading rate from 48 percent in 1969 to 75 percent.[5]

Splitting of passenger tires for door mats, boat deck mats, industrial mats, and horse trailer mats is done by two small firms. Total tire consumption is approximately 90 tons per year and is not expected to increase significantly. In a recent investment feasibility analysis, it was found that this market was insufficient for a proposed expanded operation. It is possible, however, that a more modest investment in better production facilities and a properly financed but low-key selling effort could result in significantly greater sales and adequate return on investment. There was a small firm in Portland that made tire boots from old tires, but the owner died and the equipment was sold. The nearest such firm is reportedly in Eugene.

A local Portland firm has developed a machine that chips tires into small square chips. The firm has three machines in production and reportedly is considering acquisition of a grinder that can process the chips into a finely ground material. The chip now produced is a bulk commodity, easily handled, and of sufficient density (55 pounds per cubic foot) for shipping at reasonable rates. One possible immediate use for this product is export to Asian or South American reclaimers who might economically utilize reclaimed rubber because of their lower labor rates and higher demand for lower grade rubber products. Other possible uses are as a mulch (not locally in view of the low cost of bark chips) or as a fuel if the pollution problem can be resolved. The ultimate use would be for subsequent grinding and reclaiming or use as rubber-asphalt paving (see following discussion, "Potential for Increased Recycling").

A contractor in Centralia, Washington, uses waste tires for riprap. The cost is approximately the same as for regular riprap at $10 per square yard, but with trees planted in the center of each tire and all tires tied together, held down by rebars, and filled with soil, the results apparently are aesthetically superior to rock.[2]

A firm in Vancouver, Washington, is making floats for houseboats and small marinas from old tires filled with polystrene. Although more expensive than traditional floats, they apparently have long life and are very satisfactory.

Potential for Increased Recycling

A minimum legal tire tread depth of 1/16-inch is required in most states as a safety measure. It would appear that a similar statute and enforcement in Oregon would have a significant effect on the salvage of tire carcasses for retreading. The best means of preventing tire damage, however, is concern on the part of each car owner.

Tire dealers should help in public education by stressing good tire care and the importance of turning in a retreadable tire carcass when purchasing tires. The cost of disposal of a nonretreadable carcass and the market value of a retreadable carcass should be passed on to the consumer if possible.

Tire retreaders should publicize their tire warranties and the general price advantage of retreads over new tires. In order to build market demand for retreaded tires, the public should be educated as to the quality of retreads and to the fact that some retreaders will even custom retread a customer's worn tires and return his own carcass with a new tread.

Conventional reclaiming of rubber does not appear economically feasible for Portland. Reclaimed rubber is not equivalent to virgin rubber, local markets for reclaimed rubber do not exist, shipping rates to other markets would be prohibitive, and existing rubber reclaiming operations are increasingly uneconomical.

Reclaimed rubber is generally inferior in quality to virgin rubber and inferior in aesthetics to plastics. Changing requirements in major reclaimed rubber uses--such as tire sidewalls requiring more flexure for the lower pressure, wide oval designs and tubeless tires instead of inner tubes--have reduced markets.[6] Although reclaimed rubber is traditionally cheaper than virgin rubber ($0.11 per pound versus $0.20 to $0.30 per pound), new low-priced synthetic butyl rubbers and low-priced plastics have greatly reduced this advantage. The use of colorful plastic has also reduced markets for such consumer items as floor mats.[6] The only advantage of reclaimed rubber over virgin rubber is better extruding qualities, and this is largely negated by low abrasion and heat resistance.

A survey of local industrial rubber users indicated that the important manufacturers could not use reclaimed rubber as their products are primarily for dam gates, precision rollers in the lumber industry, or printing and have very strict quality standards effectively excluding the use of reclaimed rubber. The local shoe industry is very small and could not support much rubber use in heels.

The possibility of tying tires together and forming an ocean reef is expected to be limited as apparently there is already sufficient fish cover off the coast. This is not the case in Florida and on the East Coast where such practices are prevalent. During the Vietnam war a large number of earthmover tires were utilized as boat bumpers for landing craft, but this use has halted. Use by tugs, barges, recreation boats, and docks is rather limited. Some tires are used as playground equipment and there is a paint that apparently will prevent the carbon black from coming off onto clothes and hands. The use of tires has been investigated for highway safety barriers and some tests have reportedly been conducted in Texas. Several other possible methods for use of old tires have been proposed, including one to make fence posts by means of a chemical-physical process.

Reclaiming of rubber is generally becoming uneconomical. As of 1971, only 20 rubber reclaimers were operating in the U.S., and several of these have since closed down leaving no reclaimers west of the Mississippi.[6] Conversations with shipping firms indicate that old rubber tires--once used for dunnage in export to Japan--are no longer being used as no outlet now exists for them there. There is a report of a reclaiming operation in England purchasing from the East Coast, but the veracity and reason for this was not investigated.

Although recommended improvements in current recycling operations can significantly increase retreading and alternative uses of tires, the only immediate possibility of major reduction in tire disposal is to find export markets for tires to be reclaimed overseas. English reclaimers are reportedly paying $20 per ton f.o.b. East Coast, but preliminary indications are that a similar Asian or Latin American market does not exist. The Port of Portland and other international trade organizations have made some preliminary investigations of possible markets and should be encouraged to continue their efforts as long as there is any possibility of market development.

The most promising solution to the tire disposal problem is the development of rubber--asphalt pavement. Major efforts to utilize rubber in roadbeds have been made over the last 130 years, particularly in Europe and England in the 1930's.[6] Previous projects (such as the one by Marion County) have generally been limited to about 5 percent rubber used as an aggregate, but recent developments (primarily made in Phoenix, Arizona) have utilized 25 percent finely ground rubber and 75 percent 85/100 penetration grade asphalt and utilized it as a hot-mix seal coat. It apparently is very successful and an economical alternative to conventional asphalt overlay when failure of existing paving and restricted overlay depth (due to curbs and gutters) otherwise requires removal and repaving. It also offers advantages for bridge decks, reservoir lining, and other applications requiring flexibility, impermeability, or resistance to weathering extremes.

Contacts with individuals in the paving industry and in federal, state, and local highway departments indicate considerable interest in the technique although no local organization has funded a demonstration project. A great amount of literature and information has been accumulated during the course of this market analysis, including an implementation package from the Federal Highway Administration. MSD should use its authority to encourage other governmental agencies to investigate the technique. Although there are some complications from licensing requirements of the patented process, this is common for new construction techniques and not an insurmountable problem. All possible efforts should be made by every agency concerned to promote demonstration projects and subsequent implementation of the technique. If feasible, the possibility of a rubber-asphalt lining for a landfill to prevent leachate from entering the water table should be investigated.

Improved reclaiming techniques or conversion by pyrolysis or other methods offer long-term possibilities, but these are ventures best undertaken by the rubber industry or the federal government.

Suggested Action

- The Department of Environmental Quality and the Metropolitan Service District should investigate the feasibility for and test the use of rubber asphalt pavements as an impermeable liner for landfills where leachate collection is necessary to prevent groundwater contamination.

- All governmental agencies and private industry should purchase retreaded tires in lieu of new tires.

- The Department of Environmental Quality should initiate and support legislation restricting the minimum tire tread depth to 1/16 of an inch on all vehicles on state highways.

- The Oregon State Highway Division should research current literature and conduct demonstration tests of rubber asphalt pavements. Rubber asphalt pavements should then be specified for State Highway projects whenever deemed suitable.

- The Metropolitan Service District should keep abreast of current research by the U.S. Environmental Protection Agency and rubber industry on destructive distillation of waste tires.

- Local tire retreaders should investigate the possibility of selling quantities of buffing dust to midwestern rubber reclaimers.

WOOD WASTE

General

Wood wastes occur in many different forms and widely varying locations. The major form of importance to the solid waste management system is sawmill and plywood mill residue. Process waste from secondary wood manufacturing industries, such as furniture and homebuilding, is the second major source of wood waste. Post-consumer waste, although comprising between 1 and 5 percent of municipal refuse, does not occur in significant concentrations except for wooden pallets in some industrial and commercial refuse loads. Logging residue occurs in large quantities and is of importance as a possible substitute for waste paper and mill residue in paper and particle board manufacture, but it is not the responsibility of the solid waste management system.

Present Local Recycling

The markets for logging residue, mill residue, secondary wood manufacturing waste, waste paper, and the combustible portion of refuse are all interrelated because of their ability to be substituted for either fiber or fuel. An attempt was made to determine the availability of wood wastes and trends in utilization in the study area. Reliable statistics were not available, however, and it was necessary to make rough approximations based on historical, industry wide data and limited surveys of incineration capacity and landfill quantities. The results were tabulated as follows:

Form of Residue	Estimated quantity, tons	Disposition
Logging residue	300,000	Left in forest
Mill residue	60,000	Incinerated in wigwam burners
Mill residue and secondary manufacturing	30,000	Public landfills
Mill residue	Unknown	Stockpiled and private landfill
Post-consumer waste	10,000-50,000	Mixed with refuse and public landfill

Although statistics are available on utilization of mill residue in Western Oregon, the most recent data are from 1968 and are considered to be obsolete. From extensive discussions with all sections of the forest products industry, it was tentatively concluded that wood waste utilization in the area will approach 100 percent within the next few years. Much of this utilization is as an alternative to disposal and is not profitable to the generating organization. It was impossible to obtain statistics to verify the hypothesis of an expanding market for shredded municipal refuse in place of wood waste. It conflicts with most projections of wood waste utilization which indicate that the generation of wood wastes is expected to exceed demand through 1985.[7]

The generation, recovery, and utilization of wood wastes appear to be primarily the responsibility of the forest products industry. However, the full utilization of wood wastes not only will reduce present landfill requirements but also will radically affect the markets for waste paper and the combustible fraction of municipal refuse.

Historically in the Northwest, the supply of wood residue from mills has been a function of lumber and plywood production which is directly tied to new building construction. The demand for wood chip residue has been tied primarily to paper demand and only secondarily to particle board demand.

Markets have changed during the last few years. In the Albany area mill residue utilization was reported to be 96 percent in 1971 and is presumably even higher now.[8] The quantities of mill residues have remained unchanged in Western Oregon and little change is expected during the next 25 years, according to a 1965 Pacific Power and Light report.[8] Logging residue, however, is decreasing at approximately 1 percent per year.

An interim report recently published by the Pacific Northwest Forest and Range Experiment Station indicated that full utilization of logging residue was not feasible with current harvesting equipment and methods.

Chippable material is chipped and used for paper pulp. Recently, the paper mills have been able to use fine residue such as sawdust. The nearest markets for pulp chips are in Oregon City, West Linn, and St. Helens as well as in Camas and Vancouver, Washington. Export of pulp chips has also become a large item. There is no marketing problem; the problem is that only large barkable logs can be chipped. The minimum chipping length for the Utilizer, a mobile chipper, is 12 feet. The development of debarking machines that can handle smaller logs and the use of mobile debarkers-chippers in the forest, such as the Utilizer Model 3, will increase the utilization of wood waste as chips.

Roofing mills use sander dust in the manufacture of felt, but this market is small and not likely to expand.

There are two local composition board plants in the study area--Stimson's hardboard plant in Forest Grove and the Kaiser Gypsum insulating board plant in St. Helens. There have been reports of the construction of a medium-density board plant in the local area.

In 1967, 12 percent of the wood wastes and 47 percent of the bark waste was burned.[2] Before the institution of air pollution controls, hog fuel sold for approximately the cost of its transportation. With pollution control, utilization dropped as many older hog fuel boilers as were phased out. Now, new hog fuel boilers are being constructed as a result of the increased costs and unavailability of conventional fuels. There are ready markets for hog fuel, however, which vary from approximately \$2 per ton to \$5 per ton. Some mills are experiencing a shortage of hog fuel and are paying premium prices. Others are using hog fuel that could be used in composition board if other fuel were available.

Potential for Increased Recycling

The real problem markets have been for bark and yard cleanup material. Bark has developed markets as a horticultural item and Publisher's Dwyer Division now bags and ships barkdust throughout the United States. Yard cleanup material is still a problem and little is utilized. Stimson is reportedly burning some in hog fuel boilers and is developing screening methods to remove most of the dirt and rocks. The viability of markets is a function of distance for transporting. Wood waste near a potential market can be sold for a profit, while that at distant locations often cannot economically be trucked to the buyer but is stockpiled or landfilled nearby. Utilization of secondary manufacturing residue has always been somewhat less than utilization of mill residue. Utilization is increasing however especially as a fuel in urban areas.

Bohemia Lumber has recently constructed a bark utilization plant near Medford that will extract essential oils from Douglas Fir bark and use the fiber in a low density board. If successful, this will radically change markets for bark.

Doctor Poo Chow of the University of Illinois has developed composition boards based on a variety of vegetable fibers. His process uses waste liquors from a semichemical pulping process to bond the fibers together. This has very high long term possibilities. An attempt is being made at Oregon State University to construct a high strength composition board with the strength of plywood. If successful, this would dramatically change the markets for wood wastes of all types.

Sale of bark dust has traditionally covered the cost of handling. Other than hog fuel, the traditional use of bark dust, especially in Portland, has been as a soil amender, mulch, or decorative cover. It is also used for weed and erosion control. Recently, some contractors have been using bark dust for erosion control on highway cuts. Publisher's Dwyer Division has built a new plant for bark and is shipping packaged and bulk bark dust throughout the United States. The price varies from approximately $21 per unit (200 cubic feet) for fine material to $36 per unit for coarse, decorative material. Rotted sawdust also is used as a soil amender and sells for approximately $5 per cubic yard.

Other markets include poultry and animal bedding for shavings, clean sawdust, and firewood. Traditionally, most sawmills and some logging companies have given firewood away free to the public. This practice may have been discontinued recently as a result of the high cost of fuel.

<u>Suggested Action</u>

- The Department of Environmental Quality should maintain an inventory of the existing sources and quantities of wood wastes in the local area.
- The Department of Environmental Quality should establish disposal regulations that encourage reuse of wood waste rather than disposal.
- The Pacific Northwest Forest and Range Experiment Station should test equipment and methods for removing dirt and rocks from lumber yard cleanup material and make the findings available to the forest products industry.

WASTE PAPER

General

Paper makes up 55 percent by weight and 62 percent by volume of all residential and commercial wastes from the study area. The typical local household discards approximately 29 pounds of paper per week. Because it is the largest constituent of solid waste and because of its high potential value if recovered, a great deal of time was expended during this study examining markets for paper and paper products. The complexities involved, however, made it impossible to provide a comprehensive overview of the local markets for paper. The markets are well developed and not in need of much stimulation. The solid waste management system cannot obtain significant quantities of waste paper--except for corrugated paper--because recovery from mixed municipal refuse is not feasible. Only a brief summary of each market is presented here.

Because of the substitutability of paper stock for wood residue, and vice versa, in both paper and board manufacture and in energy and material conversion, markets for both materials were examined concurrently. Paper and other forest products are an essential part of the local economy, and conditions are diverse and rapidly changing. One trend is obvious, however, an extremely high demand currently exists for paper fiber. The outlook at least here and now, is not as unpromising as indicated in the national literature. In waste paper markets, as in most other secondary materials markets, local effects predominate almost to the exclusion of national problems and trends. Thus, an approach based on general, national conditions, such as that pursued by NCRR or many of the firms promoting a proprietory recycling concept, is not generally applicable to the study area.

Present Local Recycling

Some 52 percent of paper production is of the lighter, thinner, and more flexible types, 41 percent is paperboard, and the remaining 7 percent is construction paper and paperboard such as roofing felt.[1] Most paper is used and discarded within 1 year. Approximately 45 percent is used for packaging, 36 percent for communications paper, 6 percent for tissue, and 8 percent for construction grades.

The four grades of waste paper are: (1) mixed, (2) newspaper, (3) corrugated, and (4) fine grade. When collected, it is called waste paper but after sorting, grading, and baling by dealers, it is referred to as paper stock. The primary sources of waste paper are residential, commercial, and industrial refuse, plus conversion waste. Residential waste paper composes 17 percent of all paper stock supplies and is almost exclusively newspaper. Commercial and industrial waste paper is either corrugated or fine grade from old files and composes approximately 43 percent of waste paper supplies. Salvage from converters, which consists of trim and cuttings from conversion of paper into paper products, composes approximately 40 percent of wastepaper supplies and is both fine grade and corrugated.

It was not possible to obtain the precise quantity of material salvaged locally or the local rate of recycling for most types of paper. On the basis of a telephone survey, the following estimate was made of the quantities handled by local brokers:

	Tons Per Month
Newspaper	2,500
Corrugated	3,300
Fine grade	3,000
Mixed grade	800

Potential for Increased Recycling

Adequate recovery is the basic impediment to increased utilization of waste paper. The only significant recovery of waste paper is by source segregation. The National Committee for Paper Stock Conservation promotes source separation as essential to ensure an adequate supply of contaminant-free material.[10] This is true with current technology as there is yet no satisfactory process to recover high grades of paper mechanically from mixed municipal refuse. Although the Black Clawson paper has been processed into a satisfactory fine grade paper by St. Regis Paper, the Black Clawson Product is a low grade paper suitable only for roofing felt.

Source separation projects are numerous. Many service clubs and charitable organizations collect newspapers or maintain depots for dropoffs. Grocery stores and some department stores use small balers or banding machines to bale corrugated paper for sale to dealers. Separation of office waste has been tried by several firms, including the U.S. National Bank, Bank of America in California, Boeing, the State of Washington, and Oregon State University. Generally, these projects have been unsuccessful and the only viable salvage has been of computer printout, cards, and obsolete files.

Markets for waste paper have traditionally been very unstable, especially for newspaper which is very dependent upon export markets. One major U.S. processor, Garden State Paper Company, has had a stabilizing effect on the newspaper markets, and increased domestic use of other grades will tend to stabilize markets for these trades also. The current high market price has caused difficulties, as scavenging of corrugated paper from drop boxes has become a serious problem for the collectors, and the high price for raw materials have caused problems for companies using waste paper.

De-inking and reuse as newsprint is the major market for newspaper waste. Garden State Paper Company is the only firm in the United States with newspaper de-inking facilities. The company has plants in New Jersey, Illinois, Texas, and California. After an initial inquiry, company spokesmen stated that insufficient paper was generated in the Portland area to justify a de-inking and papermaking plant. An inquiry was then made as to the possibility of de-inking alone as a supplementary supply for Publisher's Paper in Oregon City, but that was apparently infeasible. Next, an attempt was made to investigate the possibility of a supplementary de-inking facility at Crown Zellerbach in West Linn which uses logs instead of wood residue. This also was apparently infeasible. Finally, Portland is probably the most unfavorable city in the United States for Garden State to locate because of competition from a strong overseas market. Thus, although Garden State does buy some paper from Portland, the company plans to trade this for local material to avoid shipping costs to Los Angeles.

Shredding of newspaper for alternate uses has always been a steady market. It is used by chrome platers, delicate parts manufacturers for wrapping, packers, poultry farmers, dog track operators, and flower vendors. This material is also used for worm bedding.

Boise Cascade operates a mill in Vancouver that makes fine grade paper and uses approximately 35 percent waste paper. Much of this, however, is process waste. Many sulfate mills in Oregon have installed supplementary facilities for old corrugated boxes.

Export is the largest market for most grades of paper, especially newspaper. This market is expected to expand in future years.

The local roofing felt companies have always used newspaper and corrugated boxes. Now, however, they are experimenting with mixed paper waste and synthetic blends of orgs because of the high cost of high quality paper stock.

Tuf Board is a composition board made with very short fiber material held together by resins, and could provide a very strong market for low grades of waste paper when it is available.

Suggested Action

- The Metropolitan Service District should continue support of the newspaper collection pilot project recommended in the COR-MET Interim Report of June 1973.
- The paper products industry should develop industry-wide standards for glues and waterproofing compounds that will facilitate recycling. All containers should then be clearly marked as either repulpable or non-repulpable.
- Local roofing felt companies should consider increased use of low-grade papers in their product.
- All governmental agencies should require a maximum amount of recycled paper to be used in each office.
- Local janitorial services should examine the economics of salvaging waste paper from offices.

APPENDIX J

Appendix J

UNIT HAUL COSTS

This appendix contains additional discussion of the criteria used to estimate the direct haul costs (in collection vehicles) that were presented in Chapter 13, Volume I. Computer printouts for collection and haul combined are reproduced herein for selected collection vehicles at varying traveling speeds and distances.

REPRESENTATIVE COLLECTION VEHICLE TYPES

General

An analysis of the many types and sizes of collection vehicles used throughout the study area shows that these vehicles can be grouped into seven representative types and sizes. Because both rear loaders and side loaders are generally operated by two-man crews and equipment prices for each are approximately equal, these two types were considered equivalent for the cost analysis. It was found from the weighing program that the most representative sizes of rear and side loaders were as follows: 16 cubic yards for rural service in Clackamas and Columbia counties; 20 cubic yards for rural service in Multnomah and Washington counties as well as for urban service in Clackamas, Columbia, and Multnomah counties; and 24 cubic yards for urban service in Washington County. Front loaders are the type of collection vehicle least commonly used in the study area. Capacities of front loading vehicles generally range from 20 to 32 cubic yards, and an average size of 24 cubic yards was selected for use in the analysis. While drop box capacities range from 20 to 40 cubic yards, at least half of those used in the study area are 20 cubic yards in size, and the remainder average 35 cubic yards in size. Compaction drop boxes were found to compose an insignificant percentage of the total waste collected in drop boxes and were not represented in the analysis. A summary of the vehicle types and sizes and other characteristics assumed in the analysis is presented in Table J-1.

The computer transportation model was then used to approximate collection and haul costs for each representative vehicle type. Input to the computer model included estimated capital costs for vehicles, containers, and drop boxes; labor costs, including fringe benefits and overhead; and vehicle operating costs. Other factors which were considered in deriving the unit costs were (1) the refuse density in containers, drop boxes, and vehicles and (2) the time factors for vehicle unloading, vehicle washing, and traffic delays. The computer transportation model printout tabulations of costs per ton for each of the vehicle types are presented in Tables J-2 through J-8.

Vehicle Characteristics

Once the types and sizes of representative vehicles had been selected, it was necessary to develop data relating to each type for use in the computer collection model. One of the more important relationships to be developed was that of loose refuse density to collection vehicle rated compaction. On the basis of the number of cans per household and the refuse generation per-capita rate, the loose refuse density (defined as density of refuse in its storage container) was determined to be 225 pounds per cubic yard. Since the composite averages of compactor trucks showed compacted density to be about 510 pounds per cubic yard, the average rated compaction was determined to be 2.3 to 1. Volume utilization of all vehicles (defined as the percent actual volume of rated capacity) was assumed to be 90 percent for all types of vehicles.

Table J-1

REPRESENTATIVE VEHICLE TYPES AND SIZES FOR COMPOSITE COLLECTION SYSTEMS

Vehicle type	Vehicle or drop box capacity, cy	Type of area served	Typical container size collected	Average number of containers collected per stop	Average loading time per stop, minutes
Rear or side loader	16	Rural	32 gal.	1.3	2.5
Rear or side loader	20	Rural	32 gal.	1.3	2.5
Rear or side loader	20	Urban	32 gal.	3.0	3.5
Rear or side loader	24	Urban	32 gal.	3.0	3.5
Front loader	24	Commercial or industrial	4 cy	1.0	10.0
Drop box truck	20	Commercial or industrial	20 cy	1.0	10.0
Drop box truck	35	Commercial or industrial	35 cy	1.0	10.0

Table J-2

UNIT COLLECTION AND HAUL COSTS, 16-CUBIC-YARD REAR OR SIDE LOADER RURAL SERVICE (Dollars per Ton)

HAUL SPEED	ONE WAY HAUL DISTANCE	1	4	7	10	13	16	19	22	25	28	31	34	37	40	43
15. MPH	UNIT CAP. COST	4.23	4.46	4.69	4.92	5.15	5.39	5.62	5.85	6.08	6.31	6.55	6.78	7.01	7.24	7.47
	UNIT O&M COST	29.59	31.56	33.53	35.50	37.47	39.44	41.41	43.38	45.35	47.32	49.29	51.26	53.23	55.20	57.17
	TOT. UNIT COST	33.81	36.02	38.22	40.42	42.62	44.82	47.03	49.23	51.43	53.63	55.84	58.04	60.24	62.44	64.64
20. MPH	UNIT CAP. COST	4.21	4.38	4.55	4.73	4.90	5.08	5.25	5.42	5.60	5.77	5.95	6.12	6.29	6.47	6.64
	UNIT O&M COST	29.45	31.02	32.58	34.15	35.72	37.28	38.85	40.41	41.98	43.54	45.11	46.68	48.24	49.81	51.37
	TOT. UNIT COST	33.66	35.40	37.14	38.88	40.62	42.36	44.10	45.84	47.58	49.32	51.06	52.80	54.54	56.28	58.02
25. MPH	UNIT CAP. COST	4.19	4.33	4.47	4.61	4.75	4.89	5.03	5.17	5.31	5.45	5.59	5.73	5.86	6.00	6.14
	UNIT O&M COST	29.37	30.70	32.02	33.34	34.66	35.99	37.31	38.63	39.96	41.28	42.60	43.93	45.25	46.57	47.89
	TOT. UNIT COST	33.57	35.03	36.49	37.95	39.42	40.88	42.34	43.80	45.26	46.73	48.19	49.65	51.11	52.58	54.04
30. MPH	UNIT CAP. COST	4.19	4.30	4.42	4.53	4.65	4.77	4.88	5.00	5.11	5.23	5.35	5.46	5.58	5.69	5.81
	UNIT O&M COST	29.32	30.48	31.64	32.80	33.96	35.12	36.29	37.45	38.61	39.77	40.93	42.09	43.25	44.41	45.58
	TOT. UNIT COST	33.50	34.78	36.06	37.34	38.61	39.89	41.17	42.45	43.72	45.00	46.28	47.55	48.83	50.11	51.39
35. MPH	UNIT CAP. COST	4.18	4.28	4.38	4.48	4.58	4.68	4.78	4.88	4.98	5.08	5.18	5.27	5.37	5.47	5.57
	UNIT O&M COST	29.28	30.33	31.37	32.42	33.46	34.51	35.55	36.60	37.64	38.69	39.74	40.78	41.83	42.87	43.92
	TOT. UNIT COST	33.46	34.61	35.75	36.90	38.04	39.19	40.33	41.48	42.62	43.77	44.91	46.06	47.20	46.55	49.49
40. MPH	UNIT CAP. COST	4.18	4.26	4.35	4.44	4.52	4.61	4.70	4.79	4.87	4.96	5.05	5.13	5.22	5.31	5.39
	UNIT O&M COST	29.25	30.21	31.17	32.13	33.09	34.05	35.00	35.96	36.92	37.88	38.84	39.80	40.76	41.72	42.68
	TOT. UNIT COST	33.43	34.47	35.52	36.57	37.61	38.66	39.70	40.75	41.80	42.84	43.89	44.93	45.98	47.03	48.07
45. MPH	UNIT CAP. COST	4.17	4.25	4.33	4.41	4.48	4.56	4.64	4.72	4.79	4.87	4.95	5.02	5.10	5.18	5.26
	UNIT O&M COST	29.23	30.12	31.01	31.90	32.79	33.69	34.58	35.47	36.36	37.25	38.14	39.04	39.93	40.82	41.71
	TOT. UNIT COST	33.40	34.37	35.34	36.31	37.28	38.25	39.22	40.18	41.15	42.12	43.09	44.06	45.03	46.00	46.97
50. MPH	UNIT CAP. COST	4.17	4.24	4.31	4.38	4.45	4.52	4.59	4.66	4.73	4.80	4.87	4.94	5.01	5.08	5.15
	UNIT O&M COST	29.21	30.05	30.89	31.72	32.56	33.40	34.24	35.07	35.91	36.75	37.59	38.42	39.26	40.10	40.94
	TOT. UNIT COST	33.38	34.29	35.20	36.10	37.01	37.92	38.82	39.73	40.64	41.55	42.45	43.36	44.27	45.18	45.08
55. MPH	UNIT CAP. COST	4.17	4.23	4.30	4.36	4.42	4.49	4.55	4.61	4.68	4.74	4.80	4.87	4.93	4.99	5.05
	UNIT O&M COST	29.20	29.99	30.78	31.58	32.37	33.16	33.96	34.75	35.54	36.34	37.13	37.92	38.72	39.51	40.30
	TOT. UNIT COST	33.36	34.22	35.08	35.93	36.79	37.65	38.51	39.36	40.22	41.08	41.93	42.79	43.65	44.50	45.36

Table J-3

UNIT COLLECTION AND HAUL COSTS, 20-CUBIC-YARD REAR OR SIDE LOADER RURAL SERVICE (Dollars per Ton)

HAUL SPEED	ONE WAY HAUL DISTANCE	1	4	7	10	13	16	19	22	25	28	31	34	37	40	43
15. MPH	UNIT CAP. COST	4.58	4.78	4.98	5.19	5.39	5.60	5.80	6.00	6.21	6.41	6.62	6.82	7.03	7.23	7.43
	UNIT O&M COST	29.11	30.68	32.26	33.83	35.41	36.99	38.56	40.14	41.72	43.29	44.87	46.44	48.02	49.60	51.17
	TOT. UNIT COST	33.68	35.46	37.24	39.02	40.80	42.58	44.36	46.14	47.92	49.70	51.49	53.27	55.05	56.83	58.61
20. MPH	UNIT CAP. COST	4.56	4.71	4.86	5.02	5.17	5.32	5.48	5.63	5.78	5.94	6.09	6.24	6.40	6.55	6.70
	UNIT O&M COST	29.00	30.25	31.50	32.76	34.01	35.26	36.51	37.77	39.02	40.27	41.52	42.78	44.03	45.28	46.53
	TOT. UNIT COST	33.56	34.96	36.37	37.77	39.18	40.59	41.99	43.40	44.80	46.21	47.61	49.02	50.43	51.83	53.24
25. MPH	UNIT CAP. COST	4.55	4.67	4.79	4.92	5.04	5.16	5.28	5.41	5.53	5.65	5.77	5.90	6.02	6.14	6.26
	UNIT O&M COST	28.93	29.99	31.05	32.11	33.17	34.23	35.28	36.34	37.40	38.46	39.52	40.58	41.63	42.69	43.75
	TOT. UNIT COST	33.48	34.66	35.84	37.02	38.21	39.39	40.57	41.75	42.93	44.11	45.29	46.47	47.65	48.83	50.01
30. MPH	UNIT CAP. COST	4.54	4.64	4.75	4.85	4.95	5.05	5.15	5.26	5.36	5.46	5.56	5.66	5.77	5.87	5.97
	UNIT O&M COST	28.89	29.82	30.75	31.68	32.61	33.54	34.46	35.39	36.32	37.25	38.18	39.11	40.04	40.97	41.90
	TOT. UNIT COST	33.43	34.46	35.49	36.52	37.56	38.59	39.62	40.65	41.68	42.71	43.74	44.77	45.80	46.84	47.87
35. MPH	UNIT CAP. COST	4.54	4.62	4.71	4.80	4.89	4.97	5.06	5.15	5.24	5.32	5.41	5.50	5.59	5.67	5.76
	UNIT O&M COST	28.86	29.70	30.53	31.37	32.21	33.04	33.88	34.71	35.55	36.39	37.22	38.06	38.90	39.73	40.57
	TOT. UNIT COST	33.40	34.32	35.24	36.17	37.09	38.02	38.94	39.86	40.79	41.71	42.64	43.56	44.48	45.41	46.33
40. MPH	UNIT CAP. COST	4.53	4.61	4.69	4.76	4.84	4.92	4.99	5.07	5.15	5.22	5.30	5.38	5.45	5.53	5.60
	UNIT O&M COST	28.84	29.60	30.37	31.14	31.90	32.67	33.44	34.21	34.97	35.74	36.51	37.28	38.04	38.61	39.58
	TOT. UNIT COST	33.37	34.21	35.06	35.90	36.74	37.59	38.43	39.28	40.12	40.96	41.81	42.65	43.49	44.34	45.18
45. MPH	UNIT CAP. COST	4.53	4.60	4.67	4.73	4.80	4.87	4.94	5.01	5.07	5.14	5.21	5.28	5.35	5.41	5.48
	UNIT O&M COST	28.82	29.53	30.24	30.96	31.67	32.38	33.10	33.81	34.52	35.24	35.95	36.66	37.38	38.09	38.80
	TOT. UNIT COST	33.35	34.13	34.91	35.69	36.47	37.25	38.04	38.82	39.60	40.38	41.16	41.94	42.72	43.51	44.29
50. MPH	UNIT CAP. COST	4.53	4.59	4.65	4.71	4.77	4.83	4.90	4.96	5.02	5.08	5.14	5.20	5.26	5.32	5.39
	UNIT O&M COST	28.80	29.47	30.14	30.81	31.48	32.15	32.82	33.49	34.16	34.83	35.50	36.17	36.84	37.51	38.19
	TOT. UNIT COST	33.33	34.06	34.79	35.53	36.26	36.99	37.72	38.45	39.18	39.91	40.65	41.38	42.11	42.84	43.57
55. MPH	UNIT CAP. COST	4.53	4.58	4.64	4.69	4.75	4.80	4.86	4.92	4.97	5.03	5.08	5.14	5.19	5.25	5.31
	UNIT O&M COST	28.79	29.43	30.06	30.70	31.33	31.97	32.60	33.24	33.87	34.51	35.14	35.77	36.41	37.04	37.68
	TOT. UNIT COST	33.32	34.01	34.70	35.39	36.08	36.77	37.46	38.15	38.84	39.53	40.22	40.91	41.60	42.29	42.98

Table J-4

UNIT COLLECTION AND HAUL COSTS, 20-CUBIC-YARD REAR OR SIDE LOADER URBAN SERVICE (Dollars per Ton)

HAUL SPEED	ONE WAY HAUL DISTANCE	1	4	7	10	13	16	19	22	25	28	31	34	37	40	43
15. MPH	UNIT CAP. COST	2.93	3.14	3.34	3.54	3.75	3.95	4.16	4.36	4.57	4.77	4.97	5.18	5.38	5.59	5.79
	UNIT O&M COST	18.69	20.29	21.89	23.49	25.08	26.68	28.28	29.88	31.47	33.07	34.67	36.27	37.86	39.46	41.06
	TOT. UNIT COST	21.62	23.43	25.23	27.03	28.83	30.63	32.44	34.24	36.04	37.84	39.64	41.44	43.25	45.05	46.85
20. MPH	UNIT CAP. COST	2.92	3.07	3.22	3.37	3.53	3.68	3.83	3.99	4.14	4.29	4.45	4.60	4.75	4.91	5.06
	UNIT O&M COST	18.58	19.86	21.13	22.41	23.68	24.96	26.23	27.50	28.78	30.05	31.33	32.60	33.87	35.15	36.42
	TOT. UNIT COST	21.50	22.93	24.35	25.78	27.21	28.64	30.06	31.49	32.92	34.34	35.77	37.20	38.63	40.05	41.48
25. MPH	UNIT CAP. COST	2.90	3.03	3.15	3.27	3.39	3.52	3.64	3.76	3.88	4.01	4.13	4.25	4.37	4.50	4.62
	UNIT O&M COST	18.52	19.60	20.68	21.76	22.84	23.92	25.00	26.08	27.16	28.24	29.32	30.40	31.48	32.56	33.64
	TOT. UNIT COST	21.42	22.63	23.83	25.03	26.23	27.44	28.64	29.84	31.04	32.25	33.45	34.65	35.85	37.06	38.26
30. MPH	UNIT CAP. COST	2.90	3.00	3.10	3.20	3.31	3.41	3.51	3.61	3.71	3.82	3.92	4.02	4.12	4.23	4.33
	UNIT O&M COST	18.48	19.43	20.38	21.33	22.28	23.23	24.18	25.13	26.08	27.03	27.98	28.93	29.88	30.83	31.78
	TOT. UNIT COST	21.37	22.43	23.48	24.53	25.59	26.64	27.69	28.74	29.80	30.85	31.90	32.95	34.01	35.06	36.11
35. MPH	UNIT CAP. COST	2.89	2.98	3.07	3.16	3.24	3.33	3.42	3.51	3.59	3.68	3.77	3.86	3.94	4.03	4.12
	UNIT O&M COST	18.45	19.30	20.16	21.02	21.88	22.74	23.59	24.45	25.31	26.17	27.03	27.88	28.74	25.60	30.46
	TOT. UNIT COST	21.34	22.28	23.23	24.18	25.12	26.07	27.01	27.96	28.90	29.85	30.79	31.74	32.69	33.63	34.58
40. MPH	UNIT CAP. COST	2.89	2.97	3.04	3.12	3.20	3.27	3.35	3.43	3.50	3.58	3.66	3.73	3.81	3.88	3.96
	UNIT O&M COST	18.42	19.21	20.00	20.79	21.58	22.37	23.15	23.94	24.73	25.52	26.31	27.10	27.89	28.68	29.46
	TOT. UNIT COST	21.31	22.18	23.04	23.91	24.77	25.64	26.50	27.37	28.23	29.10	29.96	30.83	31.69	32.56	33.43
45. MPH	UNIT CAP. COST	2.89	2.95	3.02	3.09	3.16	3.23	3.30	3.36	3.43	3.50	3.57	3.64	3.70	3.77	3.84
	UNIT O&M COST	18.40	19.14	19.87	20.61	21.34	22.08	22.81	23.55	24.28	25.02	25.75	26.49	27.22	27.96	28.69
	TOT. UNIT COST	21.29	22.09	22.90	23.70	24.50	25.31	26.11	26.91	27.71	28.52	29.32	30.12	30.92	31.73	32.53
50. MPH	UNIT CAP. COST	2.88	2.95	3.01	3.07	3.13	3.19	3.25	3.31	3.37	3.44	3.50	3.56	3.62	3.68	3.74
	UNIT O&M COST	18.39	19.08	19.77	20.47	21.16	21.85	22.54	23.23	23.92	24.61	25.31	26.00	26.69	27.38	28.07
	TOT. UNIT COST	21.28	22.03	22.78	23.53	24.29	25.04	25.79	26.54	27.30	28.05	28.80	29.56	30.31	31.06	31.81
55. MPH	UNIT CAP. COST	2.88	2.94	2.99	3.05	3.11	3.16	3.22	3.27	3.33	3.38	3.44	3.50	3.55	3.61	3.66
	UNIT O&M COST	18.38	19.04	19.69	20.35	21.00	21.66	22.32	22.97	23.63	24.29	24.94	25.60	26.25	26.91	27.57
	TOT. UNIT COST	21.26	21.97	22.69	23.40	24.11	24.82	25.53	26.24	26.96	27.67	28.38	29.09	29.80	30.52	31.23

Table J-5

UNIT COLLECTION AND HAUL COSTS,
24-CUBIC-YARD REAR OR SIDE LOADER
URBAN SERVICE
(Dollars per Ton)

HAUL SPEED	ONE WAY HAUL DISTANCE	1	4	7	10	13	16	19	22	25	28	31	34	37	40	43
15. MPH	UNIT CAP. COST	3.53	3.74	3.95	4.16	4.37	4.57	4.78	4.99	5.20	5.41	5.62	5.83	6.04	6.24	6.45
	UNIT O&M COST	18.33	19.66	20.99	22.32	23.65	24.98	26.31	27.65	28.98	30.31	31.64	32.97	34.30	35.63	36.96
	TOT. UNIT COST	21.86	23.40	24.94	26.48	28.02	29.56	31.10	32.64	34.18	35.72	37.26	38.80	40.34	41.88	43.42
20. MPH	UNIT CAP. COST	3.51	3.67	3.83	3.98	4.14	4.30	4.45	4.61	4.77	4.92	5.08	5.24	5.39	5.55	5.71
	UNIT O&M COST	18.24	19.30	20.36	21.42	22.48	23.54	24.61	25.67	26.73	27.79	28.85	29.91	30.98	32.04	33.10
	TOT. UNIT COST	21.75	22.97	24.19	25.40	26.62	27.84	29.06	30.28	31.50	32.71	33.93	35.15	36.37	37.59	38.81
25. MPH	UNIT CAP. COST	3.50	3.63	3.75	3.88	4.00	4.13	4.25	4.38	4.50	4.63	4.76	4.88	5.01	5.13	5.26
	UNIT O&M COST	18.18	19.08	19.98	20.88	21.78	22.68	23.58	24.48	25.38	26.28	27.18	28.08	28.98	29.88	30.78
	TOT. UNIT COST	21.68	22.71	23.73	24.76	25.78	26.81	27.84	28.86	29.89	30.91	31.94	32.96	33.99	35.01	36.04
30. MPH	UNIT CAP. COST	3.50	3.60	3.70	3.81	3.91	4.02	4.12	4.23	4.33	4.44	4.54	4.64	4.75	4.85	4.96
	UNIT O&M COST	18.15	18.94	19.73	20.52	21.31	22.11	22.90	23.69	24.48	25.27	26.07	26.86	27.65	28.44	29.23
	TOT. UNIT COST	21.64	22.54	23.43	24.33	25.23	26.12	27.02	27.92	28.81	29.71	30.61	31.50	32.40	33.29	34.19
35. MPH	UNIT CAP. COST	3.49	3.58	3.67	3.76	3.85	3.94	4.03	4.12	4.21	4.30	4.39	4.48	4.55	4.65	4.74
	UNIT O&M COST	18.12	18.83	19.55	20.26	20.98	21.69	22.41	23.12	23.84	24.55	25.27	25.98	26.70	27.41	28.13
	TOT. UNIT COST	21.61	22.42	23.22	24.02	24.83	25.63	26.44	27.24	28.05	28.85	29.66	30.46	31.26	32.07	32.87
40. MPH	UNIT CAP. COST	3.49	3.57	3.64	3.72	3.80	3.88	3.96	4.04	4.11	4.19	4.27	4.35	4.43	4.50	4.58
	UNIT O&M COST	18.10	18.76	19.41	20.07	20.73	21.39	22.04	22.70	23.36	24.02	24.67	25.33	25.99	26.64	27.30
	TOT. UNIT COST	21.59	22.32	23.06	23.79	24.53	25.27	26.00	26.74	27.47	28.21	28.94	29.68	30.41	31.15	31.88
45. MPH	UNIT CAP. COST	3.48	3.55	3.62	3.69	3.76	3.83	3.90	3.97	4.04	4.11	4.18	4.25	4.32	4.39	4.46
	UNIT O&M COST	18.09	18.70	19.31	19.92	20.53	21.15	21.76	22.37	22.98	23.60	24.21	24.82	25.43	26.04	26.66
	TOT. UNIT COST	21.57	22.25	22.93	23.62	24.30	24.98	25.66	26.34	27.02	27.71	28.39	29.07	29.75	30.43	31.12
50. MPH	UNIT CAP. COST	3.48	3.54	3.61	3.67	3.73	3.80	3.86	3.92	3.98	4.05	4.11	4.17	4.23	4.30	4.36
	UNIT O&M COST	18.07	18.65	19.23	19.80	20.38	20.95	21.53	22.11	22.68	23.26	23.84	24.41	24.99	25.57	26.14
	TOT. UNIT COST	21.56	22.19	22.83	23.47	24.11	24.75	25.39	26.03	26.67	27.31	27.94	28.58	29.22	29.86	30.50
55. MPH	UNIT CAP. COST	3.48	3.54	3.59	3.65	3.71	3.76	3.82	3.88	3.94	3.99	4.05	4.11	4.16	4.22	4.28
	UNIT O&M COST	18.06	18.61	19.16	19.70	20.25	20.80	21.34	21.89	22.44	22.99	23.53	24.08	24.63	25.17	25.72
	TOT. UNIT COST	21.54	22.15	22.75	23.36	23.96	24.56	25.17	25.77	26.37	26.98	27.58	28.19	28.79	29.39	30.00

Table J-6

UNIT COLLECTION AND HAUL COSTS, 24-CUBIC-YARD FRONT LOADER COMMERCIAL-INDUSTRIAL SERVICE (Dollars per Ton)

HAUL SPEED	ONE WAY HAUL DISTANCE	1	4	7	10	13	16	19	22	25	28	31	34	37	40	43
15. MPH	UNIT CAP. COST	2.41	2.64	2.88	3.11	3.34	3.57	3.80	4.04	4.27	4.50	4.73	4.96	5.20	5.43	5.66
	UNIT O&M COST	4.56	5.42	6.28	7.14	8.00	8.86	9.72	10.58	11.44	12.30	13.16	14.02	14.88	15.74	16.60
	TOT. UNIT COST	6.97	8.06	9.16	10.25	11.34	12.43	13.52	14.62	15.71	16.80	17.89	18.99	20.08	21.17	22.26
20. MPH	UNIT CAP. COST	2.39	2.57	2.74	2.91	3.09	3.26	3.44	3.61	3.78	3.96	4.13	4.31	4.48	4.65	4.83
	UNIT O&M COST	4.51	5.22	5.92	6.63	7.34	8.05	8.76	9.47	10.18	10.88	11.59	12.30	13.01	13.72	14.43
	TOT. UNIT COST	6.90	7.78	8.67	9.55	10.43	11.31	12.20	13.08	13.96	14.84	15.73	16.61	17.49	18.37	19.25
25. MPH	UNIT CAP. COST	2.38	2.52	2.66	2.80	2.94	3.08	3.22	3.36	3.49	3.63	3.77	3.91	4.05	4.19	4.33
	UNIT O&M COST	4.48	5.09	5.71	6.33	6.95	7.56	8.18	8.80	9.42	10.03	10.65	11.27	11.89	12.50	13.12
	TOT. UNIT COST	6.86	7.61	8.37	9.13	9.88	10.64	11.40	12.15	12.91	13.67	14.42	15.18	15.94	16.69	17.45
30. MPH	UNIT CAP. COST	2.37	2.49	2.61	2.72	2.84	2.95	3.07	3.19	3.30	3.42	3.53	3.65	3.77	3.88	4.00
	UNIT O&M COST	4.46	5.01	5.57	6.13	6.68	7.24	7.80	8.35	8.91	9.47	10.02	10.58	11.14	11.69	12.25
	TOT. UNIT COST	6.83	7.50	8.18	8.85	9.52	10.19	10.87	11.54	12.21	12.88	13.56	14.23	14.90	15.57	16.25
35. MPH	UNIT CAP. COST	2.37	2.47	2.57	2.67	2.77	2.86	2.96	3.06	3.16	3.26	3.36	3.46	3.56	3.66	3.76
	UNIT O&M COST	4.44	4.96	5.47	5.98	6.50	7.01	7.52	8.03	8.55	9.06	9.57	10.09	10.60	11.11	11.63
	TOT. UNIT COST	6.81	7.42	8.04	8.65	9.26	9.87	10.49	11.10	11.71	12.32	12.94	13.55	14.16	14.77	15.39
40. MPH	UNIT CAP. COST	2.36	2.45	2.54	2.62	2.71	2.80	2.89	2.97	3.06	3.15	3.23	3.32	3.41	3.49	3.58
	UNIT O&M COST	4.43	4.91	5.39	5.87	6.35	6.83	7.32	7.80	8.28	8.76	9.24	9.72	10.20	10.68	11.16
	TOT. UNIT COST	6.80	7.36	7.93	8.50	9.07	9.63	10.20	10.77	11.34	11.90	12.47	13.04	13.61	14.17	14.74
45. MPH	UNIT CAP. COST	2.36	2.44	2.52	2.59	2.67	2.75	2.82	2.90	2.98	3.06	3.13	3.21	3.29	3.37	3.44
	UNIT O&M COST	4.42	4.88	5.33	5.79	6.24	6.70	7.15	7.61	8.07	8.52	8.98	9.43	9.89	10.34	10.80
	TOT. UNIT COST	6.78	7.32	7.85	8.38	8.91	9.45	9.98	10.51	11.04	11.58	12.11	12.64	13.17	13.71	14.24
50. MPH	UNIT CAP. COST	2.36	2.43	2.50	2.57	2.64	2.71	2.78	2.85	2.91	2.98	3.05	3.12	3.19	3.26	3.33
	UNIT O&M COST	4.42	4.85	5.29	5.72	6.16	6.59	7.03	7.46	7.90	8.33	8.77	9.20	9.64	10.07	10.51
	TOT. UNIT COST	6.77	7.28	7.78	8.29	8.79	9.30	9.80	10.31	10.81	11.32	11.82	12.32	12.83	13.33	13.84
55. MPH	UNIT CAP. COST	2.36	2.42	2.48	2.55	2.61	2.67	2.74	2.80	2.86	2.93	2.99	3.05	3.12	3.18	3.24
	UNIT O&M COST	4.41	4.83	5.25	5.67	6.08	6.50	6.92	7.34	7.76	8.18	8.60	9.01	9.43	9.65	10.27
	TOT. UNIT COST	6.77	7.25	7.73	8.21	8.69	9.18	9.66	10.14	10.62	11.10	11.58	12.07	12.55	13.03	13.51

Table J-7

UNIT COLLECTION AND HAUL COSTS, 20-CUBIC-YARD NONCOMPACTED DROP BOX TRUCK COMMERCIAL-INDUSTRIAL SERVICE (Dollars per Ton)

HAUL SPEED	ONE WAY HAUL DISTANCE	1	4	7	10	13	16	19	22	25	28	31	34	37	40	43
15. MPH	UNIT CAP. COST	1.08	1.44	1.81	2.17	2.54	2.90	3.27	3.63	4.00	4.36	4.73	5.09	5.45	5.82	6.19
	UNIT O&M COST	2.45	4.49	6.52	8.55	10.59	12.62	14.65	16.69	18.72	20.76	22.79	24.82	26.86	28.8[illegible]	30.92
	TOT. UNIT COST	3.53	5.93	8.33	10.73	13.12	15.52	17.92	20.32	22.72	25.12	27.52	29.91	32.31	34.71	37.11
20. MPH	UNIT CAP. COST	1.05	1.32	1.59	1.87	2.14	2.42	2.69	2.96	3.24	3.51	3.78	4.06	4.33	4.61	4.88
	UNIT O&M COST	2.33	3.98	5.64	7.30	8.95	10.61	12.26	13.92	15.58	17.23	18.89	20.55	22.20	23.86	25.51
	TOT. UNIT COST	3.37	5.30	7.23	9.16	11.09	13.02	14.95	16.88	18.81	20.74	22.67	24.60	26.53	28.46	30.39
25. MPH	UNIT CAP. COST	1.03	1.25	1.47	1.69	1.90	2.12	2.34	2.56	2.78	3.00	3.22	3.44	3.66	3.88	4.09
	UNIT O&M COST	2.25	3.68	5.11	6.54	7.97	9.40	10.83	12.26	13.69	15.12	16.55	17.98	19.41	20.84	22.27
	TOT. UNIT COST	3.28	4.93	6.58	8.23	9.88	11.52	13.17	14.82	16.47	18.12	19.77	21.42	23.07	24.71	26.35
30. MPH	UNIT CAP. COST	1.02	1.20	1.38	1.56	1.75	1.93	2.11	2.29	2.48	2.66	2.84	3.02	3.21	3.39	3.57
	UNIT O&M COST	2.20	3.48	4.76	6.04	7.32	8.60	9.87	11.15	12.43	13.71	14.99	16.27	17.55	18.83	20.10
	TOT. UNIT COST	3.22	4.68	6.14	7.60	9.06	10.52	11.99	13.45	14.91	16.37	17.83	19.29	20.75	22.21	23.68
35. MPH	UNIT CAP. COST	1.01	1.16	1.32	1.48	1.63	1.79	1.95	2.10	2.26	2.42	2.57	2.73	2.88	3.04	3.20
	UNIT O&M COST	2.17	3.34	4.51	5.68	6.85	8.02	9.19	10.36	11.53	12.70	13.88	15.05	16.22	17.39	18.56
	TOT. UNIT COST	3.17	4.50	5.83	7.16	8.48	9.81	11.14	12.47	13.79	15.12	16.45	17.77	19.10	20.43	21.76
40. MPH	UNIT CAP. COST	1.00	1.14	1.28	1.41	1.55	1.69	1.82	1.96	2.10	2.23	2.37	2.51	2.64	2.78	2.92
	UNIT O&M COST	2.14	3.23	4.32	5.41	6.50	7.59	8.68	9.77	10.86	11.95	13.04	14.13	15.22	16.31	17.40
	TOT. UNIT COST	3.14	4.37	5.59	6.82	8.05	9.27	10.50	11.73	12.96	14.18	15.41	16.64	17.86	19.09	20.32
45. MPH	UNIT CAP. COST	1.00	1.12	1.24	1.36	1.48	1.60	1.73	1.85	1.97	2.09	2.21	2.33	2.46	2.58	2.70
	UNIT O&M COST	2.12	3.15	4.17	5.20	6.23	7.25	8.28	9.31	10.34	11.36	12.39	13.42	14.44	15.47	16.50
	TOT. UNIT COST	3.11	4.26	5.41	6.56	7.71	8.86	10.01	11.16	12.30	13.45	14.60	15.75	16.90	18.05	19.20
50. MPH	UNIT CAP. COST	0.99	1.10	1.21	1.32	1.43	1.54	1.65	1.76	1.87	1.98	2.09	2.20	2.31	2.42	2.53
	UNIT O&M COST	2.10	3.08	4.05	5.03	6.01	6.99	7.96	8.94	9.92	10.89	11.87	12.85	13.82	14.80	15.78
	TOT. UNIT COST	3.09	4.18	5.27	6.35	7.44	8.53	9.61	10.70	11.78	12.87	13.96	15.04	16.13	17.22	18.30
55. MPH	UNIT CAP. COST	0.99	1.09	1.19	1.29	1.39	1.49	1.59	1.69	1.79	1.88	1.98	2.08	2.18	2.28	2.38
	UNIT O&M COST	2.09	3.02	3.96	4.89	5.83	6.77	7.70	8.64	9.57	10.51	11.44	12.38	13.32	14.25	15.19
	TOT. UNIT COST	3.08	4.11	5.15	6.18	7.22	8.25	9.29	10.32	11.36	12.39	13.43	14.46	15.50	16.53	17.57

Table J-8

UNIT COLLECTION AND HAUL COSTS, 35-CUBIC-YARD NONCOMPACTED DROP BOX TRUCK COMMERCIAL-INDUSTRIAL SERVICE (Dollars per Ton)

HAUL SPEED	ONE WAY HAUL DISTANCE	1	4	7	10	13	16	19	22	25	28	31	34	37	40	43
15. MPH	UNIT CAP. COST	0.84	1.05	1.26	1.47	1.67	1.88	2.09	2.30	2.51	2.72	2.93	3.13	3.34	3.55	3.76
	UNIT O&M COST	1.46	2.62	3.78	4.94	6.11	7.27	8.43	9.59	10.75	11.92	13.08	14.24	15.40	16.55	17.73
	TOT. UNIT COST	2.30	3.67	5.04	6.41	7.78	9.15	10.52	11.89	13.26	14.63	16.00	17.37	18.74	20.12	21.49
20. MPH	UNIT CAP. COST	0.82	0.98	1.13	1.29	1.45	1.60	1.76	1.92	2.07	2.23	2.39	2.54	2.70	2.86	3.01
	UNIT O&M COST	1.39	2.33	3.28	4.23	5.17	6.12	7.06	8.01	8.96	9.90	10.85	11.80	12.74	13.69	14.64
	TOT. UNIT COST	2.21	3.31	4.41	5.52	6.62	7.72	8.82	9.93	11.03	12.13	13.24	14.34	15.44	16.54	17.65
25. MPH	UNIT CAP. COST	0.81	0.94	1.06	1.19	1.31	1.44	1.56	1.69	1.81	1.94	2.06	2.19	2.31	2.44	2.56
	UNIT O&M COST	1.34	2.16	2.98	3.79	4.61	5.43	6.24	7.06	7.88	8.70	9.51	10.33	11.15	11.96	12.78
	TOT. UNIT COST	2.15	3.10	4.04	4.98	5.92	6.87	7.81	8.75	9.69	10.63	11.58	12.52	13.46	14.40	15.34
30. MPH	UNIT CAP. COST	0.80	0.91	1.01	1.12	1.22	1.33	1.43	1.53	1.64	1.74	1.85	1.95	2.06	2.16	2.26
	UNIT O&M COST	1.31	2.04	2.78	3.51	4.24	4.97	5.70	6.43	7.16	7.89	8.62	9.35	10.09	10.81	11.54
	TOT. UNIT COST	2.12	2.95	3.79	4.62	5.46	6.29	7.13	7.96	8.80	9.63	10.47	11.30	12.14	12.97	13.81
35. MPH	UNIT CAP. COST	0.80	0.89	0.98	1.07	1.16	1.25	1.34	1.43	1.51	1.60	1.69	1.78	1.87	1.96	2.05
	UNIT O&M COST	1.29	1.96	2.63	3.30	3.97	4.64	5.31	5.98	6.65	7.32	7.98	8.65	9.32	9.99	10.66
	TOT. UNIT COST	2.09	2.85	3.61	4.37	5.13	5.89	6.64	7.40	8.16	8.92	9.68	10.44	11.20	11.95	12.71
40. MPH	UNIT CAP. COST	0.80	0.87	0.95	1.03	1.11	1.19	1.27	1.34	1.42	1.50	1.58	1.66	1.73	1.81	1.89
	UNIT O&M COST	1.28	1.90	2.52	3.15	3.77	4.39	5.02	5.64	6.26	6.88	7.51	8.13	8.75	9.36	10.00
	TOT. UNIT COST	2.07	2.78	3.48	4.18	4.88	5.58	6.28	6.98	7.68	8.38	9.09	9.79	10.49	11.19	11.89
45. MPH	UNIT CAP. COST	0.79	0.86	0.93	1.00	1.07	1.14	1.21	1.28	1.35	1.42	1.49	1.56	1.63	1.70	1.77
	UNIT O&M COST	1.27	1.85	2.44	3.03	3.61	4.20	4.79	5.37	5.96	6.55	7.14	7.72	8.31	8.90	9.48
	TOT. UNIT COST	2.06	2.72	3.37	4.03	4.69	5.34	6.00	6.65	7.31	7.97	8.62	9.28	9.94	10.59	11.25
50. MPH	UNIT CAP. COST	0.79	0.85	0.92	0.98	1.04	1.10	1.17	1.23	1.29	1.35	1.42	1.48	1.54	1.60	1.67
	UNIT O&M COST	1.26	1.81	2.37	2.93	3.49	4.05	4.61	5.16	5.72	6.28	6.84	7.40	7.95	8.51	9.07
	TOT. UNIT COST	2.05	2.67	3.29	3.91	4.53	5.15	5.77	6.39	7.01	7.63	8.26	8.88	9.50	10.12	10.74
55. MPH	UNIT CAP. COST	0.79	0.85	0.90	0.96	1.02	1.07	1.13	1.19	1.24	1.30	1.36	1.41	1.47	1.53	1.59
	UNIT O&M COST	1.25	1.78	2.32	2.85	3.39	3.92	4.46	4.99	5.53	6.06	6.60	7.13	7.66	8.20	8.73
	TOT. UNIT COST	2.04	2.63	3.22	3.81	4.40	5.00	5.59	6.18	6.77	7.36	7.95	8.54	9.14	9.73	10.32

The costs for owning and operating collection equipment were estimated in the following manner. The purchase price was obtained from manufacturers for various types and sizes of collection vehicles. These costs were amortized over 6 years at an interest rate of 8 percent. Maintenance and repairs, insurance, and licenses were expressed as lump sum annual costs. Fuel consumption was reported by collectors in the area to range from 3 to 4.5 miles per gallon. Depending on the type of truck, 3.0, 3.5, or 4.5 miles per gallon was used with fuel costs of $0.35 per gallon to determine fuel consumption costs.

Containers

Types and sizes of containers were determined from interviews with collectors. The typical residential storage containers are 32-gallon barrels (0.158 cubic yard). A volume utilization factor of 100 percent was used for urban and rural residential containers assuming that the homeowners' garbage cans are generally full when collected. An average number of 1.3 32-gallon containers per stop was used for rural residential service based on the COR-MET rural questionnaire sampling and projected increases in the per-capita waste generation rate. An average number of 1.5 containers per household, or 3 containers per stop, was used for urban residential service as the collectors reported that 50 percent of urban households use two containers and two houses are serviced per stop. It was assumed that residential containers are owned by the homeowner, so no cost for these was included.

Commercial and industrial refuse storage containers vary greatly depending on types and quantities of waste and frequency of service. For front loader service, a 4-cubic-yard container was selected as the typical size, with a collection frequency of three times per week. Drop box capacities of 20 cubic yards and a composite 35 cubic yards (to represent 30- and 40-cubic-yard boxes) were used for the analysis.

The volume utilization factor for containers and drop boxes was set at 90 percent of the rated capacity. Unlike residential collection service, the collector generally owns all containers and drop boxes used for commercial and industrial service. Purchase prices for containers and drop boxes were obtained from manufacturers and amortized over a 10-year period at an interest rate of 8 percent. These costs were increased by 10 percent for 4-cubic-yard containers and 20-cubic-yard drop boxes and by 15 percent for the less frequently used 30- and 40-cubic yard drop boxes to reflect a standby supply of containers and drop boxes that collectors generally have at their yard.

Collection Crews

Information related to the collection crew was obtained mostly through interviews with collectors. The most common crew sizes found were two men, including the driver, for both rear and side loaders, and one man for front loaders and drop box trucks.

Salaries were determined on the basis of the $5.00 per hour union rate with an additional $500.00 per year for drivers. An acceleration of 15 percent includes workmen's compensation and benefits. Overhead was an assumed 40 percent per employee. Salaries for front loader and drop box truck drivers were increased an additional $500.00 ($1,000 per year over union rates) for the extra skill requirements of their jobs. Since most collectors operate 5-1/2 days per week, with the Saturday workload at a reduced volume, an average of 5-1/4 work days were assumed.

Time Factors

Other factors influencing the collection analysis are frequency of service and miscellaneous time values for loading, dumping, washing, and delaying. For residential service, frequency of collection was determined to be once per week by consensus of the interviews with collectors. For commercial and industrial service, an average frequency of three times per week was assumed for front-loading containers and two times per week for drop boxes. Loading time per stop for residential collection was determined mathematically to reflect the weekly vehicle utilization for both rural and urban service. The derived loading time might be high for both types of service, but it compensates for miscellaneous times not accounted for due to lack of available information. The time values include travel to the next stop. The values derived were 2.5 minutes per stop for rural service (2 minutes per container) and 3.5 minutes per stop for urban service (1.2 minutes per container). Collection time for front loaders and drop box trucks was set at 10 minutes per stop. A dumping time of 6 minutes, established in a previous study, was utilized here. Delays of 10 minutes per trip were applied for rural service and 15 minutes for urban service for a packer truck. Ten-minute delays were used for drop box trucks due to their one-stop requirement.

COMPOSITE COLLECTION SYSTEMS

The COR-MET weighing program data and supplementary data from other landfill operations in the study area were used to determine collection vehicle types and sizes found in each refuse generation center and the number of trips each vehicle made to a landfill during a one-week period. Composite refuse collection systems were synthesized by determining the percentage by weight of refuse collected in each refuse generation center by the representative types of collection vehicles. Thirty-three composite collection systems were used to represent the 50 refuse generation centers. The computer transportation model provided a tabulation of costs for each of the composite collection systems for distances ranging from 1 to 43 miles in 3-mile increments at average vehicle speeds ranging from 15 to 55 miles in 5-mile-per-hour increments.

In developing the alternative systems, specific collection and haul costs in dollars per ton were utilized from each refuse generation center to each alternative transfer, processing, or disposal point. One-way haul distances were measured over routes presently used by collection vehicles. Average travel speeds on these routes were determined by data supplied by the Oregon State Highway Division from their computer model of traffic flow in the metropolitan Portland area. Using the determined speed and distance, the collection and haul unit cost was selected from the composite collection cost tabulation and used as input to the computer screening models for alternative systems.

APPENDIX K

Appendix K

POTENTIAL DISPOSAL SITES

The potential disposal sites considered suitable for inclusion in the alternative systems are described in Chapter 14, Volume I. The remaining potential sites are described in the following sections.

CLACKAMAS COUNTY

Barton Pit

The Barton pit is a 25-acre county-owned gravel pit about 6 miles northwest of Estacada. The site is located in a Natural Rivers Corridor with the county-owned Barton Park located to the south. The predominant surrounding land use is farming. A small drainage ditch flowing from the pit would present a problem in design and operation. Main access to the gravel pit is off the Barton Park Road from Highway 224. The site was eliminated as a potential regional landfill after review by the special landfill rating group because of its small size, but the site could still be considered as a potential land reclamation project using processed refuse.

Crosswhite

The Crosswhite site is a 33-acre gravel pit located at 6641 S.E. Johnson Creek Boulevard. The gravel pit is bounded on S.E. Johnson Creek Boulevard on the south, vacant land on the east, Alberta Street and residential and commercial development on the north, and S.E. Flavel Drive on the west. Johnson Creek flows from east to west about 250 to 500 feet south of the proposed site. Access to the site is off S.E. Johnson Creek Boulevard from 82nd Avenue. The gravel pit was evaluated by the special landfill rating group and was eliminated from further consideration as a regional landfill because of its small size and its location near residential areas, but the site could still be considered as a potential landfill for nonprocessible wastes or as a potential fill using processed refuse for land reclamation.

Wilsonville

The Wilsonville site is a 3-acre hillside gravel pit located in a rural agricultural area. Access to the site is off Peters Road from Staford Road and Interstate 205. The site was evaluated by the special landfill rating group and was eliminated from further consideration as a regional landfill because of its small size.

COLUMBIA COUNTY

Alston

The Alston site is located about one-half mile east of Alston, just north of Wonderly Road. The site is one-quarter mile south of the Bonneville Power Administration's (BPA) Alston Substation, and lies on BPA right-of-way between towers 43-3 and 43-4 of the Keeler-Alston 500-KV line. In addition, the proposed site is crossed by a buried cable of the Pacific Northwest Bell telephone company. This site was considered previously by the county and rejected because of the unwillingness of Bonneville Power to allow development of the site on their right-of-way. The site was not considered further due to the conflicting land uses.

Apiary

The Apiary site is an abandoned rock quarry located 2 miles north of Apiary adjacent to the road from Apiary north to old U.S. Highway 30. The quarry is small in size, about 5 acres, and does not have on-site cover material. The site is located in a sparsely populated, wooded area. This site was not considered past the initial investigation phase due to its small size.

Beaver

The Beaver site lies north of Clatskanie, adjacent to the Columbia River. The 800-acre site is owned by Columbia County and parcels are leased to various industries, including Portland General Electric who is now constructing the Beaver Electrical Plant. The site is low-lying, diked land surrounded by agricultural land. Access is over 5 miles of county roads from Clatskanie. The site also has rail access. The site was evaluated by the special landfill rating group and was eliminated from further consideration due to poor access, possible land use conflicts with electrical generating facilities, and lack of suitable cover material.

Beaver Creek

The Beaver Creek site is a small abandoned rock quarry located adjacent to the road from Delena to Inglis. The site is in an unpopulated area of steep, wooded slopes. This site was eliminated during the initial investigation stage due to its small size, steep slopes, and nearness to Beaver Creek.

Clatskanie Disposal Site

The Clatskanie site was investigated for inclusion as a potential site. The 15-acre site owned by the City of Clatskanie is located just east of the Clatskanie City limits. This site was eliminated from consideration early in the study as a potential disposal site due to the poor cover material, unsuitable access, and steepness of slopes.

County Rock Quarry

This 30-acre quarry is located immediately adjacent to U.S. Highway 30, 1 mile north of St. Helens. The site is surrounded by undeveloped land, with direct access from Highway 30. The site was eliminated from consideration due to the fact that it is underlain by a permeable columnar basalt layer. Additionally, there is a lack of on-site cover material.

Coal Creek, Washington

The Coal Creek site is operated by Cowlitz County about 15 miles from the City of Rainier with access via the Longview Bridge. The present site will be closed sometime in mid-1975 and a new site opened. The use of this site for the disposal of refuse from the northern region of Columbia County was eliminated based on objections from the Cowlitz County Solid Waste Department that the additional Columbia County wastes would shorten the life of the new site and also create problems with fee collection rates.

Deer Island

The Deer Island site is a small abandoned gravel pit located adjacent to U.S. Highway 30, 1 mile south of Deer Island. The site is surrounded on the north by residences and by undeveloped land to the south. This site was eliminated from further consideration following the initial investigation phase due to the small size and the close proximity of residential water wells to the site.

Goble

The Goble site is an existing rock quarry 3/4 mile west of Goble along Goble Road. Surrounding land is primarily undeveloped with sparse population. The small size of the site, its location on a steep slope, and its existing use all combined to eliminate this site following initial field investigation.

Inglis

The Inglis site is a small abandoned rock quarry located about 2 miles west of Inglis. The site is in an unpopulated area of steep, wooded slopes. This site was eliminated at the initial investigation stage due to its small size, steep slope, and poor access.

Marshland

The Marshland site is an area of marginal farmland located north of U.S. Highway 30. The area is diked and access is via county roads from U.S. 30. A disposal site could be located on any available parcel of land within the diked areas. The site was evaluated by the special landfill rating group and dropped from further consideration as a sanitary landfill because of its remote location and poor access.

Natal

The Natal site is an abandoned rock quarry located adjacent to Oregon State Highway 47 at Natal. The site is surrounded by sparsely populated land and bordered on the north by the Nehalem River. This site was rejected at the initial investigation phase due to the small site area, steepness of slope, and proximity to the Nehalem River.

Neer City

The Neer City site is a small abandoned rock quarry one-half mile west of Neer City. The access to the site is over a steep gravel road, and the surrounding land is undeveloped. Due to the small size, steep access, and remote location, this site was eliminated following initial field investigations.

Petersen

The Petersen sites are located on Tide Creek Road, one-half mile west of U.S. Highway 30. There are two separate sites, both similar in nature. Surrounding land usage is undeveloped forest land and some agricultural land. Wood wastes were dumped at both sites in 1971 and 1972, and one of the sites caught fire in July of 1972. The operation of both sites was subsequently halted by the Department of Environmental Quality. Based upon the small site sizes, the steep, narrow access road, and the presence of the previously improperly filled material, these sites were rejected following the initial field investigation.

Rainier

The former Rainier Disposal Site is located about 2 miles south of Rainier over a moderately steep access road. Surrounding land use is undeveloped forest with some scattered residential buildings. The site was eliminated from further consideration following initial field investigations because of the presence of large quantities of material left from the former burning dump, the small site size, the narrow access road, and the steep banks.

Scappoose Sand and Gravel

The Scappoose Sand and Gravel site is located on the north boundary of Scappoose, immediately adjacent to U.S. Highway 30. The present gravel operation is mining just above the water table and there are plans to mine below the water table. There is residential development east of the site, but the predominant land use is commercial-industrial. This site was eliminated from further consideration during the preliminary investigation phase, partly because of the limited site capacity, but primarily because mining will occur below the water table.

Shoreline Rock Products

The Shoreline Rock Products site is located 2 miles north of Scappoose, just off U.S. Highway 30, on Honeyman Road. Surrounding land use is primarily agricultural. This site was dropped from further consideration after the initial field investigation because of its small size and proximity to the groundwater table.

Vernonia Disposal Site

The Vernonia Disposal Site is located about 1 mile from Vernonia over a narrow and winding road. Surrounding land use is predominantly undeveloped timber on steep slopes. This site is now open 1 day per week for the disposal of nonputrescible wastes. However, it was not considered suitable for use as a potential site because of its small size, lack of suitable cover material, narrow access road, and steep slopes.

MULTNOMAH COUNTY

Burlington

The Burlington site consists of about 200 acres of lowland and sloughs located between Sauvie Island Bridge and the community of Burlington. The site is bounded by Multnomah Channel on the east and by Burlington Northern Railroad tracks on the west. Access to the site is off St. Helens Highway. The average depth of fill in the site would be about 10 feet because of the relatively low elevation of the railroad tracks along one boundary of the site. The shallow depth of fill would severely limit the volume and life as a landfill. The site had been considered previously for use as a nonprocessible wastes landfill, but the application for a disposal site permit was turned down by the Oregon State Environmental Quality Commission. The site was not investigated further because of its previous rejection by the Environmental Quality Commission and because of its relatively small size compared to other potential lowland sites.

Columbia Sand and Gravel

The Columbia Sand and Gravel site consists of a 9-acre gravel pit located at the corner of 122nd Street and N.E. San Rafael Street. The pit is bounded by roads on two sides and by a school playground and a residential area on the other two sides. Access to the site is off 122nd Street and Interstate 80N. The site was evaluated by the special landfill rating group and was subsequently dropped from further consideration as a regional landfill because of its small size and its location in a residential area, but the site could still be considered as a potential landfill for nonprocessible wastes or as a potential fill using processed refuse for land reclamation.

East Multnomah

The East Multnomah site consists of approximately 245 acres of flat land on the south side of Interstate 80N between N.E. 148th and N.E. 169th avenues, just north of N.E. Halsey Street. The area is surrounded by fairly dense residential neighborhoods. Access to the site would be off N.E. 148th or N.E. 169th avenues from N.E. Halsey Street or N.E. Sandy Boulevard. The site was eliminated after initial investigation because it was surrounded by residential neighborhoods and because the site would not benefit by being filled. In fact, the land would generally be less usable after filling than before.

Gresham Sand and Gravel

The Gresham Sand and Gravel site is an 8-acre area being mined for gravel. After the gravel is removed, the area would be a potential landfill site. Gravel operations owned by Rogers Construction are located on the east side of the site with the completed Vance Pit landfill located on the north and 190th Avenue on the west. There is some residential housing to the south of the site and the overall area is generally residential except for the gravel operations. Access to the site is from 195th or 190th avenues from Division Street or Stark Street. The site might not be available as a disposal site because of the owner's intention to mine gravel a considerable depth below the water table. The site was evaluated by the special landfill rating group and was subsequently dropped from further consideration as a regional landfill. The site should not be considered in the future as a potential landfill for nonprocessible wastes or processed refuse unless assurance can be given that the gravel pit will not be mined below the water table.

Nash Gravel Pit

The Nash site is a 24-acre gravel pit located in Northeast Portland. The site is bounded by Cully Boulevard on the west, Union Pacific Railroad tracks and Columbia Boulevard on the north side of the pit, and some residential housing on the south side of the pit. The area is primarily industrial and commercial in land use. Access to the site is off Cully Boulevard from N.E. Portland Highway or Columbia Boulevard. This site, along with the Yett gravel pit on the west side of Cully Boulevard, was considered as a potential regional landfill, but was eliminated in favor of the larger sites at Hayden Island and St. John's. The site should still be considered for use as a potential landfill for nonprocessible wastes.

Oregon Asphaltic Paving

The Oregon Asphaltic Paving site consists of a 20-acre gravel pit located at 155th Avenue and S.E. Main Street. The site is in a residential area with a school on one side, a playground on another side, and the remainder of the site surrounded by residential housing. Access to the site is off S.E. Main Street from S.E. Stark or S.E. 162nd Avenue. The site was eliminated after evaluation by the special landfill rating group because of its small size and location in a residential neighborhood. The site could still be considered as a potential landfill for processed refuse. Such a landfill would involve a minimum amount of traffic and nuisance and would transform an empty gravel pit into a park or playground.

Portland Sand and Gravel

The Portland Sand and Gravel site consists of a 35-acre gravel pit located at 10717 S.E. Division Street. Residential housing, a park, and a school are located around the pit. The main access to the site is off Division Street through commercial and residential neighborhoods. The site was evaluated by the special landfill rating group and was eliminated from further consideration as a regional landfill because of its small size and location in a residential area. The site should still be considered as a potential landfill for nonprocessible wastes or as a potential land reclamation site using processed refuse as fill material.

Rogers Construction Company

The Rogers Construction Company site is a 53-acre area being mined for gravel. Gravel operations owned by Gresham Sand and Gravel and a portion of the completed Vance Pit landfill are located on the west and south sides of the site, with 190th Avenue on the north and residential housing on the east. Access to the site is off 190th Avenue from Division Street or Stark Street. The site was evaluated by the special landfill rating group and was subsequently eliminated from further consideration as a regional landfill because of the nearby residential housing and its relatively small size. The site could still be considered as a potential landfill for nonprocessible wastes or as a potential land reclamation site using processed refuse as a fill material.

Waybo Gravel Pit

The Waybo, Inc., site is a 15-acre gravel pit located on N.E. Killingsworth Street just off 82nd Avenue. The pit is bounded by commercial establishments on the east, residential housing on the south, another small gravel pit on the west, and N.E. Killingsworth on the north. The gravel pit adjacent to the Waybo site could probably be filled along with the Waybo gravel pit, but it was not considered as a specific site. Access to the Waybo site would be off N.E. Killingsworth from 82nd Avenue or Columbia Boulevard. The site was considered as a potential regional landfill, but was eliminated in favor of the larger sites at Hayden Island and St. John's. The site could still be considered as a potential landfill for nonprocessible wastes or as a potential land reclamation site using processed refuse as a fill material.

Yett Gravel Pit

The Yett site is a 42-acre gravel pit located in Northeast Portland. The site is bounded by Cully Boulevard on the east, the Union Pacific Railroad tracks and warehouses on the north, N.E. Portland Highway on the south, and a limited amount of residential housing on the west. Access to the site is off Cully Boulevard from N.E. Portland Highway or Columbia Boulevard. This site, along with the Nash gravel pit on the east side of Cully Boulevard, was considered as a potential regional landfill, but was eliminated in favor of the larger sites at Hayden Island and St. John's. The site could still be considered as a potential landfill for nonprocessible wastes.

WASHINGTON COUNTY

Cooper Mountain

The Cooper Mountain site consists of a series of gravel pits with a total area of 200 acres off Farmington Road 4 miles southwest of Beaverton. The site is located in the northwest portion of Cooper Mountain and is isolated from residential development. Access to the site is off Farmington Road and Clark Hill Road. The owner estimates that the present gravel operation could last up to 20 years and that he would not consider using the site for landfill until he has finished the gravel extraction. Another important consideration is that there are four public wells located on or adjacent to Cooper Mountain which severely limit the use of this site. The site, when gravel operations are completed and if an alternate public water supply were located, could be considered as a long-range potential landfill.

Frank

The 51-acre Frank site is situated on a hillside which slopes down to a flood plain of the Tualatin River. A number of small springs pass through the property, emptying into the Tualatin River. The property has a predominately silty clay soil. The property and surrounding area are agriculturally sound with farm houses located on either side of the property on Beef Bend Road, the nearest of which is roughly four-tenths of a mile away from the operating face. This site was considered as a potential regional landfill, but eliminated due to the following facts: (1) the Frank site is a nonconforming prior land use, and the Washington County Planning Commission has indicated opposition to any expansion of the site; (2) in 1973 the owner of the site attempted to expand his facilities and was denied a permit by the County Planning Commission; (3) the present DEQ and County permits specifically exclude all additional site users by stating that only the commercial collection trucks serving Frank's franchised area shall use the site; (4) traffic volume on Beef Bend Road leading to the site is already a problem, and expanded use of the site by additional haulers would increase the traffic loads; (5) the site has a relatively small capacity; (6) filling of the site has only marginal land reclamation value.

Porter Yett

The Porter Yett site consists of an 8-acre gravel pit and 14 additional acres of hilly land located on Scholls Ferry Road 3 miles west of Tigard. The site is situated on the southeast slopes of Cooper Mountain and is relatively isolated from residential development. Access to the site is off Scholls Ferry Road. The site has been previously considered for use as a sanitary landfill, but the application for a disposal site permit was turned down by the Environmental Quality Commission. Because of limited size and previous rejection by Environmental Quality Commission further investigation was not pursued.

Sexton Mountain

The 40-acre Sexton Mountain site consists of a gravel pit and other hilly land located off Murray Road 2 miles south of Beaverton. There are scattered homes near the site, and the main access road to the site, Murray Road, passes through a heavily developed residential neighborhood. The site is less than 1 mile from a public well and for this reason did not receive further consideration as a potential site. Should an alternative water supply be located, this site would again have potential for landfill purposes from the standpoint of the public benefit derived from filling the pit.

APPENDIX L

Appendix L

GEOLOGY AND SOILS OF SELECTED SITES

INTRODUCTION

This report provides the following information for each landfill site.

1. Elevation of water table and water table gradient
2. Potential flood hazard
3. Erosion hazard
4. Suitability of site material for leachate retention
5. Suitability of on-site cover material
6. Potential for landfill gas migration
7. General design considerations

Field reconnaissance by a COR-MET geologist, map and literature studies, and conferences with Portland State University Environmental geologists and U.S. Geological Survey personnel helped supply the desired information.

Invaluable guidance was received from Randy Sweet, hydrogeologist with the Office of the State Engineer.

Soil description are based on visual and tactile examination of soils sampled during field reconnaissance.

Confidence in soil depth determination varies from site to site. It is high for sites that have excavated pits and low for sites that have no excavations or nearby wells. This is true for information on water table parameters and elevations of any sedimentary horizon.

Geology and Hydrogeology

All of the sites studied are covered by unconsolidated sediments, sometimes hundreds of feet thick. These sediments range from impermeable to highly permeable and would allow estimated flow rates ranging from 0.001 gallons to 10,000 gallons per day per square foot.

Some of the sites have dipping or inclined sediment layers which could control the migration of water or gas.

Most of the sites are adjacent to streams or rivers assumed to be hydrogeologic boundaries to a given groundwater body. Stream or river surfaces usually provide an accurate elevation of the water table at the stream location. The water table generally rises away from the stream towards areas of higher ground elevations. This results in a flow or migration of groundwater toward the stream.

Water table data was obtained by using existing water well data. Well water elevations are elevations of free-standing surface water, not the water table. These two measures can be considerably different. To reduce errors introduced by using free-standing water surface, deeply cased wells were not used as indicator wells and interpolations were made from shallow wells.

Sanitary landfills will frequently alter the hydrogeologic environment, particularly in the cases of surface drainage and precipitation runoff. If operation of the landfill is to proceed satisfactorily, these alterations must be recognized in design.

Sanitary Landfill Design

The basic purpose of a sanitary landfill is to provide for the disposal for solid wastes in a nuisance- and hazard-free manner without an adverse effect on the environment by compacting the solid waste and covering it with soil. Usually nuisances and health hazards are prevented by compaction of the solid wastes and daily covering with soil. Since the prevention of nuisances is related mainly to daily operation, the major emphasis of design is usually on protection of the environment, namely prevention of significant ground and surface water contamination, and prevention of explosion hazards from migration of landfill gases.

Prevention of Groundwater and Surface Water Contamination. Three basic types of design are available for preventing groundwater and surface water contamination.

1. Low migration of leachate under acceptable conditions. The amount of leachate (contaminated water from landfills) is reduced by using a highly impermeable cover material and by diverting surface water runoff from outside the landfill. This procedure reduces the amount of water entering the fill and the amount of leachate that is produced from the landfill. The reduced quantity of leachate is then allowed to enter the groundwater. This procedure is usually acceptable where the groundwater is not used for domestic water supplies or where it discharges a short distance from the point of contamination to a stream of sufficient size to dilute contaminants to a negligible level. Usually monitoring wells to measure contaminants are installed near a landfill with this type of design.

2. Migration and recovery of leachate. The landfill is designed for low migration of leachate under acceptable conditions, but leachate, after entering the groundwater, is removed by pumping. This design would generally be used as a backup for a design based on a low migration of leachate under acceptable conditions, to assure a means of contaminant removal if the contaminants in the groundwater exceeded a given level.

3. Retention and recovery of leachate. The landfill is designed with a highly impermeable cover, but any leachate is retained by an impermeable soil layer or by existing impermeable soil at the landfill site. The leachate can then be collected by a system of drains and sumps and treated biologically before disposal.

The type of design to be used at a particular site usually depends on the type of soil available at the site and the use of groundwater near the site. If a relatively impermeable soil covers an extensive portion of the site, a design based on retention and recovery of leachate would be necessary because leachate produced in the landfill would tend to come out on the ground surface rather than entering the groundwater. A landfill site located near a large river and underlain by permeable soils would be designed for a low migration of leachate to the river where dilution of contaminants would result in negligible effect on the environment. When a landfill site is located in permeable soils, but at some distance from the area where groundwater would discharge into a river, a design based on retention and recovery of leachate using a bottom seal of imported, impermeable soil would probably be required.

In areas where a landfill site would be subject to flooding, dikes would be required to prevent flood waters from entering the site. The dikes would have to withstand the erosion of floodwaters as well as preventing the entrance of water. Pumps would usually be necessary at the site to remove collected precipitation or groundwater infiltrating into the diked area during periods of flooding.

<u>Prevention of Explosion Hazards</u>. One of the gases produced during biological decomposition of refuse in a landfill is methane, a gas that is explosive when mixed with air in certain concentrations. Usually, the potential for accumulating

explosive concentrations of methane from a landfill is negligible except where structures are located adjacent to or on a landfill. In such cases methane gas can migrate through loose, permeable soils and accumulate in explosive concentrations under or within the structures. To prevent the possible migration of gases to existing structures, barriers of impermeable soils or special trenches filled with loose gravel are used to cut off or intercept the gas flow. Structures built on or adjacent to completed landfills should be designed especially to prevent gas accumulations. The design of gas control devices was considered only for those sites with structures adjacent to proposed landfills.

Erosion Control. In an area of relatively high rainfall, as the Pacific Northwest, a common concept for reducing leachate is to provide a relatively impermeable final cover on the fill. While this is a sound concept, it is necessary to also ensure through final design that the cover material will not be subject to rapid erosion with subsequent exposure of the fill.

ALFORD

General Description

This location is an old (pleistocene) stream terrace; the material has the appearance of glacial outwash. The surface is a thin, gravelly soil about 1 to 2 feet thick. Below this are cobble gravels interbedded with fine sandy silts. The depth of the gravels is probably from 0 feet at the terrace margin to 100 feet at the slope to Clear Creek. The gravel and silt beds are nearly horizontal; no cross bedding was seen. The gravels overlie more consolidated materials that generally dip toward the west at the rate of about 40 feet per mile.

The property owner intends to mine this area for gravel with the intention that the excavation left after mining would be used for a landfill. The information presented here would be valid for a excavation of about 50 feet deep but would not necessarily be correct for deeper excavations.

Three large trenches previously dug for inspection purposes had water standing in them about 12 feet below the surface of the terrace. This is a local water table and indicates relatively impermeable materials below.

The site location is shown on Figure L-1.

General Geology

The proposed landfill site is underlain by old alluvium of the Estacada Formation. This formation consists of cobble gravel and bouldery-cobble gravel with interbeds of finer sands and silts. This older alluvium terrace is a remnant of a more widespread unit deposited in the ancestral Clear Creek valley. The terrace deposit overlays and is bounded to the southwest by the Sandy River mudstone. To the northeast the terrace is bounded by the Gresham Formation, which is older than the terrace but has similar composition.

Depth of the terrace alluvium ranges from zero, adjacent to Clear Creek, to about 40 or 50 feet along the contact with the Gresham Formation to the northeast.

The surficial geology of the site is mapped on Figure L-2.

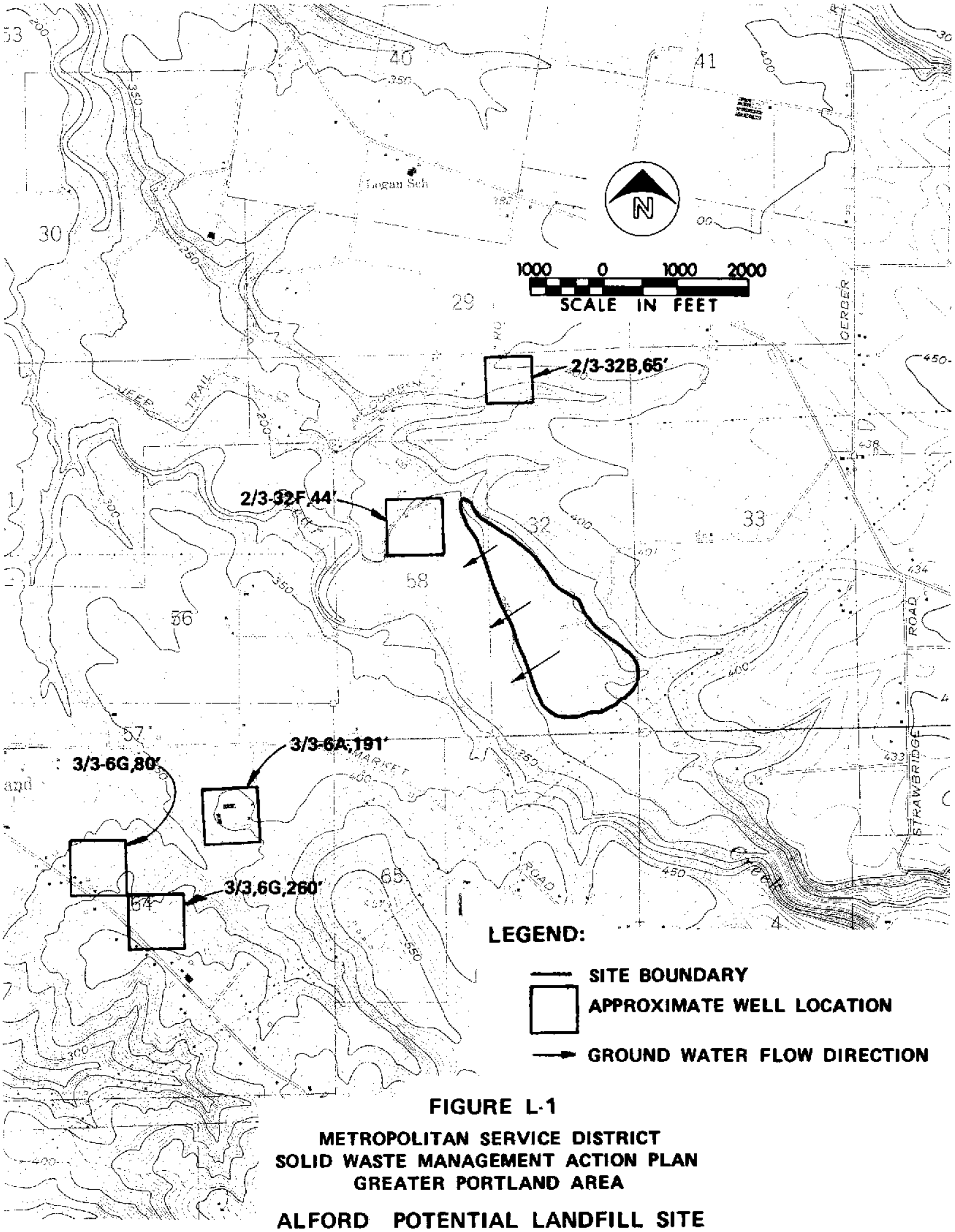


FIGURE L-1

METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

ALFORD POTENTIAL LANDFILL SITE

cor-met

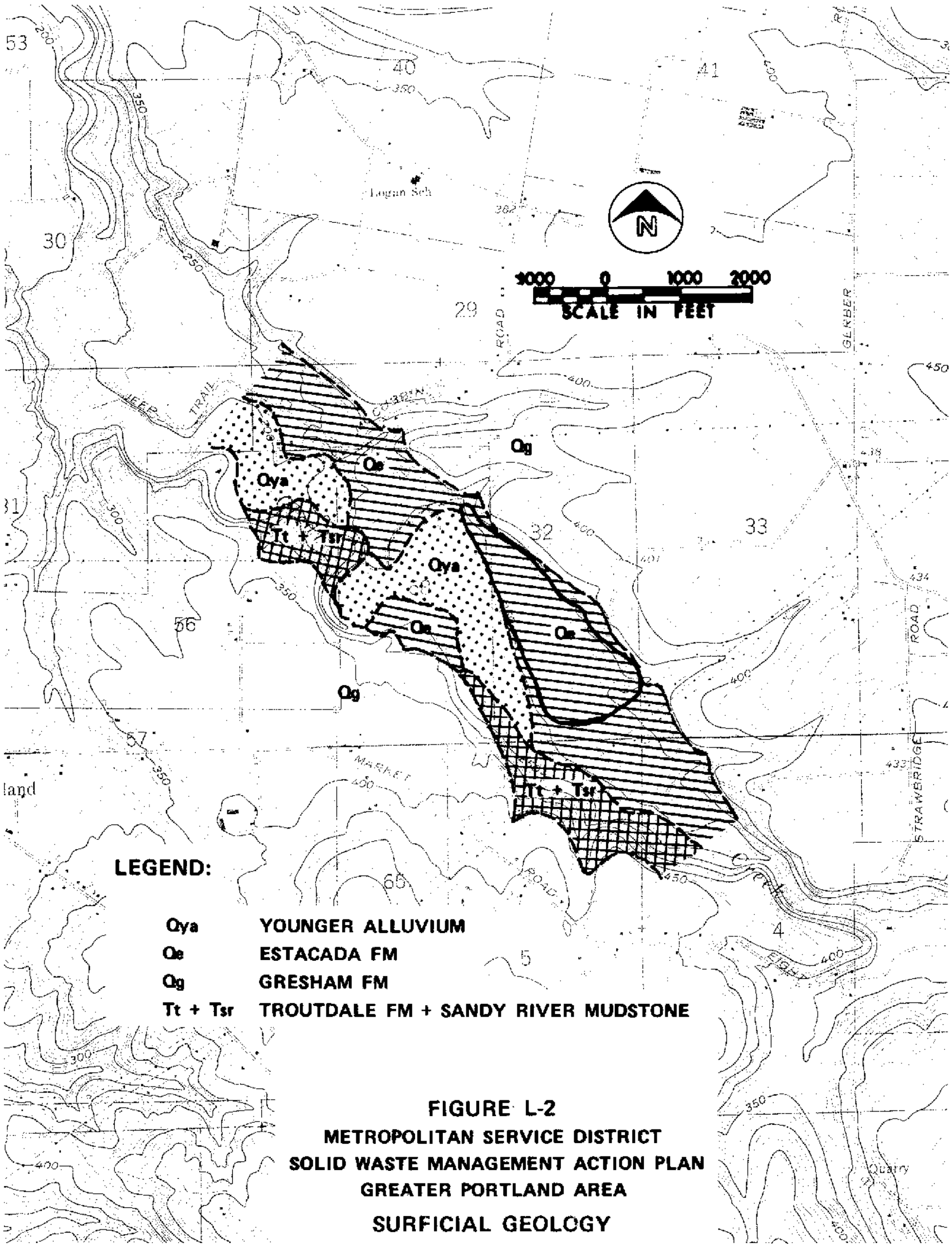


FIGURE L-2
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA
SURFICIAL GEOLOGY

Surface Water

Upland runoff to the site occurs from well defined drainages developed on the older Gresham Formation. Drainage leading from the site is not well defined, indicating either that considerable percoltion of surface inflow is occurring or that the drainage had started to develop on the Gresham Formation prior to implacement of the Estacada Formation. The drainage area above the site covers about 200 acres of moderately flat slopes. Due to the nature of the terrace soils, all surface runoff would have to be routed around the disposal area to Clear Creek, to avoid flooding of the site.

Surface flooding of the site from Clear Creek (from lateral seepage or direct inundation through erosion) could occur if the pit excavation were below flood stage.

Groundwater

Groundwater produced locally occurs in the Gresham Formation, which outcrops adjacent to the Estacada Formation underlying the site. Local wells surveyed, as shown on the site map, have a typical depth of 60 to 100 feet and have a specific capacity of about 1 gallon per minute per foot of drawdown.

The better producing Troutdale Formation outcrops above the disposal site as shown on the USGS geological map of the area. The Columbia River basalt underlies the site but it is separated from the site by the Sandy River mudstone. Well data from the USGS indicates no groundwater production from the Columbia River basalt near the disposal site.

From the geology and topography it would appear that groundwater movement would be from the Gresham Formation toward the younger Estacada Formation underlying the site.

Movement of groundwater downward from the disposal site into the Sandy River mudstone is possible, but not likely due to the low permeability of the mudstone. If saturation conditions were to develop, a more likely exit would be a seepage into the creek at the terrace margin. In addition to surface inflow, which can be routed, seepage into the pit could occur as groundwater seepage from the Gresham Formation. This seepage could also be diverted, at least in part. The low permeability of the Gresham Formation, exhibited in the low well yields, indicates that this lateral seepage should be minimal.

Generated leachate from precipitation and lateral seepage will most likely exit at the terrace margin.

Cover Material

The on-site material seems suitable for cover, provided a good mix of fines and gravel is used.

Bottom Seal Material

If a bottom seal should be considered necessary, the on-site material could probably be utilized to provide some decrease in permeability.

Gas Migration

Gas migration should pose no problem at this site. Horizontal movement is limited by the eroded slope on the Clear Creek side of the terrace and by the underlying Gresham Formation materials on the other.

Design Considerations

This area has a high potential for recreation; therefore, design standards should be high.

If the site is designed with a retention and recovery of leachate system or any system that requires a low production of leachate, then care should be taken to prevent lateral migration of surface runoff from the diversion channel to the fill area.

Surface runoff would have to be diverted from the landfill site if minimum leachate production was required.

The Washington County soil map prepared by the soil conservation service shows soils in the area that would have minimum problems with regards to traffic loads and traction.

CIPOLE

General Description

The proposed landfill area is in the Tualatin Valley, which has a rolling topography. The valley's elevation varies from 120 feet to 170 feet above sea level. Generally the higher elevations at the site are to the north; surface drainage is to the southwest toward Rock Creek. Materials near the surface consist of lacustrine sands which show cross bedding and some small (pea size) gravels. The sands are very clean and have only occasional small beds of silty material.

The site is currently being developed as a sand quarrying operation, and most of the site would be mined for sand and gravel before being used as a sanitary landfill. The site location is shown on Figure L-3.

General Geology

The proposed disposal site is underlain by older lacustrine sands in the northern portion and younger alluvium in the southern part. The older lacustrine deposits are generally coarse grained sands with lenses of pebbles. The older lacustrine sands are a flood deposited sand which contains scarcely any fine material. The younger alluvium is a deposit of silts and fine sands with some clays.

Beneath the older sands and the younger silts and clays is the Troutdale Formation. This formation consists of poorly cemented silt, clay, and silty fine sand. The Troutdale Formation contains the principally developed aquifer in the area.

Depth to the Troutdale Formation varies, in the vicinity of the disposal site, with elevation. The Troutdale Formation is found at about 100 feet above sea level here. Below the Troutdale Formation the Columbia River basalt is found from 560 feet below sea level to 300 feet below sea level. One well near the site penetrated the basalt at 370 feet below sea level.

The surficial geology of the site is mapped on Figure L-4.

Surface Water

Surface runoff poses little problem at this site. The general surface drainage is to the southwest toward Rock Creek. Imported cover material would alter the surface runoff pattern slightly, but any alterations could be handled in design.

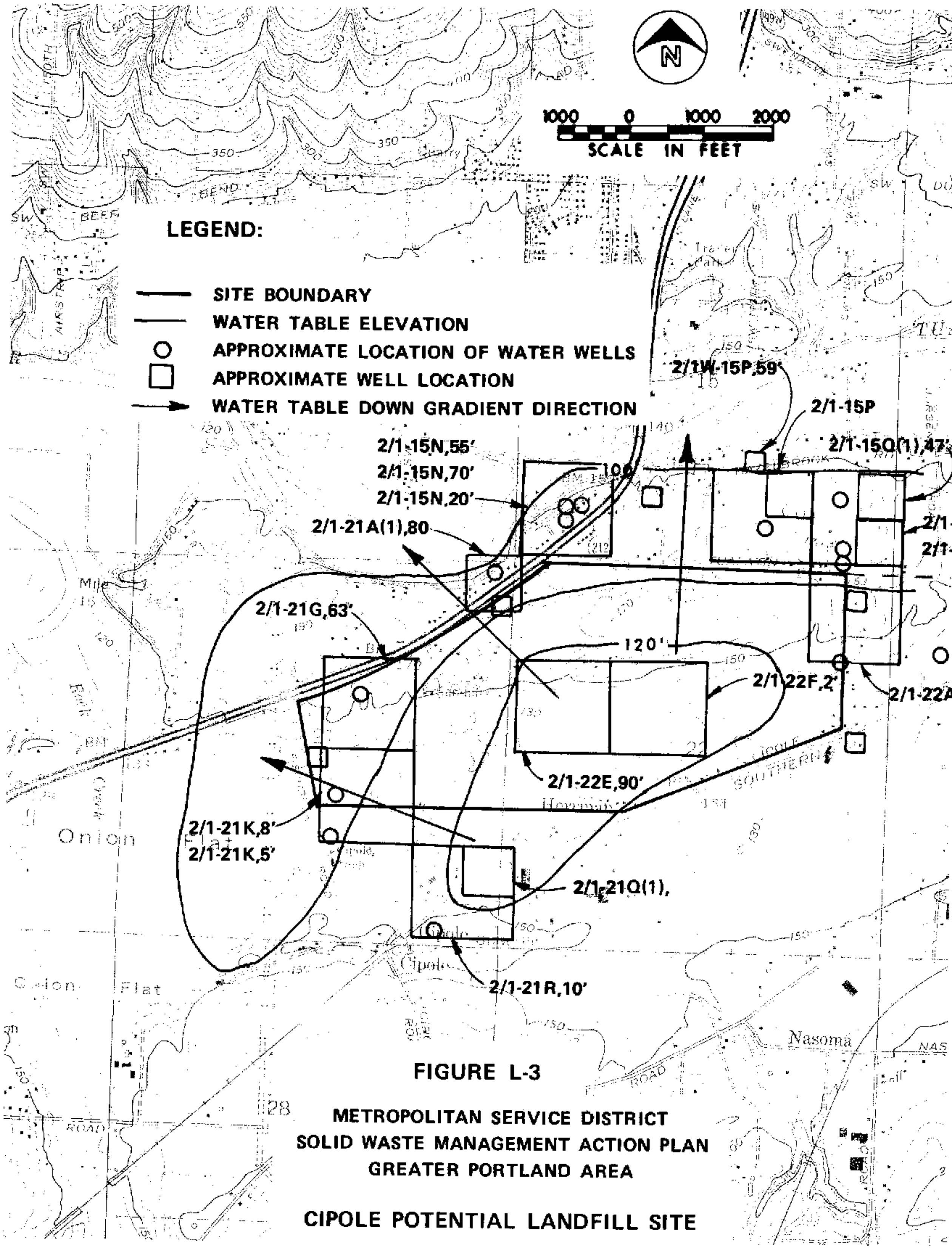


FIGURE L-3

METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

CIPOLE POTENTIAL LANDFILL SITE

cor-met

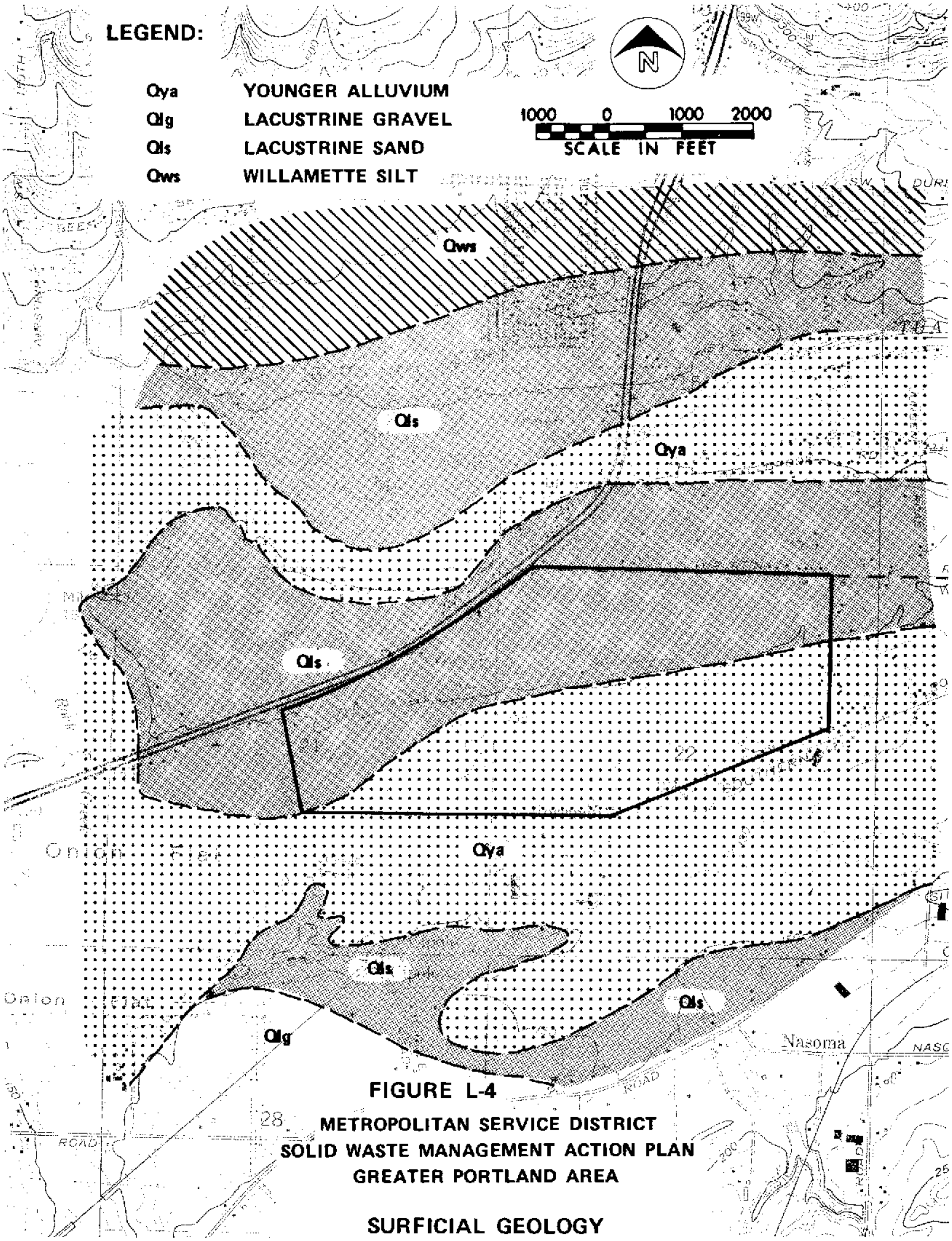


FIGURE L-4
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

SURFICIAL GEOLOGY

cor-met

The low areas of the site are subject to flooding by the Tualatin River. Flood water elevations were estimated for the floods of 1933 and 1964. The 1964 flood covered a small part of the site in the southwest corner below elevation 125 feet; the 1933 flood, an area below elevation 140 feet. Some diking would be required to protect against flood elevations of 125 feet; intensive diking would be required to protect against flood elevations of 140 feet.

Groundwater

The elevation of the water table was calculated and plotted on the basis of existing well data. One possible system of groundwater contouring and horizontal migration for the average high groundwater table is shown on Figure L-3.

Groundwater generally appears to flow west toward Rock Creek and north toward the Tualatin River as shown in Figure L-3.

A low permeability layer was inferred from some of the well logs, but this apparent layer is not discernible in the logs of the eastern part of the site. A test hole drilled by COR-MET penetrated a highly impermeable layer from a depth of 72 to 85 feet below the surface. This soil layer has a permeability of 1.1×10^{-8} cm/sec, which would effectively retard any downward migration of leachate. If this is a layer and not a lens, then it would act as a barrier to contaminated groundwater. Because available evidence does not justify assuming a layer at this time, however, the more conservative outlook would be to assume that the low permeability material occurs in lenses.

Well logs of wells in the vicinity of the site indicate that most of the domestic wells are developed in the Troutdale Formation. These wells with few exceptions have specific yields of less than 1 gallon per minute per foot of drawdown.

There is some indication that groundwater in the shallower aquifer could be contaminated. The well log for the well at Cipole School shows contaminated water from a depth of about 70 feet. When this strata was cased off and the well drilled down to a water-bearing sand at 270 feet, uncontaminated water was located.

Cover Material

Most of the area has a very shallow soil; therefore, the cover material on the site is the same as the base material, medium sand. If excessive filtration of surface water is to be prevented, a low permeability cover material would have to be imported to the site.

Bottom Seal Material

The soil present at the site has a high permeability and would not prevent leachate from entering the groundwater. A bottom seal of impermeable soil would be necessary to prevent significant quantities of leachate from entering the groundwater.

Gas Migration

Gas migration would be essentially vertical through surrounding soils and lateral movement of gases should be no problem.

Design Considerations

This site seems best suited for a low migration of leachate under acceptable conditions. It would also be possible to design for the migration and recovery of leachate by installing wells in the site and pumping them enough to cause a cone of depression in the water table near the site. This would cause groundwater to flow toward the site instead of away from it and allow recovery of the leachate. Dike material and cover material would have to be imported. Because of the permeable nature of the on-site materials, a very low permeability cover would have to be found if it was desirable to reduce leachate production. Gas migration should not be a critical factor in design.

Observation of tracks and equipment involved in the quarrying operation would indicate that the soils in the area would not present significant maneuvering problems for refuse vehicles.

DURHAM

General Description

The proposed site is in a low pass or gap between the Tualatin and Willamette valleys and is aligned with the long axis of Lake Oswego. This gap is believed to have been caused by flood erosion water of catastrophic magnitude. The Durham area is, then, the "delta" of these floods.

The subsurface material is about 100 feet thick in the site area and consists of a mixture of a silt, sand, gravel, and boulders. Two abandoned gravel pits, excavated by the owner to about 100 feet below the surface, were examined by COR-MET representatives.

The south pit contains some faint, subtle bedding. The apparent maximum boulder size in that pit is about 3 feet in diameter. The north pit has a large (approximately 100 feet by 150 feet) clay lens that remains from the gravel mining operation. The layer has 3 feet of thickness exposed. There is a minimum of 1,000 cubic yards of this clay which could be used to mix with quarry material to provide a bottom seal. A 50-foot by 100-foot pond in the north pit stands 3 feet above the pit's lowest elevation. The pond, which is above the local water table, was formed by fines from gravel washing that sealed the pit bottom. The apparent maximum boulder size in that pit is about 1.5 feet in diameter.

The site location is shown on Figure L-5.

General Geology

The site is underlain by deposits that have been mapped as lacustrine gravel by the Oregon Department of Geology and Mineral Industries. Below the lacustrine gravel, the Troutdale Formation is found at about the bed elevation of Fanno Creek. This is about 100 to 110 feet above sea level. The Troutdale Formation here consists of about 300 feet of sands and silty sands. To the south and west of the site, lacustrine silts, in some places overlain by younger alluvium, are found. To the north, the slightly older Willamette silts are found as surficial deposits.

The surficial geology of the site is mapped on Figure L-6.

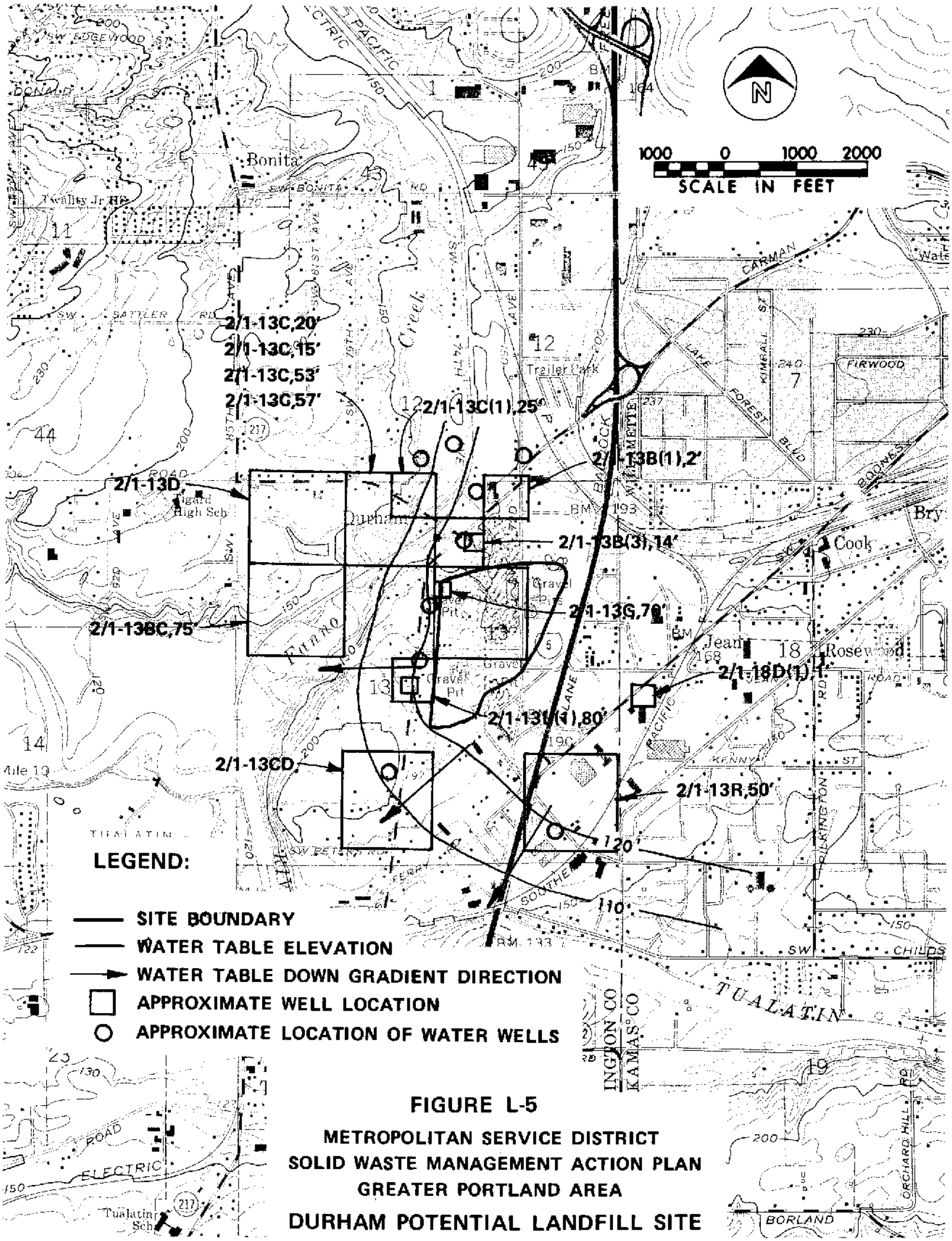


FIGURE L-5

METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

DURHAM POTENTIAL LANDFILL SITE

cormet

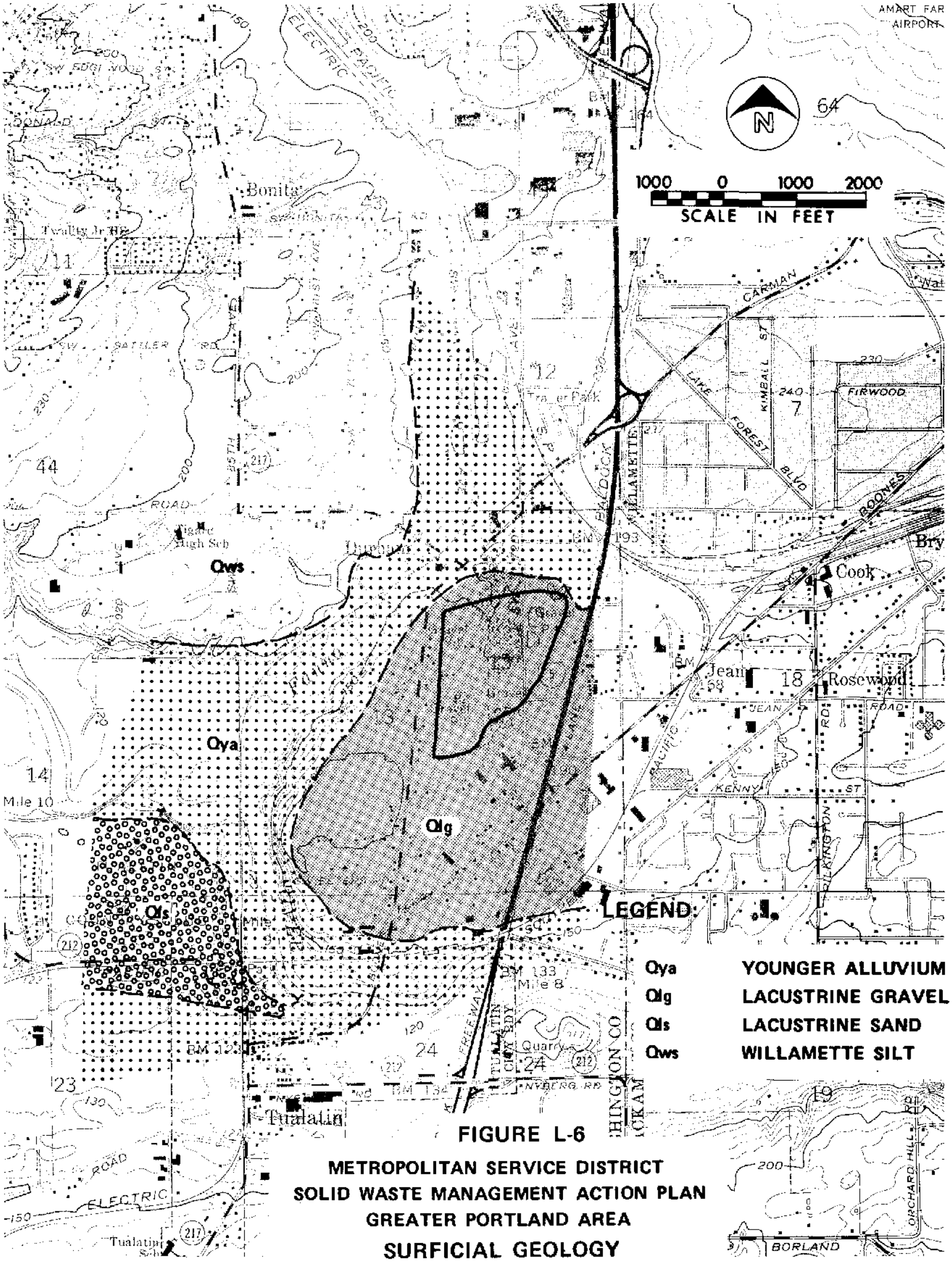


FIGURE L-6
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA
SURFICIAL GEOLOGY

cor-met

Surface Water

Surface runoff does not seem to present any problems at this site, but shallow ditching to divert surface runoff might be necessary on the south and west sides of the property.

This site's flood hazard is negligible; the entire site is above the elevations of the 1933 Tualatin River flood.

Groundwater

Groundwater elevations were obtained from existing well data. The water table gradients from this data indicate potential groundwater movement toward Fanno Creek and the Tualatin River. Both would act as discharge areas and should limit the migration of groundwater.

Well data from the area indicated that sediments underlying the landfill site are quite permeable and would not act as an effective barrier to leachate seepage.

Well logs on file with the State of Oregon indicate that modest-yield wells in the site area are producing from the Tualatin Formation. These wells generally have specific capacities of less than 1 gallon per minute per foot of drawdown, although some wells produce over this figure.

One well drilled near the site in 1961 encountered turbid water at a depth of 65 to 90 feet. This would be in the lacustrine gravels. This stratum was cased off and the well completed to 146 to 165 feet where usable water was found.

The gravel mining operation in these pits was reported to have contaminated nearby wells. Both turbidity from wash water and bacterial contamination were reported. It should be noted that domestic sewage in the area at the time was processed by subsurface disposal (septic tanks) methods.

The distance from the general land surface down to the water table is about 40 feet. One of the pit excavations is below this elevation and would allow the water table to reach the surface during periods of high water. Without a barrier, infiltration of rainwater and contact with the water table would produce leachate.

Cover Material

There is generally no cover material on the site because the site consists of a large excavation. Material from the road separating the two pits is not suitable for impermeable cover material, so cover material would have to be imported.

Bottom Seal Material

The clay lens in the north pit could be mixed with pit material to give a highly impermeable bottom seal. Various test mixes would have to be tried to determine the feasibility of this option. The addition of the clay and reworking of the other materials could reduce the permeability of the bottom of the site.

Gas Migration

Gas migration from the site into the surrounding material is possible. Once in the surrounding material, gas migration would probably be nearly vertical because of this material's high permeability. As the filling progressed upward, sealing at the side would be required to prevent gas migration to nearby buildings.

Design Considerations

This site is best suited for a design based on retention and recovery of leachate, or a low migration of leachate under acceptable conditions. Some impermeable bottom and cover material would have to be imported. Surface water drainage would present only minimal problems. Gas migration to nearby residences would have to be controlled with soil barriers or other devices.

Traffic maneuverability on the natural site materials would be good. The character of the imported cover would determine traffic maneuverability on those portions of the site where it was used.

HAYDEN ISLAND

General Description

Hayden Island is in the Columbia River, about 1 mile upstream from the mouth of the Willamette River. It is composed primarily of recent alluvial sands. Dredge spoil is located on the eastern part of the island and possibly on other parts as well. The spoil would consist of river sand, so no difference in material characteristics would be noted.

The site location is shown on Figure L-7.

General Geology

Hayden Island is composed of and underlain by recent alluvium. Soil borings at Terminal 6 just south of the site across North Portland Harbor indicate that this alluvium extends

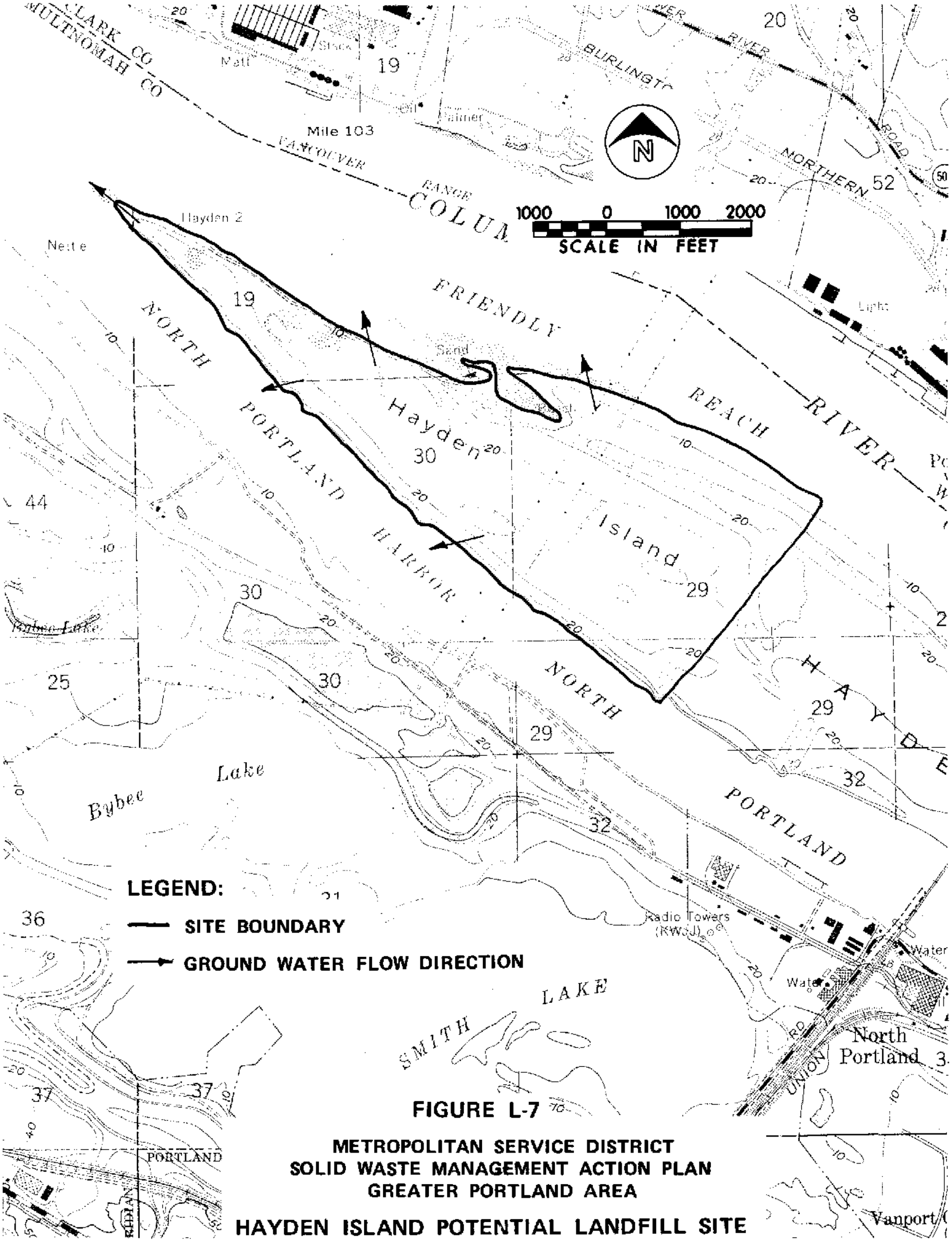


FIGURE L-7

METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

HAYDEN ISLAND POTENTIAL LANDFILL SITE

downward at least 180 feet. The recent alluvium was deposited in a variable current and river level environment. This mode of deposition results in variable texture and noncontinuous sedimentary units. Subsurface materials would consist of sands and silts.

The surficial geology of the site is mapped on Figure L-8.

Surface Water

Very little surface drainage has developed on the island because of the high permeability of the sands composing the island. If a landfill were constructed here, surface runoff could be controlled easily. Flooding, from high levels of the Columbia River, is a distinct possibility. Elevations on the undeveloped, western part of the island are between 10 and 20 feet. Dikes on the eastern side of North Portland Harbor Channel are at an elevation of 32 feet. This seems to be the general elevation of dikes in the area, although some are higher.

Groundwater

The area is one of groundwater discharge with the Columbia River on the north and North Portland Harbor on the south. During high river stages, the water table reaches ground surface in the low portions of the island. The water table can be expected to vary with the river stage. Placing refuse in low spots could bring the water table into contact with the refuse during periods of high water. However, because of the high dilution capacity of the Columbia River the effect of intermittent contact of the refuse with groundwater should be negligible.

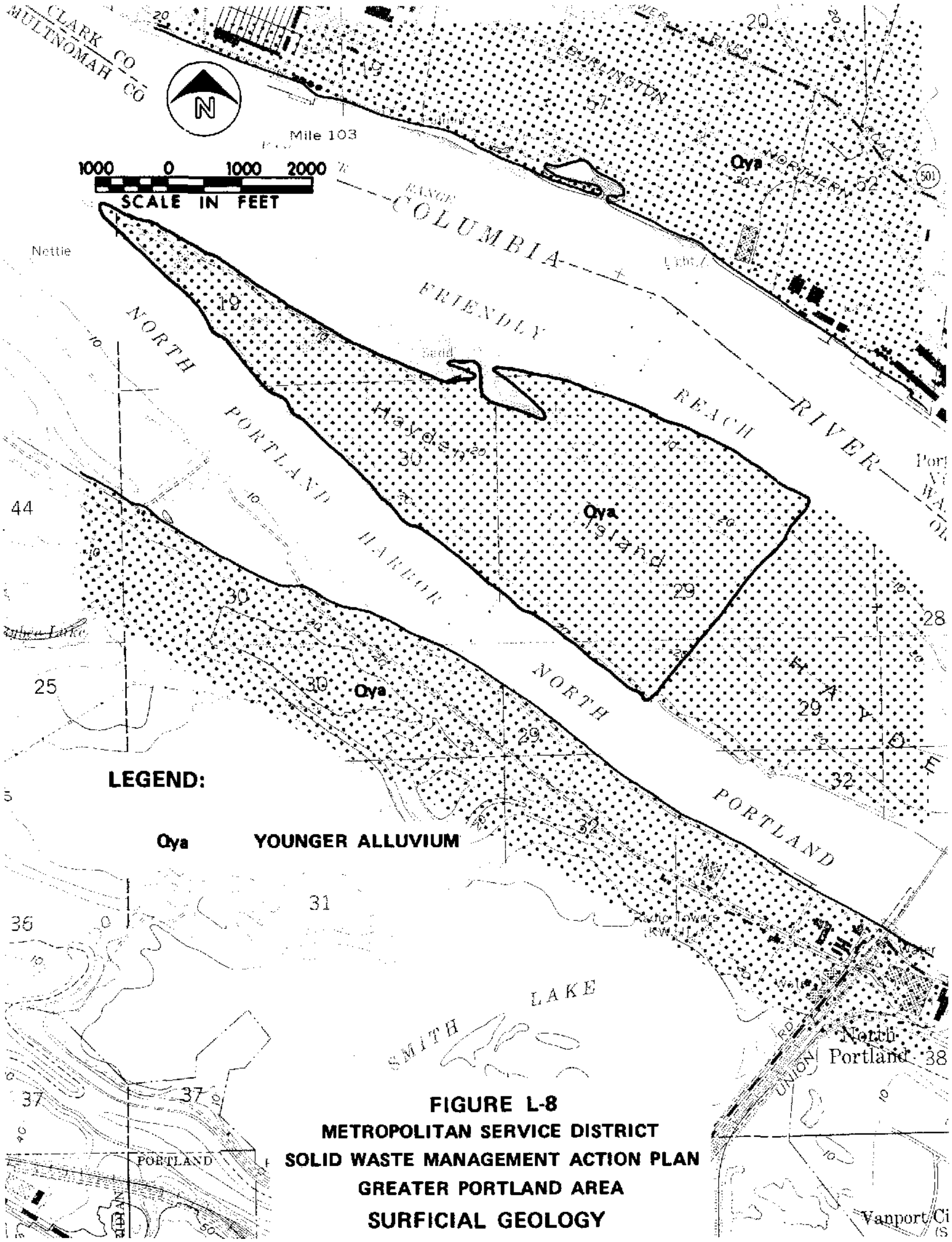


FIGURE L-8
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA
SURFICIAL GEOLOGY

Well logs on file with the USGS indicate that wells in the recent alluvium can develop high yields. A well on the south side of North Portland Harbor had a specific yield of 175 gallons per minute per foot of drawdown.

Cover Material

The cover material on the site is highly permeable; non-permeable cover material would have to be imported.

Bottom Seal Material

The material on the site is too permeable to be considered a bottom seal. However, bottom seal material should not be required at this site because the groundwater at the site is little used and is directly connected with the Columbia River.

Gas Migration

Gas migration should pose no problem at this site. There are no confining strata and no immediately adjacent buildings.

Design Considerations

The most suitable design would be a low migration of leachate under acceptable conditions. Large-scale diking with imported material would be required. Diking should conform to the standards of the U.S. Corps of Engineers to withstand erosion and washout. Surface runoff, with the exception of flooding, should present only minor problems. Cover material would have to be imported. Dredge spoil could possibly be used for this purpose. Gas migration should pose no problems here.

The condition of the unimproved roads on the island indicates that trucks and machinery should be able to move on the surface with little problem. The nature of any imported cover material might alter this for those areas covered.

OLD PUMPKIN

General Description

This site lies at the foot of the southwest flank of the Tualatin mountains. The materials near the surface are silts and silty gravels overlying basalt. The unconsolidated materials are 50 to 100 feet thick (less on ridges). Both the silts and silty gravels are fairly impermeable when compacted.

The site location is shown on Figure L-9.

General Geology

The majority of the surficial material at the site location is Willamette silt. This unit consists of bedded silts and fine sand with occasional lenses of clay. To the northwest these deposits grade into Upland silt and a small portion of Helvetia Formation. The Upland silt consists of materials much like the Willamette silt except it is somewhat finer and evidence of bedding is usually lacking. Upland silt is usually thought of as being a wind blown deposit. The Helvetia Formation consists of poorly cemented sand, sandy silt, and silty clay with thin pebble beds. Beneath the Willamette silt the Troutdale Formation is found about 50 feet below the surface. The Troutdale Formation thins to the north and is probably nonexistent north of the Helvetia Formation outcrop.

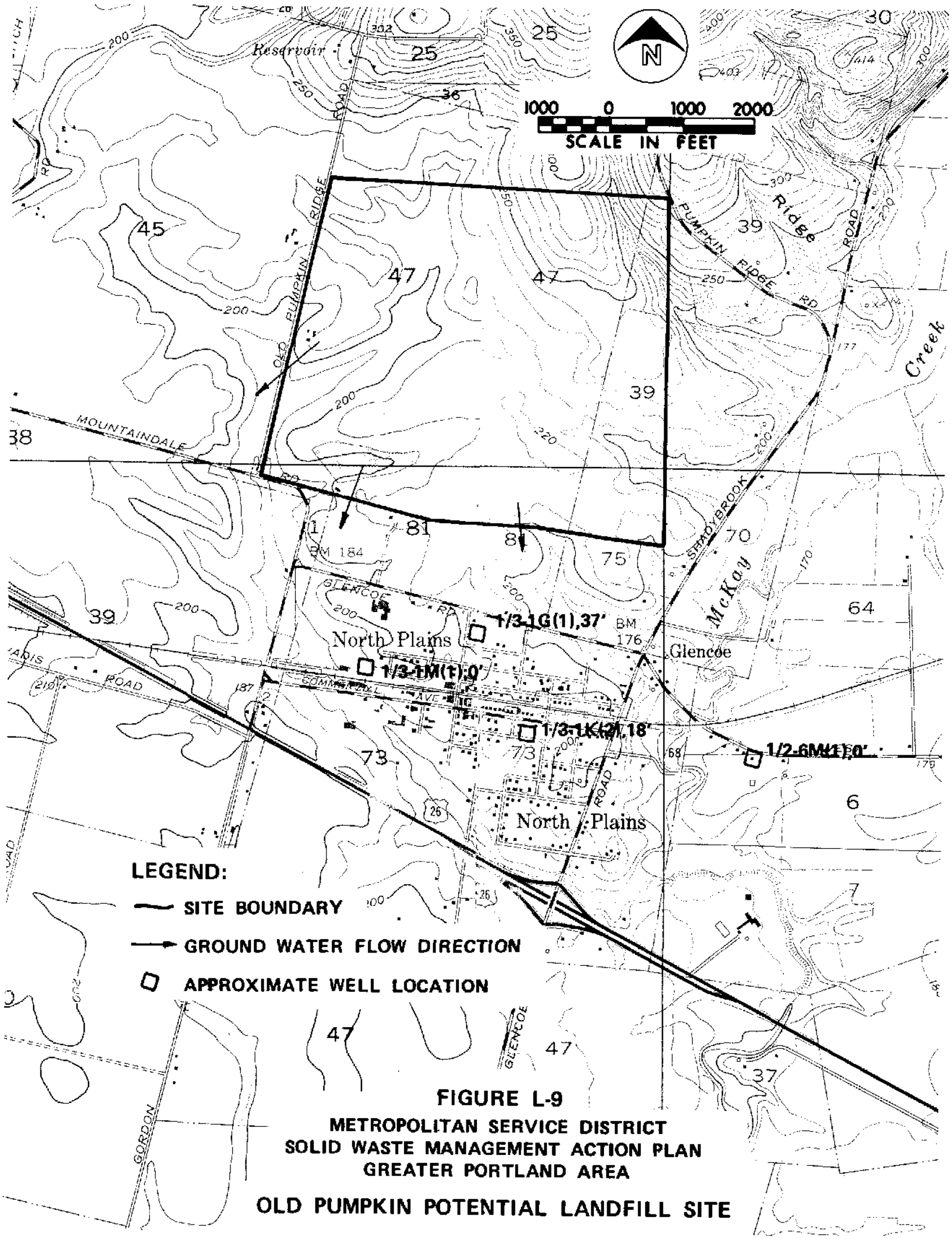


FIGURE L-9
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

OLD PUMPKIN POTENTIAL LANDFILL SITE

cor-met

The surficial geology of the site is mapped on Figure L-10.

Surface Water

Most of the site lies on an upland terrace with the topography rising steeply to the northeast. Runoff from this higher ground would have to be controlled by an interceptor ditch. There are natural drainages leading from the site to the southwest and southeast. Leachate should be collected before it can enter these channels.

Limited well data indicate that the underlying strata have low permeability; therefore, leachate will not filter down into the groundwater. The slope of site should aid in the collection of leachate for treatment.

Groundwater

Well logs on file with the USGS show very few wells; those that produce moderate amounts of water are in the Columbia River basalt. One shallow well in the silt goes dry in the summer and yields 5 gallons per minute in the winter. Wells developed in the silts commonly report iron-bearing water. The low yield of wells in these silts indicate a low permeability for this material at this location.

Cover Material

The site soil is adequate and suitable for cover material.

Bottom Seal Material

The material on the site should be adequate for sealing the bottom of the landfill.

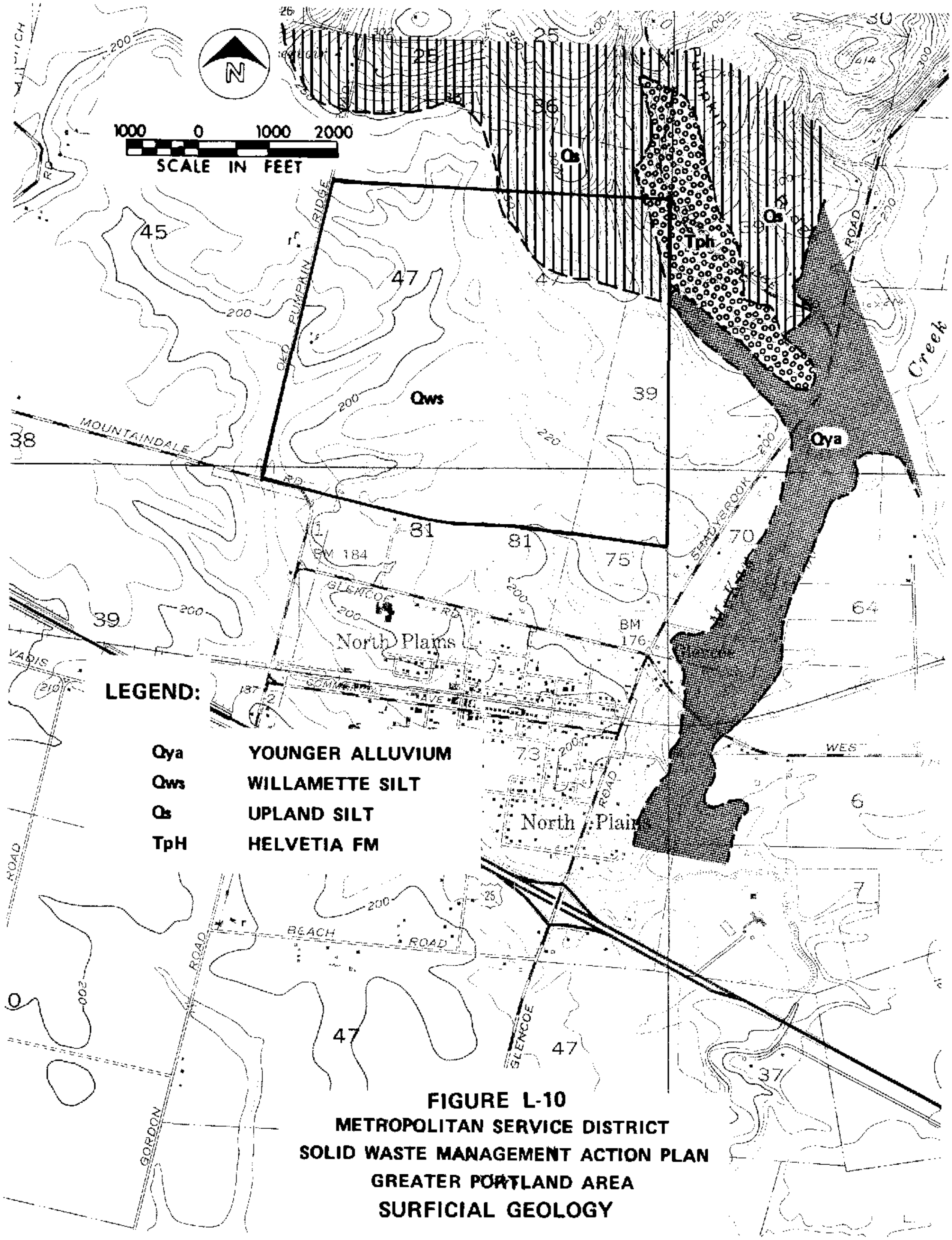


FIGURE L-10
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA
SURFICIAL GEOLOGY

cormet

Gas Migration

Gas could migrate upslope somewhat. It seems likely, however, that the cover material would be more permeable than the underlying material. No problem is anticipated from gas migration.

Design Considerations

This site is suited for a retention and recovery of leachate design. Surface runoff is the primary concern here. If runoff is controlled and the low permeability cover is well compacted on the site, production of leachate could be held to very low levels and collected for treatment. Gas migration should pose no problems here.

The Soil Conservation Service soil map for this area indicates part of the site has a severe soil limitation for roads and streets. Because of this limitation special efforts would be necessary for winter season operation with regard to trucks and machinery.

The nature of the topography and on-site soils, combined with the relatively large drainage basin upstream of this site, indicates that special care should be taken to ensure against post completion erosion into the refuse.

ROSSMAN

General Description

The site lies just south of the confluence of the Clackamas and Willamette rivers. The area is a flat terrace with an average elevation of 30 feet. The fill site is bounded on the east by the relatively steep topography of Clackamas Heights and on the south and west by dikes of elevation 40 feet. The existing landfill is located in the southern part of the site.

The site location is shown on Figure L-11.

General Geology

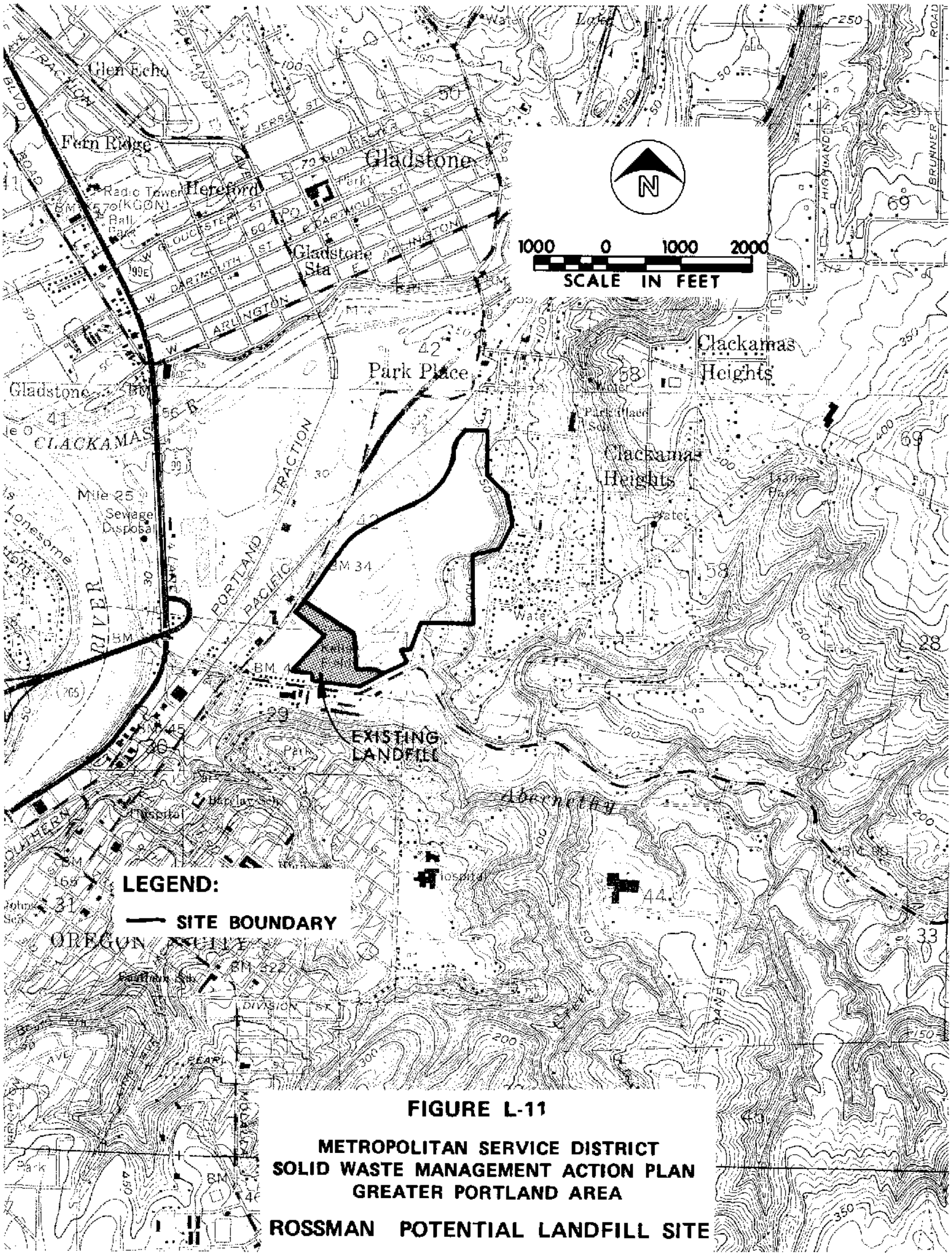
The landfill area is underlain by younger alluvium. The younger alluvium consists of sands, silts, and clays with the finer material predominating. Beneath the younger alluvium are some older silts and clays. These materials in the finer grained fractions should be fairly impermeable.

The surficial geology of the site is mapped on Figure L-12.

Surface Water

Surface water at the site drains to the east to a large ditch at the eastern boundary of the site. Drainage from the Clackamas Heights area also flows into this ditch. The water in the ditch flows south into Abernethy Creek and thence into the Willamette River. The ditch passes under the south dike where it is protected from flooding by flap gates. During periods of high water in Abernethy Creek surface water from the landfill area is pumped over the dike.

Flooding of the area by either the Willamette or Clackamas rivers is prevented by dikes to elevation 40 feet.


1000 0 1000 2000
SCALE IN FEET
LEGEND:
SITE BOUNDARY
EXISTING LANDFILL
FIGURE L-11
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA
ROSSMAN POTENTIAL LANDFILL SITE

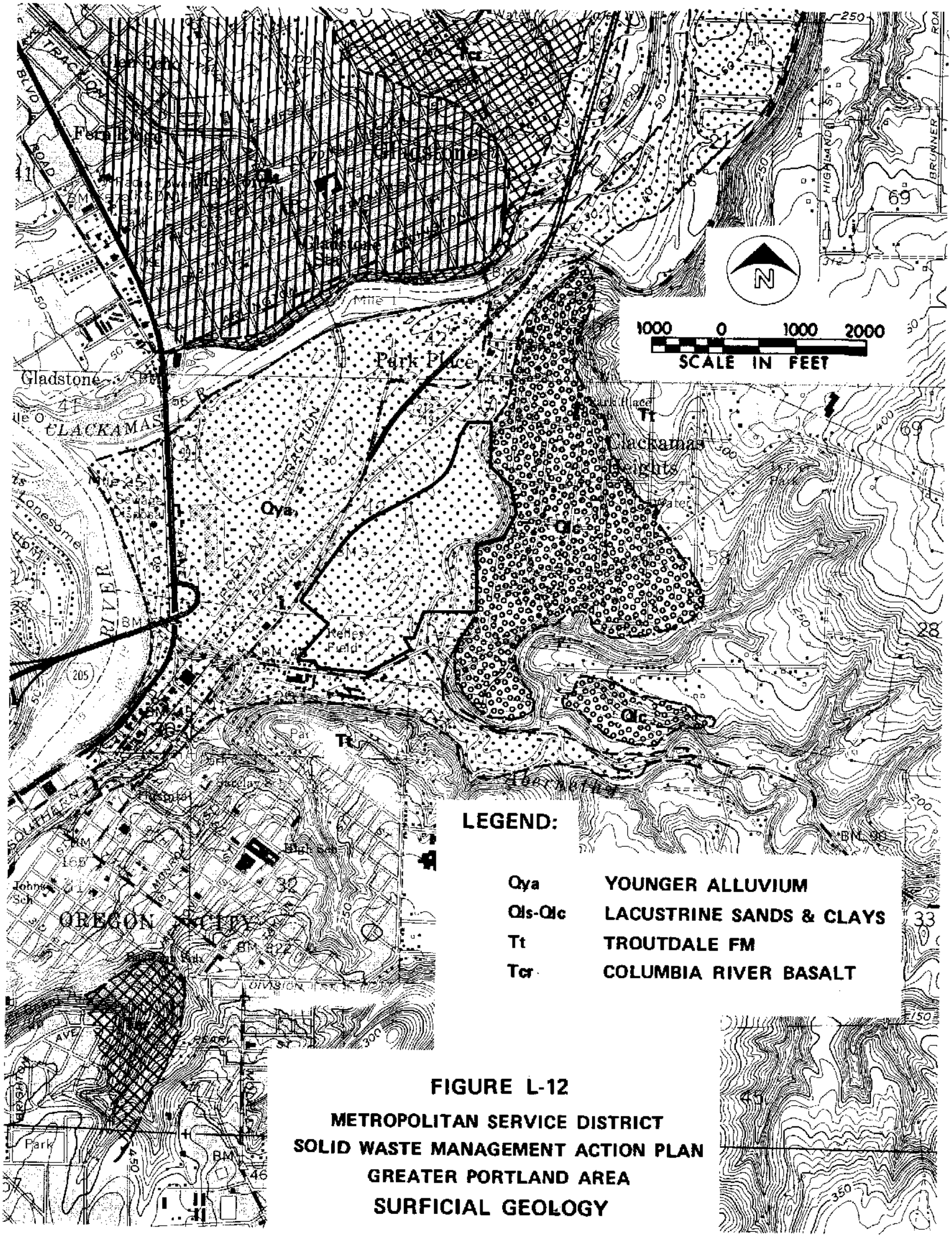


FIGURE L-12
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA
SURFICIAL GEOLOGY

Groundwater

Logs of monitoring wells drilled at the site indicate that the area is one of groundwater discharge, the discharge area being primarily Abernethy Creek. The high impermeability of soils at the site should prevent any significant contamination of groundwater.

Cover Material

The soil at the landfill makes a highly impermeable cover material. However, due to its clayey nature, the soil can become difficult to work with and operate on when it is wet. At the present time operating problems are reduced because a dragline is used for digging and placing the soil.

Bottom Seal Material

The on-site soil provides an excellent seal so there is no need to import material for a bottom seal.

Gas Migration

Gas migration in a lateral direction away from the landfill should not occur because of the elevated nature of the fill and the highly impermeable soil underlying the fill. However, vertical migration of gases through the fill surface could be possible. Such migration could possibly occur through desiccation cracks in the clayey cover material. Accordingly, buildings constructed on the landfill should be designed to prevent the migration and accumulation of gases in enclosed spaces.

Design Considerations

The site seems suited for a design based on retention and recovery of leachate. The existing landfill does not appear to have produced any significant quantities of leachate. However, if leachate should occur in significant amounts, it should be collected and treated before being discharged to surface waters.

The importation of cover material and bottom seal material is not necessary. Surface runoff is provided for in the design of the present landfill. Horizontal gas migration should not be a problem.

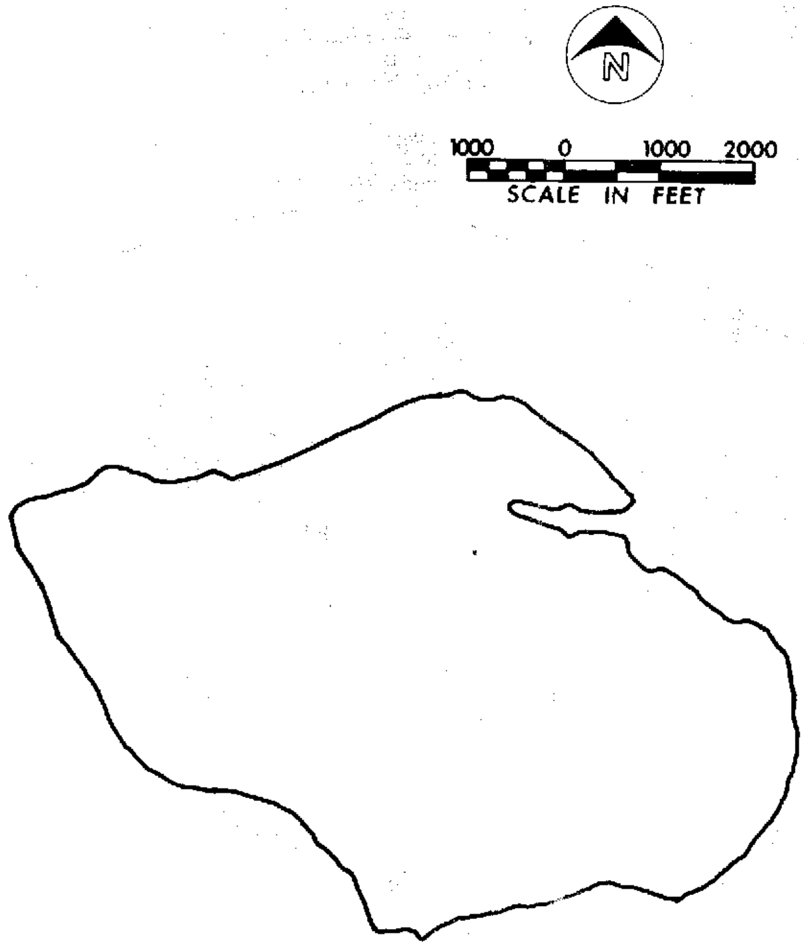
Because of the nature of the cover material and the elevated nature of the landfill, erosion protection should be ensured after site completion to avoid exposure of the fill.

SANDY DELTA

General Description

The Sandy Delta site is at the mouth of the Sandy River where it joins the Columbia River. The Sandy River has formed a delta out into the Columbia River, and the Columbia River bends around it. During high water, much of the area is submerged and a thin (1-inch to 2-inch) peaty layer has developed there. The Sandy River has a relatively steep gradient near the mouth (10 feet per mile) and during flood stages has high transporting energy.

The site location is shown on Figure L-13.



LEGEND:

— SITE BOUNDARY

FIGURE L-13

METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

SANDY DELTA POTENTIAL LANDFILL SITE

General Geology

The proposed disposal site is underlain by younger alluvium which consists of sands and gravels with occasional beds of silt. The younger alluvium is in excess of 100 feet thick at this site. Sedimentation of this type is quite irregular and no geologic units would extend over the entire site area.

The surficial geology of the site is mapped on Figure L-14.

Surface Water

Diking would be necessary to protect against the frequent flooding from the Columbia and Sandy rivers that occurs regularly in this area. High river stages in the Sandy River could expose dikes to strong currents.

Dikes should be built to the standards of the U.S. Corps of Engineers to protect the dikes against erosion and washout.

Groundwater

The area is usually one of groundwater discharge; there is no consumptive use of groundwater between the site and the river. Even with dikes, during high river stages the water table would reach the ground surface. The groundwater gradient would be into the site if this water were pumped out. The depth to the water table would depend on the river stages of the Sandy and Columbia rivers. High river stages for the Sandy River would be expected in the winter rainy season and the early spring rainy season that occurs during the first snow melt. The Columbia River would be expected to flood during late spring as a result of the snow melt in the Rocky Mountains.

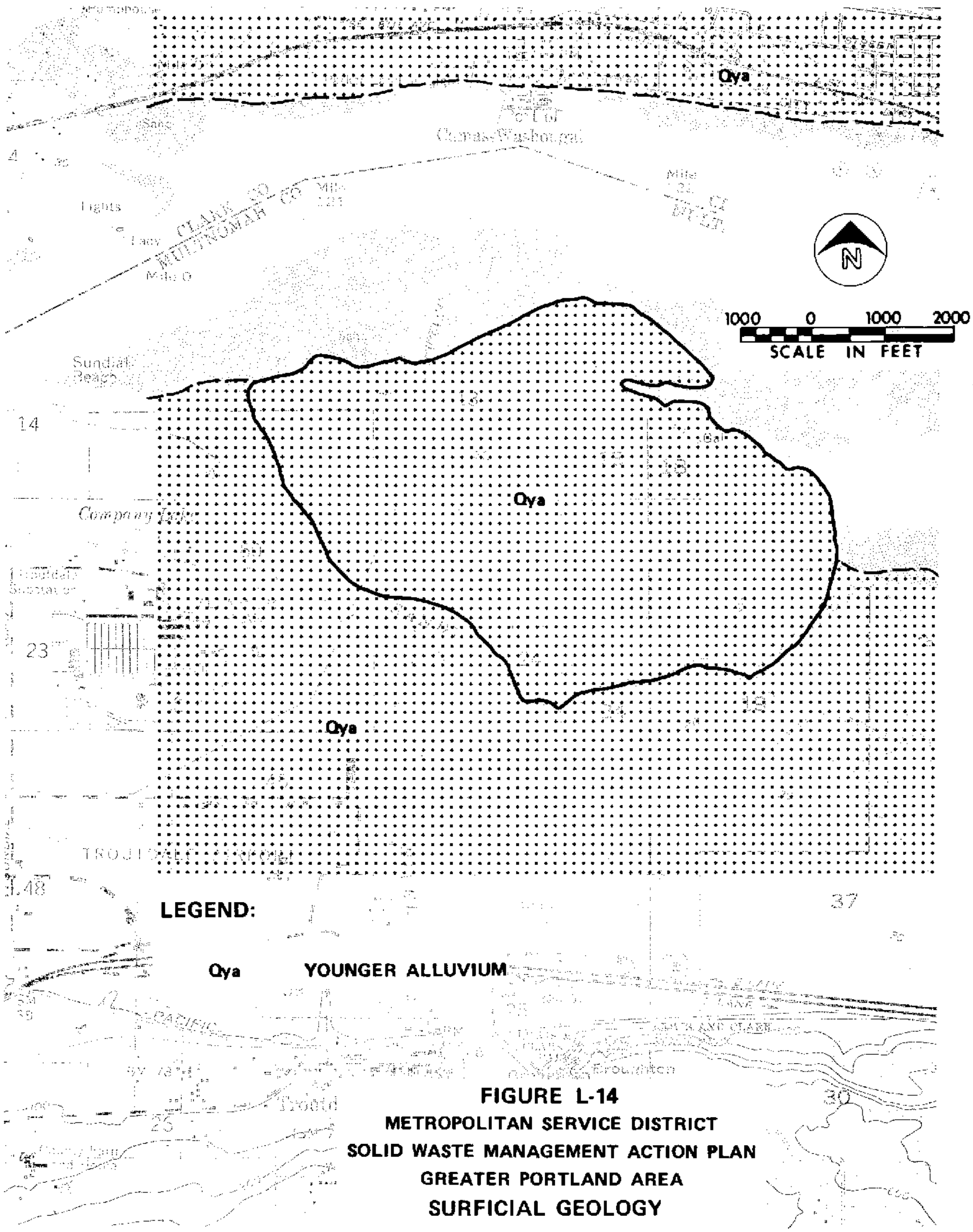


FIGURE L-14
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA
SURFICIAL GEOLOGY

Cover Material

Cover material is permeable with the exception of occasional silt beds. A cover material of low permeability would have to be imported.

Bottom Seal Material

The material on site is too permeable to be considered a bottom seal. However, bottom seal material should not be required at this site because the groundwater at the site is unused and is shortly connected with the Columbia River.

Gas Migration

Gas migration should pose few problems at this site. No confining beds are present, and cover material would be the only influencing factor.

Design Considerations

The only workable design for this site would be for low migration of leachate under acceptable conditions. Diking would be necessary for continuous operation, and much cover material would have to be imported.

Material would have to be imported for dike construction. Dike construction on the Sandy River side would have to be capable of withstanding high velocity currents. Lateral gas migration would be no problem at this site.

Traffic maneuverability on this site could be a problem during periods of high water. Some of the on-site materials are fairly silty and could get soft when wet.

SANTOSH

General Description

The site lies just to the north of the Santosh gravel quarry and is bounded on the north by Scappoose Creek. The gravel quarry is operating in old terrace gravel with surface elevations of the terrace at about 30 feet. The terrace terminates on the north with a steep slope down to elevations of about 10 feet.

The site location is shown on Figure L-15.

General Geology

The currently active disposal site is underlain by younger alluvium. To the northwest, across Scappoose Creek, and to the southeast, an older gravel terrace outcrops. The alluvium in the Scappoose Creek channel seems to be quiet water deposits of nearby lacustrine character. Immediately below a surface soil and peat layer is a nearby impermeable clay. For all practical purposes, this clay can be considered watertight. The portion of the site toward Scappoose Creek is diked to elevation 22 feet MSL; the dikes seem highly impermeable.

The surficial geology of the site is mapped on Figure L-16.

Surface Water

Surface runoff from outside the site is easily controlled. Due to the exceptionally tight nature of the site material, surface runoff from within the site can be collected and pumped out. Flooding from high levels of the Columbia River could

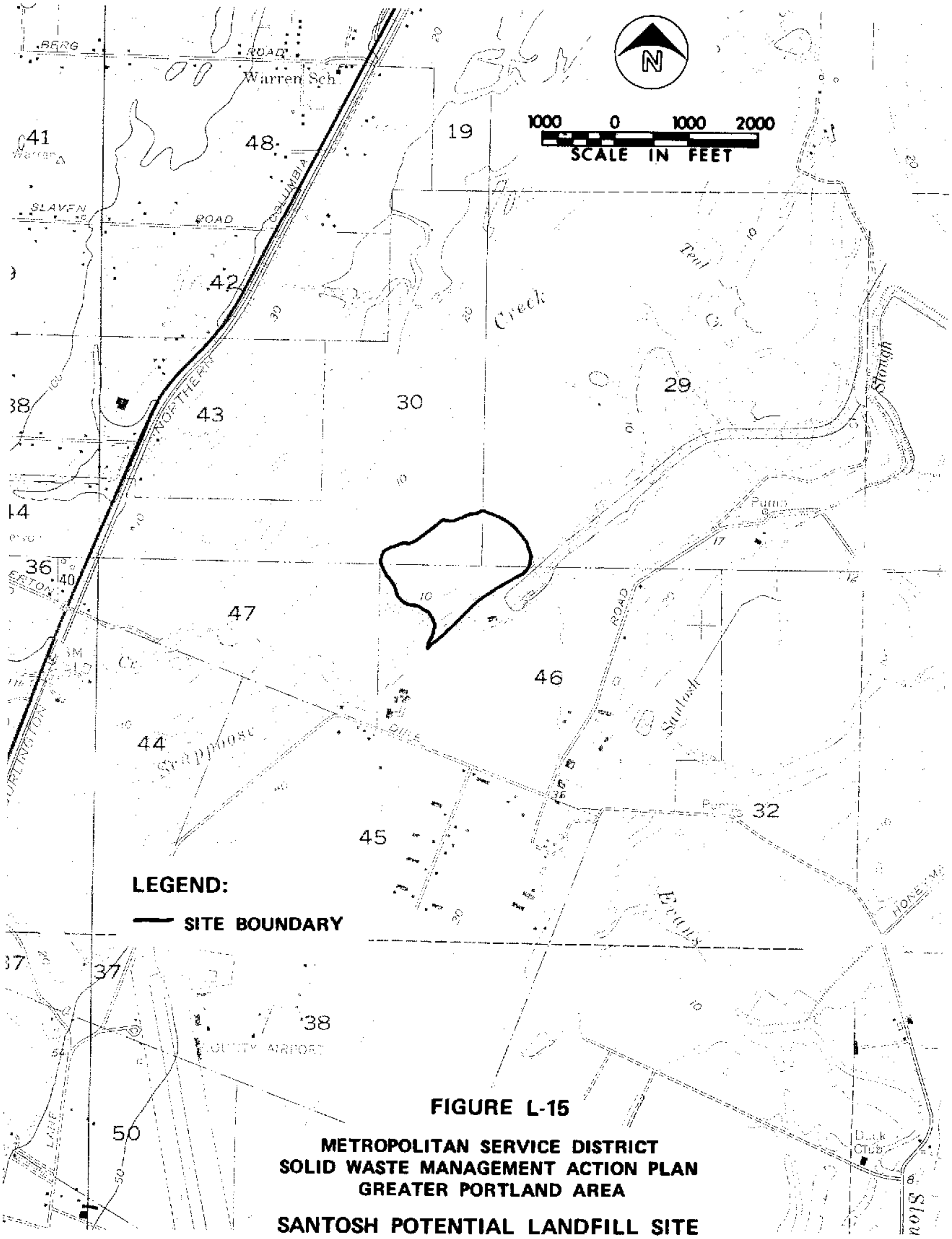


FIGURE L-15

METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

SANTOSH POTENTIAL LANDFILL SITE

cor-met

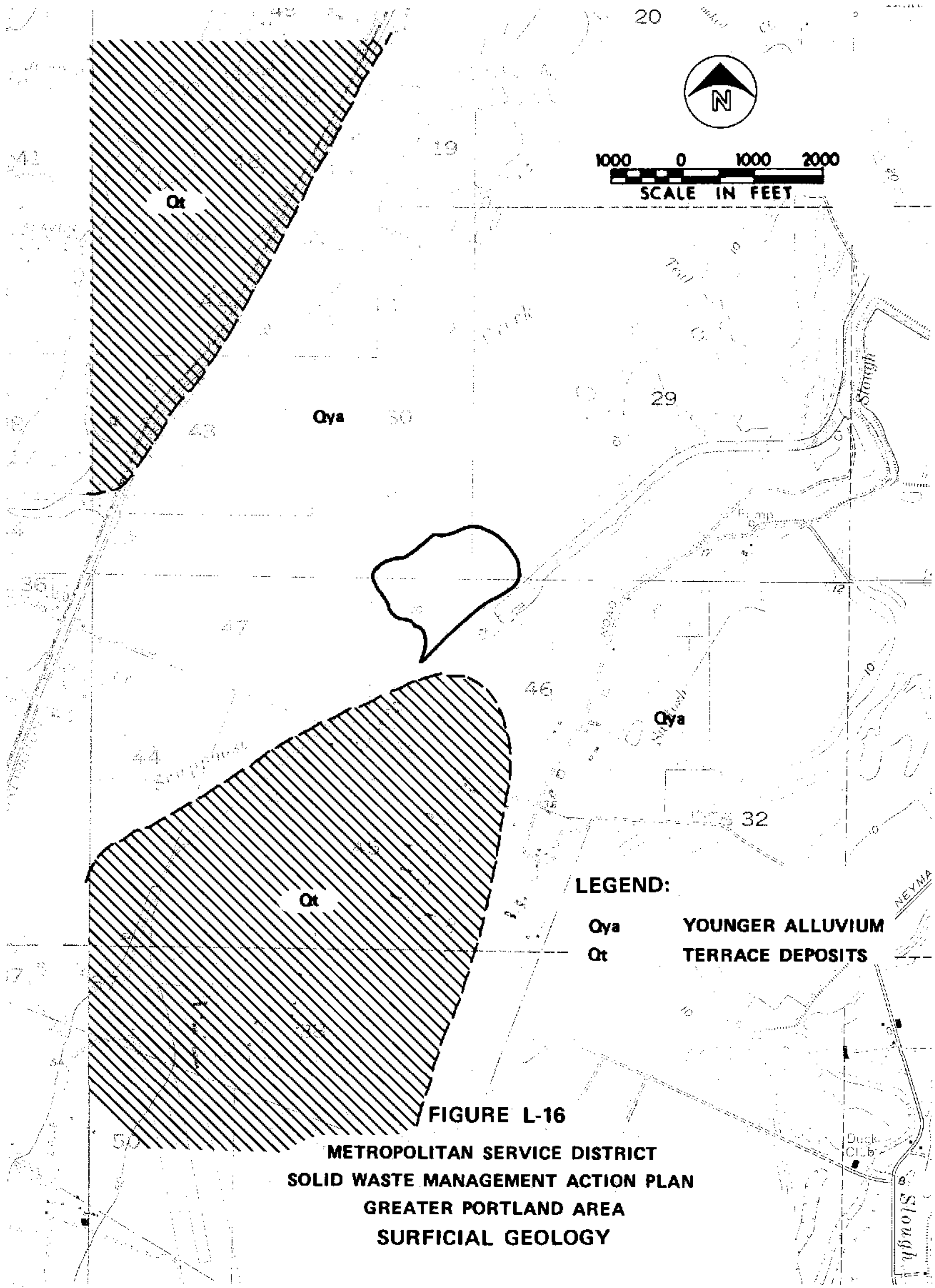


FIGURE L-16

METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA
SURFICIAL GEOLOGY

cor-met

pose some problems, but the present dikes could be extended and raised if necessary. New dikes, required for fill expansion, can be constructed using local soils.

Groundwater

The water table lies near the surface with a probable small northward gradient. There are no nearby down-gradient users of the water. The site seems to be nearly isolated from the water table, and the level of infiltration would be extremely low in any case.

Cover Material

There is no cover material on the site; it has to be imported. The overburden from the gravel operation could be used for cover if a location could be found to stockpile it.

Bottom Seal Material

The existing soil provides an excellent seal so there is no need to import material for a bottom seal.

Gas Migration

As the filling progresses, it is possible that gas migration could occur toward the south. This should pose no problem, however, because migration is toward an open gravel pit.

Design Considerations

The present sanitary landfill is retaining leachate. Collection and treatment of this leachate might be necessary in the future if it cannot be retained within the landfill.

Dike materials are satisfactory. Outside surface runoff is well controlled and only rainfall within the site boundaries is of concern. The exceptionally impermeable bottom material eliminates serious groundwater contamination. Gas migration should not present any serious problems.

ST. JOHN

General Description

The site is on the peninsula formed by the junction of the Willamette and Columbia rivers. The Columbia River during flood stages has deposited a deltaic type of sediment at its confluence with the Willamette River. These flood deposits are of sand and silt and are generally found at elevations of less than 25 feet MSL. The entire area is naturally one of low swampy ground with numerous lakes that fluctuate with high and low water stages of the Columbia River. The landfill site is bounded on nearly all sides by lakes and sloughs which flow into the Columbia Slough to the northwest.

The site location is shown on Figure L-17.

General Geology

The landfill site is underlain by younger alluvium of variable thickness. Beneath the younger alluvium and outcropping to the south is an older sand and silt deposit. The thickness of these alluvial deposits exceeds 50 feet over most of the site area. Most of the area is being artificially filled to above the water table and the surficial geology is controlled by the nature of the fill.

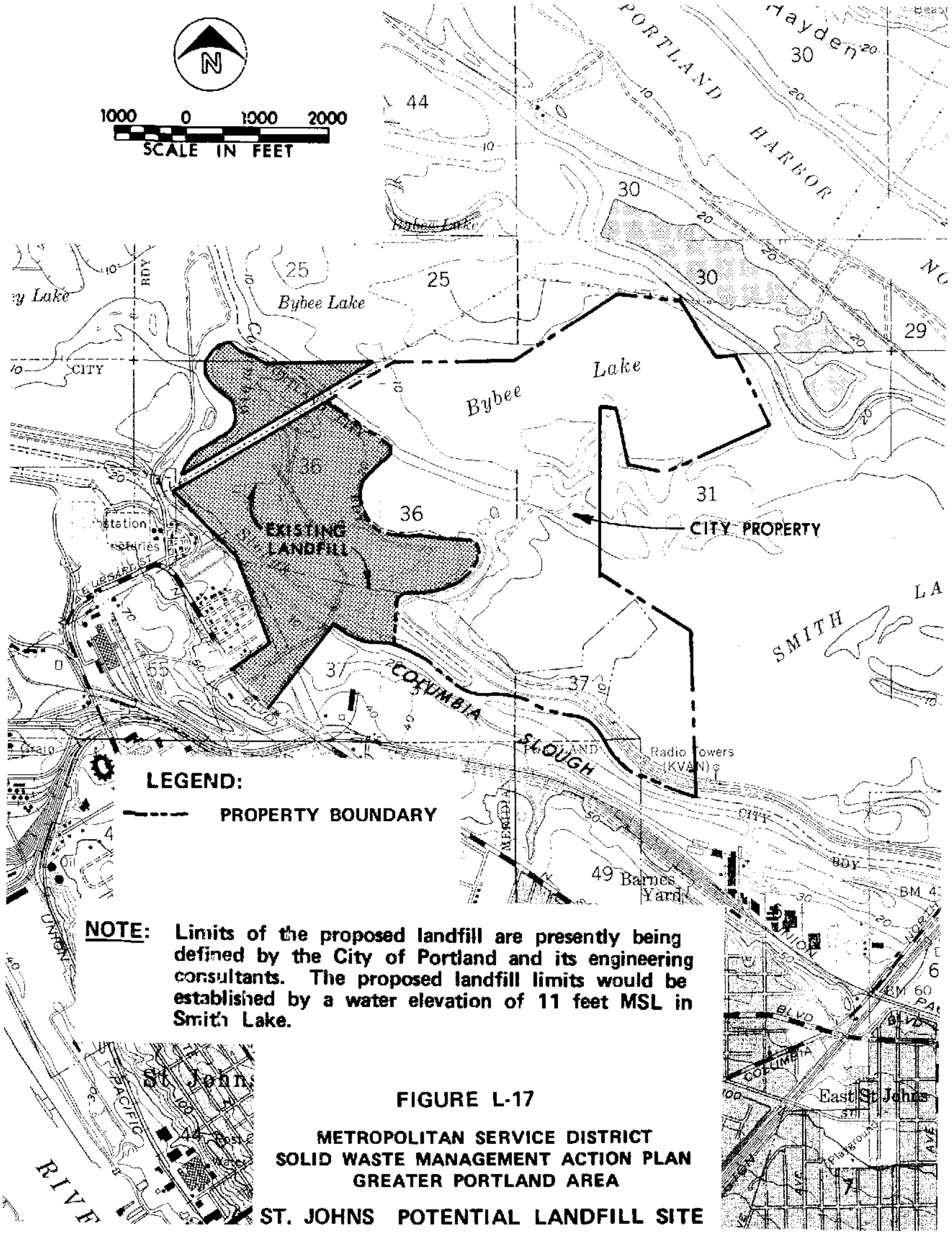


FIGURE L-17

METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA

ST. JOHNS POTENTIAL LANDFILL SITE

The surficial geology of the site is mapped on Figure L-18.

Surface Water

Surface drainage in this low lying area is poor, consisting of a system of sloughs and shallow lakes. Although the peninsula area is generally protected by dikes, Columbia Slough is open to the Willamette River and connected to Smith and Bybee lakes near the St. Johns site. Accordingly, the area around the site is subject to fluctuations in the levels of the Willamette and Columbia rivers. To prevent flooding during high water the areas intended for sanitary landfill must be diked.

Groundwater

The area is one of groundwater discharge to the Columbia River on the north and the Willamette River on the west, with some discharge toward Columbia Slough to the northwest. However, the soils in the site area are relatively impermeable, thus retarding downward migration of groundwater. There seem to be few down-gradient groundwater users from the alluvium aquifer, so little impact would be expected from leachate.

Cover Material

Cover material, consisting generally of dredge fill, is imported to the existing landfill. Continued importation of an impermeable cover material will be necessary for future operations.

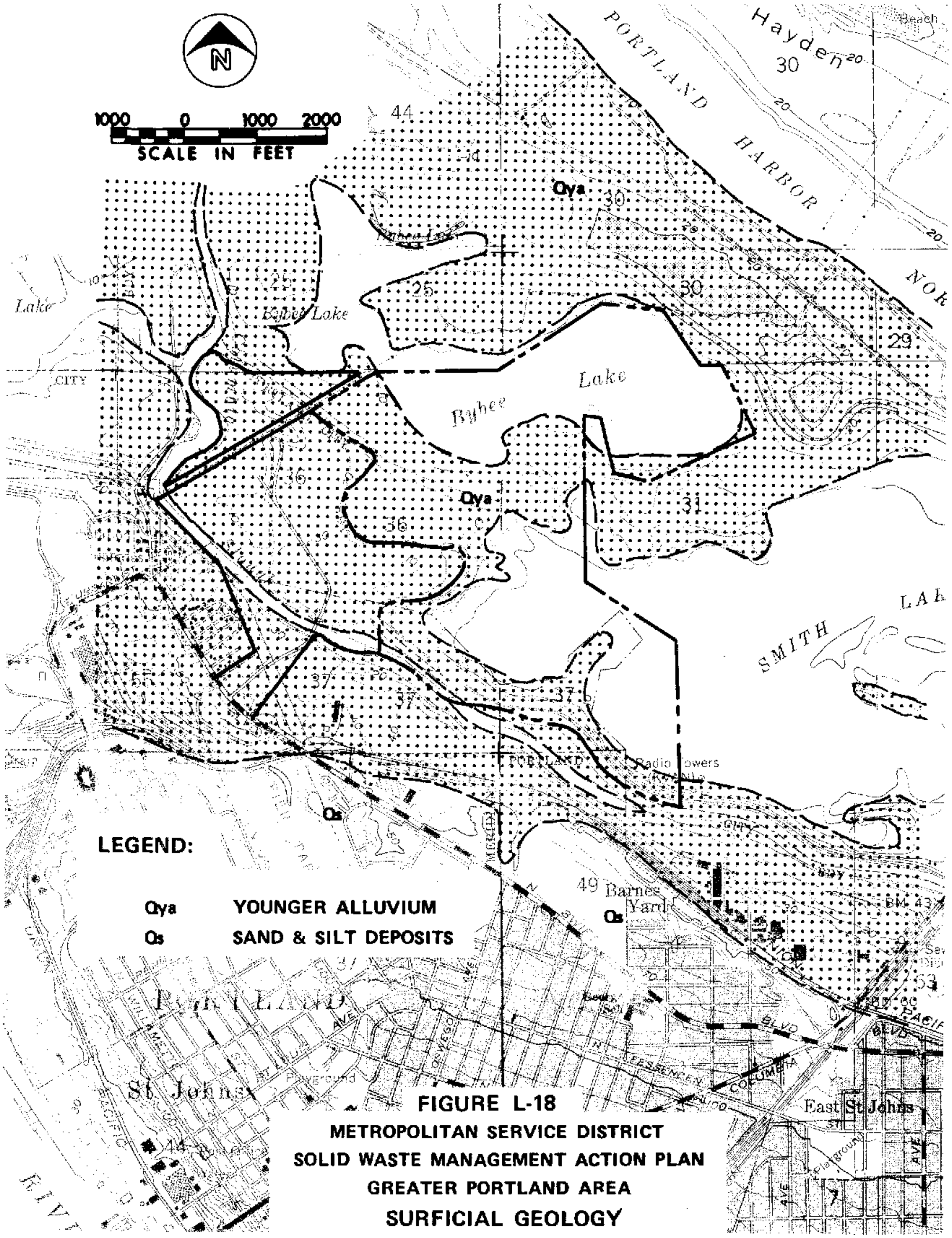


FIGURE L-18
METROPOLITAN SERVICE DISTRICT
SOLID WASTE MANAGEMENT ACTION PLAN
GREATER PORTLAND AREA
SURFICIAL GEOLOGY

cormet

Bottom Seal Material

Bottom seal material is not necessary at this site as there is an impermeable silty clay layer beneath the entire site which effectively acts as a seal.

Gas Migration

Gas migration is not a problem at this site. There are no immediately adjacent structures that would be affected by gas production, and no geologic formations which would indicate that gas migration in the horizontal direction would be likely at all.

Design Considerations

The present design of the landfill site is based on low migration of leachate under acceptable conditions. This type of design should be adequate for future landfill operations. In order to prevent leachate from draining through the sides of the landfill, impermeable dikes should be constructed around the future landfill operations.

Impermeable soil should be imported for final cover material at the site and care should be exercised in final cover design to prevent erosion of the final cover.

APPENDIX M

Appendix M

COMPUTER PROGRAM DESCRIPTION

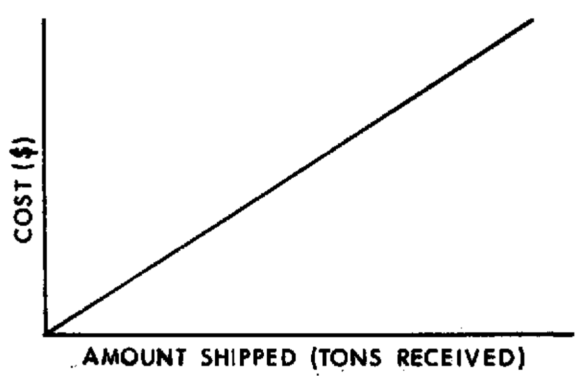
GENERAL

The linear model used to evaluate the economics of alternative solutions for this study is one that chooses the size of solid waste facilities, the timing of facility construction, and the direction for refuse movement according to the criterion of minimum total cost. Minimum total cost can be computed for a range of time periods. In all cases the solution achieved is one that minimizes total cost for the entire period selected. Since it is a linear model, it may be solved using any linear programming technique. Strictly linear cost functions are not applicable to all the costs in the model; however, linear separable cost functions (as described here) can be used in most solution algorithms.

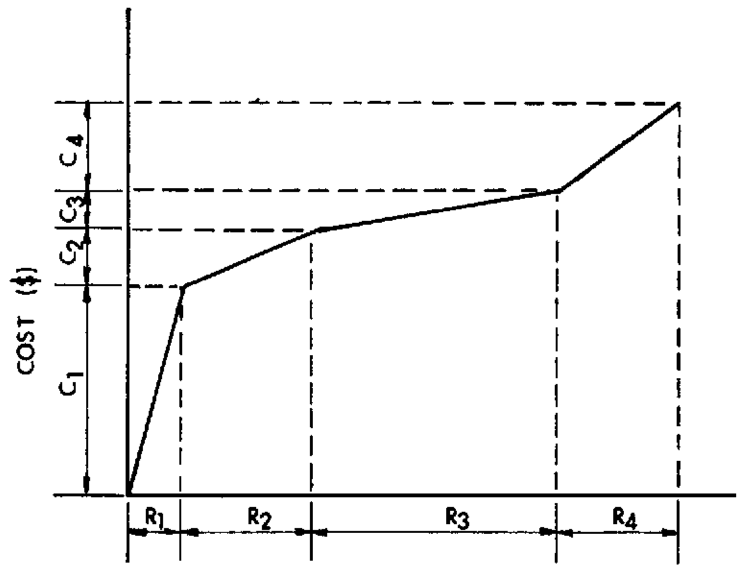
COST FUNCTIONS

There are two kinds of cost curves: strictly linear and linear separable.

A. Strictly linear – all haul costs and perhaps some operating costs. The cost relationship is linear throughout the functional limits used in this study.



B. Linear separable — all facility (building) costs and most operating (processing) costs. The cost relationship is linear through a limited function, breaks linearity at a discrete function point, and then assumes a new slope and linearity to another discrete point.



BUILDING - SIZE OF FACILITY (CAPACITY BUILT)
PROCESSING - AMOUNT RECEIVED

INPUT AND OUTPUT DATA

The inputs for this program are divided into two categories. The first category is the unit cost of each transport trip and the unit cost of transfer, processing, and disposal. These data are in the library matrix of the program. The second category is the constraint data which represent refuse quantity generated at each refuse center and the capacity of the facilities used for handling and disposal.

The input data were prepared from the collected information of this study and include the population of each center of refuse, transport routes, average speed of refuse vehicles on each route, average loading of refuse vehicles, crew size, distance of refuse routes, and annual collection, processing, and disposal costs. An assumption was made that the transport cost is linearly proportional to the time consumed during transport, regardless of the variation in refuse loading at different collection times and different centers of refuse. The uniformity of refuse loading on each trip is necessary for the analysis.

The output of the program gives a total optimized cost of the system within Portland region constraints. The matrix was prepared to allow the selection of transport routes either directly to disposal sites or through a transfer station to disposal sites.

OBJECTIVE FUNCTION

Minimize:

$$\left.\begin{aligned} &PL \sum_i \sum_j \sum_t S_{ijt} X_{ijt} + PL \sum_i \sum_k \sum_t S_{ikt} X_{ikt} + \\ &PL \sum_i \sum_l \sum_t S_{ilt} X_{ilt} + PL \sum_k \sum_j \sum_t V_{kjt} X_{kjt} + \\ &PL \sum_l \sum_k \sum_t T_{lkt} X_{lkt} + PL \sum_l \sum_j \sum_t T_{ljt} X_{ljt} + \end{aligned}\right\} \text{Haul costs}$$

$$\left.\begin{aligned} &\sum_k \sum_t F_{kt} X_{kt} + \\ &\sum_l \sum_t F_{lt} Z_{lt} + \end{aligned}\right\} \text{Facility costs}$$

$$\left.\begin{aligned} &PL \sum_k \sum_t O_{kt} P_{kt} + \\ &PL \sum_l \sum_t O_{lt} P_{lt} + \\ &PL \sum_j \sum_t O_{jt} P_{jt} \end{aligned}\right\} \text{Operating costs}$$

CONSTRAINTS

A. In order to treat processing costs as linear separable functions it is necessary to sum the quantity received at any facility into one variable.

1. Landfills

$$\sum_i S_{ijt} + \sum_k V_{kjt} + \sum_l T_{ljt} - P_{jt} = 0$$

where $j = 1 \ldots L$
$t = 1 \ldots T$

2. Transfer stations

$$\sum_i S_{ilt} - P_{lt} = 0$$

where $l = 1 \ldots S$
$t = 1 \ldots T$

3. Volume reduction facilities

$$\sum_i S_{ikt} + \sum_l T_{lkt} - P_{kt} = 0$$

where $k = 1 \ldots V$
$t = 1 \ldots T$

B. Each collection district must dispose of all its solid waste in every time period.

$$\sum_j S_{ijt} + \sum_k S_{ikt} + \sum_l S_{ilt} = R_{it}$$

where $i = 1 \ldots N$
$t = 1 \ldots T$

C. There are transshipment node constraints on all facilities except landfills.

1. Transfer stations

$$P_{lt} - \sum_j T_{ljt} - \sum_k T_{lkt} = 0$$

where $l = 1 \ldots S$
$t = 1 \ldots T$

2. Volume reduction facilities

$$m_{kt} P_{kt} - \sum_j V_{kjt} = 0$$

where $k = 1 \ldots V$
$t = 1 \ldots T$

D. Ultimate capacity constraint on landfills.

$$PL \sum_t P_{jt} \leq Q_j$$

where $j = 1 \ldots L$

E. If present capacity is defined as the original capacity (C_{k0}) plus the summation over time of all capacity increases or

$$C_{k\tau} = C_{k0} + \sum_{t=1}^{\tau} Z_{kt}$$

and the quantity received ($P_{k\tau}$) must be less than or equal to present capacity, then:

1. Transfer stations

$$P_{l\tau} - C_{l\tau} \leq 0$$

$$\therefore \quad P_{l\tau} - \sum_{t=1}^{\tau} Z_{lt} \leq C_{l0}$$

where $\tau = 1 \ldots T$
$l = 1 \ldots S$

2. Volume reduction facilities

$$P_{k\tau} - \sum_{t=1}^{\tau} Z_{kt} \leq C_{k0}$$

where $\tau = 1 \ldots T$
$k = 1 \ldots V$

F. An additional constraint has been added in order to produce solutions that are more operationally sound, though not necessarily cheaper. This constraint forces the quantity processed at transfer stations and volume reduction facilities to remain the same or increase from time period to time period.

1. Transfer stations

$$P_{lt} - P_{l(t+1)} \leq 0$$

where $l = 1 \ldots S$
$t = 1 \ldots (T-1)$

2. Volume reduction facilities

$$P_{kt} - P_{k(t+1)} - 0$$

where $k = 1 \ldots V$
$t = 1 \ldots (T-1)$

G. Finally, the P_{jt}, P_{kt}, and P_{lt} will all have an upper bound, the handling limit of the site.

$P_{jt} \leq D_j$ all t, j

$P_{kt} \leq D_k$ all t, k

$P_{lt} \leq D_l$ all t, l

VARIABLES

i	Index of collection zones $i = 1 \ldots N$
j	Index of landfills $j = 1 \ldots L$
k	Index of volume reduction facilities (VRF) $k = 1 \ldots V$
l	Index of transfer stations $l = 1 \ldots S$
t	Index of time periods $t = 1 \ldots T$
S_{ijt}	Shippage from collection zone i to landfill j during period t

S_{ikt} Shippage from collection zone i to VRF k during period t

S_{ilt} Shippage from collection zone i to transfer station l during period t

V_{kjt} Shippage from VRF k to landfill j during period t

T_{lkt} Shippage from transfer station l to VRF k in period t

T_{ljt} Shippage from transfer station l to landfill j in period t

R_{it} Refuse produced in collection zone i during period t

Q_j Ultimate capacity of landfill j

m_{kt} Volume reduction coefficient of VRF k in time t

D_k Handling capacity at VRF k

D_l Handling capacity at transfer station l

D_j Handling capacity at landfill j

P_{kt} Shippage to VRF k in period t

P_{jt} Shippage to landfill j in period t

P_{lt} Shippage to transfer station l in period t

C_{kt} Capacity at VRF k in period t

C_{lt} Capacity at transfer station l in period t

Z_{kt} Capacity change at VRF k from period t-1 to period t

Z_{lt} Capacity change at transfer station l from period t-1 to period t

X_{xyt} Haul costs from x to y in period t. There are six terms: (x,y) = (i,j), (i,k), (i,l), (k,j), (l,k), (l,j)

F_{kt} Facility cost function of VRF k in period t

F_{lt} Facility cost function of transfer station l in period t

O_{kt} Operating cost function of VRF k in period T

O_{lt} Operating cost function of transfer station l in period t

O_{jt} Operating cost function of landfill j in period t

PL Period length

APPENDIX N

Appendix N

MATERIALS ROUTING IN REGIONAL ALTERNATIVES

This appendix contains detailed information on the movement of refuse from each refuse generation center to transfer, processing, and disposal sites in each of the four regional alternative systems.

The locations of the refuse generation centers are shown on Figures 8 and 9 in Chapter 11, Volume I. The locations of the transfer, processing, and disposal sites for Regional Alternatives A, B, C, and D are shown on Figures 23, 25, 27, and 29, respectively, in Chapter 15, Volume I.

The materials routing for Regional Alternative A, transfer with landfill, is shown in Table N-1; for Regional Alternative B, milling with materials recovery and landfill, and for Regional Alternative C, baling with limited materials recovery and landfill, in Table N-2; and for Regional Alternative D, incineration with heat recovery and landfill, in Table N-3.

Table N-1

MATERIALS ROUTING FOR REGIONAL ALTERNATIVE A

<table>
<tr><th rowspan="2">Refuse generation center</th><th colspan="5">Collection vehicle destination</th></tr>
<tr><th>1976-1980</th><th>1981-1985</th><th>1986-1990</th><th>1991-1995</th><th>1996-2000</th></tr>
<tr><td>7. Forest Grove</td><td colspan="5">Cornelius-Hillsboro[a]</td></tr>
<tr><td>8. Hillsboro</td><td colspan="5">Cornelius-Hillsboro[a]</td></tr>
<tr><td>9. Aloha</td><td>Progress[a]</td><td colspan="3">Cipole[b]</td><td>Old Pumpkin[b]</td></tr>
<tr><td>10. Cedar Mill</td><td colspan="4">Progress[a]</td><td>Old Pumpkin[b]</td></tr>
<tr><td>11. Beaverton</td><td colspan="5">Progress[a]</td></tr>
<tr><td>12. Chehalem Mountain</td><td>Cornelius-Hillsboro[a]</td><td colspan="3">Progress[a]</td><td>Cornelius-Hillsboro[a]</td></tr>
<tr><td>13. Tigard</td><td>Newberg[b]</td><td colspan="3">Cipole[b]</td><td>Old Pumpkin[b]</td></tr>
<tr><td>14. West County</td><td colspan="4">Cornelius-Hillsboro[a]</td><td>Old Pumpkin[b]</td></tr>
<tr><td>15. Stafford</td><td>Rossman[b]</td><td colspan="4">Cipole[b]</td></tr>
<tr><td>16. Canby</td><td colspan="2">Rossman[b]</td><td colspan="3">Alford[b]</td></tr>
<tr><td>17. Beaver Creek</td><td colspan="2">Rossman[b]</td><td colspan="3">Alford[b]</td></tr>
<tr><td>18. Redland</td><td rowspan="5">Rossman[b]</td><td colspan="4" rowspan="5">Alford[b]</td></tr>
<tr><td>19. Estacada</td></tr>
<tr><td>20. Sandy</td></tr>
<tr><td>21. Boring</td></tr>
<tr><td>22. Clackamas</td></tr>
<tr><td>23. Milwaukie</td><td colspan="2" rowspan="6">Rossman[b]</td><td colspan="3">Alford[b]</td></tr>
<tr><td>24. Gladstone e</td><td colspan="3" rowspan="4">Rossman[a]</td></tr>
<tr><td>25. Oregon City</td></tr>
<tr><td>26. West Linn</td></tr>
<tr><td>27. Lake Oswego</td></tr>
<tr><td>28. Molalla</td><td colspan="3">Alford[b]</td></tr>
<tr><td>29. S.W. Barbur Blvd</td><td colspan="5" rowspan="4">Multnomah[a]</td></tr>
<tr><td>30. Hillsdale</td></tr>
<tr><td>31. Sylvan</td></tr>
<tr><td>32. Portland Heights</td></tr>
<tr><td>33. Downtown</td><td rowspan="7">St. John[b]</td><td colspan="4">Multnomah[a]</td></tr>
<tr><td>34. N.W. Residential</td><td colspan="4" rowspan="6">Hayden Island[b]</td></tr>
<tr><td>35. N.W. Industrial</td></tr>
<tr><td>36. St. Johns</td></tr>
<tr><td>37. Rivergate Industrial</td></tr>
<tr><td>38. Swan Island</td></tr>
<tr><td>39. North Portland</td></tr>
<tr><td>40. Portland Airport</td><td colspan="5">82nd and Killingsworth[a]</td></tr>
<tr><td>41. Northeast</td><td colspan="5">82nd and Killingsworth[a]</td></tr>
<tr><td>42. Ladd Addition</td><td colspan="5" rowspan="5">Southeast Portland[a]</td></tr>
<tr><td>43. Reed</td></tr>
<tr><td>44. Milwaukie-Multnomah</td></tr>
<tr><td>45. Mt. Tabor</td></tr>
<tr><td>46. Southeast</td></tr>
<tr><td>47. Parkrose</td><td colspan="5">82nd and Killingsworth[a]</td></tr>
<tr><td>48. Wood Village</td><td colspan="5" rowspan="3">Gresham[a]</td></tr>
<tr><td>49. Gresham</td></tr>
<tr><td>50. Corbett</td></tr>
</table>

a. Unprocessed refuse transfer station.

b. Disposal site.

Table N-2

MATERIALS ROUTING FOR REGIONAL ALTERNATIVES B AND C

Refuse generation center	Collection vehicle destination				
	1976-1980	1981-1985	1986-1990	1991-1995	1996-2000
7. Forest Grove	←		Cornelius-Hillsboro[a]		→
8. Hillsboro			↕		
9. Aloha			↕		
10. Cedar Mill	←		Cornelius-Hillsboro[a]		→
11. Beaverton	←		Durham[a]		→
12. Chehalem Mountain	←		Cornelius-Hillsboro[a]		→
13. Tigard	←		Durham[a]		→
14. West County	←		Cornelius-Hillsboro[a]		→
15. Stafford	←		Durham[a,b]		→
16. Canby	←		Rossman[a,b]		→
17. Beaver Creek			↕		
18. Redland			↕		
19. Estacada			↕		
20. Sandy			↕		
21. Boring			↕		
22. Clackamas	←		Rossman[a,b]		→
23. Milwaukie	←		Southeast Portland[a]		→
24. Gladstone	←		Rossman[a,b]		→
25. Oregon City			↕		
26. West Linn			↕		
27. Lake Oswego			↕		
28. Molallo	←		Rossman[a,b]		→
29. S.W. Barbur Boulevard	←		Durham[a,b]		→
30. Hillsdale	←		Durham[a,b]		→
31. Sylvan	←		Columbia Boulevard[a]		→
32. Portland Heights			↕		
33. Downtown			↕		
34. N.W. Residential			↕		
35. N.W. Industrial			↕		
36. St. Johns			↕		
37. Rivergate Industrial			↕		
38. Swan Island			↕		
39. North Portland	←		Columbia Boulevard[a]		→
40. Portland Airport	←		82nd and Killingsworth[a]		→
41. Northeast			↕		
42. Ladd Addition	←		82nd and Killingsworth[a]		→
43. Reed	←		Southeast Portland[a]		→
44. Milwaukie-Multnomah			↕		
45. Mt. Tabor			↕		
46. Southeast	←		Southeast Portland[a]		→
47. Parkrose	←		82nd and Killingsworth[a]		→
48. Wood Village	←		82nd and Killingsworth[a]		→
49. Gresham	←		Southeast Portland[a]		→
50. Corbett	←		82nd and Killingsworth[a]		→

a. Refuse processing station.

b. Disposal site.

Table N-3

MATERIALS ROUTING FOR REGIONAL ALTERNATIVE D

<table>
<tr><th rowspan="2">Refuse generation center</th><th colspan="5">Collection vehicle destination</th></tr>
<tr><th>1976-1980</th><th>1981-1985</th><th>1986-1990</th><th>1991-1995</th><th>1996-2000</th></tr>
<tr><td>7. Forest Grove</td><td colspan="5">Cornelius-Hillsboro</td></tr>
<tr><td>8. Hillsboro</td><td colspan="5">Cornelius-Hillsboro</td></tr>
<tr><td>9. Aloha</td><td colspan="5" rowspan="5">Progress</td></tr>
<tr><td>10. Cedar Mill</td></tr>
<tr><td>11. Beaverton</td></tr>
<tr><td>12. Chehalem Mountain</td></tr>
<tr><td>13. Tigard</td></tr>
<tr><td>14. West County</td><td colspan="5">Cornelius-Hillsboro</td></tr>
<tr><td>15. Stafford</td><td colspan="5" rowspan="14">Rossman</td></tr>
<tr><td>16. Canby</td></tr>
<tr><td>17. Beaver Creek</td></tr>
<tr><td>18. Redland</td></tr>
<tr><td>19. Estacada</td></tr>
<tr><td>20. Sandy</td></tr>
<tr><td>21. Boring</td></tr>
<tr><td>22. Clackamas</td></tr>
<tr><td>23. Milwaukie</td></tr>
<tr><td>24. Gladstone</td></tr>
<tr><td>25. Oregon City</td></tr>
<tr><td>26. West Linn</td></tr>
<tr><td>27. Lake Oswego</td></tr>
<tr><td>28. Molalla</td></tr>
<tr><td>29. S.W. Barbur Boulevard</td><td colspan="5" rowspan="4">Multnomah</td></tr>
<tr><td>30. Hillsdale</td></tr>
<tr><td>31. Sylvan</td></tr>
<tr><td>32. Portland Heights</td></tr>
<tr><td>33. Downtown</td><td colspan="5" rowspan="3">Incinerator</td></tr>
<tr><td>34. N.W. Residential</td></tr>
<tr><td>35. N.W. Industrial</td></tr>
<tr><td>36. St. Johns</td><td colspan="5" rowspan="4">Columbia Boulevard</td></tr>
<tr><td>37. Rivergate Industrial</td></tr>
<tr><td>38. Swan Island</td></tr>
<tr><td>39. North Portland</td></tr>
<tr><td>40. Portland Airport</td><td colspan="5">82nd and Killingsworth</td></tr>
<tr><td>41. Northeast</td><td colspan="5">82nd and Killingsworth</td></tr>
<tr><td>42. Ladd Addition</td><td colspan="5">Incinerator</td></tr>
<tr><td>43. Reed</td><td colspan="5">Incinerator</td></tr>
<tr><td>44. Milwaukie-Multnomah</td><td colspan="5" rowspan="3">Southeast Portland</td></tr>
<tr><td>45. Mt. Tabor</td></tr>
<tr><td>46. Southeast</td></tr>
<tr><td>47. Parkrose</td><td colspan="5">82nd and Killingsworth</td></tr>
<tr><td>48. Wood Village</td><td colspan="5" rowspan="3">Gresham</td></tr>
<tr><td>49. Gresham</td></tr>
<tr><td>50. Corbett</td></tr>
</table>

Note: All site names denote unprocessed refuse transfer stations from which wastes are transported to the incinerator.

APPENDIX O

Appendix O

DETAILS OF RECOMMENDED REGIONAL SYSTEM

This appendix contains detailed tabular information for the recommended regional system. The design quantities for each of the six milling-transfer stations for each of the years from 1976 through 2000 are shown in Table O-1. These quantities are the maximum expected and do not reflect possible reductions due to potential increased diversion at the source of wastes into the secondary materials market.

Detailed staffing lists of operating personnel for each of the milling-transfer stations for the years 1976, 1977, 1978, 1979, 1980, 1985, 1990, 1995, and 2000 are presented in Tables O-2 through O-10. The operation and maintenance costs for each of the milling-transfer stations for each of those same years are presented in Tables O-11 through O-19.

The design quantities for each of the seven milled refuse landfills for each year from 1976 through 2000 are listed in Table O-20. These quantities are the maximum expected and do not reflect possible reductions due to potential increased diversion of wastes into the secondary materials market.

Detailed staffing lists of operating personnel for each of the landfills for the years 1976, 1977, 1978, 1979, 1980, 1985, 1990, 1995, and 2000 are shown in Tables O-21 through O-29. The operation and maintenance costs for each of the landfills for each of those same years are presented in Tables O-30 through O-38. It should be noted that the operation and maintenance costs allow for the purchase of all cover material at those sites where on-site material is not available and conservatively allow for the purchase of some cover material at those sites where there appears to be sufficient and suitable on-site material available.

All operations and maintenance costs are based upon current rates for labor and supplies, with no attempt to project inflationary trends for the future.

Table O-1

REGIONAL SYSTEM
DESIGN QUANTITIES FOR MILLING-TRANSFER STATIONS
(Tons per Week)

Year	Columbia Boulevard	Durham	Hillsboro-Cornelius	Killingsworth and 82nd	S.E. Portland	Rossman
1976	--	2,980	--	--	--	--
1977	3,140	3,110	1,240	2,780	4,400	1,870
1978	3,170	3,250	1,300	2,830	4,500	1,950
1979	3,200	3,380	1,350	2,880	4,600	2,030
1980	3,230	3,520	1,400	2,940	4,700	2,110
1981	3,270	3,660	1,470	3,000	4,800	2,190
1982	3,310	3,790	1,550	3,060	4,900	2,280
1983	3,350	3,930	1,620	3,120	5,000	2,370
1984	3,390	4,070	1,700	3,180	5,100	2,470
1985	3,430	4,210	1,780	3,240	5,200	2,570
1986	3,470	4,360	1,860	3,300	5,300	2,670
1987	3,520	4,510	1,940	3,360	5,400	2,770
1988	3,560	4,660	2,020	3,430	5,500	2,870
1989	3,600	4,810	2,100	3,490	5,600	2,970
1990	3,650	4,960	2,190	3,560	5,700	3,070
1991	3,700	5,140	2,320	3,620	5,810	3,210
1992	3,760	5,320	2,450	3,690	5,920	3,350
1993	3,810	5,500	2,580	3,750	6,030	3,590
1994	3,870	5,680	2,710	3,810	6,140	3,630
1995	3,930	5,870	2,840	3,880	6,250	3,770
1996	3,990	6,060	2,990	3,950	6,370	3,920
1997	3,050	6,260	3,130	4,020	6,490	4,070
1998	4,110	6,460	3,270	4,090	6,610	4,230
1999	4,170	6,660	3,420	4,160	6,740	4,380
2000	4,240	6,860	3,560	4,230	6,870	4,540

Table O-2

REGIONAL SYSTEM
1976 OPERATING PERSONNEL
MILLING FACILITIES AND MILLED REFUSE TRANSPORT

		Durham		
Position title	Position salary, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Superintendent	14,560	1	40	14,560
Shift foreman	14,560	--	--	--
Equipment operator	13,520	2	100	33,800
Loader operator	13,520	1	50	16,900
Maintenance	13,520	1	40	13,520
Weighmaster	10,880	2	80	21,760
Clerk	9,360	1	40	9,360
Laborer	10,880	3	150	40,800
Truck driver	13,000	3	120	39,000
Total personnel		14		
Salary subtotal				189,700
Acceleration, 30%[a]				56,910
Total annual salary				246,610

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-3

REGIONAL SYSTEM
1977 OPERATING PERSONNEL
MILLING FACILITIES AND MILLED REFUSE TRANSPORT

Position title	Position salary, $/yr	Columbia Boulevard: Number of positions	Total working time, hr/wk	Salary costs, $/yr	Durham: Number of positions	Total working time, hr/wk	Salary costs, $/yr	Hillsboro-Cornelius: Number of positions	Total working time, hr/wk	Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Shift foreman	14,560	1	40	14,560	--	--	--	--	--	--
Equipment operator	13,520	4	160	54,080	2	100	33,800	2	100	33,800
Loader operator	13,520	2	80	27,040	1	50	16,900	1	50	16,900
Maintenance	13,520	1	40	13,520	1	40	13,520	1	40	13,520
Weighmaster	10,880	1	40	10,880	2	80	21,760	1	40	10,880
Clerk	9,360	1	40	9,360	1	40	9,360	1	40	9,360
Laborer	10,880	6	240	65,280	3	150	40,800	3	120	32,640
Truck driver	13,000	4	170	55,250	3	120	39,000	3	120	39,000
Total personnel		21			14			13		
Salary subtotal				264,530			189,700			170,660
Acceleration, 30%[a]				79,359			56,910			51,198
Total annual salary				343,889			246,610			221,858

Position title	Position salary, $/yr	Killingsworth and 82nd: Number of positions	Total working time, hr/wk	Salary costs, $/yr	S.E. Portland: Number of positions	Total working time, hr/wk	Salary costs, $/yr	Rossman: Number of positions	Total working time, hr/wk	Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Shift foreman	14,560	--	--	--	1	40	14,560	--	--	--
Equipment operator	13,520	3	120	40,560	4	160	54,080	2	80	27,040
Loader operator	13,520	1	55	18,590	2	80	27,040	1	40	13,520
Maintenance	13,520	1	40	13,520	1	40	13,520	1	40	13,520
Weighmaster	10,880	1	40	10,880	2	80	21,760	1	40	10,880
Clerk	9,360	1	40	9,360	1	40	9,360	1	40	9,360
Laborer	10,880	4	160	43,520	6	240	65,280	3	120	32,640
Truck driver	13,000	5	200	65,000	7	280	91,000	2	80	26,000
Total personnel		17			25			12		
Salary subtotal				215,990			311,160			147,520
Acceleration, 30%[a]				64,797			93,348			44,256
Total annual salary				280,787			404,508			191,776

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-4

REGIONAL SYSTEM
1978 OPERATING PERSONNEL
MILLING FACILITIES AND MILLED REFUSE TRANSPORT

Position title	Position salary, $/yr	Columbia Boulevard: Number of positions	Columbia Boulevard: Total working time, hr/wk	Columbia Boulevard: Salary costs, $/yr	Durham: Number of positions	Durham: Total working time, hr/wk	Durham: Salary costs, $/yr	Hillsboro-Cornelius: Number of positions	Hillsboro-Cornelius: Total working time, hr/wk	Hillsboro-Cornelius: Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Shift foreman	14,560	1	40	14,560	--	--	--	--	--	--
Equipment operator	13,520	4	160	54,080	2	100	33,800	2	100	33,800
Loader operator	13,520	2	80	27,040	1	50	16,900	1	50	16,900
Maintenance	13,520	1	40	13,520	1	40	13,520	1	40	13,520
Weighmaster	10,880	1	40	10,880	2	80	21,760	1	40	10,880
Clerk	9,360	1	40	9,360	1	40	9,360	1	40	9,360
Laborer	10,880	6	240	65,280	3	150	40,800	3	120	32,640
Truck driver	13,000	4	170	55,250	6	240	78,000	3	120	39,000
Total personnel		21			17			13		
Salary subtotal				264,530			228,700			170,660
Acceleration, 30%[a]				79,359			68,610			51,198
Total annual salary				343,889			297,310			221,858

Position title	Position salary, $/yr	Killingsworth and 82nd.: Number of positions	Killingsworth and 82nd.: Total working time, hr/wk	Killingsworth and 82nd.: Salary costs, $/yr	S.E. Portland: Number of positions	S.E. Portland: Total working time, hr/wk	S.E. Portland: Salary costs, $/yr	Rossman: Number of positions	Rossman: Total working time, hr/wk	Rossman: Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Shift foreman	14,560	--	--	--	1	40	14,560	--	--	--
Equipment operator	13,520	3	120	40,560	4	160	54,080	2	80	27,040
Loader operator	13,520	1	55	18,590	2	80	27,040	1	40	13,520
Maintenance	13,520	1	40	13,520	1	40	13,520	1	40	13,520
Weighmaster	10,880	1	40	10,880	2	80	21,760	1	40	10,880
Clerk	9,360	1	40	9,360	1	40	9,360	1	40	9,360
Laborer	10,880	4	160	43,520	6	240	65,280	3	120	32,640
Truck driver	13,000	5	200	65,000	7	280	91,000	2	80	26,000
Total personnel		17			25			12		
Salary subtotal				215,990			311,160			147,520
Acceleration, 30%[a]				64,797			93,348			44,256
Total annual salary				280,787			404,508			191,776

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-5

REGIONAL SYSTEM
1979 OPERATING PERSONNEL
MILLING FACILITIES AND MILLED REFUSE TRANSPORT

Position title	Position salary, $/yr	Columbia Boulevard: Number of positions	Columbia Boulevard: Total working time, hr/wk	Columbia Boulevard: Salary costs, $/yr	Durham: Number of positions	Durham: Total working time, hr/wk	Durham: Salary costs, $/yr	Hillsboro-Cornelius: Number of positions	Hillsboro-Cornelius: Total working time, hr/wk	Hillsboro-Cornelius: Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Shift foreman	14,560	1	40	14,560	--	--	--	--	--	--
Equipment operator	13,520	4	160	54,080	2	100	33,800	2	100	33,800
Loader operator	13,520	2	80	27,040	1	50	16,900	1	50	16,900
Maintenance	13,520	1	40	13,520	1	40	13,520	1	40	13,520
Weighmaster	10,880	1	40	10,880	2	80	21,760	1	40	10,880
Clerk	9,360	1	40	9,360	1	40	9,360	1	40	9,360
Laborer	10,880	6	240	65,280	3	150	40,800	3	120	32,640
Truck driver	13,000	4	170	55,250	6	240	78,000	4	160	52,000
Total personnel		21			17			14		
Salary subtotal				264,530			228,700			183,660
Acceleration, 30%[a]				79,359			68,610			55,098
Total annual salary				343,889			297,310			238,758

Position title	Position salary, $/yr	Killingsworth and 82nd: Number of positions	Killingsworth and 82nd: Total working time, hr/wk	Killingsworth and 82nd: Salary costs, $/yr	S.E. Portland: Number of positions	S.E. Portland: Total working time, hr/wk	S.E. Portland: Salary costs, $/yr	Rossman: Number of positions	Rossman: Total working time, hr/wk	Rossman: Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Shift foreman	14,560	--	--	--	1	40	14,560	--	--	--
Equipment operator	13,520	3	120	40,560	4	160	54,080	2	80	27,040
Loader operator	13,520	1	55	18,590	2	80	27,040	1	40	13,520
Maintenance	13,520	1	40	13,520	1	40	13,520	1	40	13,520
Weighmaster	10,880	1	40	10,880	2	80	21,760	1	40	10,880
Clerk	9,360	1	40	9,360	1	40	9,360	1	40	9,360
Laborer	10,880	4	160	43,520	6	240	65,280	3	120	32,640
Truck driver	13,000	5	200	65,000	7	280	91,000	3	120	39,000
Total personnel		17			25			13		
Salary subtotal				215,990			311,160			160,520
Acceleration, 30%[a]				64,797			93,348			48,156
Total annual salary				280,787			404,508			208,676

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-6

REGIONAL SYSTEM
1980 OPERATING PERSONNEL
MILLING FACILITIES AND MILLED REFUSE TRANSPORT

Position title	Position salary, $/yr	Columbia Boulevard			Durham			Hillsboro-Cornelius		
		Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Shift foreman	14,560	1	40	14,560	--	--	--	--	--	--
Equipment operator	13,520	4	160	54,080	2	100	33,800	2	100	33,800
Loader operator	13,520	2	80	27,040	1	50	16,900	1	50	16,900
Maintenance	13,520	1	40	13,520	1	40	13,520	1	40	13,520
Weighmaster	10,880	1	40	10,880	2	80	21,760	1	40	10,880
Clerk	9,360	1	40	9,360	1	40	9,360	1	40	9,360
Laborer	10,880	6	240	65,280	3	150	40,800	3	120	32,640
Truck driver	13,000	4	170	55,250	6	240	78,000	4	160	52,000
Total personnel		21			17			14		
Salary subtotal				264,530			228,700			183,660
Acceleration, 30%[a]				79,359			68,610			55,098
Total annual salary				343,889			297,310			238,758

Position title	Position salary, $/yr	Killingsworth and 82nd			S.E. Portland			Rossman		
		Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Shift foreman	14,560	--	--	--	1	40	14,560	--	--	--
Equipment operator	13,520	3	120	40,560	4	160	54,080	2	80	27,040
Loader operator	13,520	1	55	18,590	2	80	27,040	1	40	13,520
Maintenance	13,520	1	40	13,520	1	40	13,520	1	40	13,520
Weighmaster	10,880	1	40	10,880	2	80	21,760	1	40	10,880
Clerk	9,360	1	40	9,360	1	40	9,360	1	40	9,360
Laborer	10,880	4	160	43,520	6	240	65,280	3	120	32,640
Truck driver	13,000	5	200	65,000	7	280	91,000	3	120	39,000
Total personnel		17			25			13		
Salary subtotal				215,990			311,160			160,520
Acceleration, 30%[a]				64,797			93,348			48,156
Total annual salary				280,787			404,508			208,676

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-7

REGIONAL SYSTEM
1985 OPERATING PERSONNEL
MILLING FACILITIES AND MILLED REFUSE TRANSPORT

		Columbia Boulevard			Durham			Hillsboro-Cornelius		
Position title	Position salary, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Shift foreman	14,560	1	40	14,560	--	--	--	1	40	14,560
Equipment operator	13,520	4	160	54,080	2	100	33,800	2	80	27,040
Loader operator	13,520	2	80	27,040	1	50	16,900	2	80	27,040
Maintenance	13,520	1	40	13,520	1	40	13,520	1	40	13,520
Weighmaster	10,880	1	40	10,880	2	80	21,760	1	40	10,880
Clerk	9,360	1	40	9,360	1	40	9,360	1	40	9,360
Laborer	10,880	6	240	65,280	4	160	43,520	6	240	65,280
Truck driver	13,000	4	170	55,250	6	240	78,000	5	200	65,000
Total personnel		21			18			20		
Salary subtotal				264,530			231,420			247,240
Acceleration, 30%[a]				79,359			69,426			74,172
Total annual salary				343,889			300,846			321,412

		Killingsworth and 82nd			S.E. Portland			Rossman		
Position title	Position salary, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1.2	48	17,472	1	40	14,560
Shift foreman	14,560	--	--	--	1.2	48	17,472	1	40	14,560
Equipment operator	13,520	3	120	40,560	4.8	192	64,896	4	160	54,080
Loader operator	13,520	1	55	18,590	2.4	96	32,448	2	80	27,040
Maintenance	13,520	1	40	13,520	1.2	48	16,224	1	40	13,520
Weighmaster	10,880	1	40	10,880	2.4	96	26,112	1	40	10,880
Clerk	9,360	1	40	9,360	1.2	48	11,232	1	40	9,360
Laborer	10,880	4	160	43,520	7.2	288	78,336	6	240	65,280
Truck driver	13,000	5	200	65,000	9.0	360	117,000	4	160	52,000
Total personnel		17			30.6			21		
Salary subtotal				215,990			381,192			261,280
Acceleration, 30%[a]				64,797			114,358			78,384
Total annual salary				280,787			495,550			339,664

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-8

REGIONAL SYSTEM
1990 OPERATING PERSONNEL
MILLING FACILITIES AND MILLED REFUSE TRANSPORT

Position title	Position salary, $/yr	Columbia Boulevard: Number of positions	Columbia Boulevard: Total working time hr/yr	Columbia Boulevard: Salary costs, $/yr	Durham: Number of positions	Durham: Total working time, hr/wk	Durham: Salary costs, $/yr	Hillsboro-Cornelius: Number of positions	Hillsboro-Cornelius: Total working time, hr/wk	Hillsboro-Cornelius: Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Shift foreman	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Equipment operator	13,520	4	160	54,080	4	160	54,080	4	160	54,080
Loader operator	13,520	2	80	27,040	2	80	27,040	2	80	27,040
Maintenance	13,520	1	40	13,520	1	40	13,520	1	40	13,520
Weighmaster	10,880	1	40	10,880	2	80	21,760	1	40	10,880
Clerk	9,360	1	40	9,360	1	40	9,360	1	40	9,360
Laborer	10,880	6	240	65,280	6	240	65,280	6	240	65,280
Truck driver	13,000	4	160	52,000	7	280	91,000	6	240	78,000
Total personnel		21			25			23		
Salary subtotal				261,280			311,160			287,280
Acceleration, 30%[a]				78,384			93,348			86,184
Total annual salary				339,664			404,508			373,464

Position title	Position salary, $/yr	Killingsworth and 82nd: Number of positions	Killingsworth and 82nd: Total working time, hr/wk	Killingsworth and 82nd: Salary costs, $/yr	S.E. Portland: Number of positions	S.E. Portland: Total working time, hr/wk	S.E. Portland: Salary costs, $/yr	Rossman: Number of positions	Rossman: Total working time, hr/wk	Rossman: Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1.2	48	17,472	1	40	14,560
Shift foreman	14,560	1	40	14,560	1.2	48	17,472	1	40	14,560
Equipment operator	13,520	4	160	54,080	4.8	192	64,896	4	160	54,080
Loader operator	13,520	2	80	27,040	2.4	96	32,448	2	80	27,040
Maintenance	13,520	1	40	13,520	1.2	48	16,224	1	40	13,520
Weighmaster	10,880	1	40	10,880	2.4	96	26,112	1	40	10,880
Clerk	9,360	1	40	9,360	1.2	48	11,232	1	40	9,360
Laborer	10,880	6	240	65,280	7.2	288	78,336	6	240	65,280
Truck driver	13,000	6	240	78,000	9.0	360	117,000	5	200	65,000
Total personnel		23			30.6			22		
Salary subtotal				287,280			381,192			274,280
Acceleration, 30%[a]				86,184			114,358			82,284
Total annual salary				373,464			495,550			356,564

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-9

REGIONAL SYSTEM
1995 OPERATING PERSONNEL
MILLING FACILITIES AND MILLED REFUSE TRANSPORT

Position title	Position salary, $/yr	Columbia Boulevard: Number of positions	Columbia Boulevard: Total working time, hr/wk	Columbia Boulevard: Salary costs, $/yr	Durham: Number of positions	Durham: Total working time, hr/wk	Durham: Salary costs, $/yr	Hillsboro-Cornelius: Number of positions	Hillsboro-Cornelius: Total working time, hr/wk	Hillsboro-Cornelius: Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1.2	48	17,472	1	40	14,560
Shift foreman	14,560	1	40	14,560	1.2	48	17,472	1	40	14,560
Equipment operator	13,520	4	160	54,080	4.8	192	64,896	4	160	54,080
Loader operator	13,520	2	80	27,040	2.4	96	32,448	2	80	27,040
Maintenance	13,520	1	40	13,520	1.2	48	16,224	1	40	13,520
Weighmaster	10,880	1	40	10,880	2.4	96	26,112	1	40	10,880
Clerk	9,360	1	40	9,360	1.2	48	11,232	1	40	9,360
Laborer	10,880	6	240	65,280	7.2	288	78,336	6	240	65,280
Truck driver	13,000	4	160	52,000	13.0	520	169,000	4	160	52,000
Total personnel		21			34.6			21		
Salary subtotal				261,280			433,192			261,280
Acceleration, 30%[a]				78,384			129,958			78,384
Total annual salary				339,664			563,150			339,664

Position title	Position salary, $/yr	Killingsworth and 82nd: Number of positions	Killingsworth and 82nd: Total working time, hr/wk	Killingsworth and 82nd: Salary costs, $/yr	S.E. Portland: Number of positions	S.E. Portland: Total working time, hr/wk	S.E. Portland: Salary costs, $/yr	Rossman: Number of positions	Rossman: Total working time, hr/wk	Rossman: Salary costs, $/yr
Superintendent	14,560	1	40	14,560	1.2	48	17,472	1	40	14,560
Shift foreman	14,560	1	40	14,560	1.2	48	17,472	1	40	14,560
Equipment operator	13,520	4	160	54,080	4.8	192	64,896	4	160	54,080
Loader operator	13,520	2	80	27,040	2.4	96	32,448	2	80	27,040
Maintenance	13,520	1	40	13,520	1.2	48	16,224	1	40	13,520
Weighmaster	10,880	1	40	10,880	2.4	96	26,112	1	40	10,880
Clerk	9,360	1	40	9,360	1.2	48	11,232	1	40	9,360
Laborer	10,880	6	240	65,280	7.2	288	78,336	6	240	65,280
Truck driver	13,000	6	240	78,000	10.0	400	130,000	6	240	78,000
Total personnel		23			31.6			23		
Salary subtotal				287,280			394,192			287,280
Acceleration, 30%[a]				86,184			118,258			86,184
Total annual salary				373,464			512,450			373,464

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-10

REGIONAL SYSTEM
2000 OPERATING PERSONNEL
MILLING FACILITIES AND MILLED REFUSE TRANSPORT

		Columbia Boulevard			Durham			Hillsboro-Cornelius		
Position title	Position salary, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Superintendent	14,560	1.2	48	17,472	1.2	48	17,472	1	40	14,560
Shift foreman	14,560	1.2	48	17,472	1.2	48	17,472	1	40	14,560
Equipment operator	13,520	4.8	192	64,896	4.8	192	64,896	4	160	54,080
Loader operator	13,520	2.4	96	32,448	2.4	96	32,448	2	80	27,040
Maintenance	13,520	1.2	48	16,224	1.4	48	16,224	1	40	13,520
Weighmaster	10,880	2.4	96	26,112	2.4	96	26,112	1	40	10,880
Clerk	9,360	1.2	48	11,232	1.2	48	11,232	1	40	9,360
Laborer	10,880	7.2	288	78,336	7.2	288	78,336	6	240	65,280
Truck driver	13,000	4.0	160	52,000	15.0	600	195,000	5	200	65,000
Total personnel		25.6			36.6			22		
Salary subtotal				316,192			459,192			264,488
Acceleration, 30%[a]				94,858			137,758			79,346
Total annual salary				411,050			596,950			343,834

		Killingsworth and 82nd			S.E. Portland			Rossman		
Position title	Position salary, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Superintendent	14,560	1.2	48	17,472	1.2	48	17,472	1.2	48	17,472
Shift foreman	14,560	1.2	48	17,472	1.2	48	17,472	1.2	48	17,472
Equipment operator	13,520	4.8	192	64,896	4.8	192	64,896	4.8	192	64,896
Loader operator	13,520	2.4	96	32,448	2.4	96	32,448	2.4	96	32,448
Maintenance	13,520	1.2	48	16,224	1.2	48	16,224	1.2	48	16,224
Weighmaster	10,880	2.4	96	26,112	2.4	96	26,112	2.4	96	26,112
Clerk	9,360	1.2	48	11,232	1.2	48	11,232	1.2	48	11,232
Laborer	10,880	7.2	288	78,336	7.2	288	78,336	7.2	288	78,336
Truck driver	13,000	6.0	240	78,000	11.0	440	143,000	6.0	240	78,000
Total personnel		27.6			32.6			27.6		
Salary subtotal				342,192			407,192			342,192
Acceleration, 30%[a]				102,658			122,158			102,658
Total annual salary				444,850			529,350			444,850

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-11

REGIONAL SYSTEM
1976 OPERATION AND MAINTENANCE COSTS
MILLING FACILITIES AND MILLED REFUSE TRANSPORT
(Thousands of Dollars)

Item	Durham
Fixed plant	
Labor	195.9
Power	43.4
Water and sewer	0.4
Mill and conveyor maintenance	65.1
Compactor maintenance	5.4
Building maintenance	4.0
Front loader operation and maintenance	15.5
Yard tractor operation and maintenance	0.3
Insurance	22.8
Data processing	6.4
Subtotal	359.2
Transport	
Labor	50.7
Equipment operation and maintenance	8.7
Insurance, licenses, and taxes	12.2
Total annual cost	430.8

Table O-12

REGIONAL SYSTEM
1977 OPERATION AND MAINTENANCE COSTS
MILLING FACILITIES AND MILLED REFUSE TRANSPORT
(Thousands of Dollars)

Item	Columbia Boulevard	Durham	Hillsboro-Cornelius	Killingsworth and 82nd	S.E. Portland	Rossman
Fixed plant						
Labor	272.1	195.9	171.2	196.3	286.2	158.0
Power	32.7	32.3	14.2	30.4	38.9	17.5
Water and sewer	0.4	0.4	0.2	0.3	0.5	0.2
Mill and conveyor maintenance	49.0	48.5	19.3	43.4	68.6	29.2
Compactor maintenance	4.1	4.0	1.6	3.6	5.7	2.4
Building maintenance	3.4	4.0	1.9	3.4	4.0	3.4
Front loader operation and maintenance	15.5	15.5	12.4	15.5	15.5	7.7
Yard tractor operation and maintenance	0.2	0.2	0.1	0.2	0.3	0.2
Insurance	19.2	22.8	10.5	19.2	22.8	19.2
Data processing	5.5	6.4	3.0	5.5	6.4	5.5
Subtotal	402.1	330.0	234.4	317.8	448.9	243.3
Transport						
Labor	71.8	50.7	50.7	84.5	118.3	33.8
Equipment operation and maintenance	30.7	6.5	42.6	46.2	58.7	1.0
Insurance, licenses, and taxes	16.3	12.2	12.2	20.4	28.5	8.1
Total annual cost	520.9	399.4	339.9	468.9	654.4	286.2

Table O-13

REGIONAL SYSTEM
1978 OPERATION AND MAINTENANCE COSTS
MILLING FACILITIES AND MILLED REFUSE TRANSPORT
(Thousands of Dollars)

Item	Columbia Boulevard	Durham	Hillsboro-Cornelius	Killingsworth and 82nd	S. E. Portland	Rossman
Fixed plant						
Labor	272.1	195.9	171.2	196.3	286.2	158.0
Power	33.0	33.8	14.9	30.9	39.8	18.3
Water and sewer	0.4	0.4	0.2	0.3	0.5	0.3
Mill and conveyor maintenance	49.5	50.7	20.3	44.2	70.2	30.4
Compactor maintenance	4.1	4.2	1.7	3.7	5.9	2.5
Building maintenance	3.4	4.0	1.9	3.4	4.0	3.4
Front loader operation and maintenance	15.5	15.5	12.4	15.5	15.5	7.7
Yard tractor operation and maintenance	0.2	0.4	0.1	0.2	0.3	0.2
Insurance	19.2	22.8	10.5	19.2	22.8	19.2
Data processing	5.5	6.4	3.0	5.5	6.4	5.5
Subtotal	402.9	334.1	236.2	319.2	451.6	245.5
Transport						
Labor	71.8	101.4	50.7	84.5	118.3	33.8
Equipment operation and maintenance	30.9	20.3	45.1	46.6	59.3	1.1
Insurance, licenses, and taxes	16.3	24.3	12.2	20.4	28.5	8.1
Total annual cost	521.9	480.1	344.2	470.7	657.7	288.5

Table O-14

REGIONAL SYSTEM
1979 OPERATION AND MAINTENANCE COSTS
MILLING FACILITIES AND MILLED REFUSE TRANSPORT
(Thousands of Dollars)

Item	Columbia Boulevard	Durham	Hillsboro-Cornelius	Killingsworth and 82nd	S.E. Portland	Rossman
Fixed plant						
Labor	272.1	195.9	171.2	196.3	286.2	158.0
Power	33.3	35.2	15.4	31.4	40.7	19.0
Water and sewer	0.4	0.4	0.2	0.3	0.5	0.3
Mill and conveyor maintenance	49.9	52.7	21.1	44.9	71.8	31.7
Compactor maintenance	4.2	4.4	1.8	3.7	6.0	2.6
Building maintenance	3.4	4.0	1.9	3.4	4.0	3.4
Front loader operation and maintenance	15.5	15.5	12.4	15.5	15.5	7.7
Yard tractor operation and maintenance	0.2	0.4	0.2	0.2	0.4	0.2
Insurance	19.2	22.8	10.5	19.2	22.8	19.2
Data processing	5.5	6.4	3.0	5.5	6.4	5.5
Subtotal	403.7	337.7	237.7	320.4	454.3	247.6
Transport						
Labor	71.8	101.4	67.6	84.5	118.3	50.7
Equipment operation and maintenance	31.1	21.1	46.8	47.4	60.6	1.2
Insurance, licenses, and taxes	16.3	24.3	16.3	20.4	28.5	12.2
Total annual cost	522.9	484.5	368.4	472.7	661.7	311.7

Table O-15

REGIONAL SYSTEM
1980 OPERATION AND MAINTENANCE COSTS
MILLING FACILITIES AND MILLED REFUSE TRANSPORT
(Thousands of Dollars)

Item	Columbia Boulevard	Durham	Hillsboro-Cornelius	Killingsworth and 82nd	S.E. Portland	Rossman
Fixed plant						
Labor	272.1	195.9	171.2	196.3	286.2	158.0
Power	33.6	36.6	16.0	32.1	41.5	19.8
Water and sewer	0.4	0.4	0.2	0.4	0.5	0.3
Mill and conveyor maintenance	50.4	54.9	21.8	45.9	73.4	32.9
Compactor maintenance	4.2	4.6	1.8	3.8	6.1	2.7
Building maintenance	3.4	4.0	1.9	3.4	4.0	3.4
Front loader operation and maintenance	15.5	15.5	12.4	15.5	15.5	9.3
Yard tractor operation and maintenance	0.2	0.4	0.2	0.2	0.4	0.2
Insurance	19.2	22.8	10.5	19.2	22.8	19.2
Data processing	5.5	6.4	3.0	5.5	6.4	5.5
Subtotal	404.5	341.5	239.0	322.3	456.8	251.3
Transport						
Labor	71.8	101.4	67.6	84.5	118.3	50.7
Equipment operation and maintenance	31.8	21.7	47.3	48.0	61.2	1.3
Insurance, licenses, and taxes	16.3	24.3	16.3	20.4	28.5	12.2
Total annual cost	524.4	488.9	370.2	475.2	664.8	315.5

Table O-16

REGIONAL SYSTEM
1985 OPERATION AND MAINTENANCE COSTS
MILLING FACILITIES AND MILLED REFUSE TRANSPORT
(Thousands of Dollars)

Item	Columbia Boulevard	Durham	Hillsboro-Cornelius	Killingsworth and 82nd	S.E. Portland	Rossman
Fixed plant						
Labor	272.1	199.4	236.9	196.3	343.5	272.1
Power	33.9	39.4	16.7	32.0	46.0	29.4
Water and sewer	0.4	0.5	0.2	0.4	0.6	0.3
Mill and conveyor maintenance	53.5	65.7	27.8	50.5	81.1	40.1
Compactor maintenance	4.5	5.5	2.3	4.2	6.8	3.3
Building maintenance	3.4	4.0	1.9	3.4	4.0	3.4
Front loader operation and maintenance	15.5	15.5	15.5	15.5	18.6	15.5
Yard tractor operation and maintenance	0.2	0.4	0.3	0.3	0.4	0.3
Insurance	19.2	22.8	10.5	19.2	22.8	19.2
Data processing	6.0	7.0	4.5	6.0	7.0	6.0
Subtotal	408.7	360.2	316.6	327.8	530.8	389.6
Transport						
Labor	71.8	101.4	84.5	84.5	152.1	67.6
Equipment operation and maintenance	33.3	26.2	61.7	53.4	145.3	36.1
Insurance, licenses, and taxes	16.3	24.3	20.4	20.4	36.6	16.3
Total annual cost	530.1	512.1	483.2	486.1	864.8	509.6

Table O-17

REGIONAL SYSTEM
1990 OPERATION AND MAINTENANCE COSTS
MILLING FACILITIES AND MILLED REFUSE TRANSPORT
(Thousands of Dollars)

Item	Columbia Boulevard	Durham	Hillsboro-Cornelius	Killingsworth and 82nd	S.E. Portland	Rossman
Fixed plant						
Labor	267.9	286.2	272.1	272.1	343.5	272.1
Power	34.2	41.3	27.3	35.2	47.4	31.7
Water and sewer	0.4	0.6	0.3	0.4	0.6	0.4
Mill and conveyor maintenance	56.9	77.4	34.2	55.5	88.9	47.9
Compactor maintenance	4.7	6.4	2.8	4.6	7.4	4.0
Building maintenance	3.4	4.0	3.4	3.4	4.0	3.4
Front loader operation and maintenance	15.5	15.5	15.5	15.5	18.6	15.5
Yard tractor operation	0.3	0.5	0.4	0.3	0.4	0.4
Insurance	19.2	22.8	19.2	19.2	22.8	19.2
Data processing	6.5	7.5	5.5	6.5	7.5	6.5
Subtotal	409.0	462.2	380.7	412.7	541.1	401.1
Transport						
Labor	71.8	118.3	101.4	101.4	152.1	84.5
Equipment operation and maintenance	25.9	31.0	75.9	51.8	154.1	43.1
Insurance, licenses, and taxes	16.3	28.5	24.3	24.3	36.6	20.4
Total annual cost	523.0	640.0	582.2	590.2	883.9	549.1

Table O-18

REGIONAL SYSTEM
1995 OPERATION AND MAINTENANCE COSTS
MILLING FACILITIES AND MILLED REFUSE TRANSPORT
(Thousands of Dollars)

Item	Columbia Boulevard	Durham	Hillsboro-Cornelius	Killingsworth and 82nd	S.E. Portland	Rossman
Fixed plant						
Labor	272.1	343.5	272.1	272.1	343.5	272.1
Power	34.7	48.8	31.0	34.3	52.0	35.3
Water and sewer	0.5	0.7	0.3	0.5	0.7	0.4
Mill and conveyor maintenance	61.3	91.6	44.3	60.5	97.5	61.9
Compactor maintenance	5.1	7.6	3.7	5.0	8.1	4.9
Building maintenance	3.4	4.0	3.4	3.4	4.0	3.4
Front loader operation and maintenance	15.5	18.6	15.5	15.5	21.2	15.5
Yard tractor operation	0.4	1.0	0.5	0.4	0.5	0.4
Insurance	19.2	22.8	19.2	19.2	22.8	19.2
Data processing	7.0	8.0	6.0	7.0	8.0	7.0
Subtotal	419.2	546.6	396.0	417.9	558.3	420.1
Transport						
Labor	67.6	219.7	67.6	101.4	169.0	101.4
Equipment operation and maintenance	27.9	223.8	38.9	56.5	169.0	52.9
Insurance, licenses, and taxes	16.3	52.7	12.2	24.3	40.7	24.3
Total annual cost	531.0	1,042.8	514.7	600.1	937.0	598.7

Table O-19

REGIONAL SYSTEM
2000 OPERATION AND MAINTENANCE COSTS
MILLING FACILITIES AND MILLED REFUSE TRANSPORT
(Thousands of Dollars)

Item	Columbia Boulevard	Durham	Hillsboro-Cornelius	Killingsworth and 82nd	S.E. Portland	Rossman
Fixed plant						
Labor	343.5	343.5	276.2	343.5	343.5	343.5
Power	39.7	53.5	33.3	40.7	53.6	42.5
Water and sewer	0.5	0.8	0.4	0.5	0.8	0.5
Mill and conveyor maintenance	66.1	107.0	55.5	66.0	107.2	70.8
Compactor maintenance	5.5	8.9	4.6	5.5	8.9	5.9
Building maintenance	3.4	4.0	3.4	3.4	4.0	3.4
Front loader operation and maintenance	18.6	21.2	15.5	18.6	21.2	18.6
Yard tractor operation	0.4	1.2	0.5	0.5	0.5	0.5
Insurance	19.2	24.5	19.2	19.2	24.5	19.2
Data processing	7.5	8.5	6.5	7.5	8.5	7.5
Subtotal	504.4	573.1	415.1	505.4	572.7	512.4
Transport						
Labor	67.6	253.5	67.6	101.4	185.9	101.4
Equipment operation and maintenance	30.1	261.6	48.8	61.6	185.8	63.7
Insurance, licenses, and taxes	16.3	60.8	12.2	24.3	44.8	24.3
Total annual cost	618.4	1,149.0	543.7	692.7	989.2	701.8

Table O-20

REGIONAL SYSTEM
DESIGN QUANTITIES FOR MILLED REFUSE LANDFILLS
(Tons per Week)

Year	St.Johns	Hayden Island	Rossman	Alford	Durham	Cipole	Old Pumpkin
1976	--	--	--	--	4,170	--	--
1977	5,920	--	6,270	--	4,350	--	--
1978	6,000	--	6,450	--	--	4,500	--
1979	6,080	--	6,630	--	--	4,730	--
1980	6,170	--	6,810	--	--	4,920	--
1981	6,270	--	6,990	--	--	5,130	--
1982	6,370	--	7,180	--	--	5,340	--
1983	11,470	--	--	2,370	--	5,550	--
1984	11,670	--	--	2,470	--	5,770	--
1985	11,870	--	--	2,570	--	5,990	--
1986	12,070	--	--	2,670	--	6,220	--
1987	--	12,280	--	2,770	--	6,450	--
1988	--	12,490	--	2,870	--	6,680	--
1989	--	12,690	--	2,970	--	6,910	--
1990	--	12,910	--	3,070	--	7,150	--
1991	--	13,130	--	3,210	--	7,460	--
1992	--	13,370	--	3,350	--	7,770	--
1993	--	13,590	--	3,590	--	8,080	--
1994	--	13,820	--	3,630	--	8,390	--
1995	--	14,060	--	3,770	--	--	8,710
1996	--	14,320	--	3,920	--	--	9,050
1997	--	14,570	--	4,070	--	--	9,390
1998	--	14,820	--	4,230	--	--	9,730
1999	--	15,080	--	4,380	--	--	10,080
2000	--	15,340	--	4,540	--	--	10,420

Note: Quantities shown are maximum and do not take credit for potential reuse of reclaimed materials.

Table O-21

REGIONAL SYSTEM
1976 OPERATING PERSONNEL
MILLED REFUSE LANDFILLS

		Durham		
Position title	Position salary, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Supervisor	14,560	1	40	14,560
Equipment operator	13,520	1	40	13,520
Weighmaster-clerk	10,880	2	80	21,760
Laborer	10,880	2	80	21,760
Total personnel		6		
Salary subtotal				71,600
Acceleration, 30%[a]				21,480
Total annual salary				93,080

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-22

REGIONAL SYSTEM
1977 OPERATING PERSONNEL
MILLED REFUSE LANDFILLS

Position title	Position salary, $/yr	St. Johns Number of positions	St. Johns Total working time, hr/wk	St. Johns Salary costs, $/yr	Rossman Number of positions	Rossman Total working time, hr/wk	Rossman Salary costs, $/yr	Durham Number of positions	Durham Total working time, hr/wk	Durham Salary costs, $/yr
Supervisor	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Equipment operator	13,520	2	80	27,040	2	80	27,040	1	40	13,520
Weighmaster-clerk	10,880	2	80	21,760	2	80	21,760	2	80	21,760
Laborer	10,880	2	80	21,760	2	80	21,760	2	80	21,760
Total personnel		7			7			6		
Salary subtotal				85,120			85,120			71,600
Acceleration, 30%[a]				25,536			25,536			21,480
Total annual salary				110,656			110,656			93,080

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-23

REGIONAL SYSTEM
1978 OPERATING PERSONNEL
MILLED REFUSE LANDFILLS

Position title	Position salary, $/yr	St.Johns Number of positions	St.Johns Total working time, hr/wk	St.Johns Salary costs, $/yr	Rossman Number of positions	Rossman Total working time, hr/wk	Rossman Salary costs, $/yr	Cipole Number of positions	Cipole Total working time, hr/wk	Cipole Salary costs, $/yr
Supervisor	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Equipment operator	13,520	2	80	27,040	2	80	27,040	1	40	13,520
Weighmaster-clerk	10,880	2	80	21,760	2	80	21,760	2	80	21,760
Laborer	10,880	2	80	21,760	2	80	21,760	2	80	21,760
Total personnel		7			7			6		
Salary subtotal				85,120			85,120			71,600
Acceleration, 30%[a]				25,536			25,536			21,480
Total annual salary				110,656			110,656			93,080

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-24

REGIONAL SYSTEM
1979 OPERATING PERSONNEL
MILLED REFUSE LANDFILLS

Position title	Position salary, $/yr	St. Johns: Number of positions	St. Johns: Total working time, hr/wk	St. Johns: Salary costs, $/yr	Rossman: Number of positions	Rossman: Total working time, hr/wk	Rossman: Salary costs, $/yr	Cipole: Number of positions	Cipole: Total working time, hr/wk	Cipole: Salary costs, $/yr
Supervisor	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Equipment operator	13,520	2	80	27,040	2	80	27,040	2	80	27,040
Weighmaster-clerk	10,880	2	80	21,760	2	80	21,760	2	80	21,760
Laborer	10,880	2	80	21,760	2	80	21,760	2	80	21,760
Total personnel		7			7			7		
Salary subtotal				85,120			85,120			85,120
Acceleration, 30%[a]				25,536			25,536			25,536
Total annual salary				110,656			110,656			110,656

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-25

REGIONAL SYSTEM
1980 OPERATING PERSONNEL
MILLED REFUSE LANDFILLS

Position title	Position salary, $/yr	St. Johns: Number of positions	St. Johns: Total working time, hr/wk	St. Johns: Salary costs, $/yr	Rossman: Number of positions	Rossman: Total working time hr/wk	Rossman: Salary costs, $/yr	Cipole: Number of positions	Cipole: Total working time hr/wk	Cipole: Salary costs, $/yr
Supervisor	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Equipment operator	13,520	2	80	27,040	2	80	27,040	2	80	27,040
Weighmaster-clerk	10,880	2	80	21,760	2	80	21,760	2	80	21,760
Laborer	10,880	2	80	21,760	2	80	21,760	2	80	21,760
Total personnel		7			7			7		
Salary subtotal				85,120			85,120			85,120
Acceleration, 30%[a]				25,536			25,536			25,536
Total annual salary				110,656			110,656			110,656

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-26

REGIONAL SYSTEM
1985 OPERATING PERSONNEL
MILLED REFUSE LANDFILLS

Position title	Position salary, $/yr	St. Johns			Alford			Cipole		
		Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	working time, hr/wk	Salary costs, $/yr
Supervisor	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Equipment operator	13,520	3	120	40,560	1	40	13,520	2	80	27,040
Weighmaster-clerk	10,880	3	120	32,640	2	80	21,760	2	80	21,760
Laborer	10,880	3	120	32,640	2	80	21,760	2	80	21,760
Total personnel		10			6			7		
Salary subtotal				120,400			71,600			85,120
Acceleration, 30%[a]				36,120			21,480			25,536
Total annual salary				156,520			93,080			110,656

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-27

REGIONAL SYSTEM
1990 OPERATING PERSONNEL
MILLED REFUSE LANDFILLS

Position title	Position salary, $/yr	Hayden Island			Alford			Cipole		
		Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Supervisor	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Equipment operator	13,520	3	120	40,560	1	40	13,520	2	80	27,040
Weighmaster-clerk	10,880	3	120	32,640	2	80	21,760	2	80	21,760
Laborer	10,880	3	120	32,640	2	80	21,760	2	80	21,760
Total personnel		10			6			7		
Salary subtotal				120,400			71,600			85,120
Acceleration, 30%[a]				36,120			21,480			25,536
Total annual salary				156,520			93,080			110,656

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-28

REGIONAL SYSTEM
1995 OPERATING PERSONNEL
MILLED REFUSE LANDFILLS

Position title	Position salary, $/yr	Hayden Island			Alford			Old Pumpkin		
		Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Supervisor	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Equipment operator	13,520	3	120	40,560	1	40	13,520	2	80	27,040
Weighmaster-clerk	10,880	3	120	32,640	2	80	21,760	3	120	32,640
Laborer	10,880	3	120	32,640	2	80	21,760	3	120	32,640
Total personnel		10			6			9		
Salary subtotal				120,400			71,600			106,880
Acceleration, 30%[a]				36,120			21,480			32,064
Total annual salary				156,520			93,080			138,944

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-29

REGIONAL SYSTEM
2000 OPERATING PERSONNEL
MILLED REFUSE LANDFILLS

Position title	Position salary, $/yr	Hayden Island			Alford			Old Pumpkin		
		Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr	Number of positions	Total working time, hr/wk	Salary costs, $/yr
Supervisor	14,560	1	40	14,560	1	40	14,560	1	40	14,560
Equipment operator	13,520	4	160	50,080	1	40	13,520	3	120	40,560
Weighmaster-clerk	10,880	3	120	32,640	2	80	21,760	3	120	32,640
Laborer	10,880	3	120	32,640	2	80	21,760	3	120	32,640
Total personnel		11			6			10		
Salary subtotal				129,920			71,600			120,400
Acceleration, 30%[a]				38,976			21,480			36,120
Total annual salary				168,896			93,080			156,520

a. Includes insurance, retirement, social security, office overhead, and other personnel expenses.

Table O-30

REGIONAL SYSTEM
1976 ANNUAL OPERATION AND MAINTENANCE COSTS
MILLED REFUSE LANDFILLS

Item	Durham
Labor	93
Equipment operation and maintenance	18
Site maintenance	5
Utilities	1
Cover material purchase	54
Total annual cost	171

Table O-31

REGIONAL SYSTEM
1977 ANNUAL OPERATION AND MAINTENANCE COSTS
MILLED REFUSE LANDFILLS

Item	St. Johns	Rossman	Durham
Labor	111	111	93
Equipment operation and maintenance	26	27	19
Site maintenance	14	10	5
Utilities	1	1	1
Cover material purchase	77	82	57
Total annual cost	229	231	175

Table O-32

REGIONAL SYSTEM
1978 ANNUAL OPERATION AND MAINTENANCE COSTS
MILLED REFUSE LANDFILLS

Item	St. Johns	Rossman	Cipole
Labor	111	111	93
Equipment operation and maintenance	26	28	20
Site maintenance	14	10	19
Utilities	1	1	1
Cover material purchase	78	84	30
Total annual cost	230	234	163

Table O-33

REGIONAL SYSTEM
1979 ANNUAL OPERATION AND MAINTENANCE COSTS
MILLED REFUSE LANDFILLS

Item	St. Johns	Rossman	Cipole
Labor	111	111	111
Equipment operation and maintenance	26	29	20
Site maintenance	14	10	19
Utilities	1	1	1
Cover material purchase	79	86	31
Total annual cost	231	237	182

Table O-34

REGIONAL SYSTEM
1980 ANNUAL OPERATION AND MAINTENANCE COSTS
MILLED REFUSE LANDFILLS

Item	St. Johns	Rossman	Cipole
Labor	111	111	111
Equipment operation and maintenance	27	29	21
Site maintenance	14	10	19
Utilities	1	1	1
Cover material purchase	80	89	32
Total annual cost	233	240	184

Table O-35
REGIONAL SYSTEM
1985 ANNUAL OPERATION AND MAINTENANCE COSTS
MILLED REFUSE LANDFILLS

Item	St. Johns	Alford	Cipole
Labor	157	93	111
Equipment operation and maintenance	51	11	26
Site maintenance	14	8	19
Utilities	2	1	1
Cover material purchase	154	17	39
Total annual cost	378	130	196

Table O-36

REGIONAL SYSTEM
1990 ANNUAL OPERATION AND MAINTENANCE COSTS
MILLED REFUSE LANDFILLS

Item	Hayden Island	Alford	Cipole
Labor	157	93	111
Equipment operation and maintenance	56	13	31
Site maintenance	24	8	19
Utilities	2	1	1
Cover material purchase	252	19	46
Total annual cost	491	134	208

Table O-37

REGIONAL SYSTEM
1995 ANNUAL OPERATION AND MAINTENANCE COSTS
MILLED REFUSE LANDFILLS

Item	Hayden Island	Alford	Old Pumpkin
Labor	157	93	139
Equipment operation and maintenance	61	16	38
Site maintenance	24	8	12
Utilities	2	1	2
Cover material purchase	274	25	57
Total annual cost	518	143	248

Table O-38

REGIONAL SYSTEM
2000 ANNUAL OPERATION AND MAINTENANCE COSTS
MILLED REFUSE LANDFILLS

Item	Hayden Island	Alford	Old Pumpkin
Labor	169	93	157
Equipment operation and maintenance	66	20	45
Site maintenance	24	8	12
Utilities	3	1	3
Cover material purchase	299	30	68
Total annual cost	561	152	285

APPENDIX P

Appendix P

LANDFILLS FOR NONPROCESSIBLE WASTES

This appendix contains guidelines for selecting and operating disposal sites for nonprocessible wastes. (Additional discussion of the nonprocessible waste system is included in Chapter 17, Volume I.) It should be the responsibility of the individual making a proposal for a landfill site or applying for a permit to operate a site to supply the specific site selection information to MSD.

SITE SELECTION

Zoning Restrictions

Review all existing zoning ordinances to avoid any land use conflicts before a full-scale investigation of a potential site is undertaken.

Accessibility

Select a site which can easily be reached by major traffic routes. Avoid sites requiring travel through residential areas, unless the site is of a relatively short life and the benefits of filling the site outweigh the inconvenience of the truck traffic.

Cover Material

Select a site having an adequate and suitable supply of cover material if possible. An insufficient supply may necessitate hauling material to the site at an excessive cost. Conduct field investigations to establish the suitability and quantity of the soil available. Select a soil with good workability and compaction characteristics; sandy loam satisfies both these qualities. Clay soils may become unworkable during rainy periods, and are generally undesirable. Clay also tends to shrink when it dries, causing cracks in the cover material which permit odors to escape.

Geology

Conduct a geologic investigation in conjunction with the cover material investigation to establish the potential for ground and surface water pollution. Determine the groundwater table and obtain information on the high water level, the groundwater movement, and nearby uses of the groundwater. Almost all solid wastes can contaminate the groundwater, so landfills should be located above the range of groundwater fluctuation. Avoid sites that have a shallow, fractured, sub-surface rock stratum that could concentrate the leachate in the groundwater. If a site that has a groundwater pollution potential cannot be avoided, place a 2-foot impermeable soil or other acceptable barrier prior to the startup of the landfilling operation.

Examine the topography of the site and the surrounding area for potential flooding of the site during heavy rains. Excessive surface water runoff can quickly erode the soil cover of the fill and expose the buried refuse.

SITE IMPROVEMENTS

Access Roads and On-Site Roads

Construct all-weather off-site and on-site access roads so that traffic will not be interrupted by bad weather. Lay out access roads to facilitate the flow of traffic in and out of the site, preferably using one-way traffic.

Signs and Operating Information

Place signs showing the direction and distance to the landfill site along major access routes. Post a large sign at the entrance of the site to inform the public about the hours of operation, cost of disposal, and any important site rules, such as dumping only in specific areas. Post on-site directional signs as needed. Keep an operator on duty during all hours the landfill is open for operation.

Fencing

Provide fencing for sites that are not isolated by trees or topography. If the landfill is in view of a residential or public area, construct a sight-obscuring fence. Erect lockable gates across all access roads.

Drainage Control

Construct ditches around the site to intercept surface water draining towards the site. If a site is located in a natural drainage channel, build a diversion channel around the fill, or construct a leakproof culvert underneath the fill to pass the upstream flow. Slope the fill 2 to 3 percent toward the side drainage ditches to prevent ponding of water on the fill surface.

LANDFILL OPERATION

Operating Records

Keep records of solid waste quantities disposed of at landfills. The records should indicate the types and quantities of material accepted for disposal. Estimates of remaining landfill life should be made quarterly.

Acceptable Wastes

Building materials, rubble, appliances, furniture, glass, plastics, rock, soil, and similar materials are acceptable at a disposal site for nonprocessible wastes. All putrescible materials, oils, sludges, and other liquid wastes are prohibited.

Compaction and Covering

Place refuse in maximum 2-foot-thick layers prior to compacting it. If thicker layers are used, the degree of compaction that normal equipment can achieve is reduced. Compact the refuse upward from the bottom of the working face. Good compaction prolongs the life of the landfill and not only reduces settlement but also reduces potential fire problems.

Daily cover sufficient to prevent blowing litter and provide a neat appearance is required at demolition landfills. The cover may be of any suitable material, such as wood chips or processed wood. Cover the fill with 1 foot of intermediate soil cover whenever an area of 1 acre has been filled.

Noncombustible and nonlittering materials such as boilerhouse cinders, bricks, and broken paving do not require covering.

Blowing Litter

Design the landfill so that the prevailing wind blows into the working face of the hill. Compact promptly after dumping to prevent litter from blowing off the working face. Use snow fences downwind from the working face to control blowing litter.

Burning of Refuse and Fire Control

Allow no burning of refuse at landfill sites. Although burning reduces volume and increases the life of the site, the air pollution and nuisances created by open burning of refuse outweigh any benefits that might be gained.

Notify the nearest public fire protection service of the location and access to the landfill, and any sources of fire-fighting water on or near the site. Make arrangements with the fire department for emergency access to the site during closed hours.

Provide stockpiled soil, or a source of water at the working face, for accidental fire control. If a soil stockpile is used, provide a quantity of soil sufficient to cover the largest uncovered area of the fill with 1 foot of soil. If water is used for fire protection, provide at least 4 gallons for every square foot of uncovered area at the fill.

Fills containing wood or other combustible material should be enclosed with earth dikes to limit the spread of fires. The maximum area enclosed within dikes should be 2 acres. The minimum top width of a dike section should be 3 feet.

Construct a minimum 10-foot-wide fire trail around the perimeter of the fill to prevent accidental fires from spreading to adjacent property.

Salvaging

Remove all salvage from the site at the close of each day, or provide a small, separate, fenced area where salvaged materials can be stored in an orderly manner. Terminate the salvage operation if it becomes dangerous, unsightly, or causes a nuisance.

Maintenance

After the active period of filling operations is completed, and after the landfill has been closed, continue to maintain the fill until it has become stabilized. Ensure prompt repair of cracks, depressions, and erosion of the surface and side slopes.

Erosion Control

Plant completed landfills with suitable grass cover to control erosion. The following grass mixture is suitable for use on landfills:

Red Fescue	44 percent
Chewing Fescue	30 percent
White Dutch Clover	15 percent
Perennial Rye Grass	10 percent
Inerts, Weeds, Crop	1 percent

USE IN COMPLETED LANDFILLS

Record of Land Use

Record a detailed description and plat of the completed fill site with the County Recorder's Office to provide notice to future owners or users of the site. The detailed description should include the type of solid wastes deposited and the original and final terrain description.

<u>Gas Production</u>

If structures are to be built on or adjacent to a nonprocessible waste landfill, take precautions to prevent explosive decomposition gases from collecting beneath or entering into the structure. Require all buildings constructed on or adjacent to sanitary landfills to have suitable means of preventing gas accumulations, such as a well-ventilated air space between buildings and the fill surface.

APPENDIX Q

Appendix Q

INTERIM REPORTS

The contract for this study required that interim reports on special topics be submitted at specific times during the project. Each of those interim reports is reproduced in its entirety in this appendix. *It should be noted, however, that much of the information in the reports has been superceded through subsequent actions and events and therefore should not be construed as current information.*

The reports reproduced herein are as follows:

"Interim Report on Tire Processing and Disposal," March 1973.

"Interim Report on Washington County," March 1973.

"Interim Reports on Hidden Valley Disposal Site, Clatskanie Disposal Site, City of Portland Landfill, Boeing-Boardman Project, and Septic Tank Pumpings," June 1973.

"Action Plans to Upgrade the Existing Solid Waste System," June 1973.

INTERIM REPORT
on TIRE PROCESSING AND DISPOSAL
for METROPOLITAN SERVICE DISTRICT

Q-2

COR – MET
March 1973

31 March 1973

Metropolitan Service District Board
6400 S.W. Canyon Court
Portland, Oregon 97221

Gentlemen:

Subject: Interim Report on Tire Processing and Disposal

In response to the Special Conditions of our contract, as requested by DEQ, we submit herewith our analysis of the present tire disposal situation in the four-county study area. This interim evaluation fulfills Item B of the Special Conditions, stated as follows: "Evaluate the present tire disposal situation and economics (crisis) in the four-county study area and determine the optimum location(s) and methods for tire shredding and disposal on a regional basis."

In our report, we have summarized our investigation under the following headings: Present Conditions; Alternative Processing Methods; Potential Processing and Disposal System; Potential Processing and Disposal Sites; Implementation and Financing; and Recommendations.

It must be emphasized that this is a preliminary report which contains interim recommendations only. Because we have not yet completed our analysis of the overall solid waste system for the study area, we cannot at this time assess the tire disposal situation as an integral part of the overall system.

Accordingly, the recommendations presented herein are of a general, interim nature only.

As presented in our report, the following recommendations are made to the Metropolitan Service District Board with regard to tire processing and disposal in the four-county study area:

1. Adopt an ordinance requiring shredding, baling, or other approved mechanical processing for all tires disposed of within the MSD boundaries.

2. Encourage each of the four counties within the study area to adopt ordinances in keeping with the above.

3. Develop a four-county permit system for the licensing of tire haulers and give direction to the counties in issuing these permits. (See Attachment A.)

4. Encourage each of the four counties within the study area to adopt ordinances requiring all tire haulers to be licensed and all tire dealers to give their waste tires to licensed haulers only.

5. Require all tire processing and disposal centers within its boundaries to accept large truck and earthmover tires and encourage each of the four counties to require the same.

6. Support continued use of the present tire disposal financing system in which tire dealers include the cost as part of their overhead.

Should you have any questions concerning this report, we would be pleased to meet with you at your convenience.

Sincerely,

COR-MET

Melissa Brown
Melissa Brown
Project Manager

C. Leslie Wierson
C. Leslie Wierson
Principal-in-Charge

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SECTION I

PRESENT CONDITIONS

Identification of Problems

The major problem areas within the present tire disposal system may be categorized into those that are characteristic of tire disposal operations anywhere and those that are specific problems within the four-county study area.

1. General problems

   a. Whole tires are difficult to incorporate into a landfill because they cannot be compacted and therefore cause significant voids within the fill. Subsequent sifting of material into those voids can cause excessive settlement of the landfill.

   b. Because of their buoyancy, whole tires have been incorporated into a landfill, they tend to work their way upwards in the fill and eventually come to the surface.

   c. If tires are left uncovered, they can harbor vectors and create a fire hazard. Pockets of tires within a fill can also create a fire hazard, unless landfill cells are properly isolated with cover material.

   d. The shredders and balers that have thus far been developed specifically to process tires cannot accommodate oversized truck tires or tires from earthmoving equipment. Incineration is a process that can handle large tires, but the capital costs and operating costs for incineration are high. The excessive size of the tires also makes them exceptionally difficult to incorporate directly in a landfill.

2. Specific problems within the study area

   a. At some of the disposal sites presently accepting tires, disposal is not in accordance with State standards. These substandard methods lead to low tire disposal costs, which encourage tire haulers to utilize the substandard sites. The sites that are operating in accordance with State requirements are accordingly placed at an economic disadvantage in the competitive market.

b. A significant number of tires are dumped illegally along roadsides and in wooded areas and canyons.

c. Because tires are not accepted at many disposal sites within the area, private citizens often have difficulty in finding a convenient, approved disposal site for their waste tires.

d. There is no system for policing and controlling tire collection and disposal operations within the study area.

e. Commercial tire haulers are not licensed, and there is accordingly no convenient way to monitor them.

Present Regulations

At the State level, tire disposal requirements are specified in the Oregon Revised Statutes on solid wastes (ORS 459). These requirements are described in the Oregon Administrative Rules, OAR, Chapter 340, Section 61-060, as follows:

> (3) Waste Vehicle Tires. (a) Open Dumping. Disposal of loose waste tires by open dumping into ravines, canyons, gullies, and trenches, is prohibited.
>
> (b) Tire Landfill. Bulk quantities of tires which are disposed by landfilling and which are not incorporated with other wastes in a general landfill, must be baled, chipped, split, stacked by hand ricking or otherwise handled in a manner provided for by an operational plan submitted to and approved by the Department.
>
> (c) General Landfill. Bulk quantities of tires if incorporated in a general landfill with other wastes, shall be placed on the ground surface on the bottom of the fill and covered with earth before other wastes are placed over them.

At the county level, there are no specific requirements for the disposal of tires in the four-county study area. County agencies rely upon the State regulations for tire disposal procedures.

At the municipal level, the City of Portland is the only agency within the study area that places local restrictions on the disposal of tires. Chapter 8.36.100 of the City code specifies the following:

> (3) The following refuse, rubbish, and other solid waste shall not be accepted at city disposal sites:
> A. Tree trunks and tree limbs over six feet in length,
> B. Oil, oil by-products, and liquid oily wastes,
> C. Tires.

Accordingly, tires are not officially accepted for disposal at the St. Johns landfill in Portland.

Although no other municipalities place such a restriction on their disposal sites, most disposal site operators in the area have set policies of not accepting tires at their sites because of the difficulties in properly incorporating the tires in a landfill.

Present Tire Collection System

Tire haulers are not licensed within the four-county study area. The individuals who engage in tire hauling in the area contact local tire dealers, negotiate a price for collection and disposal services, and establish a minimum frequency for collection. The tire dealer has no direct control over where the tires are disposed of. The haulers can salvage any of the tires they collect that are suitable for resale, but the most promising tires have already been culled by the dealers for recapping.

Discussions with local tire dealers indicate that the service provided by the present tire haulers is satisfactory to the dealers.

Present Major Tire Disposal Sites

The two major tire disposal sites within the study area are Mickey's Landfill and Rossman's Landfill.

Mickey's Landfill is located in Columbia County, on Smith Road about two and one-half miles from Robinette Road. The majority of waste tires from the study area are disposed of at this site. Demolition materials are also accepted at the site. The tires are not landfilled in accordance with DEQ regulations but instead are dumped in a pile, spread out by a tractor, and covered infrequently. The disposal fee for tires at Mickey's Landfill varies with the market; current prices charged are from $0.05 to $0.10 per automobile tire, $0.40 to $0.60 per truck tire, and up to $10 for earthmover tires.

Rossman's Landfill, which is located in Oregon City, Clackamas County, is one of the major sanitary landfills within the study area. Tires, garbage, demolition materials, and other general solid wastes are accepted at this site. All passenger car tires and the majority of truck tires accepted at the site are processed through a tire shredder, and the tire chips are then placed in the landfill. Truck tires too large for the shredder are stockpiled for eventual hand cutting and subsequent shredding; earthmover tires are not accepted at the site. Current processing and disposal fees at Rossman's are $0.15 per automobile tire and $0.60 per truck tire. Because of the economic competition from landfills and dumps accepting unprocessed tires, there are not enough tires presently received at the Rossman site to allow economical operation of the shredder.

Present Quantities

Current estimates of the quantity of automobile tires and truck tires to be disposed of annually within the study area were obtained from the Coordinator of the Northwest Tire Dealers Association. These estimates were derived from vehicle registrations and from estimated quantitites of tires entering the study area from outside, with an adjustment for tires diverted into the reuse market. Estimates of the quantity of earthmover tires to be disposed of annually were derived by COR-MET through a telephone survey of local tire dealers.

Following is the estimated number of tires disposed of annually in the four-county area:

automobile tires	1,400,000
truck tires	120,000
earthmover tires	1,200

SECTION II

ALTERNATIVE PROCESSING METHODS

Description of Alternatives

Current methods available for the processing of tires include the following:

1. *Incineration*, in which tires are burned in a rotating-hearth furnace at temperatures up to 2400°F. All sizes of tires are acceptable. The heat produced from this can be used to generate steam, a useful byproduct. The capital cost for a 1,000-tire-per-shift unit is about $1,200,000. Operating costs must include three men per shift.

2. *Shredding*, in which tires are mechanically reduced to chips. Different types of machines produce chips of different sizes. Some machines reject the tire bead; others accept it. At the present time, there are no tire shredders on the market that will accept large truck or earthmover tires; these would first have to be hand cut to make them acceptable for feeding into the shredders. Some shredders are available mounted on trailers, to allow easy movement from site to site. Typical capital costs for tire shredders range from $5,000 for a 480-tire-per-shift unit to $57,000 for a 3,000-tire-per-shift unit. Operating costs should include one or two men per shift, depending upon the unit.

3. *Baling*, in which a stack of tires is compressed by a machine into a bale that is then hand-bound. A typical unit compresses a stack of ten tires to a one-foot height. Earthmover tires cannot be baled. The machine can be trailer- or truck-mounted for ready mobility. A commercially available unit that can process 1,000 tires per shift sells for $9,000. Operating costs must include one man per shift.

4. *Splitting*, in which a machine is used to cut tires in half around the circumference. The operation involves a significant amount of hand labor. Oversized tires cannot be processed. A typical unit that can split about 500 tires per shift costs about $4,000. Operating costs must include one man per shift.

5. *Hand ricking*, in which whole tires are individually placed by hand in a landfill. The hand placement minimizes, but does not eliminate, the excessive voids caused by tires in a landfill. There is no special equipment required for this operation, but the labor costs are high.

A comparison of the tire processing methods considered is summarized in Table 1.

Evaluation of Alternatives

Review of the alternative processing methods indicates that shredding appears to offer the best interim solution for the processing and disposal of tires within the study area.

Hand ricking can be eliminated because it is a difficult method to enforce[(1)] and because, even at best, it is not a process that produces optimum landfill conditions. Splitting is only slightly more effective than hand ricking and is very costly. Incineration can be discounted because of its excessively high costs and the high degree of skill required for proper operations. Baling is a reasonably priced and reasonably effective process, but there are some problems with handling and properly placing the bales in landfills. Shredding, on the other hand, offers the advantages of reasonable cost and ready incorporation of the shredded pieces (chips) into landfills.

(1) The fact that there is no investment in capital equipment for the process encourages operators to cease hand ricking operations altogether when no one is observing. The tires are then allowed to accumulate in loose piles that are randomly covered--thereby increasing the potential for fire, vector harborage, and subsequent landfill settlement.

SECTION III

POTENTIAL PROCESSING AND DISPOSAL SYSTEM

It is not feasible, at this stage in developing the Solid Waste Management Plan, to propose a definitive processing and disposal facility (or facilities) for the four-county study area. Although shredding appears to be the most feasible process for tires, it would be unrealistic to propose a system that would require shredders for tires alone, for the final results of our study might well recommend shredding for the major portion of the *total* solid waste stream. Under those circumstances, tires could be shredded with the rest of the solid wastes and may not require special handling.

For the purpose of this interim report we have, however, analyzed a typical tire processing and disposal system which could be used as an interim solution. After comparison among alternative shredders and shredding costs, we have selected a unit with a capacity of about 3,000 tires per shift.[2]

Considering the estimated 1,400,000 automobile tires to be disposed of annually within the study area, assuming that 70 percent of the estimated 120,000 truck tires could be processed annually, and assuming a 6-day processing week, there would be about 4,760 tires to be processed and disposed of daily within the four-county study area. It is not likely that all of these tires would find their way to central processing units, for there could be some competition from small shredders, balers, or splitters operated by individual tire dealers and haulers for their own use. In addition, if regulations were enacted and enforced to ensure adequate processing for all tires within

[2] The estimate conservatively allows for six productive hours during a shift, with two hours deducted for startup, general maintenance, and hauling chips to the fill.

the study area, some waste tires might be hauled out of the area to places with less stringent requirements. Given these fluctuating circumstances, the waste tires delivered for centralized processing might vary anywhere from 3,000 to 5,000 tires per operating day. This quantity could be handled by a single shredder of the typical 3,000-tire-per-shift size (with provision for two operating shifts per day, if needed) or by two units operating at less than rated capacity.

Because there is a tire shredder of the estimated typical size already operating within the study area, actual operation and maintenance costs were obtained for that unit. To this were added capital expenditures for the equipment. Including costs for operating and maintenance, administration, landfilling the tire chips, and a conservative 20 percent return on invested capital over 5 years, costs for the unit ranged from $0.08 per tire at full capacity to $0.17 per tire at 40 percent of the rated capacity.

SECTION IV
POTENTIAL PROCESSING AND DISPOSAL SITES

Number of Sites

From the preceding analysis, it appears that the study area could readily support one centralized processing facility, and possibly two, for waste tires. Assuming that a system of free enterprise would be allowed to continue within the waste tire market, it would not be necessary to define the optimum number of sites in advance, for the market would stabilize itself. This would, however, still require that appropriate agencies enact and enforce regulations requiring suitable processing for *all* tires, so that the processing centers would not have to complete with sites allowing disposal without suitable processing. Beyond that, the economic pressures of the free enterprise system would soon prove how many centralized tire processing facilities the area would support.

If, on the other hand, the Department of Environmental Quality or the Metropolitan Service District would choose to limit the number of sites at which tire processing should be accomplished, it would be reasonable to select a single centralized site with enough processing units(3) to handle about 3,000 tires per shift. If the quantity of waste tires brought into the site should exceed the capacity of the unit, the number of operating days per week could be increased, an extra shift could be added, or a second processing center could be opened at another site. Discussions with tire haulers indicate that overall haul costs within the study area would not differ greatly if there were one tire processing site in the area, or two. The main benefit of two processing facilities would be flexibility in operations rather than cost.

(3) It should be noted that, if tire processing becomes a requirement within the study area, adequate standby parts or units will be necessary to assure proper processing at all times.

To aid in evaluating whether it would be more desirable to have an agency control the number of tire processing sites or to allow a free market system to determine the optimum number, various tire dealers, private tire haulers, and tire processors were contacted to determine their preferences and opinions. All of the individuals contacted stated that they considered a free enterprise system the only viable and acceptable method. Given that local preference, the only condition that might warrant restriction of the number of tire processing sites would be the potential for a centralized processing and reclamation site to handle *all* wastes within the study area. Commentary on that situation must await completion of the Solid Waste Management Plan.

Site Locations

The optimum locations for centralized tire processing facilities cannot be determined without first analyzing tire processing and disposal in conjunction with the total solid waste handling system. Accordingly, recommendations on site locations will be included in our final report.

SECTION V

IMPLEMENTATION AND FINANCING

The following actions would be required to establish a system of tire processing and disposal within the study area and to insure proper functioning of that system.

1. *Strong enforcement of existing State regulations.* DEQ should initiate a program of policing and strong enforcement to insure that the State regulations for proper tire disposal are firmly adhered to.

2. *Enactment, at a local level, of more restrictive regulations than the State requirements.* As indicated previously, the State requirements for tire disposal cannot readily be policed because there is no economic incentive for landfill operators to fulfill the requirements during times that no one is observing their operations. Even when State requirements are followed, the presence of whole tires in a landfill still creates significant problems. In contrast, the use of proper capital equipment for processing tires not only assures an end product that can readily be incorporated in a landfill but also offers economic incentive for the operator to utilize fully the equipment in which he has invested. Accordingly, it would be advisable for the Metropolitan Service District to require shredding, baling, or other approved mechanical processing for all tires disposed of within the MSD boundaries and to encourage cooperation of the four counties within the study area in enforcing those same requirements outside the MSD boundary. Monitoring would be required to insure compliance with the regulations, but the monitoring and enforcement could be simplified through the use of a permit system.

3. *Development of a permit system for tire haulers.* Tire haulers should be licensed through a special permit system that would require all permit holders to haul tires to disposal sites which are approved by DEQ and which have tire processing in accordance with the proposed MSD and County requirements. All commercial haulers would be required to obtain a permit to haul tires within the four-county area, and special permits would be issued to tire dealers

wishing to haul their own wastes.[4] (Permits would not be required for transporting loads of less than ten tires.) Commercial haulers would be required to post a bond to insure full compliance with permit requirements. MSD could develop a unified permit system for the four-county study area, the individual counties could issue permits in accordance with the overall system, and MSD could assume the responsibility for monitoring the system. Enforcement of the permit system would be simplified through use of a typical system described in Attachment A.

4. *Enactment, at a local level, of regulations specifying the use of licensed haulers.* Once a permit system has been developed, each County within the study area should enact ordinances requiring all tire haulers to be licensed and all tire dealers to give their waste tires to licensed haulers only.

5. *Establishment of a method for financing additional costs incurred through tire processing requirements.* Because only a small portion of the tires within the four-county area are presently being processed and properly disposed of, the proposed requirements for adequate processing and disposal would increase the costs for handling of waste tires. These increased costs could be covered through any one of three main alternatives: (1) surtax charged the customer at time of tire purchase to cover the cost of tire disposal plus costs of administering the tax system; (2) inclusion of extra cost in the dealer's overhead, so that the customer pays indirectly for tire disposal at the time of tire purchase; or (3) disposal fee charged directly to the customer when old tires are turned in on new ones. The disadvantages of the first method are that it requires additional revenue for administering the tax collection system and that it would encourage non-taxed tires purchased outside the area to be brought into the area for disposal. The disadvantage of the second method is that the competitive market forces a dealer to dispose of his tires as cheaply as possible--sometimes without regard to appropriate processing methods or disposal sites. The disadvantage of the third method is that it encourages private individuals to dispose of their own tires (sometimes at illegal sites) rather than paying a special fee to the dealer. The method presently used for financing tire disposal is the second one. The tire dealers contacted

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[4] If it should prove desirable, the general permit system could be modified either to restrict the total number of permits issued or to set up franchised areas of service.

consider this method to be the most practical, even for covering increased disposal expenses. The disadvantage of this method as noted above would be taken care of through Items 3 and 4 of the system implementation. It appears, therefore, that financing of tire processing and disposal costs can best be handled through continued inclusion of these costs in the tire dealers' overhead.

SECTION VI

RECOMMENDATIONS

It is recommended that:

1. MSD adopt an ordinance requiring shredding, baling, or other approved mechanical processing for all tires disposed of within the MSD boundaries.

2. MSD encourage each of the four counties within the study area to adopt ordinances in keeping with the above.

3. MSD develop a four-county permit system for the licensing of tire haulers and give direction to the counties in issuing these permits. (See Attachment A.)

4. MSD encourage each of the four counties within the study area to adopt ordinances requiring all tire haulers to be licensed and all tire dealers to give their waste tires to licensed haulers only.

5. MSD require all tire processing and disposal centers within its boundaries to accept large truck and earthmover tires and encourage each of the four counties to require the same.

6. MSD support continued use of the present tire disposal financing system in which tire dealers include the cost as part of their overhead.

Table 1

TIRE PROCESSING COMPARISON

Processing Method	Relative Cost of Processing, Considering Both Capital Costs and O&M Costs	Possible Environmental Problems	Final Disposal Problems	Limitations
Incineration	High	Discharge of particulates and gases, unless controlled.	None. (The residue is easily handled.)	Requires highly skilled operators. Does not have the mobility of other processing units.
Shredding	Low	Dust and noise, unless controlled.	None. (The chips are easily handled.)	Oversized tires cannot be processed.
Baling	Low	None	Bales must be carefully placed in fill. They can hinder future driving of piles in the fill.	Oversized tires cannot be processed.
Splitting	Medium to High	None	Split tires are still large enough to present handling problems and create voids. They can hinder future driving of piles in the fill.	Oversized tires cannot be processed.
Hand Ricking	Low	Potential fire hazard.	Whole tires cause extensive voids in a fill. Tires tend to work up to the fill surface. Those that stay buried can hinder future driving of piles in the fill.	Difficult to enforce hand ricking requirements.

ATTACHMENT A

POTENTIAL PERMIT SYSTEM FOR TIRE HAULERS

For continuity throughout the study area, the permit system might best be developed and monitored by MSD, with the individual counties issuing the permits.

Included in the requirements for all permits should be the specification that the hauler take all tires to disposal sites which are approved by DEQ and which have tire processing in accordance with the proposed MSD and County requirements. To obtain a permit, each hauler would be required to post a performance bond. The permits would be non-transferrable.

Following are the fundamentals of a permit system that would lend itself to reasonably easy monitoring through its formalized accounting system:

1. MSD would distribute receipt books which all licensed tire haulers would be required to use. The tickets would be sequentially numbered, and the tire hauler's name would appear on each ticket. Each ticket would be bound into the book in triplicate.

2. Every time a hauler received tires from a customer, he would be required to fill out a receipt (reproduced in triplicate) and give one copy of the receipt to the customer. The customer would be required to retain each receipt for one full year, to allow subsequent cross-checking by MSD.

3. Each month, the tire hauler would be required to send to MSD one copy of all his receipts for the month. All sequentially numbered tickets would have to be accounted for.

4. Whenever the hauler took a load of tires to the processing and disposal site, he and the processing attendant would agree upon the estimated number of tires in the load. Experience has shown that these estimates are generally quite accurate because the processor tends to estimate high (to insure adequate processing and disposal charges) whereas the hauler tends to estimate low (to save on processing and disposal charges). Accordingly, a quantity agreed upon by the two is reasonably accurate. The alternative to estimating would be counting--a task not generally worth the time it requires. One load of tires for the hauler generally includes pickups from a number of customers, so he would have several customer receipts to cover the load. And because some haulers salvage a portion of the tires they collect, not all collected tires would be turned over for processing and disposal. The tire processor would record, in triplicate, the estimated number of tires received and would identify the hauler delivering them. The hauler would receive a copy of the receipt at the time of the transaction.

5. Each month, the processing-disposal attendant would be required to submit to MSD one copy of all receipts recording the estimated tire quantities brought into the landfill.

6. MSD would compare the total quantity of tires collected by each hauler during the month against the total quantity of tires disposed of by each hauler during that same month. If quantities collected did not agree closely with quantities disposed of, the hauler would be required to furnish reasonable proof of the destination of the missing tires--reasonable proof being receipts for resale of used tires or receipts for disposal at sites outside the four-county area.

INTERIM REPORT on WASHINGTON COUNTY for METROPOLITAN SERVICE DISTRICT

Q-24

COR - MET
March 1973

31 March 1973

Metropolitan Service District Board
6400 S.W. Canyon Court
Portland, Oregon 97221

Gentlemen:

Subject: Interim Report on Washington County

In response to the Special Conditions of our contract, as requested by DEQ, we submit herein our interim analysis of the current solid waste handling situation in Washington County. This interim evaluation fulfills Item A of the Special Conditions, stated as follows: "Examine the present solid waste handling situation in Washington County and determine whether there are serious immediate needs that require immediate interim attention and cannot wait for resolution through the proposed regional plan development schedule. If an interim implementation is necessary, develop a proposal for immediate action which is compatible with the planning program."

Our interim investigation of Washington County has revealed that long haul distances to approved disposal sites are a major inconvenience for many of the refuse collectors and private citizens. In spite of this inconvenience, however, the solid wastes are being collected and disposed of in a satisfactory manner that does not create a public health nuisance.

From our interim investigation, we conclude that there are no immediate needs in Washington County that cannot await resolution through the final Solid Waste Management Plan, to be completed by January 1, 1974. We therefore recommend that the present solid waste handling system in Washington County continue until completion of the final management plan.

Details of our interim investigation are presented in the attached report. Should you have any questions, we would be pleased to meet with you at your convenience.

Sincerely,

COR-MET

Melissa Brown

Melissa Brown
Project Manager

C. Leslie Wierson

C. Leslie Wierson
Principal-in-Charge

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SECTION I
BACKGROUND INFORMATION

Until 1971, Shadybrook was the major disposal site within Washington County authorized to accept all general types of solid wastes, including food wastes. About half of the wastes from the county were taken to this site, with the remainder going to sites inside and outside the county. In June of 1971, the Shadybrook site was closed because of leachate problems and decreasing capacity. The closing of that site forced most commercial haulers and many private citizens to take their wastes outside the county for disposal. For some, it has meant round-trip hauls of as much as 70 miles.

Various disposal sites within Washington County have been reviewed as a possible replacement for the Shadybrook site, but all have been rejected by the County Board of Commissioners or by the State Environmental Quality Commission. In January 1973, the State Department of Environmental Quality recommended to the State Solid Waste Citizens Advisory Committee that the solid waste management policy for Washington County should be one of conveniently located transfer stations with transport to a regional landfill for disposal.

SECTION II
PRESENT SOLID WASTE SYSTEM

Identification of Problems

There are three major problem areas within the Washington County system.

1. Many of the private collectors have long hauls to disposal, which leads to inefficient operations, increased costs, and overloaded vehicles.

2. The local citizens who do not utilize private collection services have no convenient place to dump their own wastes. The result has been increased indiscriminate dumping, particularly in rural areas.

3. There is no security for Washington County collectors in that disposal sites outside the county could at any time refuse to accept their wastes.

Present System

Municipal refuse is collected weekly by about 25 refuse collection firms franchised by Washington County and by cities within the county. There are two approved disposal sites in the county. The only site authorized to accept food wastes is Frank's Landfill, where the owner of the site disposes exclusively of wastes from his own franchised area around Tigard. The second site is the Hillsboro Landfill, which serves residents in and around Hillsboro for disposal of their non-putrescible wastes. The disposal sites for all other wastes produced in Washington County are located in Multnomah, Clackamas, Clatsop, and Yamhill counties. Homeowners not utilizing private collection services must haul their own wastes to the sometimes-distant disposal sites.

The present system has been in effect for almost two years. Although inconvenient for many refuse collectors and private citizens, it does function smoothly and creates no public health nuisance. Representatives of the Washington County private collectors have stated that they would be willing to continue with the present system until the final Solid Waste Management Plan has been completed.

SECTION III

CONCLUSIONS AND RECOMMENDATIONS

Our interim investigation has revealed that there are no conditions in Washington County that will not await resolution through the final Solid Waste Management Plan. We therefore recommend that the present solid waste handling system continue until completion of the final plan on January 1, 1974.

INTERIM REPORTS of JUNE 1, 1973 for METROPOLITAN SERVICE DISTRICT

COR - MET

cor-met | CORNELL, HOWLAND, HAYES & MERRYFIELD
METCALF & EDDY
1600 S.W. FOURTH AVENUE, SUITE 601 PORTLAND, OREGON 97201 503/224-9190

1 June 1973

Metropolitan Service District Board
6400 S.W. Canyon Court
Portland, Oregon 97221

Gentlemen:

Subject: Interim Reports on Hidden Valley, Clatskanie, St. Johns, Boeing-Boardman, and Septic Tank Pumpings

In response to the Special Conditions of our contract, as requested by DEQ, we submit herewith the five interim reports due June 1, 1973.

Our report is divided into the following sections:

Section 1 - Hidden Valley Disposal Site
Section 2 - Clatskanie Disposal Site
Section 3 - City of Portland Landfill
Section 4 - Boeing-Boardman Project
Section 5 - Septic Tank Pumpings

A brief summary of the conclusions and recommendations in each of those sections is contained in the following list:

1. The Hidden Valley site is not considered suitable for use in alternative future solid waste management systems. Until future sites have been identified and evaluated within the context of the entire system, however, it is not possible to determine the exact closing date for this site. Detailed recommendations for interim improvements to the site are included in Section 1 of the report.

2. The Clatskanie site should remain in operation until at least June 1, 1974. The final results of our study on January 1, 1974, will indicate whether or not this deadline should be further extended. Interim recommendations for improving the site are shown in Section 2 of the report.

3. No alternatives to the St. Johns site are considered necessary at this time. The final results of our study will include an analysis of alternatives to the City's

site. If an alternative other than St. Johns should be selected and it should prove desirable to close down the St. Johns site by mid-1975, then with emergency scheduling the alternative could be implemented between January 1974 and July 1975.

4. Unless additional facts should be presented which would alter the present scope and content of the Boeing-Boardman project, we would recommend that it be dropped from further consideration for disposal of wastes from the four-county area.

5. MSD should review periodically the effectiveness of DEQ and the counties in carrying out their present regulations for the collection, processing, and disposal of septic tank pumpings. If there is no improvement in effective enforcement by these agencies, then MSD may decide to coordinate among the counties the licensing of septic tank pumpers and to monitor the overall system.

Should you have any questions concerning this report, we would be pleased to meet with you at your convenience.

Sincerely,

COR-MET

J. Melissa Brown

J. Melissa Brown
Project Manager

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SECTION 1

HIDDEN VALLEY DISPOSAL SITE

Requirements

This interim evaluation of the Hidden Valley disposal site fulfills Item C of the Special Conditions of our contract, stated as follows: "Determine environmental impact of Hidden Valley disposal site, including plan and time schedule for phase out or upgrading."

We shall, in this interim report, assess the environmental effects of the Hidden Valley site, as specified in the contract; and an evaluation of the suitability of the site for continued use will be given. No attempt will be made, however, to show a time schedule for phasing out the site. Because the opening or closing of any site cannot be isolated from the rest of the system being analyzed, a time schedule for the phase-out of Hidden Valley will be included in the system recommendations at the conclusion of our study.

Site Description

The Hidden Valley landfill site is located in Multnomah County about one-quarter mile west of the Sauvie Island Bridge, just off Highway 30. Access to the site is by means of a moderately steep (12 percent grade) unpaved road leading west from Highway 30 about 500 feet to the landfill area. The landfill site is owned and operated by Land Reclamation, Inc. The site is open to the public from 8:00 a.m. to 4:30 p.m. Monday through Friday and from 8:00 a.m. to 12:00 p.m. on Saturday. The total site encompasses an area of about 73 acres.

The land surrounding the site is mainly forest, with the Burlington Northern Railroad and U.S. Highway 30 several hundred feet to the north. An active quarry operation is located about 400 feet to the east of the site and a marina is located along the Multnomah Channel.

The Bonneville Power Administration has power lines which cross the landfill site, with one pair of power poles located on a ridge near the fill area. Soil has been excavated from the area near the power poles, but no harm appears to have been done to the soil foundation around the poles. Landfill operations have, however, caused damage in the past to access roads along the Bonneville Power Administration easement.

The site consists of three steeply sloping canyons that join together into a common drainage basin. Two main canyons, one on the north and one on the south, have been partially filled during past landfill operations. Surface water drainage from the canyons has been diverted to a drainage pipe located under each fill. Water draining from these pipes ultimately flows to the Multnomah Channel located north of the site.

The estimated weekly quantity of refuse disposed of at Hidden Valley is about 360 tons. The material accepted at the site for disposal includes demolition waste, land clearing waste, construction waste, appliances and other non putrescible wastes. Some tires are also being placed in the landfill. Garbage is not accepted at the landfill.

Of the 73 acres available for filling, the operation has been confined to approximately 3 acres. The hill side area near the entrance to the site is presently being used for the landfill operation. The refuse is compacted in layers 2 to 3 feet thick and is covered frequently with large amounts of soil from the nearby hill side. During wet weather covering is less frequent.

History

The Hidden Valley landfill was first operated in the spring of 1969. The operation was generally poor and many of the permit requirements were never followed. The initial fill in the north canyon was placed to form a dam. A 24-inch drain pipe was placed under this fill but was allowed to become clogged with debris. Subsequently during the rainy period of February 1970 a large pond of water was impounded behind the fill, and a portion of the fill was washed away. Fill material washed into the 48-inch culvert under the railroad tracks requiring work by railroad personnel to prevent the culvert from being plugged.

During the spring of 1970 underground fires, lasting for a period of several months, broke out in the fill causing extensive smoke and odors. At this time the property was purchased by Land Reclamation, Inc., and another permit was issued for operation of landfill in May 1970. The underground fires at the landfill were extinguished as part of the requirements of the permit granted to Land Reclamation, Inc. During March 1973, smoke and odors were observed coming from an extensive area of the north canyon fill, but by May 1973 the fire appeared to have been extinguished.

Suitability of Site for Landfill Operations

The key points for assessing the suitability of a site for landfill operations* are accessibility, availability of cover material, potential for leachate formation, land contouring and filling sequence, depth of fill, and potential for land reclamation. The

*The listed points do not include environmental factors, which are discussed later.

following paragraphs contain a discussion of each of these items for Hidden Valley.

Accessibility. The location of the site with respect to surrounding areas of refuse generation is quite good. Haul distances are therefore reasonable, and U.S. Highway 30 provides primary access at high traveling speeds. The 12 percent grade on the entrance road to the site is excessive. A maximum grade of about 7 percent is normally recommended for travel by loaded trucks.

Availability of Cover Material. There is adequate cover on the site, but obtaining it requires stripping and grubbing of forests to make the soil available.

Potential for Leachate Formation. Because the canyons are natural drainage areas, there is a high potential for the formation of leachate. Efforts have been made to control this by placing a drainage pipe underneath the area presently being filled but, as mentioned previously, there have been problems with the pipe.

Land Contouring and Filling Sequence. The Hidden Valley site must be rated poorly with regard to this item. The canyons are steep and allow only limited utilization of land areas because of excessive grades. There is a strong possibility of shifting soils (earth slides) within the completed landfills if the operations are not properly designed and skillfully executed. The underground burning at the site is especially poor because it not only causes odors and allows the formation of water pockets, it also allows excessive earth settlement (which may induce land failure).

Depth of Fill. The small, steep canyons lend themselves to fills having small surface areas and excessive depths. Present fill areas are already to a depth of 50 feet in some places, and there is no natural barrier between these fill depths and U.S. Highway 30 below. There is accordingly a strong potential for gas seepage and earth slides onto the highway.

Potential for Land Reclamation. A basic tenet for location of landfills is that they should accomplish land reclamation by converting land of only marginal use into land of higher value. In this regard, the Hidden Valley site must receive a poor rating. Steep grades prevent using the finished landfill for anything other than a wildlife habitat-which is what the site was before disposal operations were begun there.

Environmental Effects

The key points for environmental assessment of a disposal site are noise, odors, discharges to the air, aesthetics, surrounding land use, traffic patterns, drainage patterns, and surface- and ground-water effects. These items are assessed for the Hidden Valley site in the following paragraphs.

Noise. The noise created by refuse hauling vehicles and landfill compaction vehicles at Hidden Valley has a limited adverse effect on the surroundings because even the most remote areas of the site are within 1,000 feet of the highway. The added noise level over that from the highway traffic is small.

Odors. Properly operated landfills receiving non putrescible wastes do not ordinarily produce odors during landfill operations (although there may be subsequent odor production after completion of the fill). The Hidden Valley site is an exception to this, however, for there are some odors at present-which are probably caused by the underground burning. As indicated previously, the underground burning causes not only odors but also excessive settlement. Fires are normally prevented or minimized in good sanitary landfill operations by shutting off the oxygen supply through good compaction and adequate cover and also by limiting the extent of fires through proper cell construction. Once the fires have started, however, it is very difficult to extinguish them without completely unearthing the fire areas and either allowing the refuse to burn completely or extinguishing the burning with water, or smothering with good earth cover.

Discharges to the Air. Dust is generated by truck traffic and covering operations. In addition, smoke and particulates are released to air from the underground burning.

Aesthetics. The Hidden Valley site is well-screened from its surroundings. The natural tree growths and height of the area above the road below make the site very difficult to see from any populated areas.

Surrounding Land Use. Because the surrounding lands are forest, the Hidden Valley disposal site has an adverse effect on its surroundings. Some forest land must be stripped to obtain cover material, and the wildlife habitat is disturbed. Dust from the landfill operation may also affect wildlife.

Traffic Patterns. Vehicles entering and leaving the site have an adverse effect on traffic patterns on U. S. Highway 30. Trucks approaching from the south must cross two lanes of oncoming traffic to turn into the site, and grade visibility is poor for vehicles approaching a refuse vehicle that has stopped for turning. Both conditions cause potential safety hazards to human life.

Drainage Patterns. Landfill operations affect the drainage patterns of the three canyons traversing the site. Even with drainage culverts under the fill, the drainage patterns are changed, and this could cause silting downstream of the site.

Surface Water and Groundwater. Extensive surface water drainage from the surrounding hills presently flows onto the completed fill area. Much of this surface water drainage percolates into the fill and adds to the potential quantities of leachate that may be produced from the fill. Some leachate is already being produced.

The 12-inch drain pipe under the south canyon fill has a large slime growth at its outlet, indicating water contamination. The water falls from the drain onto the side of the fill where it takes on a reddish color and generally appears more contaminated.

A sample taken by DEQ showed that the water coming from the drain had a BOD of about 37 mg/l. A BOD value of this magnitude indicates some contamination of surface water is occurring but that the level of contamination is relatively low.

Groundwater pollution from the landfill is probably minimal because the flow of groundwater in canyons is usually towards the canyon bottom rather than downward into deeper aquifers.

Conclusions and Recommendations

The Hidden Valley site is not considered suitable for use in alternative future solid waste management systems. Until future sites have been identified and evaluated within the context of the entire system, however, it is not possible to determine the exact closing date for this site.

Between now and the completion of our study on January 1, 1974, the following improvements should be made to the Hidden Valley site:

1. All filling should be restricted to the far northern canyon.
2. The inlet to the 24-inch drainage pipe under the north canyon fill should be repaired.
3. The 12-inch drainage pipe under the south canyon fill should be extended so that the pipe will discharge beyond the side of the landfill rather than onto the side of the fill, as it presently does.
4. The access roads to the Bonneville Power Administration easement should not be disturbed.
5. An engineering report (including soil borings) describing the proposed filling sequence and present soil stability in the northern canyon should be completed by October 1, 1973.

SECTION 2
CLATSKANIE DISPOSAL SITE

Requirements

This interim evaluation of the Clatskanie disposal site corresponds to Item D of the Special Conditions of our contract, stated as follows: "Develop phase out plan and time schedule for present Clatskanie disposal site including cost figures for alternatives and recommendation for action."

It is not possible, at this stage in our investigations, to develop a definitive phase-out plan and time schedule for the Clatskanie site. The timing for closing out Clatskanie will depend upon the timing for a site or sites to replace it-information that will not have been developed and substantiated until the conclusion of our study on January 1, 1974. Neither is it possible at this time to give definitive cost estimates for alternatives because alternative system analyses will not be conducted within our study until September or October.

Accordingly, evaluation of the Clatskanie site at this time must be of a general, interim nature only.

Site Description

Located in northwestern Columbia County, the Clatskanie disposal site lies adjacent to the westerly edge of the city limits and about 2 miles southwest from the city center.

The present operation is situated approximately halfway down the side of a moderately sloping hill. Runoff from the hillside drains into Mary's Creek, a minor tributary of the Clatskanie River. The total site encompasses an area of about 19 acres of City property. Additional City property of 38 acres adjacent to the eastern portion of the site is now utilized partially for a shooting range and partially for a cemetery. There is one residence about one-third of a mile north of the site and a small residential development about one mile southwest of the site. A power transmission line runs east-west one-quarter mile north of the site, following the ridge of the hill.

Access to the site is over City streets and County roads. The final one-quarter mile stretch of County road climbing up the hill to the site rises at a moderate to steep grade. This road has a good oil and gravel mat surface to the dump entrance, then continues to the crest of the hill with an improved crushed rock surface. This County road is not maintained on a priority basis and there are short periods during the winter when the road is impassable.

The site is leased by the City of Clatskanie to a local refuse collector who operates the disposal site for himself and for local citizens. The site is open on Saturdays from 9 A.M. to 6 P.M. for the public and open only to the collector during the week.

The estimated weekly quantity disposed of at Clatskanie is 39.6 tons. About 37 tons of that total are dumped by the refuse collector, and the remaining 2.6 tons come from local citizens using the site on Saturdays. There are presently no large industrial users of the disposal site. The service area of the site encompasses all of northwestern Columbia County, including the Mist-Birkenfeld area.

Of the 19 acres available, the present operation is confined to approximately 5 acres. Attempts have been made to run the site as a landfill, with orderly compaction and covering; but unsuitable cover material, small amounts of incoming refuse, and large amounts of rain throughout the majority of the year combine to make this operation highly uneconomical. Cover is therefore applied on a regular twice-weekly basis during the dry part of the summer and much less frequently during the winter.

Cost Figures for Alternatives

The only alternative to the Clatskanie disposal site at present would be to haul all wastes to the Santosh site, near Scappoose.* We do not yet have the total disposal cost information for Clatskanie and Santosh, to compare one against the other, so for the purpose of this analysis we shall assume that the disposal costs are the same. In that case, the only cost effect of hauling to Santosh would be increased hauling expenses. The present collector at Clatskanie has a 16-cubic yard truck. In the absence of actual cost data from his operations, we have assumed that the total cost for owning and operating his vehicle is $0.40/ton/mile with a one-man crew and a 45-mile-per-hour traveling speed. The approximate quantity collected is 1,924 tons per year, and the round-trip haul distance from Clatskanie to Santosh is 86 miles, or 80 miles more than his present haul. Based upon these parameters, the total additional cost for the collector would be about $61,600 per year.

The haul to Santosh would also mean added costs for the private citizens presently hauling their own wastes to Clatskanie. Assuming a private automobile expense of $0.10/mile and a once-a-week 80-mile round trip to the disposal site, the total additional cost to each family hauling its own wastes would be about $416 per year.

Future alternatives, as defined in subsequent portions of our study, will probably indicate a more conveniently located transfer station or disposal site than Santosh as a replacement for the present Clatskanie site.

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*Some private citizens presently take their wastes to the Coal Creek disposal site in Cowlitz County, Washington, but this site will be closed at the end of this year.

Conclusions and Recommendations

The soil conditions at the Clatskanie site and the small quantities of refuse deposited there would make daily covering and proper sanitary landfill operations relatively expensive at that site. The remote westerly location of Clatskanie makes it inconvenient for drawing refuse from other populated areas; the access road is not readily traversable during certain times of the year; and drainage at the site has historically been poor, although some improvements have recently been made. Given these conditions, we do not consider the Clatskanie site suitable for inclusion in any future systems.

The Clatskanie site could be phased out at any time an appropriate alternative site becomes available. The exact definition of this alternative site and the timing for it will not be available until the conclusion of our study on January 1, 1974. A phase-out plan would include final contouring of the site, final covering, and installation of permanent gravel drains around the site perimeter to intercept upland drainage.

Following are our interim recommendations for the Clatskanie disposal site:

1. The Clatskanie site should remain in operation until at least June 30, 1974. The final results of our study on January 1, 1974, will indicate whether or not this deadline should be further extended.
2. Drainage protection for the existing site should be improved and maintained. The existing drainage ditch should be regraded to increase the slope and prevent the accumulation of standing water in the channel. The ditch should be cleared at all times of accumulated debris.
3. Site preparation should be extended to provide downhill refuse retention dikes for those areas that will be in use until June 30, 1974. At no time should the depth of filled refuse extend above the top of the retention dike. This will ensure that any leachate will be filtered through the dike or will migrate downward into underlying soils thereby preventing direct discharge into Mary's Creek.

SECTION 3

CITY OF PORTLAND LANDFILL

Requirements

This interim evaluation of the City of Portland St. Johns disposal site corresponds to Item E of the Special Conditions of our contract, stated as follows: "Pursue a change in legislation to allow the planners to consider the desirability of extending operation of the present City of Portland Landfill beyond July 1, 1975, and be prepared to reconsider and possibly alter the direction of the planning if legislative efforts fail. Alternatives, if necessary, will be submitted for review."

Analysis

Legislative amendments to extend the life of the St. Johns landfill have gone from the committee to the floor of the House with a recommendation to pass.

The final results of our study--to be available January 1, 1974--will include an analysis of alternatives to the St. Johns landfill. If an alternative other than St. Johns should be selected and it should prove desirable to close down the St. Johns site by mid-1975, then with emergency scheduling the alternative could be implemented between January 1974 and July 1975. Because the present mid-1975 closing date presents no severe planning problems, we will follow the normal planning sequence and present alternatives as a part of the final report in January 1974.

SECTION 4

BOEING-BOARDMAN PROJECT

Requirements

This interim evaluation of the Boeing-Boardman project fulfills Item F of the Special Conditions of our contract, stated as follows: "Feasibility of Boeing-Boardman Project should be determined early to help give redirection to planning in case the City of Portland Landfill closure legislation remains unaltered. Determine the potential costs and practicality of the Boardman Project for receipt of solid wastes from Metro area."

Summary of the Boeing-Boardman Plan

The Boeing Company has leased from the State, through the year 2040, about 100,000 acres of sparsely vegetated land near Boardman. Although a small portion of the land is used for testing jet engines, much of the land is sub-leased to farmers for cattle and sheep grazing and for the cultivation of dry-land wheat. About half of the 100,000 acres are considered irrigable, and on those 50,000 acres Boeing is involved in a seeding and irrigation operation to develop alfalfa crops and fescue for grazing pastures. As a part of that seeding and irrigation project, Boeing is exploring the feasibility of land disposal of municipal refuse on the agricultural lands. In proposing the waste disposal, Boeing considered that the wastes would be beneficial to crop productivity and soil stabilization and would also help to solve the solid waste disposal problem for the greater Portland area.

The original proposal for the land disposal project was made in 1971. In deriving the solid waste quantities for the proposal, it was assumed that landfills for demolition-type wastes would continue to operate in the Portland area and that only wastes from the regular residential, commercial, and industrial collection routes would be taken to Boardman for disposal. The estimated quantity to be disposed of at Boardman was 1,000 tons per day, with an assumed additional 1,000 tons to be disposed of daily in demolition landfills in Portland.

The proposal specified a single waterfront processing station in Portland to receive all wastes bound for Boardman. The wastes would be shredded at the station, mixed with sewage sludge, and loaded by conveyors into specially constructed barges. There would be no separation of the wastes unless recovery and sale of metals should prove profitable, in which case metals separation would be added. Otherwise, the wastes intended for land application would include metals and other inert materials.

The wastes would be barged up the Columbia River and unloaded by conveyor into trucks. The trucks would then transport the shredded wastes to designated areas, the waste would be dumped onto the ground, and a disking machine would till them into the soil.

To determine the feasibility of the land disposal project on a pilot scale, Boeing contracted with the Oregon State University Department of Soil Science in 1971 to conduct a one-year feasibility study of the disposal of municipal wastes on sandy soils. Test plots were prepared on the Boardman site, and wastes were imported from the shredding facility at Vancouver, Washington. The objective of the study was to determine the chemical and physical changes in the soil and to evaluate crop production at various intensities of application of the wastes.

The following are excerpts from the recently published results* of the Oregon State University study:

> The first year alfalfa yield was slightly reduced with waste application of 100 tons per acre; larger yield reductions were obtained with the higher waste application. Much of the alfalfa yield was equivalent or higher in the 100 ton waste treatment plots than in the check plots at the 2nd and 3rd alfalfa cutting. Fescue yields decreased very slightly after application of 100 and 200 tons of waste. The maximum rate of waste application to sandy soils should not exceed 200 tons per acre unless significant yield reductions in the first year fescue and alfalfa production are acceptable.
>
> Intensive cropping systems are under investigation in greenhouse studies. Bean, alfalfa, wheat, and fescue crops have been grown on the waste treated sand. Plant growth reduction was similar to field growth observations.
>
> Moisture retention by the soil at any given tension was increased by the addition of shredded waste, particularly during the early stages of decomposition.
>
> Soil losses resulting from the wind erosion were drastically reduced by incorporation of shredded waste. The erosion losses were reduced 88 percent by the application of 200 tons/acre of waste.
>
> Considerable waste decomposition has occurred. Paper products have largely disappeared and larger residual waste components, rubber tires, plastic bottles, and wire are becoming more obvious. Separation of larger metallic items from the waste and finer grading would definitely reduce the problems associated with the waste and farm implement operations.

These results indicate that crop production was not significantly enhanced by the addition of the wastes. Some improvements to soil stabilization were noted, but from an agricultural marketing standpoint the benefits are negligible.

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* "Disposal of Municipal Wastes on Sandy Soils," Oregon State University Department of Soil Science," September 1972.

Nevertheless, Boeing considers the project worthwhile strictly as a waste disposal operation.

Boeing Cost Estimates

It is difficult to present descriptive cost data for the Boeing project because there is very little definitive back-up information available. Printed literature and proposals are of a very general nature in which the individual elements of the system are not clearly defined. In contacts with the originators of the cost estimates, we were not always able to determine exactly which items had been included in the estimates and which had possibly been omitted. We have, however, compiled the information that was available.

The 1971 proposal for the Boeing land disposal operation consisted of two separate estimates: one for the Portland waterfront processing station and subsequent barging operations; the other for the Boardman waterfront receiving station and subsequent spreading operations. Private operation was planned for all facilities.

Planning for the Portland processing and barging phases of the project was initiated by the Columbia Processors Co-op, but that organization has since restricted its interests to liquid wastes and sludges. As a result, the Metropolitan Disposal Corporation (MDC), a private organization of refuse collectors and landfill operators, has assumed interest and involvement in this phase of the plan.

The conceptual plans for the processing station include a truck unloading area, surge storage, shredding, and barge loading. There would be two operating shredders and one additional unit on standby. The entire unloading and shredding operation would be enclosed in a building. Details of the transfer of refuse from the dumping floor were not available, but subsequent transport of the wastes to barges would be by conveyors. No provision was made for separation of the wastes, but it was considered that a metals separation and recovery system could be added at such time as the process might prove to be self-supporting. The total cost for the processing station, as estimated by the engineering consultant for Columbia Processors Co-op, was $1.13 per ton (without separation of metals). This 1971 estimate included amortized capital costs, operation and maintenance costs, and profit. The estimated cost apparently did not include docking facilities.

Barging costs were obtained in 1971 from PAC, a barging company in Vancouver, Washington. It was estimated that the barges could be built and operated for about $1.50 per ton of refuse hauled, excluding administration and profit expenses. Allowing 20 percent to cover those items, the total barging cost would be $1.80 per ton. Details on the type and size of the barges were not available.

Planning for the Boardman receiving and spreading phases of the project was undertaken by the Boeing Company itself. The preliminary design included a docking and unloading facility, but no details are available for the type of unloading facilities intended. An enclosed conveyor would carry the wastes from the unloading facility to a separate, enclosed terminal where the wastes would be transferred from the conveyors into vehicles that would transport the wastes to agricultural lands and spread them there. Plans were also made for a sanitary landfill at the Boardman site to be used as a backup for possible equipment breakdowns, frozen soil, and any other events that might cause a buildup of incoming refuse. An additional element of the system was evaporation ponds for hazardous wastes that would be trucked in from the Portland metropolitan area (independent from the barging operation).

The life of the waste disposal project is estimated as 35 years, based upon a single application of refuse over the entire 50,000 acres, an application rate of 200 tons per acre, and an assumed constant refuse rate of 1,000 tons per day, 5-1/2 days per week throughout the entire 35-year period. The 1971 estimated cost of the Boardman facility, including operation, maintenance, amortization of capital investment, and profit was $2.35 per ton. The cost included all equipment and operations from docking and unloading through spreading; it did not include the cost of disking the wastes into the ground, for Boeing includes those costs elsewhere, in its land development operation. The cost of the on-site landfill for emergency use is said to be included in the estimated figure. Boeing is currently documenting its plans in order to make application to the Department of Environmental Quality for a permit to dispose of shredded wastes on agricultural lands.

Summation of the unit costs for processing, barging, and spreading the wastes yields a 1971 estimated cost of $5.28 per ton of refuse handled. Increasing this by 15 percent (in accordance with the Engineering News Record Construction Index) to bring it to 1973 prices would result in a total of $6.07 per ton.

Evaluation of Costs

Evaluation of the Boeing-Boardman project is hampered by the lack of available details. Without a detailed breakdown of the 1971 cost estimates, it is not possible to evaluate their appropriateness. For example, the Boardman cost of $2.35 per ton appears too low to include the expense of a backup sanitary landfill, but there is no data available as to the cost that was estimated for the landfill.

One element of the system that seems to have been significantly underestimated in the 1971 cost figures is the Portland processing station, which was estimated at $1.13 per ton. Using the basic design assumptions of the project, we estimate the total cost of the processing facility at about $2.30 per ton of refuse processed. (This includes the 15 percent increase to 1973 prices.)

With revision of the shredding cost and updating of the other costs to 1973 figures, the total estimated cost of the Boeing-Boardman project would be about $7.10 per ton, excluding docking facilities in Portland. This would be increased further if the Portland docking facilities were included, and further yet if separation of metals (as recommended in the Oregon State University report) were part of the project. Nevertheless, the $7.10 figure can be used for basic comparison purposes.

Conclusions and Recommendations

The results of the Oregon State University tests indicate that the Boeing-Boardman project contributes little toward increased crop production; in fact, the production is often less than on similar lands receiving no wastes at all. The project therefore becomes one of waste disposal rather than land reclamation. As such, it should be compared with alternative methods of disposal.

The present cost for disposal of wastes through sanitary landfills in the Portland area range from $3.00 to $3.50 per ton (as determined from user fees and densities obtained in the COR-MET weighing program). Our study has shown that the present quantity of wastes being disposed of in the four-county study area is about 2,360 tons per day, or 16,500 tons per week. If the original Boeing proposal were followed, only 1,000 tons per day, 5-1/2 days per week, would be received at Boardman or 5,500 tons per week. This would mean that 10,600 tons per week would have to continue to be landfilled in the Portland area (at $3.00 to $3.50 per ton) while 5,500 tons per week would be disposed of at Boardman (at about $7.10 per ton). There was no explanation in the Boeing-Boardman proposal of how the wastes would be handled during the 1-1/2 days per week that the system would not be operating.

Given the facts that are available to us at this time, we do not consider the Boeing-Boardman project a feasible alternative for disposal of wastes from the Portland area. As previously stated, the project would be one of waste disposal rather than land reclamation, and it would cost at least twice as much as proper sanitary landfill disposal within the study area. In addition, the proposed Boeing-Boardman method of disposal would result in an accumulation of metals, rubber, plastics, and other inert materials being deposited and left exposed on the surface of the 50,000-acre Boardman site. (To remove those inert materials prior to disposal would require air classification, magnetic separation, and dense media separation, which would increase the costs well beyond the estimated $7.10 per ton--probably to as much as $10.00 per ton.) We do not consider this a satisfactory method of waste disposal, for it tends to deface the land. Sanitary landfilling can be accomplished far more economically and can be used in a positive manner to reclaim marginal lands for ultimate use as parks, golf courses, and other recreational areas. Although our investigation of future land disposal sites is still under way, there is every indication that suitable land reclamation areas will be available within the study area to meet the needs of the area throughout the study period.

Unless additional facts should be presented which would alter the scope and content of the proposed Boeing-Boardman project, we would recommend that it be dropped from further consideration for disposal of wastes from the four-county study area.

SECTION 5

SEPTIC TANK PUMPINGS

Requirements

This interim evaluation of the collection, transport, and disposal of septic tank pumpings within the study area fulfills Item H of the Special Conditions of our contract, stated as follows: "Examine the current critical situation concerning disposal of sewage septic tank pumpings and septic tank pumpings which are unacceptable to Sewage Treatment Plants. Develop alternatives and recommended course of action for disposal of such wastes."

This analysis is concerned with pumpings from domestic septic tanks, septic holding tanks, and chemical toilets. The special wastes from industrial holding tanks have been classed as hazardous wastes and are accordingly excluded from our contract except as an inventory item. Recommendations on the handling and disposal of hazardous wastes will, however, be forthcoming from the Department of Environmental Quality.

Background

It is estimated that 25 percent of the individual residences in the four-county study area are served by septic tanks. Well-drained soils are a fundamental requirement for the proper functioning of septic tanks and their leaching fields, yet eastern Multnomah County is the only extensive portion of the study area that has proper soils for this function. Much of the remainder of the study area is characterized by relatively impervious soils with high groundwater levels during winter and spring. The result is that septic tanks require frequent cleaning and are subject to early failure. The Oregon State Board of Health recommends that septic tanks be checked every year for performance and that homeowners have their tanks pumped out every 3 years. In reality, however, most residential septic tanks are checked and pumped only when they fail.

The pumpings from septic tanks are a sludge containing digested and partially digested sewage solids. Over the years, the pumpings in three of the counties have routinely been disposed of in privately operated septic tank sludge lagoons, in which the solids were allowed to settle out and then were dried. The dried solids remained on site.

Early in 1970, the Health Departments in Clackamas, Multnomah, and Washington counties closed all septic tank sludge lagoons--partly due to malfunctioning of some lagoons, but largely due to intense public opposition to the lagoons. It was apparently intended that the pumpings should be disposed of in existing sewage treatment plants, but most of the plants in the area were already operating at or near capacity and thus were unable to accept any additional loading from the septic tank pumpings. In April of 1970, after a couple of months with no place for the pumpers to dump their wastes, the City of Portland began accepting domestic septic tank pumpings at its two sewage treatment plants (Columbia Boulevard and Tryon Creek). In June of 1970, the counties of Clackamas, Multnomah, and Washington entered into a formal agreement designating the two City of Portland treatment plants as the only two septic tank pumping disposal sites for wastes originating within the three counties. Multnomah County later agreed to accept chemical toilet wastes and septic holding tank sludges from all three counties at its Inverness sewage treatment plant.

Unlike the other three counties, Columbia County has for many years, disposed of its septic tank pumpings through a sewage treatment plant--the one in St. Helens.

Present Collection System

There are approximately 25 septic tank pumpers licensed by the State who operate within the four-county study area. Homeowners who wish to have their septic tanks pumped out usually contact several of the local pumpers to obtain bids for the service. Once an agreement has been reached, the selected pumper cleans out the septic tank and generally leaves a receipt with the customer.

Pumpers discharge the contents from one or two septic tanks into a truck, and most of them then proceed to one of the four sewage treatment plants accepting their wastes. There are, however, some pumpers in the study area who dump the wastes illegally on privately owned land, on public land, or into unauthorized sewer manholes in order to avoid dumping fees and long haul distances. Those who do take their wastes to treatment plants are required to record the sources of the wastes for each load discharged. At the Columbia Boulevard and Tryon Creek plants, the pH level is checked for every incoming load, and laboratory analyses are performed on questionable loads to determine if the waste is compatible with the plant processes.

Some of the pumpers in the area have formed the Columbia Processors Coop. The purpose of the organization is to establish proper procedures for collection, transport, and disposal of all liquid wastes and sludges.

Present Disposal Sites

The four sewage treatment plants that accept septic tank pumpings within the study area are the Columbia Boulevard plant in the City of Portland and Tryon Creek plant in the City of Lake Oswego, the Inverness plant in Multnomah County, and the St. Helens plant in the City of St. Helens. None of these plants has been specifically authorized by DEQ to accept septic tank pumpings. The plants are described briefly in the following paragraphs.

Columbia Boulevard. The Columbia Boulevard plant, which is located in northern Portland, is a primary plant that is presently being expanded to secondary treatment. Septic tank pumpings are discharged from the trucks through an 8-inch riser into a manhole located on the influent line to the plant. The only facilities provided are the pipe riser and a graveled area around the riser. Because the wastes are discharged directly into the interceptor, the plant operator has no control over the rate at which the pumpings are fed into the plant flow. Septic tank pumpings can be discharged between the hours of 8 a.m. and 5 p.m., five days per week. There is no access at any other time. Fees for dumping are 1-1/2 cents per gallon for the first 1,000 gallons and 1 cent for every gallon thereafter.

Tryon Creek. The Tryon Creek plant is located in the City of Lake Oswego on Foothills Road. It is an activated sludge plant which will soon be expanded to a greater capacity. The receiving facilities for septic tank pumpings consist of a concrete dumping pad, a 2,000-gallon open concrete receiving tank, a pumping system to inject the contents of the receiving tank into the plant influent, truck washing facilities, and overhead lighting. The capacity of the receiving tank is so small that it does not function well as a holding tank. Some of the pumping trucks have a greater capacity than the receiving tank, so the tank contents are generally pumped directly into the plant as soon as the tank is partially full. The receiving facility is open 24 hours per day, 7 days per week. Dumping fees are the same as at the Columbia Boulevard plant, but pumpers prefer to use the Tryon Creek plant because of its truck washing facilities.

Inverness. The Inverness plant is located west of N.E. 122nd Avenue and north of Sandy Boulevard, in Multnomah County. It is an activated sludge plant. Chemical toilet wastes and septic holding tank wastes are discharged directly into a manhole ahead of the influent pumping station. There is a graveled area surrounding the manhole; other than that, no special facilities are provided. The plant operator has no control over the rate of discharge of the wastes into the sewage stream, and he has therefore requested the addition of a 10,000-gallon holding tank with a metering system and generally improved receiving facilities. Wastes are received at the plant from 8 a.m. to 3 p.m. Monday through Friday. The fee is 1 cent per gallon.

St. Helens. The St. Helens plant is an activated sludge plant located on South Sixth Street in St. Helens. Septic tank pumpings and chemical toilet wastes are discharged into a manhole on the influent line to the plant. A graveled area around the manhole is the only provision made for the pumpers. There is no control over the quantity of wastes injected into the sewage stream. The receiving facility is open from 8 a.m. until 4 p.m. Monday through Friday, and closed all other times. The fee is a flat $7.50 per truck load, without regard to the size of the truck.

It was reported to us that several licensed pumpers discharged their wastes to treatment facilities outside the study area. Contacts with the reported treatment plants indicated, however, that they receive only insignificant quantities of wastes from our four-county study area. They further indicated that they would discourage an influx of pumpings from outside their own jurisdiction.

Present Quantities

It is difficult to estimate accurately the quantity of septic tank pumpings within the four-county area, for there are few records. It is estimated that 25 percent of the individual residences in the four-county area are served by septic tank systems. If one assumes that each person served by a septic tank generates 0.3 gallons per day of sludge, then approximately 26 million gallons per year or 73,000 gallons per day are produced. Septic tank installations in portions of Washington, Columbia, and Clackamas county require pumping every 2 to 3 years, while installations in other portions of these counties and in Multnomah County require less frequent cleaning and pumping. Based on data received from those plants which are presently accepting septic tank pumpings and chemical toilet wastes and from discussions with local county health departments and septic tank pumpers serving the region, it is estimated that approximately 14,000 gallons of sludge are pumped each day and that 11,000 of those gallons are disposed of daily in a legal manner.

It is not anticipated that the quantity of septic tank pumpings will increase significantly over the coming years. Although new housing developments in unsewered areas will add to the quantity of pumpings, the introduction of sewers to already-developed areas will decrease the pumpings, and it is estimated that these activities will result in a reasonably stable total quantity. The one factor that might noticeably alter the volume of septic tank pumpings would be for homeowners to have their tanks pumped more frequently than they do at present.

Adequacy of the Present System

The system as it presently functions is a reasonably satisfactory solution for the collection and disposal of pumpings from domestic septic tanks, septic holding tanks, and chemical toilets. The treatment plants accepting the wastes have adjusted their aeration mixtures and detention times to accommodate the wastes, so the wastes do not impede the treatment processes.

The capacities of the treatment plants are adequate to receive the wastes. The present limit for pumpings received at each of the plants is as follows: Columbia Boulevard, 15,000 gallons per day; Tryon Creek, 6,000 gallons per day; Inverness, 10,000 gallons per day; St. Helens, no limit; total, 31,000 gallons per day plus the quantities received at St. Helens. As was previously indicated an estimated 14,000 gallons are pumped within the study area each day, so the capacity of the receiving plants is adequate.

The major problems within the existing system are as follows:

1. The haul distances from remote portions of the study area are major--ranging up to 35 miles one way. This is due to the fact that all four treatment plants that receive the pumpings are located near the central metropolitan area. Because a pumper can only accept the wastes from one or two houses before emptying his truck, the major haul distance is of significant concern to him.
2. More than 20 percent of the wastes collected by pumpers are discharged illegally along the roadside or on private land. This causes a potential hazard to health and also creates noxious odors. Some of the pumpings have been illegally discharged into isolated sewer manholes that lead to small treatment plants not ordinarily accepting the wastes. Discharge of the wastes to these plants has seriously interfered with their operations.
3. Those pumpers who discharge their wastes illegally and thereby avoid excessive hauling costs and disposal fees can charge lower rates to their customers. This places the reputable pumpers at a disadvantage in negotiating with customers.
4. Although discussions with local county health officials indicate that the general service provided by septic tank pumpers is adequate, there were some complaints about overcharging, incorrect recording of quantities pumped, and pumping of the

liquid portion from tanks while leaving the sludge in place.

5. The receiving facilities at all four of the plants are deficient in one or more ways. The Columbia Boulevard, Inverness, and St. Helens plant all lack concrete dumping pads and truck washing facilities. None of these plants has a holding tank and flow control system for the pumpings; the holding tank at Tryon Creek is inadequately sized. None of the plants has an odor control system for the pumpings.

6. The State requirement that pumpers secure from the county health officer a permit to allow pumping within the county is not presently being enforced in Clackamas and Columbia counties.

Alternative Disposal Methods

Four possible ways to dispose of septic tank pumpings are as follows: (1) land disposal; (2) treatment in conjunction with sewage; (3) separate biological treatment; and (4) incineration. These are discussed briefly in the subsequent paragraphs.

Land disposal of septic tank pumpings can be accomplished either through lagooning or through spreading on the land surface and disking into the soil. Local county health officials have discouraged the use of land disposal techniques because of operational problems, generally inadequate soil conditions, high seasonal groundwater levels, and major public opposition. It is accordingly not considered a suitable disposal method for the study area.

Treatment of septic tank pumpings in conjunction with the treatment and disposal of sewage is the method presently used within the study area. It can be a highly satisfactory method, provided the quantity of pumpings does not represent too high a proportion of the flow through the plant and also provided the treatment process is amenable to the pumpings. Important adjuncts to the system are a holding tank, odor control, and a controlled feed rate to prevent shock loading that might overload or upset the biological process of the plant. In spite of the fact that this can be a very satisfactory treatment process, it is viewed by representatives of the Department of Environmental Quality as an interim solution only. The reasons stated by DEQ representatives for this viewpoint are that the pumpings take up sewage treatment plant capacity and would better be dewatered and incinerated without prior treatment. DEQ requirements for the suitability of a sewage treatment plant to accept septic tank pumpings on an interim basis are (1) full operational control, (2) proper equipment, and (3) full administrative control for proper billing and accounting. Only the larger plants within the study area are capable of meeting DEQ requirements.

Separate biological treatment of septic tank pumpings is theoretically a desirable system, but in reality it can be a very costly set-up. For it means a complete sewage treatment plant to handle septic tank pumpings alone, and the volume of pumpings in a given area is generally so small as to make the unit costs very high. In addition, the sporadic supply of pumpings to a plant would make efficient treatment very difficult in the absence of a continuous raw sewage influent to stabilize plant inflow. DEQ is giving some consideration to converting soon-to-be-abandoned sewage treatment plants into plants for the exclusive treatment of septic tank pumpings. After biological treatment, the wastes would be further processed through sludge digesters and then would be lagooned, landfilled, incinerated, or disked into the soil.

Incineration of septic tank pumpings requires dewatering of the pumpings by means of a vacuum filter or other thickening devices and then incineration in a multiple-hearth furnace. The incinerator residue is generally disposed of in a landfill. Incineration is a very costly investment and rarely proves feasible for septic tank pumpings alone because of their relatively low volume. Septic tank pumpings may, however, be dewatered and incinerated in conjunction with sewage treatment plant sludge. Several of the sewage treatment plants proposed as regional plants for the study area will include sludge incinerators, and when these facilities are constructed DEQ intends that septic tank pumpings shall be dewatered and incinerated with the sewage sludge.

Proposed Disposal System

It is the intention of DEQ that the long-term solution for the processing and disposal of septic tank pumpings be through incineration at sludge incinerators that will eventually be built at the major sewage treatment plants within the area. The regional sewer plan of the Columbia Regional Association of Governments includes sludge incinerators at the following sewage treatment plants: Columbia Boulevard, Portland; City of Gresham; Tryon Creek, Lake Oswego; Unified Sewerage Agency, Durham; City of Hillsboro; City of Vancouver, Washington. These incinerators are still in the proposal state, and there is no clear indication as to when they will be constructed. The principle of incineration for septic tank pumpings is a sound one if the economics will support it. Economic evaluation of sludge incineration lies in the realm of liquid waste treatment and is beyond the scope of our project. We shall, therefore, accept DEQ's long-range plans of incineration for septic tank pumpings and concentrate herein on the short-range solution.

The present system of treating and disposing of septic tank pumpings in conjunction with sewage is a satisfactory one, and we would recommend its continuance, with some modifications.

In addition to the four plants that already receive septic tank pumpings within the study area, there are long range plans to expand the Gresham plant so that eventually it will accept pumpings, and short range plans to construct a regional plant at Durham which would accept pumpings, and to expand the Hillsboro Rock Creek plant which would also accept pumpings. Although there is sufficient capacity within the four existing plants to accept all septic tank pumpings generated within the area, the addition of the proposed plants would add geographic flexibility to the system and thereby cut down on the excessive haul distances presently experienced by the pumpers.

Preliminary plans for existing treatment plants include the addition of one 12,000-gallon and one 14,000-gallon holding tank for pumpings at Columbia Boulevard and one 5,000-gallon holding tank at Tryon Creek. The proposed tanks at the Columbia Boulevard plant will enable the pumpers to begin using 3,000-gallon drop tanks to make their own operations more efficient--something they have so far been prevented from doing because of insufficient holding tank capacity at the receiving stations. The proposed tank at Tryon Creek appears somewhat undersized; one day's storage would be 6,000 gallons.

Every sewage treatment plant that accepts septic tank pumpings should be inspected for adequacy and approved by DEQ. Each plant should be equipped with a concrete dumping pad, a holding tank of minimum one day's capacity, rock screens, flow controls for injecting the pumpings into the raw sewage flow, a chemical odor control system, and facilities for washing down the concrete pad, the holding tank, and the inside and outside of the pumping trucks.

Implementation and Financing

The following actions would be required to ensure proper functioning of the collection, processing, and disposal system within the study area.

1. *Strong enforcement of existing State regulations.* DEQ should initiate a program for policing illegal disposal sites used for septic tank pumpings to ensure that State regulations for proper disposal are firmly adhered to. In addition to ensuring disposal under non-nuisance conditions, this will also eliminate unfair cost competition from those pumpers who illegally dispose of the wastes.

2. *Enactment at a local level of more restrictive regulations.* Each county within the study area should initiate stronger programs enforcing the State requirements for septic tank pumpers to obtain a written permit from each county in which the pumper collects wastes and disposes of them.

3. *Expansion of the existing multi-county agreement.* Columbia County should enter into the multi-county agreement previously formed by Clackamas, Washington, and Multnomah counties and the City of Portland. This multi-county agreement should be strengthened by including the following provisions:

   a. All domestic septic tank pumpings should be disposed of at DEQ-authorized sites, and the site operators should be required to record the source and quantity of every load accepted at the site.

   b. Additional plants as approved by DEQ to receive and process septic tank pumpings should be included under the agreement.

   c. All treatment plants authorized by DEQ to accept septic tank pumpings should be required to provide suitable receiving facilities for the pumpings.

   d. An annual inspection of all septic tank pumping equipment should be made by each county.

   e. A uniform schedule of disposal fees should be specified for all plants within the four-county area, and the fees should ensure that the processing and disposal operations are self-supporting.

4. *Establishment of a method of financing.* The septic tank pumping system should be self-supporting. Item 3e above will ensure that the costs of the processing and disposal operations are covered, and the septic tank pumper can then include those costs in his total fee to the homeowner.

Recommendations

If the present system for handling septic tank pumpings were properly enforced, the system would be adequate for the needs of the study area. The only recommendation we can present to the Metropolitan Service District at this time would be for MSD to review periodically the effectiveness of DEQ and the counties in carrying out their regulations. If there is no improvement in the enforcement, then MSD may decide to coordinate among the counties the licensing of septic tank pumpers and to monitor the overall system. If MSD should decide to assume this role, then a record system similar to the one recommended in our tire disposal report of March 1973 might be instituted.

REPORT to METROPOLITAN SERVICE DISTRICT on ACTION PLANS to UPGRADE THE EXISTING SYSTEM

Q-70

COR-MET
June 1973

22 June 1973

Metropolitan Service District
6400 S. W. Canyon Court
Portland, Oregon 97221

Gentlemen:

Subject: Action Plans to Upgrade the Existing Solid Waste System

Submitted herewith are our suggested action plans for upgrading the existing system. The presentation of these plans is divided into the following sections:

Section 1	-	Introduction
Section 2	-	Clackamas County
Section 3	-	Columbia County
Section 4	-	Multnomah County
Section 5	-	Washington County
Section 6	-	Multi-County

The multi-county plans are applicable to all the counties and could be implemented on either a regional or a county-by-county basis.

The responsibility for implementing each action plan will generally rest with the agency presently responsible for the given segment of the system. The Metropolitan Service District could offer overall coordination and support for the projects.

We will be present at the regularly scheduled Board meeting on July 13 to discuss with you our suggested action plans. Should you have any questions prior to that time, do not hesitate to call us.

Sincerely,

COR-MET

J. Melissa Brown

J. Melissa Brown
Project Manager

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SECTION 1
INTRODUCTION

Action plans to upgrade the existing system are presented herein for each of the counties and the region. The suggested programs, which are the result of our inventory and evaluation of the present solid waste management system, are positive actions that can be accomplished prior to the January 1974 conclusion of the COR-MET study. A detailed outline of the actions that should be taken from January on will be presented in our final report.

Each suggested action plan to upgrade some element of the existing system is directed toward the agency presently responsible for that element of the system. Accordingly, City agencies, County agencies, State agencies, and private enterprise will all have the opportunity to cooperate in improving solid waste management in the study area. The Metropolitan Service District could lend direction and coordinative support to these individual agencies.

SECTION 2

CLACKAMAS COUNTY

Overall Appraisal of the System

General. The system of solid waste collection and disposal in Clackamas County appears adequate, with minor exceptions, to satisfy the present needs of the County. With most of the system operated by franchises administered through the County Solid Waste Division, sufficient standards of operation and service are maintained. The Solid Waste Division and the Solid Waste Advisory Committee to the Board of Commissioners are actively involved in the enforcement of the County's Solid Waste Collection and Disposal Ordinance. Nuisances and other special solid waste problems are being effectively reduced by the actions of these bodies.

Major Problem Areas. Of the shortcomings that do exist in the county, the most notable are junked and abandoned automobiles (see multi-county recommendations), insufficient collection or disposal service for rural residents, and poorly closed dumps.

1. Junked and Abandoned Vehicles. The presence of junked and abandoned vehicles scattered throughout the county constitutes perhaps the major solid waste handling problem for the county. Most of these vehicles belong to the owners of the property on which the vehicles are located, and their accumulation can be attributed to the unwillingness or inability of the owner to remove the vehicles because of the high cost involved. A suggested plan for action to remedy this problem is presented in the multi-county recommendations.

2. Rural Collection. Rossman's is the only disposal site in the county that accepts all types of residential refuse. Its urban location creates relatively long hauling distances for commercial collectors to service scattered rural households. Accordingly, the cost of collection increases. This factor combined with a lower income level for most rural residents presents them with a situation which makes collection costs appear prohibitive. The problem is aggravated by the inacessibility of many farm houses for collection vehicles. The situation induces these residents to find other means of disposing their wastes, such as burying, burning, or self-hauling to Rossman's. In some cases it leads to illicit dumping along roadways or in canyons. Solid waste collection is not a part of our study, so there will be no interim action plans regarding rural collection.

3. Closed Disposal Sites. In the past few years, nine dumps and landfills of varying types have been closed throughout the county. Three of these closed sites are less than satisfactory from the standpoint of aesthetics or public safety and health. The *Bloom site* in Oregon City is a deep fill with steep side slopes of exposed debris. The great amounts of exposed debris and insufficient cover on top of the fill constitute a considerable fire hazard with potential for harboring rodents and vectors. The *Burright site* at Happy Valley is located adjacent to a trailer court and several houses. Presently it is a fairly level, clay-covered lot. The most notable condition at this site is lack of adequate surface drainage and lack of sufficient compaction and depth of cover material. The resulting effects are erosion channels and exposed debris in scattered locations. The *J and W site*, about

four miles east of Happy Valley, has a history of underground fires, and the problem has not been entirely eliminated. It should be noted that of all the sites closed, the one at Brightwood is by far the cleanest in appearance. There is no evidence of previous dumping activity and tree seedlings have been planted, making this site a model for others to be patterned after. Suggestions for improving the three sites listed above are included in the interim action plans.

Interim Action Plans

Following are suggested plans of action for upgrading some of the conditions described above and for improving other undesirable solid waste management conditions within the county.

Closed Disposal Sites. The *Bloom site* will require extensive grading and reworking of the exposed face to provide stabilized, covered slopes. The top surface should be covered with enough soil to provide a total of 2 feet of compacted material above the refuse level. It is possible that stockpiling of final cover material could begin through advertising for clean fill from excavation and road construction.

Upgrading of the *Burright site* will require filling and compacting of cover material to a level 2 feet above that of the refuse. The surface should then be graded to provide suitable surface drainage to the adjoining ravine.

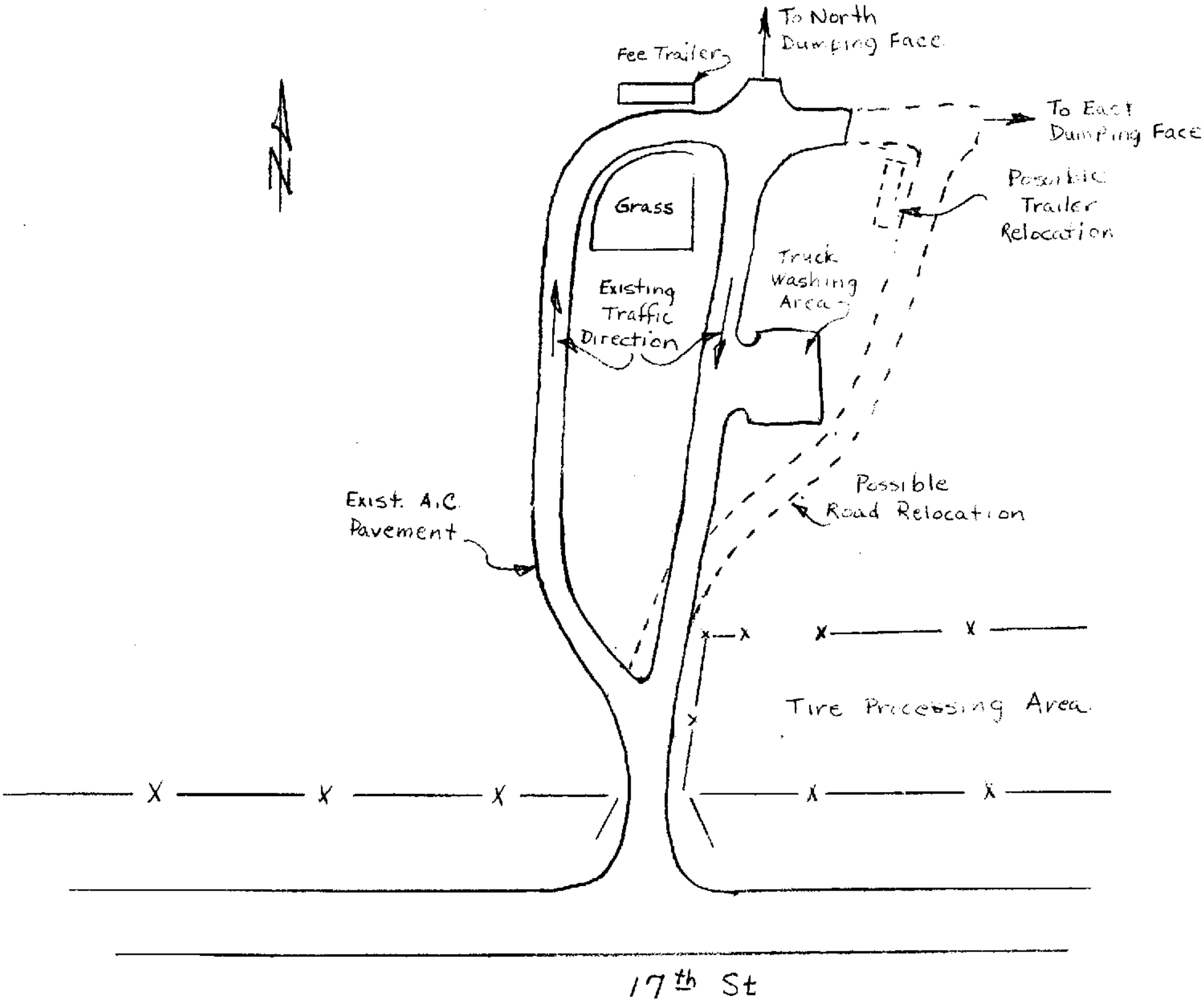
Representatives of the County have indicated that development in the immediate area of the *J and W site* will be marginal because the area is not sewered and is not well suited for septic tanks. Action at this site could therefore be limited to intermittent monitoring for fires until the County is reasonably satisfied that no further fire danger exists. There is no way to determine how long this might take.

Rossman's Disposal Site. In general the conditions at Rossman's are adequate with little need for improvements. The appearance of the site is clean, with the exception of papers blowing on windy days. These are usually policed promptly. One situation that could be improved, however, is the traffic pattern at the entrance to the site. The existing site layout requires that entering traffic bear left to pass the toll booth. This is complicated by the tendency of exiting traffic to bear right upon nearing the gate, causing a crossing pattern just inside the entrance. The only traffic control device is a small sign about 50 yards from the road directing incoming traffic to the left. This sign cannot be seen until one has already turned into the entrance.

The most effective solution to this situation would be to route the traffic in the opposite direction, in which entry and exit would be to the right. But this cannot be accomplished with the existing roads because entering traffic would conflict with exiting trucks using the truck washing area. Thus it would be necessary to re-route the entrance road around the washing area (assuming this would be less expensive than relocating the washing area with its appurtenant drains and a septic tank). The length of this new road would be approximately 300 feet and the cost of paving and installing traffic-control features (signs, striping, etc.) would be on the order of $3,500. See attached sketch.

Barring relocation of the road, the next-best solution would be to maintain the existing traffic pattern and provide clearly visible traffic controls at the entrance. Such controls should include large direction arrows painted on the

Rossman's Disposal Site
Paving Plan



pavement at the entrance which will be evident to drivers prior to reaching the entrance. There should also be a road divider from the entrance up to a point at which the access road itself divides (a distance of about 50 yards). This divider could be a double yellow line accentuated with lane-dividing "bumps" or other methods of physical control. Signs should also be provided to help clarify this unusual flow of traffic. The cost of these improvements would be about $200.

One other situation which could easily be corrected is control of private automobiles at the dumping face. These vehicles are often directed too close to the dumping edge, presenting a precarious situation for people trying to unload their refuse. Passenger vehicles parked close to the edge allow only limited working space behind the vehicle and sometimes require the driver to stand to the side of the vehicle and reach around it into the trunk. It is suggested that spotters direct passenger cars to stop within a few feet of the edge of the fill to allow freedom of movement behind the car.

Sandy Collection Station. This drop box facility, presently operated by the Clackamas County Department of Public Works, is located at the site of the closed Sandy dump. The surface of the dump is covered with soil and is generally well-compacted, but debris is still exposed on the slopes. The County is presently engaged in a program to cover the slopes with soil excavated at the site, but this operation is expected to continue for several years. It is suggested that the County consider advertising for clean fill (as construction in the area permits) to hasten the operation. The County might also consider the haul of excavated soil to Sandy as a requisite of future construction contracts which provide an excess of clean fill.

It is further suggested that safer dumping conditions be instituted at the site. There is a guard rail at the site which provides adequate protection for passenger car drivers, but its height does not affect truck drivers. The present situation generally consists of pickup trucks backing up to the guard rail and resting the tail gates over the rail. This presents a sharp drop of about 12 feet from the edge of the pickup bed to the bottom of the drop box. It is recommended that a safety railing of galvanized pipe at least 1-1/2 inches in diameter be extended horizontally the entire width of the dumping zone (about 30 feet) at a height of approximately 7 feet above the top of the retaining wall. This would provide a handrail height of about 4 feet relative to the person standing on the pickup bed. It would also provide enough room to dump almost any load under the rail. The most important feature of this railing would be safer conditions for the average public user. A side benefit might result in that dumping could proceed at a faster rate because of the increased confidence of the user. A preliminary evaluation indicates a cost of about $150 to construct the railing.

SECTION 3
COLUMBIA COUNTY

Overall Appraisal of the System

General. The existing system of refuse collection and disposal in Columbia County is generally adequate to handle the present quantities of solid waste generated in the more densely populated county areas, but only marginally adequate for the refuse generated in the remaining areas of the County. Refuse collection in those areas served by commercial collectors is reliable, but much of the county has no formal refuse collection system. Public acceptance and use of authorized disposal sites is minimal and there is general agreement among the commercial collectors and the City and County officials concerned with solid waste management that more conveniently located disposal sites and a more responsible attitude on the part of local citizens are needed.

The general administrative framework established by County and City ordinances also appears to be adequate for proper management of the present solid waste collection and disposal system.

Major Problem Areas. The major problem areas in Columbia County are identified as follows:

1. Disposal Site Operations. The operations at all authorized disposal sites in the county are in need of improvement. Recommendations for the Clatskanie site were included in our interim report of June 1. Suggestions for improving the Santosh site are included in the interim action plans of this report.

2. Haul Distances. Commercial haulers and private residents both express concern over the long haul distances to authorized disposal sites. Clatskanie, Santosh and Mickey's are the only authorized sites in the county, and their locations are not convenient for much of the area. There can be no recommendations to correct this condition at this time, for the location of alternative transfer and disposal sites must await completion of our study in January 1974.

3. Rural Collection. Residents in many areas of the county complain about the lack of reasonably priced collection service for rural areas. Our study does not include a direct assessment of collection, so we will provide no recommendations for revising rural collection.

4. Illicit Dumping. There are numerous illicit dump sites throughout the county, and public officials and private citizens alike have expressed major concern about the appearance of these dumps and their effect on the environment. Interim action plans for site cleanup and public education can be instituted immediately to close out the illicit dumps and encourage the use of authorized disposal sites, and suggestions for such a program are contained herein.

Interim Action Plans

Cleanup of Illicit Dumps. It is suggested that a County-wide cleanup campaign be organized and administered by the Columbia County Organization of Governments (CCOG) with assistance from the Columbia County Health Department.

The county cleanup campaign coordinator, suggested to be the CCOG Planning Director, could compile information on the location and extent of illicit dumping in all areas of the County. Sources of the information could be observations by County sanitarians, City officials, private companies owning forest land, and general citizens. The site inventory should identify property locations owner, and extent of debris. Based upon the results of this survey, the coordinator would select tentative sites for cleanup, schedule the cleanup operations, and estimate the labor and equipment needs. Possible sources of volunteer labor within the county would then be contacted, including such groups as the 162nd Engineering Company, Oregon National Guard, St. Helens; Oregon National Guard units spending summer camp in Columbia County; Kiwanis; Elks; local Boy Scout troops; and local high school volunteer groups.

The coordinator would then estimate the expense of providing necessary support equipment and labor in excess of that volunteered and would locate a source of funds. There might be a possibility of some financial support from the large timber companies in Columbia County, and local fraternal organizations might also be interested in contributing to a public service program of this nature. Use of the Columbia County Solid Waste franchise application fees might also be appropriate for this program, but this should be cleared through the County Solid Waste Advisory Committee.

Following this initial phase of groundwork, the coordinator would finalize the number and location of sites to be cleaned up and also establish a specific work schedule, detailing the deployment of available men and equipment. A firm commitment of men and equipment would be secured from those groups who indicated a willingness to be included in this cleanup effort. At this time the coordinator would inform each group of its assigned task, including time, location, and nature of the work to be done.

Those sites designated for cleanup but located on private property would be separated from the dump sites on public property and the list of property owners and site locations would be given to the Administrator of the Columbia County Solid Waste Collection and Disposal Ordinance. All property owners would be contacted and asked to participate in the upcoming cleanup campaign by allowing the volunteer forces to enter and work on the property in question. For those property owners who refuse to cooperate, the Administrator specified above could, upon the recommendation of the Columbia County Health Department, determine that the deposited solid waste is in violation of Section 10.01 of the County Solid Waste Ordinance and give written notice of this violation to the Board of County Commissioners and the alleged violator. The violator would be informed of the subsequent actions that may be taken by the County and the procedure for abatement of the nuisance (as detailed in Section 10.03 of the County Solid Waste Ordinance). Following this explanation of the nuisance abatement procedure, the property owner should again be given the option of allowing the volunteer labor force to clean up the dump site as scheduled during the cleanup campaign. It is expected that this procedure will encourage all private property owners to participate in the cleanup effort.

At the completion of the cleanup work, an assessment of the impact of the program on the number of illicit dump sites should be made by the coordinator, and the need for followup work determined.

Publicity for Cleanup of Illicit Dumps. If the cleanup of illicit dumps is undertaken, then one week prior to the date of the county-wide cleanup campaign, the program coordinator should prepare a press release for all newspapers published in Columbia County. The news release would contain the following information:

1. A brief explanation of the extent and causes of the illicit dumping problem in Columbia County.

2. An explanation of the county-wide cleanup campaign, including a list of volunteer groups.

3. The scheduled date and general county areas where work will be carried out.

4. A phone number where interested individuals can contact the program coordinator.

Upon completion of the cleanup campaign, the coordinator should issue another press release to inform the citizens of Columbia County of the effectiveness of the cleanup campaign and to increase the general awareness of actions taken by the County on the illicit dumping problem. The information would be distributed to all newspapers published in Columbia County and also to the Longview-Kelso area papers and would contain the following information:

1. A list of sites cleaned up and the participating volunteer groups.

2. A list of the disposal sites approved by the Board of County Commissioners pursuant to the Columbia County Solid Waste Collection and Disposal Ordinance. The location, the hours of operation, and the types of material accepted for disposal at each site should be included.

3. A statement that there are *no* other legal dump sites in Columbia County.

4. A summary of Sections 10.01, 10.02 and 10.03 of the Columbia County Solid Waste Collection and Disposal

Ordinance, stressing the illegality of using unauthorized dump sites.

5. A statement that Columbia County, through the Health Department and the County Sheriff, has begun investigations to determine continuing users of illicit dump sites.

6. A summary of Section 11.04 of the Columbia County Solid Waste Collection and Disposal Ordinance, listing maximum penalties for violation of relevant sections of this ordinance.

After completion of the county-wide cleanup campaign, the Columbia County Road Department should construct and erect "dumping prohibited" signs at the site of every chronically-used illicit dump site, as located by the County Health Department. These signs should contain at least the following information:

1. NO DUMPING ALLOWED
By
Columbia County Solid Waste Ordinance
Section 10.02

2. VIOLATORS WILL BE PROSECUTED
under Section 11.04
$1,000.00 FINE or 1 YEAR IMPRISONMENT

3. Investigations to be carried out by:
COLUMBIA COUNTY SHERIFF

So that County residents desiring to use a disposal site may be readily advised of the site location, it is suggested that the Columbia County Road Department erect directional road signs to all county-approved disposal sites. The signs should conform to existing county road signing standards and should specify an approximate distance to the disposal site. Expenses for this item could be paid from the County Road Department Budget.

Enforcement against Illicit Dumping. It is suggested that the Columbia County Health Department pursue the abatement of those illicit dumps on private property that were identified but not cleaned up during the county-wide cleanup effort. Authorization comes from Sections 10.01 and 10.02(2) of the Columbia County Solid Waste Collection and Disposal Ordinance.

Independent of the county-wide cleanup campaign, the Columbia County Health Department, with assistance from the Columbia County Sheriff, should initiate investigations into users of chronic dumps throughout the County. This may involve accumulation of refuse samples traceable to one source over a period of time for use only as circumstantial evidence, should a violator be apprehended during the commission of an illegal act. An alleged violator would be subject to prosecution under Sections 10.02(1) and 11.04 of the Columbia County Solid Waste Collection and Disposal Ordinance.

In our contacts with various public officials, we discovered that some were not aware of the Columbia County Solid Waste Collection and Disposal Ordinance. It is therefore suggested that the County sanitarian, as Administrator of the ordinance, contact all County agencies who play a part in administration or enforcement of the ordinance. The agencies should be informed of their duties and responsibilities specified by ordinance along with the realistic expectations of the Administrator of the ordinance. Future plans for involvement of the concerned County agency should also be discussed.

The following list is suggested for initial contacts:

1. County Sheriff
2. County Extension Agent
3. Director of Columbia County Park Commission
4. Columbia County Road Department
5. Columbia County Counsel

Santosh Disposal Site. It is suggested that the operator of the Santosh disposal site be required to use a pump or pumps of adequate capacity to keep the diked fill area free from accumulated water. The disposal of refuse into water is not an acceptable method of operating a disposal site, and action should be taken to prevent standing water from accumulating at any time during the year. Implementation of this suggestion would create conditions conducive to more orderly compaction procedures at Santosh, prevent the formation of major amounts of leachate, and lessen the production of gas and odors.

The operator of the Santosh site should also arrange for increased use of soil cover material. A possible source of this material would be the existing gravel operation adjacent to the site. This material should replace the present use of paper sludge waste as a cover material, because the sludge does not compact appreciably nor does it possess fire retardant properties inherent in a soil cover material.

The completed portions of the fill should be covered with a minimum 2-foot compacted layer of soil cover material, and subsequent compacted lifts of refuse should be covered at least twice a week with a suitable cover material.

City of Rainier Closed Disposal Site. In conjunction with the suggested placement of the "dumping prohibited" sign at the entrance to the former City of Rainier disposal site, the City of Rainier and the County agency responsible for the erection of the "dumping prohibited" sign should, through a suitable arrangement, provide for the installation of a standard street light at the entrance to the closed disposal site as a deterrent to night-time dumping. This light should be placed so that the "dumping prohibited" sign and the area surrounding the site entrance is fully illuminated.

<u>City of Vernonia Disposal Site</u>. The City of Vernonia has applied for a Columbia County disposal franchise to operate the formerly closed city disposal site on a one-Saturday-a-month temporary basis, for the disposal of lawn trimmings, grass clippings, and similar material. It is suggested that Columbia County approve this franchise application, which will provide the Vernonia area with a site for the disposal of this type of refuse until a more acceptable long-term alternative for the disposal of all wastes from the Vernonia region can be determined. As a part of the franchise agreement, the County should require the operator of the disposal site to compact and cover all exposed refuse at the close of each operating Saturday.

The City of Vernonia should require the operator of the disposal site to erect a sign at the entrance of the site, as specified by City Ordinance No. 427, containing at least the following information:

1. Name of site
2. Disposal fee schedule
3. Dates and hours of operation
4. Types of refuse accepted
5. Emergency telephone number

SECTION 4
MULTNOMAH COUNTY

Overall Appraisal of the System

General. The solid waste collection and disposal system in Multnomah County is adequate in most respects. Private refuse collectors provide minimum weekly collection service to all but the very remote areas of the county. The level of service is good, although there have been some complaints of route duplication by refuse collectors within the City of Portland and by residents of the city.

Landfill sites within Multnomah County and at Oregon City in Clackamas County provide convenient locations for refuse disposal, being within 10 miles of the vast majority of the population. Only a few areas east of the Sandy River are farther than 10 miles from the nearest disposal site.

Operations at the St. Johns site have improved vastly in the last few years, and the agencies responsible for that site are to be commended. There are, however, some minor improvements that still need to be instituted.

Major Problem Areas. The major problem areas in Multnomah County are identified as followed:

1. St. Johns Landfill. Most of the problems at St. Johns are of a minor nature, but because it is a very large operation, it has come under much public attention. The most notable problem resulting from St. Johns is the litter along Columbia Boulevard and Swift Boulevard, which has led to many complaints by area residents. Some on-site operating problems result from the traffic control of private vehicles using the

landfill, night dumping by refuse collectors, trucks becoming stuck during wet weather, paper blowing, and the dumping of unacceptable materials by refuse collectors. Because final fill elevations are being approached in portious of the disposal site, potential problems with the completed fill should be studied now and the solutions prepared in advance.

2. <u>LaVelle and Yett Landfill</u>. The LaVelle and Yett disposal site is generally well operated, but there is a potential problem from the migration of methane gas out of the fill to nearby buildings. The operators of the landfill are currently preparing a method to prevent any undesireable gas migration.

3. <u>Overlapping Collection Routes in Portland</u>. The duplication of collection routes within the city of Portland is inefficient and sometimes results in nuisances from collection truck traffic.

The suggestions made for upgrading these problem areas can be begun immediately without awaiting the final results of the study.

<u>Interim Action Plans</u>

<u>Litter Along Haul Routes to St. Johns</u>. Significant amounts of litter have been observed along Columbia Boulevard and Swift Boulevard leading to St. Johns Landfill, and numerous complaints have been made about the litter problem by local citizens. The City has attempted to control the problem in the past by picking the litter up weekly or once every two weeks, but because of the continuous nature of the littering weekly pickup has not been sufficient.

Most of the litter appears to come from improperly covered refuse hauled by private individuals. In order to reduce the problem at its source, the City is preparing an ordinance that requires all vehicles hauling refuse to be properly covered. The main problem with the old ordinance was that it simply prohibited littering, which is difficult to enforce unless the offender is caught in the act. The relative ease of enforcing the covering requirement should influence most people to obey the law. In addition to enforcement by the police, the City is also planning to encourage covering by making an additional charge at the disposal site for any uncovered loads of refuse coming to St. Johns.

The action of the City to require covering of refuse is an important step and should reduce the amount of littering on Columbia Boulevard and Swift Boulevard. Assuming that some littering will continue, it suggested that the frequency of litter pickup be increased to daily instead of weekly. Considering that the littering occurs on a daily basis, the best level of correction would be to remove the litter on a daily basis also.

Inasmuch as the criticism for littering is directed at the operation of the St. Johns disposal site, the responsibility for correcting the problem should be placed under the control of the Director of Solid Waste Management rather than with the City Road Maintenance. The Director could then utilize landfill personnel for the daily pickup of litter along specified sections of Columbia Boulevard and Swift Boulevard.

Traffic Control at St. Johns. During the week of the COR-MET weighing program at St. Johns, from 10 to 15 private autos drive past the entrance to the public dumping area and interferred with commercial traffic as they turned around or stopped to ask directions. These observations were made during

March, when there was a relatively small amount of public dumping. The problem could be magnified considerably during the summer months.

A large sign, with a clearly visible arrow, indicating "Public Dumping Area" should be erected at the "Y" where the road splits to the commercial and public dumping areas.

Night Dumping at St. Johns. The St. Johns disposal site is open to commercial collectors 24 hours a day. It was noted during the COR-MET weighing program that each morning there would be from 20 to 50 loads of uncovered refuse dumped on the previous day's fill. The loads were dumped during the night, and it was usually 8:30 or 9:00 a.m. before landfill equipment was on the fill spreading and compacting refuse. This procedure creates these problems:

1. The refuse is often accumulated in a large pile away from the working face rather than being dumped in a single row along the top of the working face.

2. Trucks that become stuck while dumping at night must wait until 8:30 or 9:00 a.m. before being pulled out.

3. The accumulated refuse is often simply pushed over the fill with little or no compaction, in an attempt to clear up the area before the daily flow of trucks begin arriving.

4. The piled refuse attracts a large number of seagulls and crows, and could also attract rodents.

5. The uncompacted refuse is easily blown and scattered by the wind, creating a large amount of litter and blowing paper.

In order to provide better dumping conditions at night, the City is planning to use a portable light source and possibly a spotter to help the trucks dump in a more orderly fashion along the working face. In addition, it is suggested that one equipment operator work a shift from 6:00 a.m. to 2:30 p.m. each day. This operator could prevent the backlog of refuse, improving the efficiency of the filling operation.

Blowing Paper at St. Johns. It has been noted that there is a significant blowing paper problem during the regular working hours. Existing litter control fences are sometimes clogged with paper and not maintained during the week.

We suggest that, in addition to the low litter fences now in use, portable litter fences about 10 feet high and mounted on skids be used at the landfill working face during windy weather. A design similar to the litter fences now in use at the LaVelle and Yett Landfill appears to work well. The fences should not be allowed to become clogged with paper during windy weather.

Unacceptable Refuse at St. Johns. To help cut down on the amount of tires and other unacceptable items that are delivered to St. Johns in drop boxes, it is suggested that all drop box owners be advised of the types of materials not accepted at the St. Johns Landfill. In addition, the City could prepare stickers listing unacceptable materials and require that these stickers be placed on every drop box dumping at the landfill.

Landfill Engineering at St. Johns. The City has contracted to have additional engineering work prepared for the landfill. We suggest that this engineering include the following:

1. Plans for gas generation monitoring in areas where any enclosed structures are to be located on or near the landfill.

2. Soils investigation to determine the characteristics of the final cover material being used on the site so that the behavior of the material relative to sealing, cracking, plant growth, etc., can be predicted.

3. Design for the use of catchbasins and drainpipes in areas of the fill being brought to final grade. The use of catchbasins and drainpipes will reduce any erosion of the fill surface as well as reduce the potential of leachate from surface water infiltration.

Gas Migration at LaVelle and Yett. The LaVelle and Yett Landfill at 3000 N.E. 82nd Avenue is being constructed in a gravel pit. There is some concern that, as the fill progresses, methane gas will migrate from the fill into the gravel surrounding the pit and eventually accumulate under or in nearby houses in concentrations that could be explosive. There are existing structures along one side of the fill only.

The operators of the landfill are beginning to build a system of gas interception and venting along one side of the pit to prevent gas from flowing through the gravel to the existing structures. Their system will consist of first placing a layer of impermeable soil on the gravel side of the pit. A layer of permeable gravel will then be placed over the soil layer and a number of perforated pipes will be placed in the gravel layer. The perforated pipes will be driven down into the completed layers of refuse in the pit. Gas will flow from the pit into the gravel layer and will then be transported through the perforated pipes to the atmosphere. If methane concentrations are high enough, the gas can be burned as it exits from the pipes.

We suggest that the operator's plans for gas control be evaluated by DEQ as soon as possible and that construction of the system be completed rapidly. In addition, we suggest that DEQ, in cooperation with the City Building Bureau, plan a program of testing for methane concentrations around the landfill.

Overlapping Collection Routes in Portland. There is a large amount of duplication and overlapping of residential and commercial collection routes within the City of Portland. Comments have been made that there are sometimes as many as four or five different companies collecting along the same street, the duplication resulting in costly inefficiencies and increased noise in residential neighborhoods.

The refuse collectors, through the leadership of the Sanitary Truck Drivers Local Union No. 220, have recently begun to reorganize their routes to eliminate as much duplication as possible. We suggest that the voluntary consolidation of routes be continued at a rapid rate.

SECTION 5
WASHINGTON COUNTY

Overall Appraisal of the System

General. The present solid waste handling system in Washington County is temporarily functioning in a satisfactory manner. The long haul distances to disposal sites are inconvenient, but solid wastes are generally being stored, collected, hauled, and disposed of by methods consistent with public health standards. Through the County franchising system and in spite of the necessity to haul collected refuse long distances, the private collectors are providing continuous, relatively economical service to industry, commerce, and all of the public who desire such service. Two positive aspects of the somewhat strained collection system are better management and unity among the collectors. Most of the collectors serving the County have banded together to form a strong association which has the ability to deal with local problems arising in their industry and possibly to assume a strong role in future systems.

The limited number of landfill sites located in the County are presently being operated in compliance with their State DEQ and County Health Department permit requirements. The cleanup of windblown and scattered debris from the periphery of these sites and their immediate access roads (as discussed in the multi-county recommendations) would greatly improve their public acceptance.

Major Problem Areas. The major deficiencies of the existing system can be related to the lack of landfill sites open to private haulers and to the public.

1. Collection Equipment Usage. Other than Frank's Sanitary Service, every hauler collecting putrescible wastes in the County must haul his wastes to landfills located outside of Washington County.

   Collection vehicles designed for collection and short haul are consequently being used for long hauls--which results in inefficient equipment utilization, increased costs, overloaded vehicles, and more frequent replacement of individual vehicles. The constantly increasing population and commercial and industrial activities in the eastern portion of the county will eventually begin to limit the quality of service that the collectors can provide with the present types of equipment. The solution to this problem must be integrated with and be a part of the final Solid Waste Management Plan and for the interim, we conclude that the present solid waste system can continue until the completion of the final plan.

2. Illicit Dumping. Local citizens who do not utilize private collection services and those citizens outside the franchised service areas have no convenient place to legally dump their own wastes within Washington County. This decreases overall public acceptance of the present system. The result has been increased illicit dumping along the roadside, particularly in rural areas. Provision of collection service to nonfranchised areas is currently being pursued by the County Solid Waste Advisory Committee in cooperation with the County Haulers Association. This work should be encouraged to continue and may alleviate some of the roadside dumping.

3. Bulky Waste Disposal Facilities. Citizens can only dispose of their bulky household wastes, tree prunings

and brush wastes at the Hillsboro disposal site, which is not convenient to eastern and western portions of the County. This factor contributes to the roadside dumping problem; however, they can be delt with now.

Interim Action Plans

Bulky Waste Pilot Program. Bulky items are difficult to dispose of by the homeowner because of the lack of local demolition sites open to the public. Because the collectors cannot use their compactor trucks for this type of waste, they must send out a separate open body truck and two men to load the truck. The collectors rightfully charge higher rates to provide this service as the costs are high and the number of calls is small. Homeowners are reluctant to use the service because of the cost or to haul their own wastes any distance.

In the interim period until January 1974, the County should consider initiating a pilot program to determine the need for conveniently located bulky waste drop points. The program could be operated one Saturday per month for a 3-month trial period to determine its suitability. Drop boxes would be provided on the given day at five selected drop points located on publicly-owned land at facilities such as sewage treatment plants or public works yards in the urban centers of the county. Each day would be advertised well in advance to insure public awareness of the campaign.

Private haulers providing drop box service would be invited to participate by supplying drop boxes with rear-hinged doors and hand trucks. In this manner, large wastes could be placed in the drop box without the need for a drop-off platform. The program would be set up and monitored by the Health Department. Each drop point would be manned by County personnel, private-industry labor, or possibly volunteer labor to collect a minimal fee and insure that no putrescible wastes were deposited. It should be required that refrigerator doors be taken off, for safety, prior to deposit.

The fee would have to be predetermined, high enough to cover associated costs yet low enough to encourage general public participation. During the pilot program, a questionnaire would be used to determine the distance the waste was hauled, if hauling was a problem, if the program was satisfactory, and the type of permanent facility desired in the future. The county should consider financing the initial program if the private collectors choose not to or if user fees do not cover the cost of the program.

Brush Chipping. Residents in suburban areas have a difficult time disposing of tree limbs, prunings, and brush wastes because there is only one disposal site (in Hillsboro) open to the public accepting these wastes. The site charges a high rate for brush wastes because they are difficult to compact and take up a significant volume of the fill. Because the wastes are not readily compactible, the collectors do not ordinarily pick up these wastes with compactor trucks but instead use an open-body truck requiring a separate trip to the home. Collection costs for this type of wastes are high (because of the special trip), and homeowners are reluctant to use this service. The problem will be compounded after January 1975 when no open burning will be allowed.

Brush wastes, prunings, and small tree limbs (usually to 6-inch diameter) can be economically reduced using a brush chipper. The County and each larger city should consider providing a self-supporting brush-chipping service to reduce the volume of wastes, reduce open burning, and increase incentive of the homeowner to better maintain his yard. Brush chippers are already owned by some public agencies for park and road maintenance programs. Trailer-mounted brush chippers are usually towed behind a pickup truck. A container could be mounted on the truck to transport the chipped wastes if the homeowner should not wish to retain them for use.

The City of Hillsboro began providing this service a few years ago and reports that last year's service calls totaled over 200. Since this program began, open burning has been significantly reduced. The city charges a flat hourly rate with a $3.50 minimum service charge; most calls require 5 to 10 minutes of actual work. Most, if not all, residents desire to keep the chipped waste for compost or mulch or for landscaping. The charge has been calculated to cover fuel, operating costs, and city labor to keep the program self sufficient.

The program if utilized by the County and cities would have to be planned, publicly announced, and advertised in the local papers. Service calls would have to be scheduled through the agency providing the service to promote efficient use of equipment and personnel. Possibly a one- or two-week period in the spring and the fall could be designated and advertised accordingly. Serious consideration should be given to a program of this nature before a total open burning ban is in effect. The program should also be viewed as a recycling benefit to the environment as it utilizes yet another waste for a beneficial purpose, potentially reduces air pollution, and conserves landfill volume.

Illicit Dumping. The problem of illicit dumping, either to avoid paying monthly collection bills or to protest the lack of convenient dumping locations, occurs in Washington County as in others. Enforcement of anti-littering and anti-dumping laws is lacking. A public information campaign would provide education on the potential hazards of illegal dumping as well as the blight it produces.

Should the County consider this problem a significant one, it is suggested that a program similar to the one detailed in Section 3 be used.

SECTION 6

MULTI-COUNTY

Junked and Abandoned Automobiles

Present Situation. It has been determined through interviews and questionnaires that the accumulation of junked and abandoned automobiles is one of the more pressing solid waste problems in the study area. The problem is due partly to the high cost of disposing of a vehicle. (Towing charges can be as high as $40 or $50 for rural areas.) In addition, the system of complaints and public hearings to cause removal of junked vehicles from private property inhibits citizens who would otherwise like to see the old automobiles removed from their neighbors' yards. Senate Bill 686, called the "Abandoned Vehicles Act," would provide some relief in that it would "Encourage the development of procedures and operational techniques that will facilitate the expeditious removal of abandoned vehicles from public and private lands . . ."[1] The bill, which is currently in the legislature, declares that abandoned vehicles are nuisances and eliminates some of the restrictions on law enforcement agencies in their processing procedures.

Suggested Action. It is recommended that a comprehensive program be initiated which will eliminate many of the junked and abandoned vehicles scattered throughout the study area. The term "abandoned vehicles" as used here is intended to include only those vehicles left stranded on private property without consent of the property owner. To include vehicles abandoned on public property in the comprehensive plan would involve many complications which would diminish the chances for successfully organizing the program.

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[1] Senate Bill 686, Engrossed, Oregon Legislative Assembly-1973 Regular Session.

It should be pointed out that no information is available on the actual number of junked vehicles on private property. It is nearly impossible, therefore, to determine precisely in advance the magnitude of the project. It would probably also be difficult to execute the plan in all four counties simultaneously. Since junked and abandoned vehicles constitute perhaps the foremost solid waste problem in Clackamas County, it is suggested that such a plan be initiated there. Upon completion of the program, the remaining counties would have a base from which to plan their respective programs.

The basic intent of this program would be to facilitate the processing and removal of the automobiles by combining efforts of several agencies and industries, thereby reducing the cost of removal to an absolute minimum. In order to determine the feasibility of such a program, a preliminary investigation was made and favorable response was demonstrated by all parties concerned. From these contacts, a preliminary plan was developed which could be readily implemented and would present a unique opportunity to many county residents who have been unable to dispose of their junked automobiles.

The procedure for implementing and operating the plan would be as follows. Public announcement of the plan would be made through local newspapers and television as a public service. This would be done two or three months in advance of the actual operation. Owners of junked automobiles would be encouraged to notify the County Solid Waste Department of their intention to have the vehicles removed. The district attorney could prepare release forms which, when signed by the vehicle owner, would authorize removal from private property and indemnify the County against claims resulting from the removal. It could also be pointed out in the public information phase that storage of old automobiles on private property could be determined to be a nuisance, empowering the County to enforce its removal; a reminder of the increased cost for that removal once the program has ended should encourage the public to participate in the program.

Once the County has determined the approximate number and locations of vehicles to be removed, it should then determine the number and locations of collection points where these vehicles would be deposited. These collection areas should be located to minimize haul distances, but would depend largely on available land for this type of use. An ideal location would be a naturally screened abandoned gravel pit or vacant County property with suitable access to a main road. The selection of a site must also account for possible storage of vehicles to be deposited there for up to several months, depending on final coordination of the plan and unforeseen setbacks in scheduling. Temporary use permits may be required for use of the selected locations.

Most of the expense for the operation could be involved in towing the vehicles from their existing locations to the collection centers. For that reason, two alternatives were investigated to determine the possibilities of reducing this cost. The first would be to contract with commercial towing companies to participate in the program at a reduced per-vehicle rate. Several towing outfits have expressed a willingness to do so with an estimated reduction of 1/4 to 1/3 off the regular rate (or $10 to $15 per automobile), with the exact rate dependent on the haul distance and number of vehicles handled.

Another approach would be to obtain the services of the Oregon National Guard to tow the vehicles as a community service. The National Guard has indicated a willingness to participate, but it has not yet been determined whether the Guard could handle the volume resulting from the program. This is due partly to the varying availability of manpower and the necessary scheduling of most projects on weekends. The Guard also participates in summer field training exercises, which limits their availability until about September. It may be possible that combined efforts of the National Guard and commercial towing companies could be implemented, but care must be taken to insure that conflicts of interest are not at stake when involving the National Guard with a profit-making operation. In any case, the vehicle owners could be encouraged to tow the automobiles themselves to avoid whatever nominal charges that might arise from the program.

A short time prior to the commencement of the program, a second series of public notices should be presented which would inform the vehicle owners of the locations of collection centers and times and dates they would be open. Another appeal should also be made for those people not yet responding.

Once the vehicles have been deposited at the collection centers, the next step is to process them for salvaging. This could be accomplished by private enterprise operations such as Masher, Inc., of Medford, Oregon. Masher has several units of equipment which compress automobiles and stack them on a truck for delivery to a steel processor. Each unit can process about 100 cars per day. This operation must be preceded by stripping the vehicles of seats, wheels, batteries, and gas tanks. Representatives of Masher, Inc., have indicated a willingness to participate in the program by agreeing to offer a small price for each car, with the price depending on the volume. (The usual procedure is to accept the car with no exchange of money, whereby all profit is derived from the sale to the steel processor.) Drop boxes should be placed at the collection centers to collect the strippings prior to "mashing." The drop boxes could be financed by the County or by revenue generated by remuneration received from participating industries for the vehicles.

After processing the vehicles, the private operator would haul them to an industry salvage operation such as Schnitzer Industries of Portland. It may be possible to receive further subsidy for the program from that industry. Initial indications are favorable, but the actual extent has not been determined. Representatives of Schnitzer did indicate that they can more easily accommodate the increased volumes during the summer months, when longer daylight hours are in effect.

It can be seen that, with the implementation of such a program, the costs to the vehicle owners could range from nothing to a fraction of the ordinary costs. Participation of the National Guard would significantly reduce the cost. It is suggested that this program be confined to as short a period as possible in order to keep a high-volume, steady operation. It should also be accomplished by late summer or early fall to avoid rains and cold weather. This would coordinate well with operating plans of Schnitzer and the National Guard. Once it has been completed, it is possible that the National Guard could be retained to continue hauling vehicles on weekends as they accumulate. This is being done presently in Jackson County, Oregon, with a high degree of success (1,500 automobiles in 2 years.) The procedure involves citizens of Jackson County requesting removal of their automobiles through the County Solid Waste Department, where the requests are compiled and sent to the National Guard Unit. At present, the unit cannot keep up with the number of requests.

Another cleanup program was conducted in 1966 in Klamath County, Oregon, in which the County charged $3.50 per car for removal and subsidized the remaining cost (approximately $10.50). Since then a program has been conducted every May, and in 1970 over 2,500 vehicles were removed from that county.

From these examples it is clear that such a program is feasible. Planning by the County should begin immediately if a program is to be implemented by fall of this year. Complications in the title clearing process are anticipated and should be resolved prior to planning the remainder of the program.

Secondary Materials

Present Situation. The reclamation and reuse of most secondary materials is but a fraction of the material being disposed of in the Portland area. This does not hold true, however, for newspaper. Newspaper is, in fact, the only household waste being reclaimed in significant amounts. It is estimated that the present salvage rate of newspaper is approximately 40 to 45 percent for the four-county study area. This is twice the national newspaper salvage rate of 22 percent and even exceeds the 40 percent salvage rate for the well-publicized Madison, Wisconsin, program which picks up newspaper weekly as part of the regular municipal collection service. This local high rate of salvage is due to the very strong export market which purchases most of the newspaper collected.

The local newspaper collection system consists of depots and periodic paper drives by organizations such as the Kiwanis, Lions, Boy Scouts, and Volunteers of America. On the basis of preliminary analysis and conversations with persons involved with current newspaper collection efforts, it is estimated that the present efforts could be increased to as much as 70 percent through a system of periodic home collection. This would largely eliminate the waste from one major consumer commodity and alleviate to a small degree the pressure on the solid waste disposal system. In addition, at the current market price of $20 per ton, this would provide an additional annual income of $250,000 for the collecting organizations.

Suggested Action. It is suggested that the MSD Citizens Advisory Committee investigate the feasibility of district-wide home collection of newspapers and conduct a pilot project to determine the public response to and economic viability of such a program.

In addition, the organizations presently salvaging newspapers should be encouraged to form a coordinating committee to reduce duplication of effort and to insure that every area is adequately served by a convenient drop-off depot and periodic paper drives.

Goals and Scope of Pilot Project. The purpose of the pilot project is to determine: (1) if a periodic home collection program would salvage significantly greater amounts of newspaper; (2) what the additional costs of such an intensive collection effort would be; and (3) if the increased amount of newspaper is worth the additional effort.

The pilot project would be limited to an initial study, a canvass, a pickup of newspapers for a limited duration in a representative area, and the final report--similar to the Northeast Recycling Pilot Project[2] except for newspapers instead of cans and bottles.

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[2] "Recycling: Can It Be Done?" The Report of the Northeast Recycling Pilot Project, Portland, Oregon, June 1972.

Organization and Responsibilities of Pilot Project. It is assumed that the Citizens Advisory Committee would have ultimate responsibility for the project. The CAC would define the goals and criteria for the project and select the participants to do the house-to-house canvass and the pickup. The participants selected would be a volunteer organization such as the League of Women Voters to conduct the canvass and a charitable organization such as the Volunteers of America or Kiwanis to do the actual pickup of the newspaper. The CAC would analyze the existing data and previous efforts, select the project area, and determine the duration of the project. The volunteer canvassing organization would prepare the canvass plan, public information program, pickup methods and schedule, and household information leaflets. They would then conduct the canvass and appoint block captains. Prior to each pickup, news releases would be made and the block captains would contact and remind their neighbors to set out their newspapers. The charitable organization would provide pickup trucks and manpower to make the actual pickup and arrange for a paper broker to purchase the newspaper and to provide a van to be loaded within the pilot project area. At the end of the project, the volunteer canvassing organization would make a post-project canvass of the participants and issue a report with analysis of the results and a recommendation to either discontinue or expand the program throughout the metropolitan area.

Analysis of Public Response. Public response is the key to any home collection system. The project should therefore be designed to minimize inconvenience to the homeowner and maximize his sense of participation in a worthwhile project. In order to minimize inconvenience the program should be limited to newspapers because they are (1) relatively uncontaminated, (2) accumulated regularly in most homes,

(3) normally segregated, folded once, and stacked separately from the rest of the household garbage, (4) easily handled by the homeowner and require no processing or packaging other than a string around the bundle, and (5) easily stored. This should overcome most of the problems experienced by the Northeast Recycling Pilot Project.

The ease of participation will help produce a high rate of response, but a sense of participation in a worthwhile community effort is probably the most important motivating force. Public motivation requires considerable analysis but should probably be based on the homeowner's concern for his community and his environment. The block captain concept should help instill a sense of community involvement. The knowledge that the revenue received will go to a charitable organization would be another positive motivating force especially as the charitable organization will be directly involved in the collection.

Interference with Other Collecting Projects. Interference with current newspaper collection projects should be held to a minimum. The study area selected could be an area not now regularly served by a collecting organization. Preferably it would be an area that the participating collecting organization for this project is already serving with depots and periodic paper drives. This would give valuable information on the increased efficiency of a home collection program.

The possible interference with sanitary service franchises should be determined. In addition, the cooperation or at least acquiescence of the local sanitary service should be elicited.

Market Analysis. The short-term market conditions are excellent, with current prices paid by some local users and by brokers for overseas container van quantities at $20 per ton. This condition should hold true for the length of the pilot project.

The long-term markets are not so certain. Whereas approximately 70 percent of salvaged newspaper is exported, the market is largely dependent on foreign demand. This depends upon no interruption to shipping and continuation of the present world-wide fibre demand.

Scheduling. Sufficient time must be allowed for the pilot project to operate at a consistent level. As a preliminary estimate it is felt that at least 4 months and preferably 6 months would be sufficient. Assuming that the pilot project is considered and adopted by mid-July and that one month is required for organization and mobilization, the first pickup could be the middle of September and the project could be completed by December 1973 or February 1974.

Expansion of Pilot Project into District-wide Program. The pilot project should lend itself readily to extension throughout the metropolitan area. It would of course be necessary for the different newspaper collecting groups to coordinate their efforts and for each to take a different area of responsibility. This would be desirable even if a home collection system was not adopted as it would reduce duplication of effort and insure that areas not now adequately served with depots would have a reasonably close depot for drop-off of newspapers.

If no local market could be found for the additional newspapers collected it would be necessary to depend on the foreign market. The collection system would then have to be flexible enough to deal with the subsequent fluctuations in demand. When the demand is high the entire city could be served by home collection service. When the market is depressed, the collection effort could be curtailed except for periodic drives and drop-off depots which would provide an outlet for people desiring to recycle. The lower collection costs would probably make it economical to operate the depots. The result would be considerable fluctuation in the quantity of newspaper in the waste stream, but because newspapers represent a small portion of the volume of the average household refuse, this fluctuation should not have a major effect on the total refuse volume.

Planning for Solid Waste Removal From Commercial Complexes

Planning, architectural design, and construction phases of new apartment and commercial complexes are generally completed before any plan for the economical and efficient collection of refuse is considered. The resulting problems can include highrise apartments with no garbage chutes, inadequately sized storage areas, or areas for container storage that are inaccessible to the collector's vehicle. These problems lead to public dissatisfaction, improper utilization of manpower and equipment, and higher collection costs to the owner or occupant.

To insure economical service to new apartment and commercial complexes, the refuse collector providing service to the area should be consulted before final plans have been approved by the appropriate City or County planning commission. The City or County planning department should have the responsibility of informing the owner or developer of a new complex that he must consult with the franchised collector in his area or with a designated industry representative in nonfranchised areas. Assurance should be made that an agreement has been reached between the owner or developer and industry on the location, access, and overall sizing of the containers to be used. Benefits to the owner will include safe, economical service.

Because most building plans originate with architects, DEQ could increase the effectiveness of solid waste planning by holding a seminar for all architects in the area on solid waste management in apartment and commercial complexes.

<u>Cleanup of Litter Around Disposal Sites</u>

Our field investigations of disposal sites in the region have revealed that scattered debris and windblown litter around the site periphery and on immediate site access roads is a noticeable aesthetic problem. This problem is often a cause of public opposition to present and proposed landfills. Even a site with daily covering of the working face cannot be considered a sanitary landfill and will not be recognized by the public as such if uncovered debris can be seen around the site.

One of the most beneficial and low cost improvements to all existing sites would be to clean up this litter and debris and institute a litter control program. It is suggested that each landfill operator use portable fencing to reduce the windblown litter, require that all open body trucks and pickups be covered upon entering the site, and periodically police the immediate site access roads and site periphery for litter.

Telephone Listings for Disposal Sites

Many citizens do not know where authorized disposal sites are located, and the telephone book does not have an easy or complete reference to landfill locations. People often call public agencies about locations, and these agencies are frequently unable to help them.

It is suggested that a current listing of authorized disposal sites be prepared by MSD and distributed to the City recorders of each of the cities in the region. The listing should include the name of each site, its location, hours of operation, type of refuse accepted, and a basic cost schedule. The City of Portland and each County should have special telephone listings for disposal site information.

A suggestion could be made to Pacific Northwest Bell to adopt a better reference system for landfill telephone numbers. Instead of one listing under "Dumps, Rubbish" additional references should be made under landfill, sanitary landfill, and garbage dump. The present listing under "Dumps, Rubbish" should be expanded to include the St. Johns site.

Safety Controls on Stationary Compactors

Stationary compactors are located at many places in the study area for compacting refuse prior to transportation to a landfill. Many of these compactors are located in commercial or rural areas that are directly accessible to the public. Some of these compactors have unlocked push-button controls and feed hoppers that are easily accessible to inquisitive children, thus presenting the potential for a serious accident.

A voluntary program for installing locks or key-operated on-off switches on existing compactors and on future compactor installations that are accessible to the public could be started by MSD as an immediate step to solving the problem. We suggest that compactor dealers and refuse collectors be notified by the MSD that all stationary compactors that present an accident potential (by virtue of easy accessibility to on-off controls and feed hoppers) should be equipped with locks or key-operated on-off switches. Many of the major manufacturers of stationary compactors provide key-operated controls as optional equipment.

For a long-term solution to the problem MSD should pass an ordinance requiring locks or key-operated controls on all stationary compactors presenting an accident potential. The Counties should adopt similar ordinances to cover those areas outside of the MSD jurisdiction.

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