

8.1. INFRASTRUCTURE--CAPITAL COSTS

8.1.4. TRANSPORTATION

8.1.4.1. AERIAL TRAMWAY

The capital cost curve for the aerial tramway is for the acquisition and installation of equipment for transporting ore or waste material over a slope distance of 3.0 km at a slope angle of 15°. The bulk density of the material was assumed at 1,442.5 kg/m³ (92.0 lb/ft³). The aerial tramway system includes loading bin, apron feeders, tram cars, track and haulage ropes, loading and unloading terminals, anchor towers, intermediate (pivoted) towers and the driving unit(s).

The total capital cost is based on a single cost curve having a tramping rate (X), in metric tons of material moved per day. The curve is valid for a production range of 2,040 to 13,800 mtpd, operating three shifts per day. The curve includes all costs associated with the acquisition and installation of the equipment required for loading, unloading, tramping, and driving units.

BASE CURVE

The capital cost derived from the curve is a combination of the following costs:

Installation labor cost.....	19.0%
Installation materials cost...	4.8%
Purchased equipment cost.....	73.5%
Transportation cost.....	2.7%

The total aerial tramway capital cost is $(Y_C) = 208,182.537(X)^{0.385}$ and is distributed as follows:

- (L) Construction labor cost $(Y_L) = 39,554.682(X)^{0.385}$
- (S) Construction supply cost $(Y_S) = 9,992.762(X)^{0.385}$
- (E) Purchased equipment cost $(Y_E) = 158,635.093(X)^{0.385}$

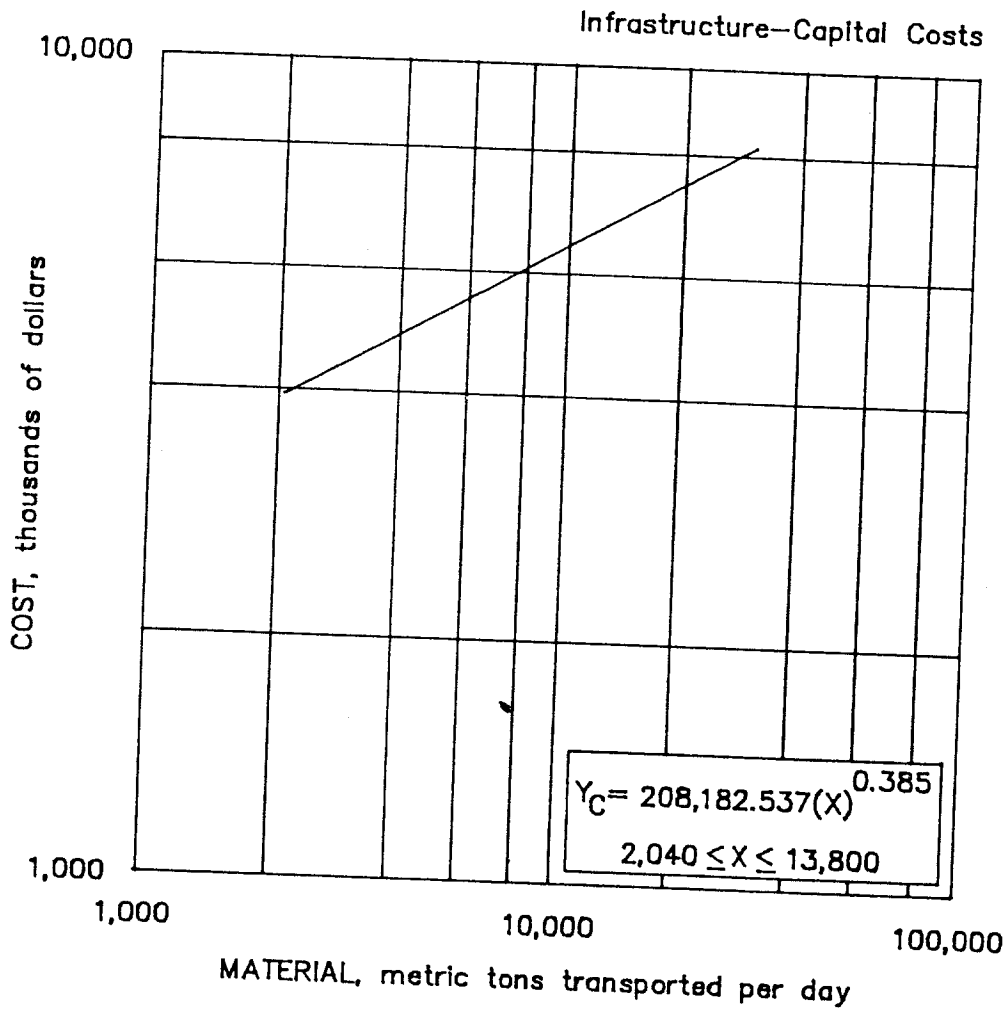
ADJUSTMENT FACTORS

Tramway Length Factor The curve is based on an aerial tramway of 3 km in slope length. To adjust for a different aerial tramway length, multiply the cost obtained from the base curve by the following factor:

Length factor $(Y_L) = 0.233(L)+0.302$
 where L = slope length, in kilometers (not to exceed 20 km).

Bulk Density Factor The base curve was calculated with a material bulk density of 1,442.5 kg/m³ (92 lb/ft³). To adjust the base curve for a different bulk density, multiply the base curve by the following factor:

Bulk density factor $(Y_D) = 1.043-[0.00003(D)]$
 where D = bulk density, in kilograms per cubic meter.



8.1.4.1. Aerial tramway

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8.1.4.2. AIRSTRIP CONSTRUCTION

Airstrip construction cost curves give the cost per meter length of basic utility airstrips varying in width from 10 meters to 40 m. The airstrip described accommodates light single-engine and small twin-engine airplanes used for personal and business purposes, plus a broader spectrum of small business and air taxi-type twin-engine airplanes. These aircraft include the Cessna 150 series, Piper PA-32-300 Commander Six, Rockwell International 114 Commander, Beech B55 Baron, Cessna 310, and Piper PA-23-250 Aztec.

BASE CURVE

The total capital cost per meter length is based on a single cost curve having an airstrip width (X), in meters. The curve is valid for widths of 10 to 40 m, operating one shift per day. Two surface options are offered, aggregate and asphalt. Not included in this curve are costs for acquisition or clearing of airstrip site, and hauling or rough leveling of fill materials. Both aggregate and bituminous asphalt strips include base preparation (grading and rolling). The aggregate surface includes a base course of 1.9-cm stone, 15 cm deep followed by final grading and rolling. The asphalt surface consists of 31.9-cm stone 10.2 cm deep underlying 3.8-cm rolled asphalt. No equipment capital costs are incurred. A 5% contingency of total capital cost covers ancillary airstrip facilities such as gas storage and pump, airstrip end and lateral markings, wind direction apparatus, and one T-hangar as needed.

The capital cost derived from the curve is a combination of the following costs:

	<u>Aggregate</u>	<u>Asphalt</u>
Construction labor cost.....	20%	16%
Construction materials cost...	80%	84%

The total asphalt airstrip capital cost is $(Y_C \text{ ASPHALT}) = 5.686(X)^{1.000}$ and is distributed as follows:

$$(L) \text{ Labor operating cost } (Y_L \text{ ASPHALT}) = 0.910(X)^{1.000}$$

$$(S) \text{ Supply operating cost } (Y_S \text{ ASPHALT}) = 4.776(X)^{1.000}$$

The total aggregate airstrip capital cost is $(Y_C \text{ AGGREGATE}) = 3.471(X)^{1.005}$ and is distributed as follows:

$$(L) \text{ Labor operating cost } (Y_L \text{ AGGREGATE}) = 0.694(X)^{1.005}$$

$$(S) \text{ Supply operating cost } (Y_S \text{ AGGREGATE}) = 2.776(X)^{1.005}$$

ADJUSTMENT FACTORS

Runway Length Factor Runway length requirement is primarily dependent on anticipated aircraft use, temperature, and elevation. Aircraft type used in the cost

curve is described above. For convenience, an equation was derived to determine length requirement when the elevation of the airstrip is known. The equation is based on maximum temperature of 38C (100F). To adjust the base curve for different lengths and elevations, multiply the cost obtained from the base curve by the following factor:

$$\text{Runway length } L = 891.915e^{(0.0005)(E)}$$

where L = airstrip length, in meters,
and E = elevation, in meters.

Runway Width Runway width requirement varies with wingspan of anticipated aircraft using the airstrip. An 18 m wide landing strip will accommodate the aircraft mentioned. This width is advised for airstrip predesign costing. Actual width should be used when calculating capital costs of existing airstrips.

Land Requirements Factor For estimation of land acquisition and clearing requirements for airstrip landing area (includes airstrip pad, and lateral-terminal clearances), use the following equation:

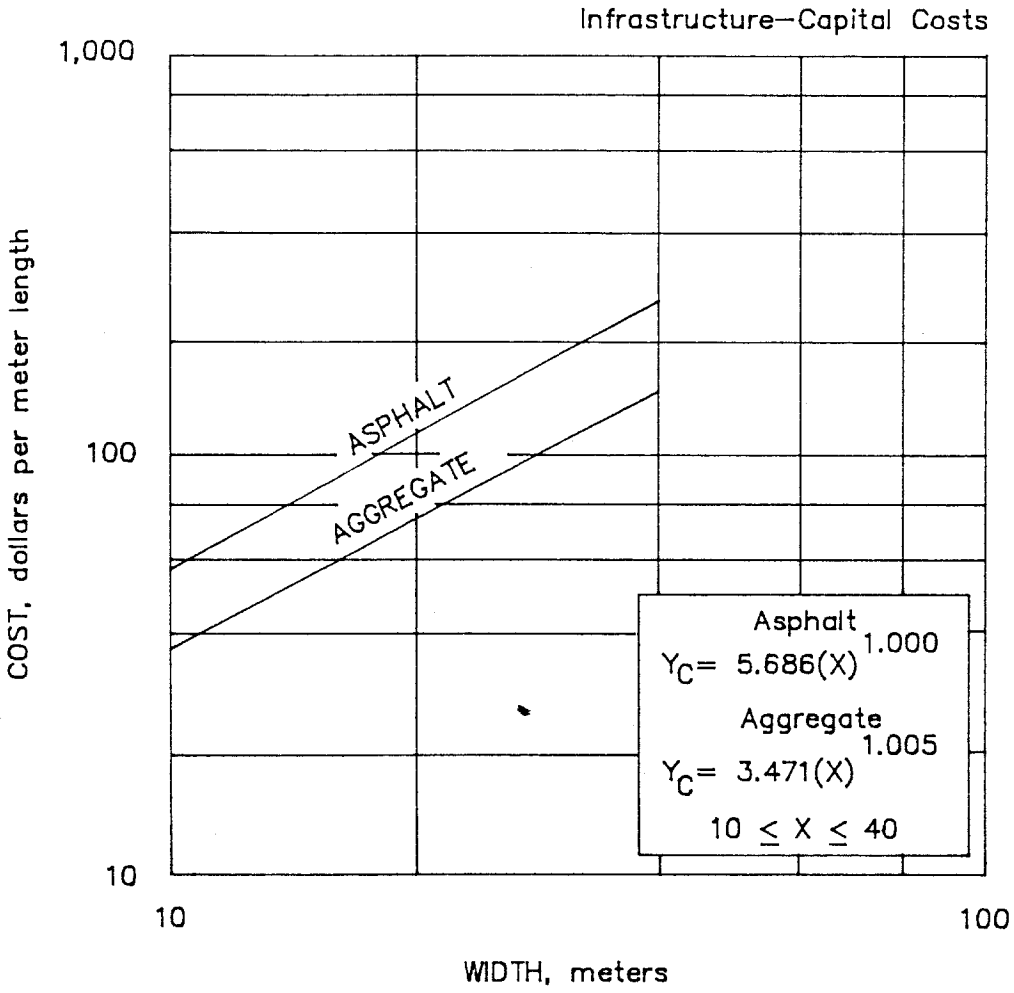
$$\text{Land area requirement in hectares } A = 0.012(L) + 1.820$$

where L = airstrip length, in meters.

Subcontractor Factor If a subcontractor is used, multiply the curves by the following factors:

$$\text{Labor factor } (F_L) = 1.5$$

$$\text{Supply factor } (F_S) = 1.2$$



8.1.4.2. Airstrip construction

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8.1.4.4. RAILROAD CONSTRUCTION

The cost in this section covers the capital expense for laying standard-gage track-
age for main lines and spurs. The cost reflects railway installation by a crew
that works on a one-shift-per-day schedule; furthermore, the cost is based on
trackage that is fully ballasted.

BASE CURVE

The total capital cost is based on a single cost curve having a railroad length
(X), in total kilometers. The curve is valid for a length range of 1 to 60 km, op-
erating one shift per day.

The capital cost derived from the curve is a combination of the following costs:

Construction labor cost.....	26%
Construction supply cost.....	69%
Purchased equipment cost.....	5%

The total railroad construction capital cost is $(Y_C) = 188,530.000(X)1.000$ and
is distributed as follows:

- (L) Construction labor cost $(Y_L) = 49,017.800(X)1.000$
 (S) Construction supply cost $(Y_S) = 130,085.700(X)1.000$
 (E) Purchased equipment cost $(Y_E) = 9,426.500(X)1.000$

ADJUSTMENT FACTORS

Ballast Factor For the installation of standard-gage trackage without ballast, mul-
tiply the cost obtained from the base curve by the following factor:

$$\text{Ballast factor } (F_B) = 0.85$$

Roadbed Construction For construction expenses resulting from roadbed clearing,
excavation, and drilling-blasting, refer to access roads sections (8.1.1.1.-
8.1.1.3.) and apply a roadway width of 6.1 m to the applicable cost equations;
the additional railway expenses so derived should then be added to this sec-
tion's capital cost.

Equipment Factor When it is necessary to purchase equipment or to have a subcon-
tractor perform the work, multiply the equipment operation value by the follow-
ing factor in order to obtain the total value of equipment expense for owner-
ship and operation:

$$\text{Equipment operation factor } (F_E) = 1.7$$

Subcontractor Factor If a subcontractor is used, to compensate for the subcontractor's markup, multiply the costs obtained from the curves by the following factors:

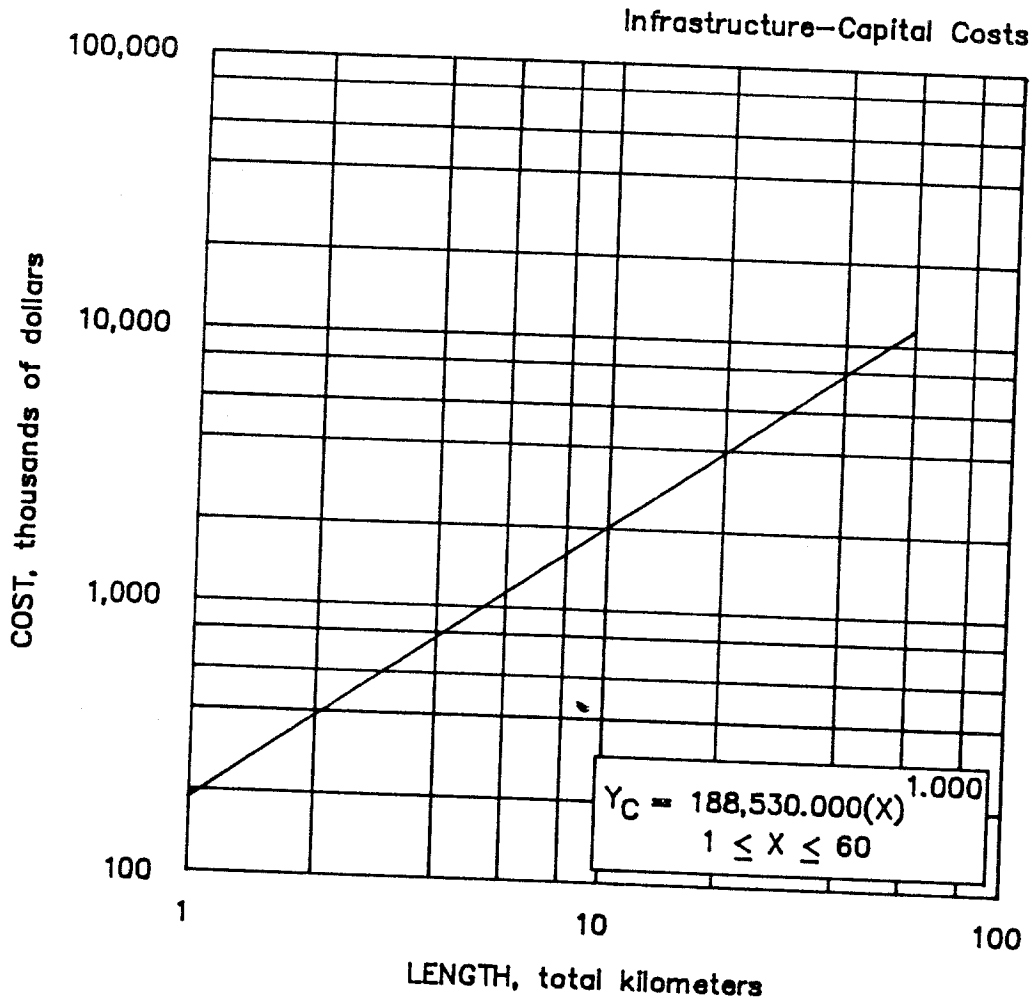
Labor factor $(F_L) = 1.5$

Supply factor $(F_S) = 1.2$

Equipment operation factor $(F_E) = 1.2$

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8.1.4.4. Railroad construction

- 8.1. INFRASTRUCTURE--CAPITAL COSTS
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- 8.1.4.5. LONG-DISTANCE SURFACE CONVEYOR

The cost curve shown is for the acquisition and erection of a long-distance surface conveyor. The conveyor is a single-flight belt conveyor made with high strength steel belting. The conveyor is designed for a 10° slope and 1-km distance. Usually, the material is crushed or screened at the mine site before being conveyed. Screen and crusher capital costs are not included in this cost but are covered in separate sections.

BASE CURVE

The total cost is based on a single cost curve having a production rate (X), in metric tons per day. The curve is valid for production rates of 15,000 to 150,000 mtpd, operating three shifts per day. The curve includes all costs associated with acquisition, installation of the belt, idlers, motors, channel, and frame, and site preparation.

The long-distance surface conveyor capital cost derived from the curve is a combination of the following costs:

Construction labor cost.....	31%
Construction supply cost.....	5%
Purchased equipment cost.....	64%

A typical breakdown of a long distance surface conveyor major cost components is

Conveyor belt.....	36%
Idler assembly units.....	44%
Motors, drive trains, belt cleaners, and other mechanical items.....	20%

The total long distance surface conveyor capital cost is $(Y_C) = 81,292.281(X)^{0.309}$ and is distributed as follows:

- (L) Construction labor cost $(Y_L) = 25,200.607(X)^{0.309}$
- (S) Construction supply cost $(Y_S) = 4,064.614(X)^{0.309}$
- (E) Purchased equipment cost $(Y_E) = 52,027.060(X)^{0.309}$

ADJUSTMENT FACTORS

Shift Adjustment The curve is based on a three-shift operation. To adjust the capital cost for a different number of daily operating shifts, multiply the actual daily tonnage (X) by the ratio of the base number of shifts (three) divided by the number of desired shifts. Then, use this modified tonnage in place of (X) in the above cost equation to obtain the adjusted cost.

Conveyor Length and Slope Factor The conveyor is 1-km long and has a 10° slope. For other lengths and slopes, multiply the cost obtained from the base curve by the following factor:

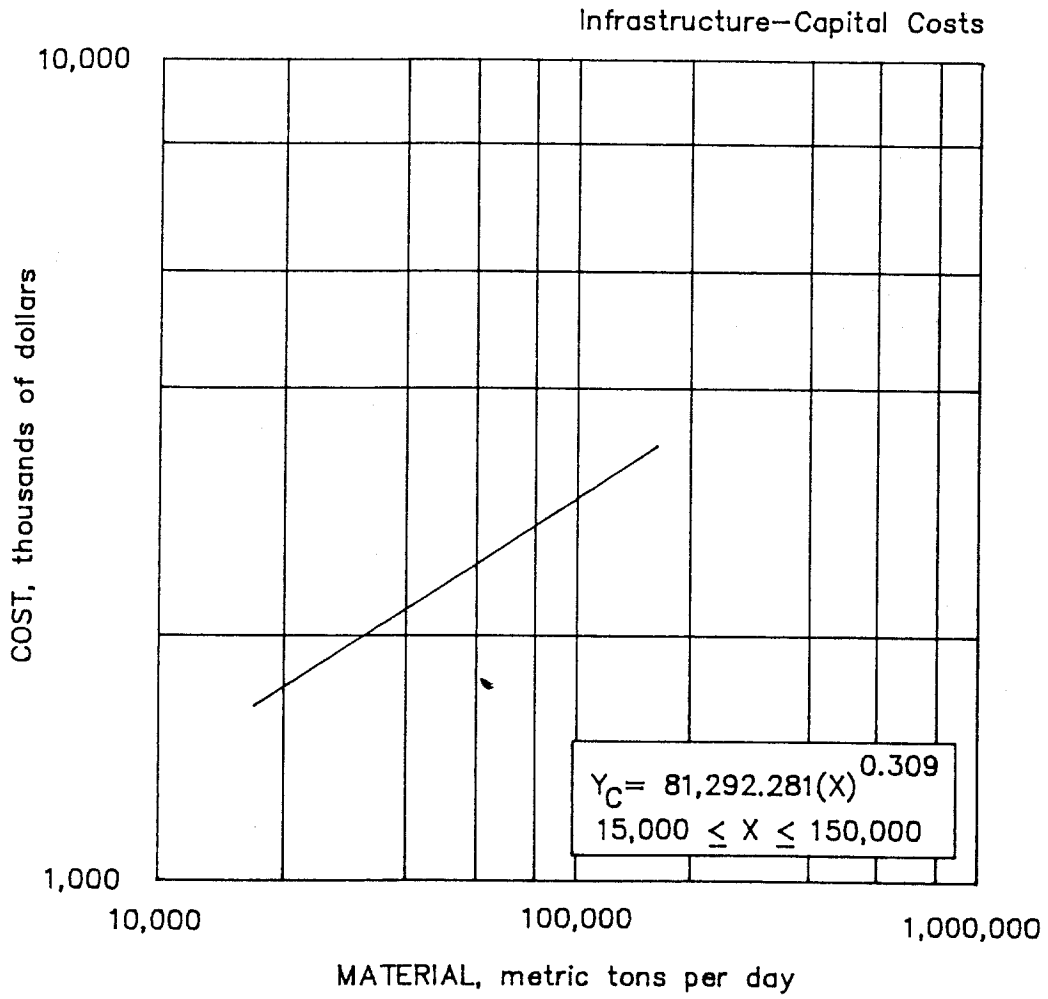
$$\text{Conveyor length and slope factor } (F_L) = [0.917 + 0.00940(S)][L/1]$$

where L = length, in kilometers
and S = slope, in degrees, between 0° and 15° .

The cost for a decline conveyor is equal to that for a horizontal conveyor (0° slope).

Stacker-Tripper Factor If the material is conveyed to a processing plant or other end point such as a port facility, the capital cost for unloading from the conveyor is included in those sections. If the material is waste rock, then the cost for a tripper or stacker should be added to the estimated capital cost. Costs for these items vary greatly but can range from \$600,000 for a stacker or tripper that handles 15,000 mtpd waste material to \$5,000,000 for a stacker or tripper that handles 150,000 mtpd of waste rock.

Belt Life The conveyor belt, 36% of equipment cost, has an average wear life of 8 to 10 yr of use, based on three shifts per day, 350 operating days per year, and depending on the abrasiveness of the material. The total replacement of the belt is standard procedure after excessive wear.



8.1.4.5. Long distance surface conveyor

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8.1.4.7. MARINE TERMINAL

The curve applies to costs for a deep-water, export, bulk ore marine terminal. Costs include basic operations of rail or barge receiving, storage (open), reclaiming, and ship-loading. Ore storage, with capability to mix different ore grades, has a capacity of 10% of annual throughput. It is assumed that soil conditions are good. Significant additional costs will be incurred under conditions of poor site soil (e.g., swamps, etc.) and shallow water (dredging required). Additionally, a requirement for covered storage will significantly add to capital costs. Capital costs do not include land acquisition, legal and permitting fees, finance charges, off-site alterations, and engineering and construction management fees (the latter, typically 8% of total direct costs).

BASE CURVE

The total capital cost is based on a single cost curve having on an annual capacity of (X), in metric tons of material. The curve is valid for capacities between 0.9 and 16 million mt, operating three shifts per day.

The ratios of supply and equipment to labor will vary greatly depending principally on the civil requirement from project to project.

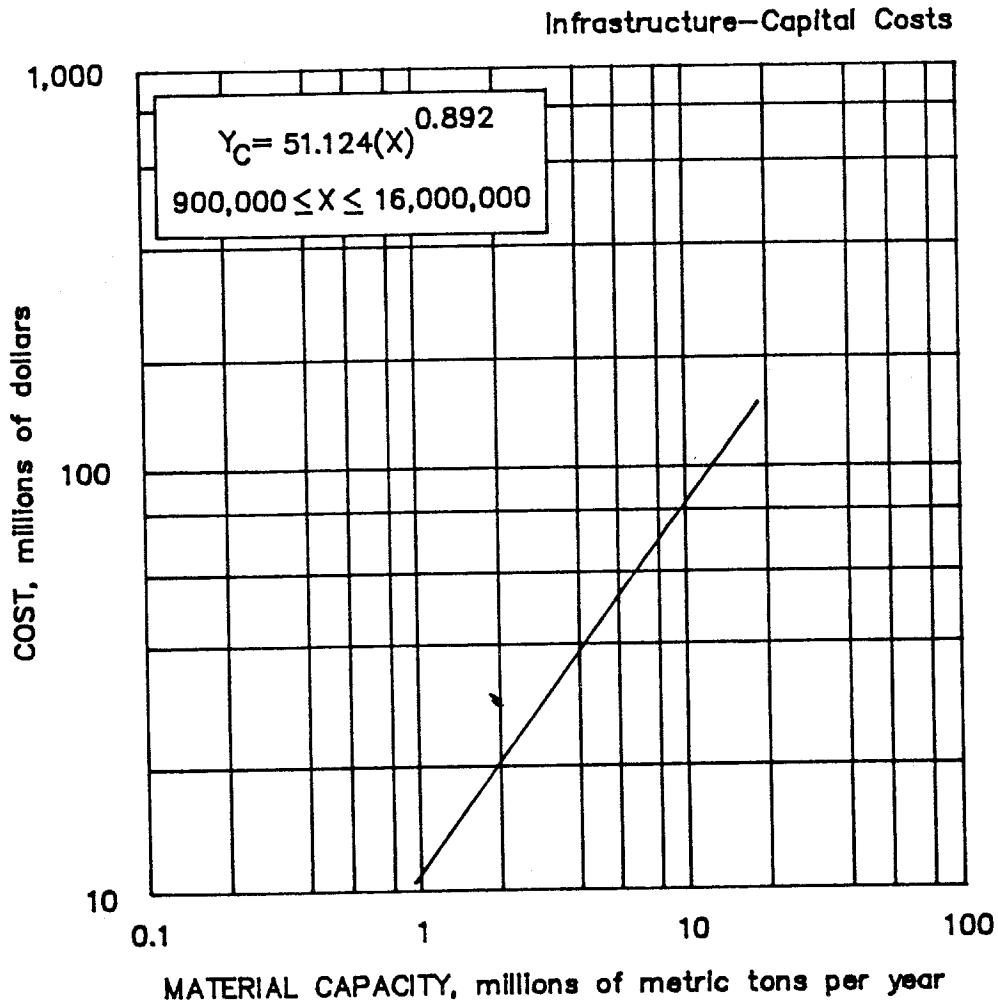
The total marine terminal capital cost is $(Y_C) = 51.124(X)^{0.892}$

ADJUSTMENT FACTOR

Density (Loose) Factor Lightweight commodities occupy more space and thus require larger handling equipment than more dense commodities. Therefore, an adjustment is required to lower the capital cost for a terminal designed to handle more dense (higher loose density) commodities and to increase the capital cost of a terminal designed to handle commodities of less loose density. To adjust the base curve for differences in weight per unit volume, multiply the cost obtained from the curve by the following factor:

Density factor $(F_D) = 3.418(D)^{-0.167}$
 where D = loose density, in kilograms per cubic meter.

See table A-2 for loose densities.



8.1.4.7. Marine terminal

8.1. INFRASTRUCTURE--CAPITAL COSTS

8.1.4. TRANSPORTATION

8.1.4.8. SLURRY PIPELINE

The capital cost curve for the slurry pipeline is for the acquisition and installation of equipment for pumping a slurry 10 km at a lift of 150 m with a specific gravity of the solids of 4.3. The slurry pipeline circuit includes slurry storage tanks, booster and high-pressure slurry pumps, and the pipeline.

The total capital cost is based on a single cost curve having a daily adjusted feed rate (X), in metric tons material slurried per day. The curve is valid for a production range of 900 to 32,000 mtpd, operating three shifts per day. The curve includes all costs associated with the acquisition and installation of the required pumps, agitators, slurry tanks, and pipeline.

BASE CURVE

The slurry pipeline capital cost derived from the curve is a combination of the following costs:

Installation labor cost.....	11.8%
Installation materials cost....	32.9%
Purchased equipment cost.....	54.6%
Transportation cost.....	0.7%

The total slurry pipeline capital cost is $(Y_C) = 21,021.709(X)^{0.546}$ and is distributed as follows:

- (L) Construction labor cost $(Y_L) = 2,480.562(X)^{0.546}$
- (S) Construction supply cost $(Y_S) = 6,916.142(X)^{0.546}$
- (E) Purchased equipment cost $(Y_E) = 11,625.005(X)^{0.546}$

ADJUSTMENT FACTORS

Pipeline Length Factor The curve is based on a slurry pipeline of 10 km in length. To adjust the base curve for different slurry pipeline lengths, multiply the cost obtained from the curve by the following factor:

$$\text{Length factor } (F_K) = 0.026(K)+0.741$$

where K = length, in kilometers.

See table A-3 for average pipeline lengths.

Slurry Pipeline Lift Factor The base curve was calculated for a slurry pipeline with a lift of 150 m. To adjust the base curve for a different lift, multiply the cost obtained from the curve by the following factor:

$$\text{Lift factor } (F_L) = 0.0009(L)+0.871$$

where L = length, in meters.

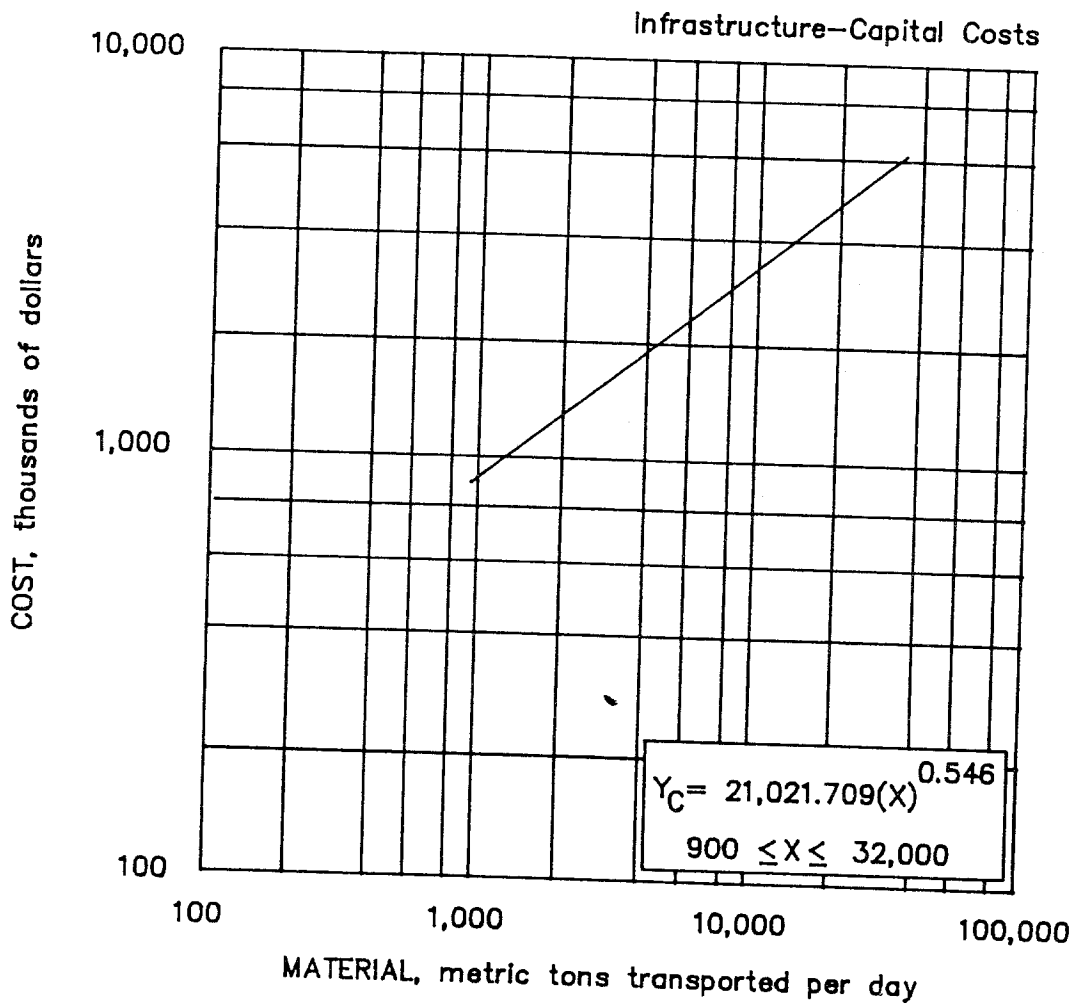
Specific Gravity Factor The base curve was calculated for a slurry pipeline pumping solids with specific gravity (S.G.) of 4.3. To adjust the curve for a different specific gravity, multiply the cost obtained from the curve by the following factor:

$$\text{Specific gravity factor } (F_g) = 0.023(S) + 0.903$$

where S = new specific gravity.

See table A-3 for average specific gravities.

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8.1.4.8. Slurry pipeline

8.1. INFRASTRUCTURE--CAPITAL COSTS

8.1.5. TOWNSITE

The following housing costs are for a typical average quality park based on using trailers or manufactured mobile home housing containing between 150 and 200 units. Costs are quoted per individual housing unit. Costs are factored by using the Bureau of Labor Statistics Industrial Materials Cost Index. Site costs do not include land site acquisition, construction of utility trunk lines to the site, or a wastewater treatment plant. Wastewater disposal uses a septic tank and drain field; however, transportation and setup costs to areas within 100 miles of Denver, CO, are included.

TYPICAL AVERAGE SITE COSTS FOR FAMILY OR BACHELOR UNIT

	Family	Bachelor
Site preparation (typical average area 410 m ²).....	\$1,050	\$320
Streets (7.9- to 9.8-m wide, 7.6-cm asphalt or 7.5-cm gravel edged or curbed).....	810	270
Patios and walks.....	610	200
Septic tank, includes drain field.....	1,360	750
Water, connected to unit.....	550	550
Gas, low-pressure, connected.....	310	310
Electrical, 80- to 150-A connected service to each unit.....	890	890
Office, recreation, laundry.....	1,250	1,250
Total.....	6,830	4,540

The following adjustment factors should be applied to the total typical 'average' site cost where either quality or quantity differs.

Site preparation adjustment multipliers to total typical 'average' site cost are as follows:

<u>Description</u>	<u>Quality factor</u>	<u>Quantity</u>	<u>Factor</u>
Low quality (300 m ² /space)	0.70	40- 80	1.07
		80-125	1.00
		150-250	0.92
Average (410 m ² /space)	1.00	50-125	1.10
		150-200	1.00
		250-300	0.95
Good (520 m ² /space)	1.30	50-150	1.10
		175-200	1.00
		250-350	0.97

In addition, the following accessories may also be required:

Skirting at base of trailer.....	\$620.00
Landing and steps.....	360.00
Canopies over landings.....	550.00
Air conditioning--using existing heater.....	840.00

HOUSING UNITS

Family Units--With living, dining, kitchen, bath, and sleeping facilities for two adults and two to four children. Cost is for typical average quality.

Single-wide (4.27m by 19.50m).....	\$15,400
Double-wide (7.31m by 14.63m).....	\$26,400

Quality adjustments to the single-wide, double-wide basic costs are made by multiplying the above housing unit average quality costs by the following factors:

Low quality	
Single-wide.....	1.12
Double-wide.....	1.16
Average	
Single-wide.....	0.90
Double-wide.....	0.87
Excellent quality	
Single-wide.....	1.25
Double-wide.....	1.34

Quantity adjustments--For quantities greater than 10 units, decrease overall costs by 10%.

Snowload adjustment--For areas of heavy snowfall, increase basic unit costs 5% for increased roof support design.

Bachelor Units--Consisting of single person motel-style rooms with a kitchen and dining room. Rooms share a centrally located restroom and shower facility. Cost is for typical average quality.

Bachelor Unit.....	\$15,000
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Number of persons adjustment--Per person cost is based on housing 400 personnel. Lodging capital costs for greater than 500 people, decrease costs by 10%. Increase costs by 15% for less than 300 and 20% for less than 200.

PRIMARY UTILITIES

Electrical, cost per linear meter:

Main overhead electric powerlines.....	\$26.32/linear m
Lateral overhead lines.....	\$ 8.25/linear m

Water

Main, 15.24 cm plastic (add or deduct \$5.75 per 2.54-cm diam.).....	\$35.80/linear m
Lateral, 2.54 cm.....	\$17.22/linear m

or