CHAPTER 3

LOGISTICAL CONSIDERATIONS

3-1. General. With the huge quantities of dredged material created during dredging operations, site utilization, economic transport handling, and storage plans become critical to the overall life and use of a project. This section will discuss procedures for dewatering, transporting, handling and storage, and cost analyses of these activities in determining beneficial use of dredged material. It should be remembered that dewatering is not applicable for some types of beneficial uses such as wetland and aquatic habitat development and aquaculture. However, dewatering is critical to nesting islands, upland habitat development, most kinds of recreational use, agriculture, forestry, horticulture, and other types of beneficial uses.

3-2. Dewatering. Dredged material is usually placed hydraulically into confined disposal areas in a slurry state. Although a significant amount of water is removed from it through the overflow weirs of the disposal area, the confined fine-grained dredged material usually consolidates to a semifluid consistency that still contains large amounts of water. The volume occupied by the liquid portion of the dredged material greatly reduces available future disposal volume. The extremely high water content also may make the dredged material unsuitable or undesirable for commercial or beneficial use. Two dewatering methods, fully described and discussed in items 24, 28, 29, 31, 57, and 84, are generally used. The first method is allowing evaporative forces to dry fine-grained dredged material into a crust while gradually lowering the internal water table. This has been the least expensive and most widely applicable dewatering method identified through dredging research. Good surface drainage, which rapidly removes precipitation and prevents ponding of surface water, accelerates evaporative drying. Shrinkage forces developed during drying return the material to a more stable form, and lowering of the internal water table results in further consolidation. The second method of promoting good surface drainage is by constructing drainage trenches in the disposal area using heavy equipment. Use of a Riverine Utility Craft to make trenches proved successful on disposal sites with fine-grained material. A site must be dewatered sufficiently to accept heavy equipment, which limits the second method in its application as long as 2 years after a disposal site has been filled, depending upon the soil characteristics of the dredged material. A less frequently used method, rarely applied to disposal sites, includes installation of underground drainage tiles or sand layers prior to filling the site.

3-3. Transport, Handling, and Storage. Fundamental features of transport systems and general guidance for analysis of technical and economic feasibility are provided in item 74. They are presented to acquaint planners with the magnitude and scope of the transport system and provide some cost-effective analysis information for five transport modes: hydraulic pipeline, rail haul, barge movement, truck haul, and belt conveyor movement. Hydraulic pipeline and truck haul have been the primary transportation methods used for most existing beneficial use sites. Since the transport of dredged material can be a major cost item in determining the economic feasibility of a project, the transport system should be evaluated early in the site selection stage, of the planning process. Legal, political, sociological, environmental, physical, technical, and economic aspects should be examined in relation to availability of transport routes, A sequence of five steps must be followed when selecting a transport route:

Step	Information Source
1. Identify available routes	Maps, ground reconnaissance
2. Classify nature (wet/dry) of dredged material	Beneficial use needs and sources of dredged material
3. Determine annual volume of dredged material and duration of project	Dredged material sources
4. Estimate cost of available transport modes	Item 74
5. Identify and evaluate technical, environmental, legal, and institutional requirements	Item 74 Specific sources: local, state, and Federal agency regulations

a. Elements of Transport Systems. Transport systems involve three major operations: loading, transporting, and unloading. The loading and unloading activities are situation dependent and are the major cost items for short distance transport. The hydraulic pipeline is the only mode which requires a unique rehandling activity; all other transport modes may interchange loading and unloading operations to suit the specific site needs. Loading, unloading, and transporting operations can be separated into detailed components (i.e., backhoes, service roads, rail spurs, cranes, conveyors, etc.) and each component examined for capacity, operational schedule and cycle, and costs of equipment and operation and maintenance.

b. Transport Modes.

(1) Hydraulic pipeline. The hydraulic pipeline is the only transport system recommended for movement of dredged material in slurry form. Assuming government construction of the disposal site, contractor operations of the dredging work, and no easement costs, this system can be economically competitive for distances up to several miles. The conditioning step requires a rehandling dredge and fluidizing system. Control of density and flow to minimize operational problems is an essential conditioning process unique to the hydraulic pipeline mode. Suggested criteria to be used in selecting a rehandling (or secondary) dredge for operation within a containment area include: unit cost of dredging; ease of transportation; minimum downtime; small size to allow maneuverability in a small basin; capability to dredge in

shallow water to minimize dike height; and maximum cutter width to reduce the number of passes. Numerous dredges fitting these criteria are on the market. Some have additional features, such as cutterheads capable of following natural contours of the basin bottom without damage to natural or man-made seals, wheel attachments for the cutterhead to allow dredging operations in plastic or rubber-lined basins, and capability of dredging forward and backward. The fluidizing system is needed to supply water from the closest source to maintain flotation of the dredge. Unloading facilities are unnecessary since the dredged material slurry is usually pumped out of the pipeline into a containment area. A schematic of rehandling operations for hydraulic pipeline transport is presented in Figure 3-1. The pipeline to the land improvement site would include a pneumatic or centrifugal hydraulic pump booster system and would be automated to the maximum extent possible.. The following items should be taken into consideration in any planning for pipeline transport:

(a) Slurry movement of saline dredged material to a freshwater environment is not recommended.

(b) Dewatering requirements before a beneficial use application may be a cost burden and may require treatment of decanted water.

(c) Building codes, easement acquisition, utility relocation, climatological factors, and urban area disruption from construction may be obstacles.

(d) Confining dikes must be provided and could be a significant cost item.

(e) Right-of-way acquisition.

(f) Federal, state, and local regulations and requirements.

Real estate and right-of-wayÆ easements are very site-specific items of political as well as economic concern. These items can impact greatly on the cost of hydraulic pipeline system and therefore should be given due consideration in any cost-benefit analysis and in the final cost evaluation. Cost guidelines do not take into account expenses due to the uniqueness of each situation.

(2) Rail haul. Rail haul using the unit train concept is technically feasible and economically competitive with other transport modes for hauling dredged material distances of 50 to 300 miles. A unit train is one reserved to carry one commodity (dredged material) from specific points on a tightly regulated schedule. Facilities are required for rapid loading and unloading to make the unit train concept work and to enable benefits from reduced rates on large volumes of bulk movement. Bottom dump cars or rotary car dumpers are needed to meet the rapid loading and unloading requirement. Economic feasibility demands the utilization of existing railroad tracks; however, the building of short intermediate spurs may be required to reach disposal areas.

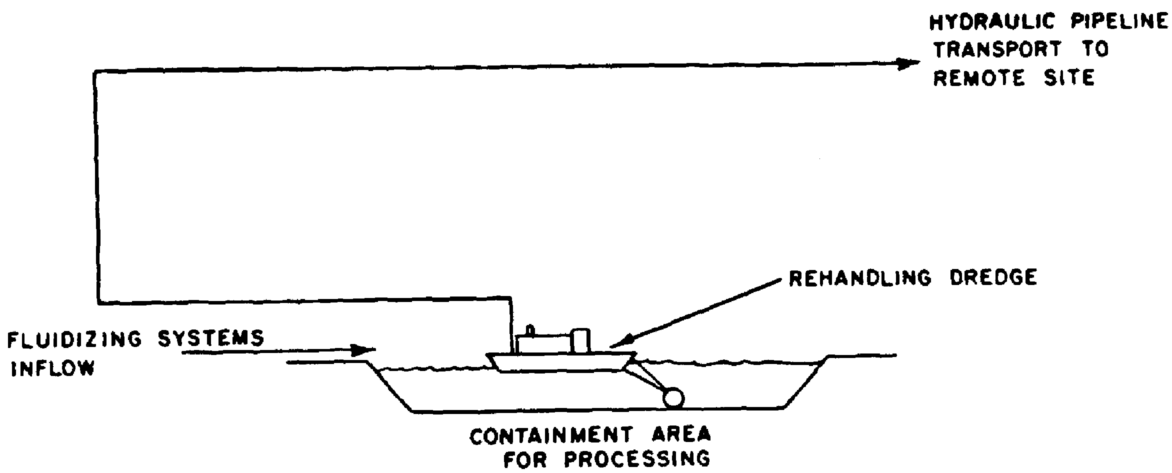

Figure 3-1. Schematic of rehandling system for hydraulic pipeline

Figure 3-2. Tugboat and barge transporting dredged material

The following items should be taken into consideration in any planning for rail haul transport to a beneficial use site:

(a) Dredged material must be dry enough to free-fall from cars.

(b) Scheduling and length of unit trains are often strictly regulated.

(c) State regulations may require open hopper cars to be covered.

(d) Dual use of hopper cars may require washing of cars between use and treatment of wash water to prevent contaminant transfer.

(3) Barge movement. Depending upon the volume of material to be moved, barge movement can be an economically competitive transport mode for the movement of dredged material up to 300 miles. Barge haul was used in the Sacramento District to remove 7 million cubic yards (yd^3) of dredged material from Grand Isle (Figure 3-2). To ensure reasonable costs, a barge unit should consist of familiar and available equipment. In addition, loading and unloading mooring docks capable of accommodating the two cargo scows simultaneously must exist with roadways between the docks and disposal areas to make barge transport practical. The following items should also be taken into consideration:

(a) Thorough information must be obtained about the waterway: navigation depth, allowable speed, lock size, traffic density and patterns, etc.

(b) Often, regulations exist concerning cleanup responsibilities with associated fines for spills in inland waters.

(c) Climatic conditions may affect operational schedules.

(d) A user charge for waterways may become a reality in the future.

(4) Truck haul. Truck haul of dredged material can be economically competitive for distances up to 50 miles. At greater distances, transport by truck is labor- and fuel-intensive and not economically justifiable. The simplicity of loading and unloading requirements and the relative abundance of available roadways make truck hauling technically the most attractive transport mode, and it has wide District application (Figure 3-3). Costs analyses are based on utilizing 25-ton dump trucks with 8.5-yd^3 capacities and assume that routes exist which are adequately upgraded and maintained. Economic feasibility of truck hauling is based on rates established by negotiation with trucking companies and include all associated driver and fuel costs. The following items should also be taken into consideration:

(a) State highway and safety regulations cover a variety of elements (gross weights of trucks, weight per axle, etc.).

(b) Emission and noise standards.

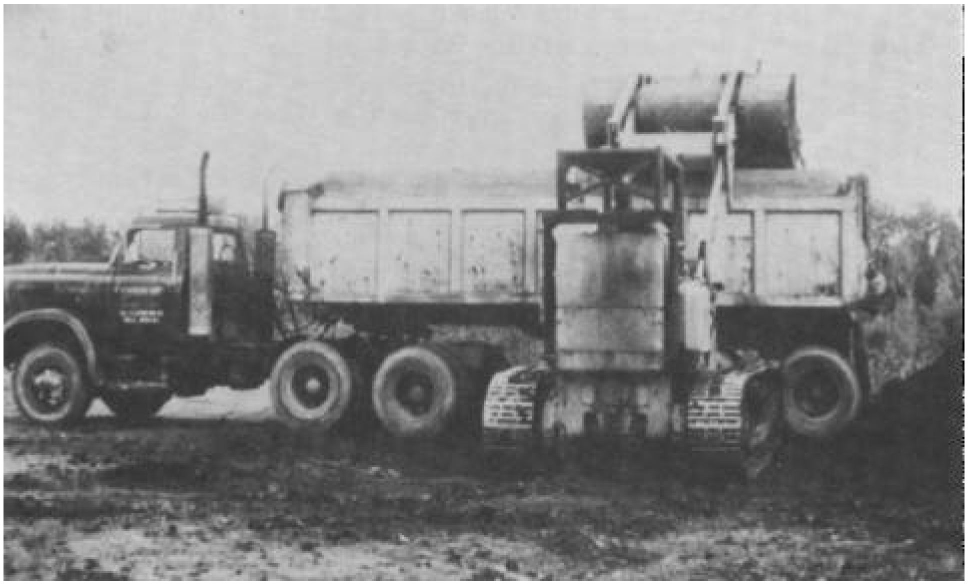

Figure 3-3. Truck haul utilized by the Chicago District

Figure 3-4. A 36-inch belt conveyer loading operation

(c) Local ordinances designating truck routes.

(d) Traffic control of truck operations during winter months in northern climates.

(e) Weight limits on bridges and roadways.

(5) Belt conveyor movement. Belt conveyor systems are employed on a limited basis to transport relatively dry dredged material for short distances. They are technically feasible and cost competitive. Belt specifications vary in width (30 to 70 inches), flight length (900 to 2,600 feet), and speed (7 to 90 miles per hour). Systems can be designed to suit project needs excluding certain terrain difficulties. Because of system flexibility, belt conveyors fit neatly into many loading and unloading operations. The California Highway Department, under an agreement with the Sacramento District, uses dozers and conveyors to load dredged material onto barges (Figure 3-4). The following items should be taken into consideration in any planning for belt conveyor transport:

(a) Building codes, easement acquisition, utility relocation, climatological factors, and urban area disruption for construction may be obstacles.

(b) Material pileup due to system failure.

(c) Malfunctions of sequential belt systems resulting in entire system stoppage.

c. Loading and Unloading Elements. Loading and unloading elements may incur high costs which can restrict project viability. Item 74 presents several examples of loading and unloading options and schematics of scenarios associated with various dry material transport modes; two examples are shown in Figures 3-5 and 3-6. Two other examples include a pair of backhoe excavators and a series of conveyor belts providing rapid loading of unit trains, and a barge haul scheme using backhoes for excavation and loading directly into dump trucks which make the intermediate haul to the scows. In this EM, cost comparisons are based on the loading and unloading component scenarios presented in Item 74. The truck haul loading element components are similar to the rail loading components which include excavation backhoes and a series of belt conveyors. The unloading system is simple back-dumping at the beneficial use site. Placement methods are important, and are discussed in Chapter 5 and other chapters where critical elevations are needed for beneficial use applications.

3-4. Cost Analysis for Dewatering and Transport.

a. Dewatering Costs. Costs associated with dewatering of dredged containment areas are directly related to the degree of trenching effort required and the type of heavy equipment necessary to accomplish dewatering. Thus, the program costs for progressive trenching are highly site-specific depending

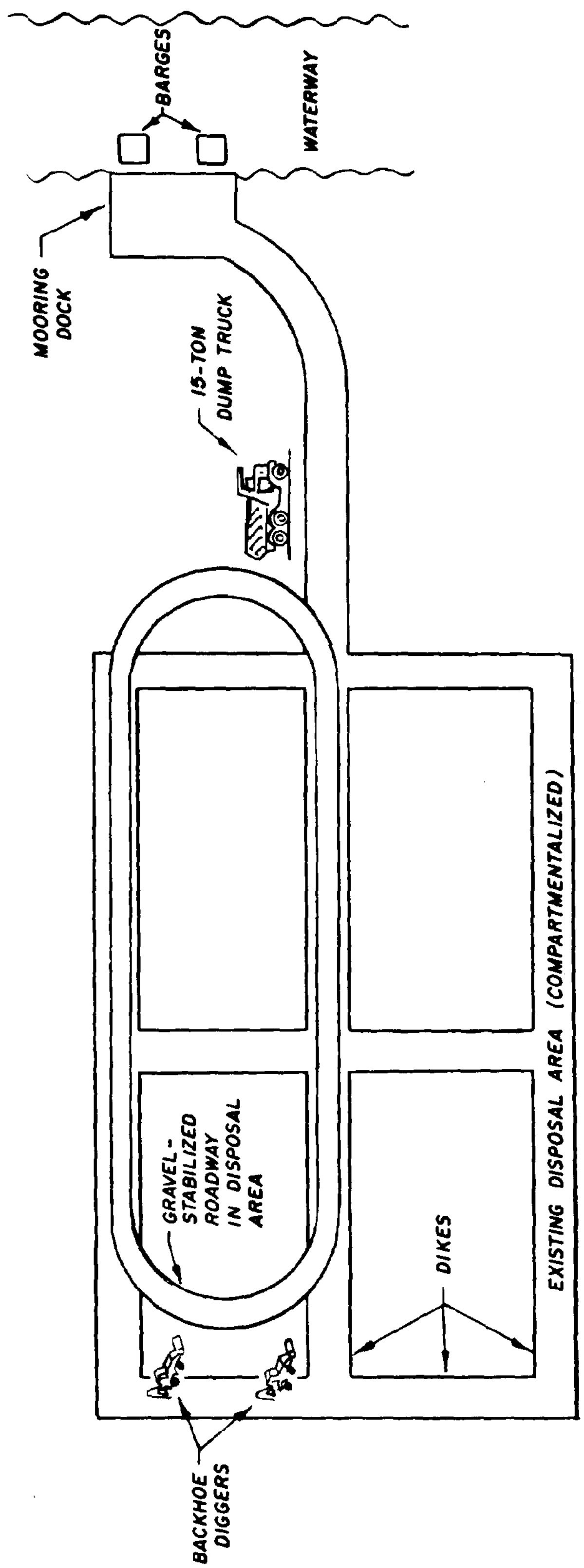

Figure 3-5. Barge loading operation

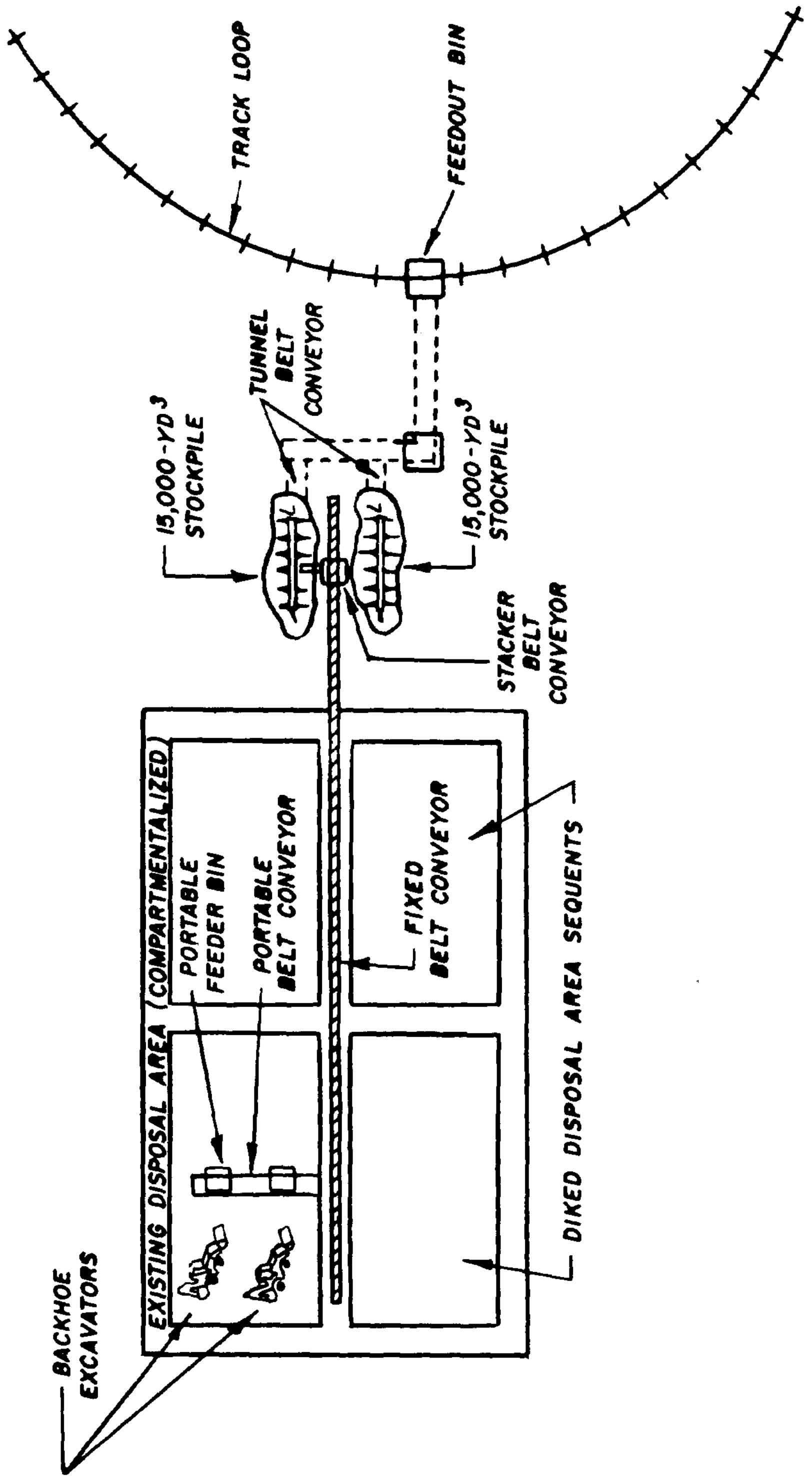

Figure 3-6. Unit train rail loading facility

upon disposal area size, equipment selected, type of access available, and frequency of trenching operations. A preliminary trenching program is developed from crust formation estimates, equipment operational characteristics (from Table 3-1), and trenching cycle intervals (from Table 3-2). Total cost may be estimated from computing equipment operating hours plus factors for nonproductive activities (30 percent is a good estimate), mobilization/ demobilization, and administrative costs.

b. Transport costs. Transport cost can account for 90 percent or more of total land improvement and beneficial use budget costs. The cost figures presented in this section are meant to serve as examples for planning and do not represent definitive cost estimates. Table 3-3 is included to provide insight into the cost relationships for various modes of transport. The table provides total system costs for all five transport modes. Transport costs are reported in dollars per cubic yard of dredged material moved. This breakdown shows that economic feasibility is limited by distance for most transport modes. This table also shows the economies of scale for larger annual volumes of material shipped. Real estate and right-of-way costs for the hydraulic pipeline system are not included in the cost-estimating procedure.

Table 3-1

Operational Characteristics of Trenching Equipment

Equipment	Crust Thickness, in., for Effective Operation: Minimum	Crust Thickness, in., for Effective Operation: Maximum	Maximum Trench Depth, in.	Approximate Trenching Rate, lin ft/hour	Approximate Rental Cost* $/hour
RUC	0	12	18	2,000+	75-100
Low-ground-pressure tracked vehicle + rotary trenchers	4	24	24	2,000+	35-45
Small dredge	4	10	30	25	50-75
Amphibious dragline	6	18**	Crust + 18	40	50-70
Small dragline on double mats	12	18	Crust + 18	30	35-50
Medium dragline on double mats	12	18	Crust + 18	40	40-50
Small dragline on single mats	18	24+	Crust + 18-24	50	35-45
Medium dragline on single mats	18	30+	Crust + 18-24	60	40-50
Large dragline on single mats	24	36	Crust + 24	80	45-55

Note: a. Vehicle or mat ground pressure must also satisfy critical layer RCI mobility criteria.
b. Low-ground-pressure tracked vehicle assumed to pull drag plow with point set only 1 or 2 in. below existing crust.
c. More exact definitions of dragline equipment given in text.

* Southeastern United States, 1977.

** Above this crust thickness, conventional dragline is usually more efficient.

\+ Between 24- and 30-in, crust thickness, use single mats.
Increase rates 10 lin ft/hour if dragline is working from perimeter dike.

Table 3-2

Estimated Interval Between Trenching Cycles for Various Equipment Items in Fine-Grained Dredged Material

Equipment Item	Equipment Location in Disposal Area	Initial Condition of Disposal Area Surface	Estimated Trenching Interval
RUC	Interior	Decant point	Each 2 weeks for first month, monthly thereafter
RUC	Interior	Crust ≥ 2 in.	Monthly
Low-ground-pressure tracked vehicle + rotary trencher	Interior	Crust ≥ 4 in.	Monthly
Small dredge	Interior	4 in. < crust – 10 in.	4 months
Amphibious dragline	Interior	Crust ≥ 6 in.	4 months
Conventional dragline	Interior	Crust ≥ 12 in.	4 months
Conventional dragline	Perimeter	Decant point	Monthly for first 3 months, bimonthly for next 3 months, 4 months thereafter
Conventional dragline	Perimeter	2 in. < crust < 6 in.	Bimonthly for first 4 months, 4 months thereafter
Conventional dragline	Perimeter	Crust ≥ 6 in.	4 months

Table 3-3

Comparison of Costs of Various Transport Systems, Quantities, and Distances**

Annual Quantity yd^3	Transport Distance miles	Cost, $/yd^3$, for Cited Transport System Pipeline	Rail	Barge	Belt	Truck
500,000	10	2.47	*	2.47	8.98	4.57
	20	3.14	*	3.14	15.15	6.61
	100	9.54	7.18	4.71	*	13.69
	250	*	9.32	7.41	*	*
1,000,000	10	1.46	*	2.92	5.39	3.73
	20	1.91	*	3.14	13.47	4.19
	100	6.45	5.39	4.49	*	12.91
	250	*	7.58	7.18	*	*
3,000,000	10	0.79	*	2.70	2.25	3.17
	20	1.12	*	2.92	3.93	3.56
	100	4.10	4.21	4.49	*	12.35
	250	*	5.34	7.35	*	*
5,000,000	10	0.67	*	2.81	1.68	3.05
	20	0.90	*	2.92	3.14	3.42
	100	3.48	4.04	4.38	13.58	12.07
	250	*	6.06	7.07	*	*

* Indicates not competitive economically.
** These costs were taken from item 57 and are adjusted to March 1978 dollars.