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Managing Municipal Solid Waste In Rural Communities

Regional landfills offer cost savings

Environmental concerns have led to more stringent regulations for the construction, operation, maintenance, and closure of municipal solid waste landfills. These regulations will increase the cost of operating landfills, especially for small communities in rural areas. However, our analysis of solid waste management in North Dakota indicates that a system of regional landfills could reduce costs by 27 to 33 percent statewide, and by up to 84 percent in the most rural counties.

The municipal solid waste problem

Waste management specialists predict that per capita municipal solid waste generation, currently about

four pounds per day, will continue increasing into the next century. Even with greater use of source reduction, recycling, and incineration, communities will dispose of most solid waste in landfills. While communities need additional landfill space, growing concern about protecting groundwater and other environmental resources has led to more stringent regulations governing landfill design and operation. The newest and most restrictive regulations are the design regulations (Subtitle D) of the Environmental Protection Agency. These EPA regulations, which took effect in October 1993, mandate costly synthetic liners and leachate collection systems for most landfills and will substantially increase the cost of landfills. The new regulations will force communities to locate landfills in least-cost locations and sizes

by Frank J. Dooley, Dean A. Bangsund, and F. Larry Leistriz

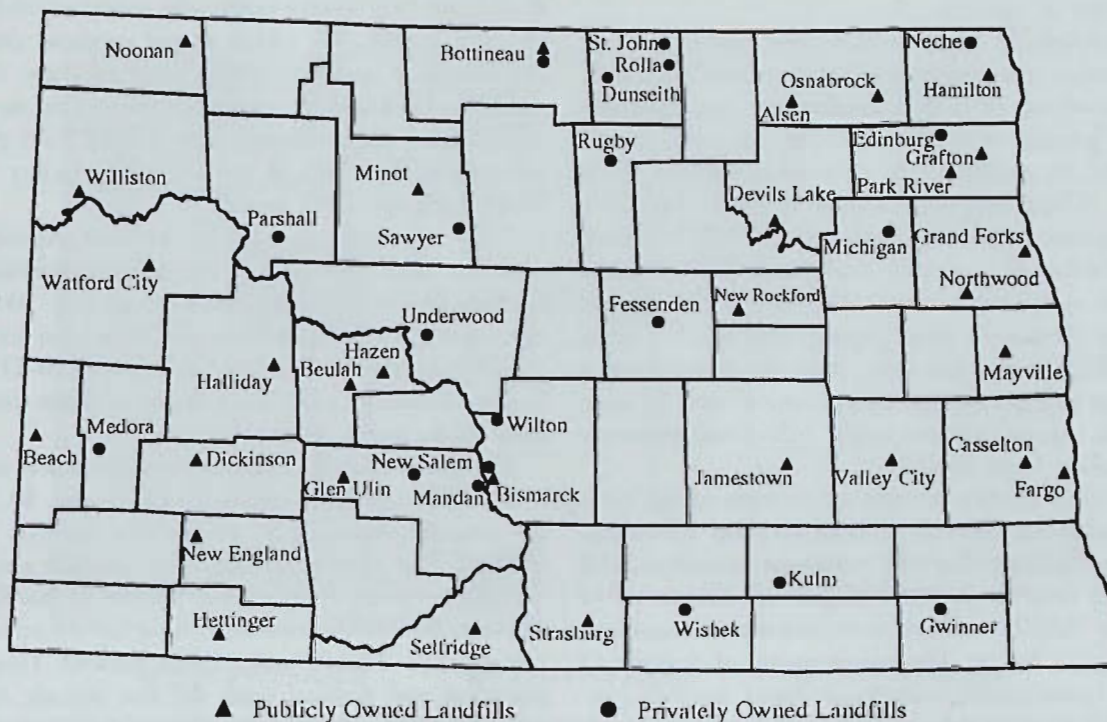


Figure 1. Permitted landfills in North Dakota, 1991

Treatment of Native American Reservations

Two Native American reservations required special treatment in the analysis. Fort Berthold and Standing Rock Native American Reservations are considered separate jurisdictions and do not fall under the control of the North Dakota state government. These two jurisdictions were assumed to build facilities with adequate capacity (20-TPD) to dispose of wastes generated on the reservation. No waste was allowed to cross the reservation boundaries. The Standing Rock Reservation is coterminous with Sioux County and its landfill (at Selfridge) would be the only one in the county. The Fort Berthold Reservation facility would be located near Parshall. Thus, the baseline scenario includes fifty-four landfills, one for each of the state's fifty-three counties plus the Fort Berthold facility.

crease economies of size cost advantages.

For municipal solid waste landfills, we found major economies of size (lower cost per unit of waste for larger waste facilities) for both the fixed and variable parts of the landfill activity. Per unit of disposal capacity, larger landfills usually incur lower costs for land acquisition, permits and licenses, buildings, erosion control, and construction management. Larger landfills also experience lower per unit operating expenses for labor, equipment maintenance, operation of the leachate collection system, and well monitoring. Considering both fixed and variable costs, we estimate that a 20-tons-per-day North Dakota landfill costs more than \$33 per ton while a 400 tons-per-day facility costs less than \$13 per ton, assuming both landfills operate at capacity.

Subtitle D regulations require replacement or extensive redesign of most existing landfills. Economies of size in landfill development and operation will provide substantial incentives for local governments to collaborate in developing regional facilities. While communities must consider water contamination, not-in-my-back-yard (NIMBY) politics, and other factors, they can greatly affect disposal costs by landfill location and size. Per ton disposal costs decrease for larger capacity facilities, but larger landfills imply that waste must be drawn from a larger area with greater transportation costs. In some cases, transfer stations might reduce transportation costs for larger landfills.

North Dakota provides an example of the types of problems that will be faced by many rural areas. North Dakota had fifty permitted municipal solid waste landfills in 1991 (figure 1). Almost all of these must be replaced or extensively redesigned in the near future. The requirements of Subtitle D will make small, community-based landfills prohibitively expensive to develop and operate. North Dakota is currently examining a regional approach

to solid waste management.

We estimated the amount of solid waste generated annually in North Dakota, fixed costs of establishing and variable costs of operating landfills given Subtitle D requirements, operating costs of transfer stations, and costs of transporting waste from generation location to disposal facility. Our computer model used this information to select least-cost landfill sizes and locations. Although relatively small amounts of municipal solid waste are presently shipped into and out of North Dakota, for purposes of the study we assumed that no interstate waste shipments would occur.

Estimating disposal costs

We estimated landfill capital and operating costs for five discrete facility sizes: 20, 75, 175, 250, and 400 tons per day (TPD). These size categories represent reasonable options for communities in North Dakota and in other rural areas. In contrast, landfills with capacities of 1,000 TPD or more are common in metropolitan areas.

Fixed costs include predevelopment, construction, and annual overhead costs. Predevelopment costs include landfill siting, engineering design, public hearings, land acquisition, and other costs. During the construction stage, costs include those for road construction, site excavation, liner development, buildings and grounds development, erosion control, construction management, leachate control system development, and final cover assembly. We estimated predevelopment and construction costs from prior engineering studies and amortized these costs over twenty years—the estimated useful life of a landfill. We added annual overhead costs for insurance and postclosure costs to those for predevelopment and construction to obtain total annual fixed costs. Average annual fixed costs per ton ranged from \$22.19 for a 20-TPD facility to \$7.48 for a 400-TPD landfill.

Daily operation of a landfill requires expenditures for labor, equipment maintenance, utilities, leachate maintenance, and well monitoring. Average variable costs ranged from \$11.26 per ton for a 20-TPD landfill to \$5.44 per ton for a 400-TPD facility. Operating costs for a transfer station averaged \$8 per ton.

Compaction trucks hauling from generation site to landfill or transfer station locations cost \$0.20 per ton-mile, assuming a running cost per mile of \$2.00 and a 10-ton payload. We assumed semi-trailers haul waste from transfer stations to landfills and cost \$0.044 per ton-mile, based on a running cost per mile of \$2.00 and a 45-ton payload. Transportation and disposal costs did not include the collection phase of solid waste disposal (i.e., curbside pickup costs).

Our first scenario assumed one landfill in each of North Dakota's fifty-three counties, plus one to service the Fort Berthold Native American Reservation (see text box). Given this assumption, one county built a 250-TPD facility, three built 175-TPD landfills, thirteen counties had 75-TPD landfills, and thirty-seven landfills had 20-TPD capacity. We estimated the total annual cost of solid waste management at \$16.9 million, statewide. Fixed costs, variable costs, and transportation costs accounted for 65, 23, and 12 percent of total costs, respectively. Total costs for the state averaged \$36 per ton.

Costs varied greatly among jurisdictions. The average total cost for counties and Native American reservations ranged from \$17 to \$229 per ton. Out of fifty-four jurisdictions, total costs averaged over \$50 per ton in thirty-three and under \$21 per ton in four. Jurisdictions under 10,000 population averaged \$63 per ton while costs for the major urban centers averaged only \$20 per ton (figure 2).

Next, we studied a system of regional landfills. The least-cost solution had twelve landfills, compared to fifty-four when we required one for each county (figure 3). Bismarck, Fargo, and Grand Forks each had a 250-TPD landfill. Dickinson, Jamestown, and Minot each had a 175-TPD facility, while 75-TPD landfills were built at Devils Lake, Rolla, Wahpeton, and Williston.

All landfills combined operated at 93 percent of capacity in our regional scenario, and the weighted average cost of disposal declined 27 percent to \$26 per ton. The state's least populous counties enjoyed the greatest cost reductions given the regional approach

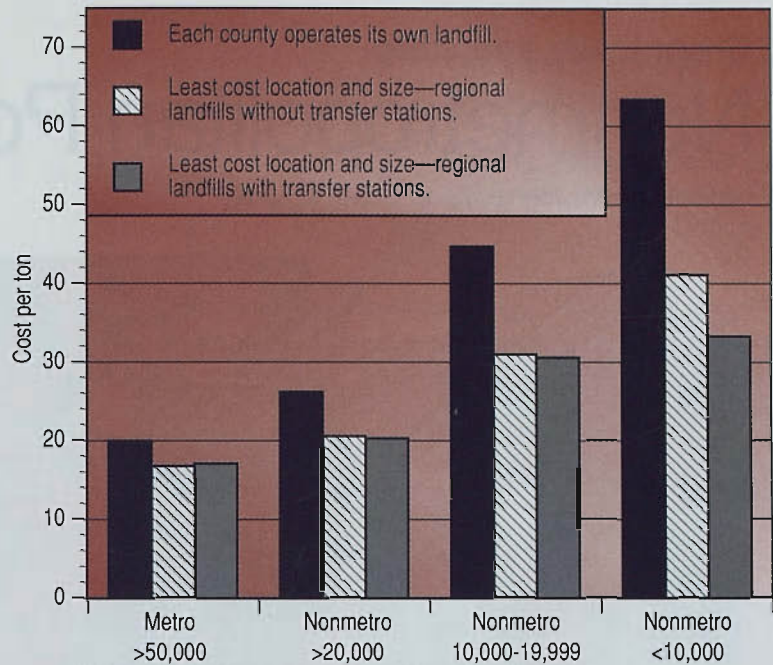


Figure 2. Average total cost per ton for solid waste disposal.

to waste management. Average total costs fell from \$63.40 to \$41.10 per ton for the group of nonmetro counties with populations less than 10,000 (figure 2). Larger counties experienced smaller cost savings.

In our third scenario, we allowed transfer stations so that waste could be transferred from compaction trucks to semitrailers for shipment to distant landfill sites. In general, the break-even distance between shipping direct to a landfill or through a transfer station was fifty miles. If a watershed was less than fifty miles

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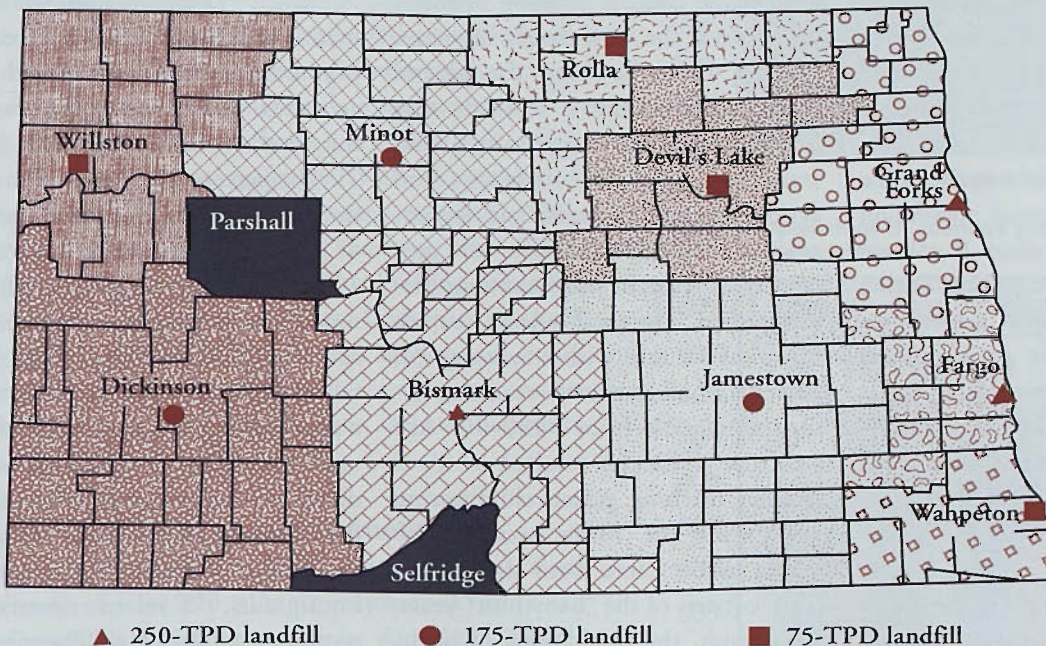


Figure 3. Waste draw areas and landfill locations using a regional approach to municipal solid waste disposal, North Dakota, 1992.

from a regional landfill, it was cheaper to ship waste directly to the facility using compaction trucks. Wastesheds farther than fifty miles would ship waste to transfer stations using compaction trucks, then ship waste from the transfer station to the regional landfill using semitrailers. Compared to our first scenario, total costs fell 33 percent to \$11.3 million statewide.

The largest potential savings from transfer stations occurred in rural counties with populations less than 10,000 (figure 2). Their average total costs declined 47.5 percent, from \$63.40 to \$33.30 per ton, by moving to regional landfills with transfer stations.

While communities must consider water contamination, not-in-my-back-yard (NIMBY) politics, and other factors, they can greatly affect disposal costs by landfill location and size.

Nonmetro counties with populations of 10,000 to 19,999 saw their average total costs decline from \$44.70 to \$30.60, a 31.6 percent decrease. Costs fell 14.4 percent in the metro counties, decreasing from \$20 to \$17.10 per ton.

Regional facilities offer savings for rural areas

New EPA requirements for landfill design and operation require that most existing facilities be replaced or extensively redesigned. These regulations place more emphasis on economies of size in landfill development and operation. Small, community-based landfills may no longer be financially feasible.

A system of regional landfills with transfer stations could reduce overall costs of solid waste transportation

and disposal in North Dakota by 33 percent. Costs would fall most in sparsely populated rural counties, in many cases by more than 50 percent. The situation in North Dakota is not unique; the implications may be applicable to other rural areas facing similar waste disposal problems.

Regional landfills may pose a number of problems for the communities involved. EPA regulations preclude siting landfills in areas with hydrologic and geologic characteristics that pose threats to groundwater. Regional landfills imply fewer local landfill units and personnel, with the attendant problems of lost jobs and the need for more coordination among jurisdictions. Finally, siting large regional landfills may be complicated by NIMBY protests by local residents. Nevertheless, regional waste management facilities can offer substantial cost savings for rural communities. ■

■ For more information

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