THE NEVADA MARBLE PROJECT

AN ECONOMIC ASSESSMENT

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FEASIBILITY SUMMARY:
THE SHAPE OF THE PROJECT

This study was undertaken to determine the best and most economic use of a deposit of some 38,000,000 tons of dolomite marble lying on the northern boundary of White Pine County in the State of Nevada. It summarizes an investigation commencing in late December, 1965, and extending to late March, 1966.

This report deals with purely economic considerations: markets, products, pricing policies, costs, capital structure, distribution, organization and profitability. These matters are set out in the text. An examination of the geological and engineering feasibility of the project is reported separately by the client's consultants in these fields.

The over-riding issue in the study is whether the implementation of any industrial project based on the resources of the deposit would be justified from an investment viewpoint. It is the sum of the factors leading to a determination of feasibility that is outlined in this introduction.

The Tests of Feasibility

The tests of economic feasibility applicable to the typical industrial enterprise are three. First, is a market available for the output of the project? Second, can the project supply this market on a competitive cost/price basis? And, third, can the project (on this

basis) operate at a satisfactory rate of return?

Any positive answer to this combination of questions requires adequate supporting evidence. Obviously, a market for the project's commodity must now exist, or be capable of creation. Moreover, to permit the entry of a new supplier into the market, the existing demand of the commodity's consumers must be unfilled, or unsatisfied in some important way, or be capable of shift, improvement, or expansion - at least to the level of volume output contemplated. From this evidence emerges the scope of the market: the share available to the project; and the particular requirements (in product type, price, quality, and availablility) that it will be obliged to meet.

Given this market horizon, evidence must also be favourable as to the costs of making the commodity available from the project. These costs are expressions of the components of production process involved: raw materials, plant, labor, capital, freight, services, taxes, and the cost of administration and sales. These components must be available to the project on a basis at which it can compete.

It is not simply the elements of cost that are important: it is their combination. This combination is expressed as the design or 'model' of the project that emerges as the most efficient (technically and economically), and that best meets the requirements of the market. This design includes the size of the project; its product range; its process; its rate of output; and its unit cost of output (which may then be related to unit price).

Normally, market (or demand) determines output, and hence cost. Yet the two factors interact. An especially favourable cost structure permits a lower market price, and the opportunity to stimulate volume

consumption. Alternatively, these costs may permit the project to meet the established market price, and secure a higher rate of return per unit of output. Whether the project 'breaks' the market price or meets it, this market/cost interaction reinforces feasibility, and allows the introduction of the third (and crucial) factor into the analysis: profit.

Assumptions in Feasibility

On these grounds, is the Nevada marble project feasible? The answer is 'yes'.

This conclusion must be qualified (or found to be supported) in three ways.

First, the marble resource from the deposit must be capable of extraction in sound form, at moderate cost, and in the grade and range of properties required. To date, these assumptions can be drawn.* Nevertheless, as development work on the deposit as a quarry proceeds, any finding of its inability to yield material to these specifications would tend to destroy the economic justification of this particular project. The decision would then be one of abandoning a marble-based enterprise altogether, or of committing the necessary capital to locate and prove an alternative deposit of a suitable nature. The project outlined in this report requires a foundation. This foundation is a superior marble deposit. Until proven otherwise, the present deposit will do very well.

Second, the execution of the project requires competent management

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* The deposit has been examined in some detail by various consultants, and their findings summarized in report form. These reports were made available to this study for information purposes.

and technical expertise. These skills lie broadly in two fields. Technical expertise is essential in production (in both quarry and plant) due to the rather exacting process of extracting marble from the ground and converting it into finished product form. Managerial competence is required because of marble's place within the building materials group of commodities, and management must be familiar with this field. No difficulties are evident in securing the key personnel required.

Third, the project must be adequately (and soundly) financed. The capital appropriation (from equity and borrowing) must be sufficient to meet all costs of quarry development and plant installation, including a provision for plant 'run in' time. A working capital reserve must be available to finance the initial (and critical) period of the project's 'break in' penetration into the market. Finally, the capital structure itself must be appropriate, not only to the needs of the project but as well to the interests of its investors. Again, no problems are apparent.

Project Feasibility: Factors

Given these assumptions, why is the project feasible? The specific factors are set out in the text, but the rationale of project economics should be summarized. Six factors are isolated:

(i) The location of the deposit/project.

(ii) The consumption/demand levels for marble in the market area defined by the location.

(iii) The competitive effectiveness of the present sources of marble within the market region.

(iv) The nature and quality of the deposit itself as a source of raw material supply.

(v) The design and efficiency of the project in terms of pro-

duction economics.

(vi) The costs involved in the project, fixed/investment and operating/unit.

In this analysis, the first four factors are taken as the primary consideration, and project design and costs as secondary factors, shaped to a substantial extent by the former, and linked by the competitive route or strategy determined as most appropriate for the project. These matters are now discussed in sequence.

Project Feasibility: Location

The location of the deposit determines the boundaries of the market area in which the project can effectively operate. Marble possesses a relatively high value per ton among building material commodities, yet its density and unit weight limit its geographic distribution - first, from quarry to plant; and, second, from plant to market outlet in finished form. In practical terms (and under appropriate competitive conditions), finished marble may be transported overland to a distance of 700 miles. This distance establishes the market radius for the project.

The quarry site is located in north-eastern Nevada, slightly to the west of the geographic centre of the region formed by the 11 western United States, and somewhat to the east of the region's centre of population distribution. The bulk of the region falls within the market radius, and is defined as the primary market area. Two peripheral or secondary market areas are also available, but on a weaker competive basis: the two western Canadian provinces and substantial segments of the U. S. Mid-West lying between the Mississippi River and the Rocky Mountains.

The primary market contains some 32,000,000 people, one-sixth of the total population of the United States, and accounts for close to one-fifth of total national personal income. The latter figure more closely determines the region's share of total U. S. marble demand. This area (without the inclusion of the secondary markets) offers sufficient scope for the project. Ideally, the deposit should be situated slightly to the west, in closer proximity to the major California market. Nevertheless, the site is determined as favourable.

Project Feasibility: Consumption/Demand

The market for marble in the region is established, well-organized, and expanding. Present consumption of marble in all forms (at producers' f.o.b. returns) is estimated at $7,500,000 a year - or 15 percent of total U. S. consumption - and in the 1964-1966 period is expanding at approximately eight percent a year. This market growth is occuring following a sustained period of relative stagnation.

The demand for marble (or potential consumption) is substantially greater, and is estimated at not less than $15,000,000 a year. The shortfall between present/potential consumption is caused by a number of factors, including delivered price, material unavailability, installation costs, delivery lags, and certain qualitative factors. The gap is now filled by substitutes or alternatives to marble which have gradually replaced it, and which (under the appropriate conditions) may be at least partially displaced.

The conversion of value consumption into tonnage equivalents is difficult in view of a lack of data and a uniform basis of measurement. An approximate estimate would suggest consumption of some 30,000 tons

of 'dimension' material and close to 50,000 tons of 'crushed/ground' material. The approximate value of dimension marble would be in the range of $200/ton (at plant if domestic; or c.i.f. plus duty if imported) and $25/ton in crushed/ground produced in the region, both in finished product form.

Given the degree of latent potential consumption, consumption levels are also favourable.

Project Feasibility: Supply

The causes noted in the gap between present/potential consumption result from relative weaknesses in the present sources of supply of marble now serving the region. These sources are of three types.

Some $3,000,000 of total supply (or two-fifths) is produced by the domestic U. S. marble industry - whether shipped into the region in finished form, or in block/slab form to manufacturing plants within the region. In either case, a significant freight cost must be added to final price. In the finished 'import', delivery lags may occur. In the case of local manufacturing, the region's plants are located in the highest producing cost areas.

A further $3,000,000 (or two-fifths) is imported into the region from foreign producers - with the bulk of supply originating from Europe. Although these imports are competitive (at present price levels), they require relatively long delivery schedules and problems of intermittent material unavailability.

The remaining $1,500,000 (or one-fifth) is supplied in 'crushed/ground' form from plants within the region, plus a small (but indeterminate) import component. Regional marble production is limited almost entirely to these lower-value products.

The region is thus an 'import' market. The reason is the complete lack of an integrated, competitive producer of 'dimension' products. This deficiency is crucial to the project. It offers the initial opportunity to displace imported material with its own products, and the further opportunity to broaden regional consumption toward potential levels.

Project Feasibility: Raw Material

Equally crucial is the nature of the deposit itself. From present geologic evidence, no shortage of marble in the ground exists in the western United States. Marble abounds, frequently in high grade. Yet known deposits are liable to any or all of a number of handicaps: a high degree of internal fracturing; inaccessible location or occurrence in a high cost area; insufficient tonnage in grade; inappropriate quarrying conditions; or a restricted range of colours and other properties essential in the market.

The Nevada deposit suffers from none of these disadvantages. The material appears sound to depth. The site is accessible, and convenient for an industrial operation. The tonnage is massive. The grade is regarded from good to superior. The local cost structure is moderate. The deposit may be quarried readily. Most strikingly, its marble occurs in a wide range of colours (and patterns), including a majority of those considered desirable in the market.

This combination of advantages is extremely favourable. If the conditions of soundness/grade/colour range are sustained on full quarry development, the deposit is capable of becoming the prime asset of a substantial and long-range industrial enterprise. These conditions alone warrant the required outlay on full development work on the deposit.

Project Feasibility: Strategy

The foregoing factors establish a framework for project feasibility. The next essential question becomes: can the project compete? For, as a new entrant into the market, it must not only be able to meet established price levels but, more important, withstand (or initiate) a 'break' in market prices from a competitive reaction on the part of the region's present suppliers. In assessing this ability, it is necessary to determine a competitive route for the project. This route (once established) imposes a size and shape - a 'design' - on the project itself.

In determining the most appropriate route, two elements of strategy arise.

First, the products selected for output must be those in which the present sources of supply are now (and are likely to be) most vulnerable. An adequate demand/supply balance in any product, and the presence of adequate or aggressive competition, would discourage entry. The search is directed instead to those product areas where successful market penetration can be secured.

Second, within these areas, each product must have a distinct (if not decisive) advantage over its competitors - fundamentally in price, but also in quality, cost of use, or availability. A competitive price structure rests on low unit production costs. These costs are most readily achieved through volume, standardized size or shape and continuous production. Where any product requires a multiplicity of separate processes, limited production runs, or variegated dimensions, the location/cost advantages of the project would be diminished. The search is also directed to those products that can be processed on a straight-run, volume basis.

Four product areas conform to this basic strategy.*

They are:

Floor tile.

Split-face 'brick'.

Furniture slabs and surfaces.

Fireplace components and 'packages' to standard size.

In each case, a market may be secured (or developed) with relative ease. The product can be manufactured to standard dimension and on a continuous production basis, permitting volume output and low unit costs. And all offer the opportunity to stimulate increased consumption on a price/quality basis. These four products are recommended as the 'dimension' range for the project.**

Project Feasibility: Design/Costs

The design of the project thus takes on a certain shape, conforming to the production objectives of the plant. The design is refined by determining the production process that is most efficient and

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* Three product areas do not. They are 'structural' components (panels, slabs, facings and the like) for individual buildings; 'monuments' whether in slab or component form; and small blocks and pieces for ornamental and special uses. The 'structural' field is the most competitive and with the 'monument' involves custom work, high value added, and non-continuous production. The last field is too small to warrant separate production. None confers any competitive advantage to the project at this time. A reassessment of the 'structural' field is recommended for 1968.

** Normally, one-half of quarried material will be unsuitable for 'dimension' conversion and is crushed and/or ground into aggregate, chip, granule or powder. Where warranted, crushed marble (as $CaCO_3$) may be quarried separately. These matters are reserved for the text, although a crushing/grinding plant is recommended as a component of the project.

appropriate. The question arises: can marble be produced on a continuous, straight-run, low cost basis? Provided the products are amenable to standardization in dimension and quality, the answer is 'yes'.

The process designed for the project is as follows:

A block of marble (quarried and transported from the deposit) is placed on a gang-saw to be sawn into slabs.

The rough slab is placed on a saw-table and trimmed to precise length and width.

The trimmed slab enters an automatic grinding/polishing line to be 'planed' and polished.

The polished slab is placed on a second saw-table and sawn into finished dimensions (e.g., a 4'x4' slab into sixteen 12"x12" floor tiles). The edges are ground and polished, if necessary (e.g., furniture surfaces.

The finished products are inspected, graded, packed, and stored for shipment.

This process varies from the typical operation in the marble industry only in establishing 'single run' production lines. The separate machines/units may be integrated and precisely co-ordinated to ensure steady, maximum throughput and a high rate of operating capacity. The principal variable cost (labor) is reduced to levels substantially below those prevalent in the industry, while fixed costs per unit of output are minimized. The plant proposed is regarded as the most efficient operation of its kind in the world.

The size of the plant is a function of market demand, but is also influenced by rate of output and machine capacity. A complete equipment specification is contained in the report.

At the initial phase of development, three production 'lines'

would be installed.

First, a floor tile 'line' producing tiles 12"x12" x 3/8" at the rate of 2,000 sq. ft. per eight hour shift (or 70 percent of full machine capacity); 4,000 sq. ft. per day; and 1,000,000 sq. ft. per year. Tonnage equivalent (net weight) is 2,656 tons.

Second, a parallel 'line' producing furniture/fireplace material in limited dimensions and in 5/8" and 7/8" thickness at rates of 1,000 sq. ft. per shift; 2,000 sq. ft. per day; or 500,000 sq. ft. per year. Tonnage equivalent (net weight) is a further 2,656 tons.

Third, a separate split-face 'brick' unit producing a maximum output of eight tons per shift; 16 tons per day; or 4,000 tons (net) per year.

The total volume of 9,312 net tons determines the rate of output at the dimension quarry - with a full allowance for material loss during production (cited in the text) a total annual output of close to 20,500 gross tons in usable form. As in excess of 6,000 gross tons of this total is recoverable as by-product raw material for the crushing/grinding plant, an annual production of 24,000 tons has been determined as feasible for the crushing quarry.

It is extremely unlikely that the manufacturing plant can be established at the quarry site.* The closest incorporated centres of industrial activity are Ely, Nevada, 60 miles to the south, and Salt Lake City, Utah, 170 miles to the east. The Ely site is selected as most economic, and involves a moderate (and tolerable) freight cost in

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* A new 'townsite' was suggested by the client, but after investigation was reported as excessive in terms of installation cost.

moving blocks from quarry to plant. As the tonnage consumption at plant per day is 64 tons (roughly the equivalent of three 'blocks' 9'x5'x6' to ensure maximum recovery), supply may be achieved by thrice-daily truck or bi-weekly rail shipment. Truck transport is recommended.

The capital cost of the project has been established at $1,800,000.

Quarrry development/equipment is estimated at $300,000.

Plant building/land cost will approximate $200,000.

The cost and installation of plant equipment is determined at $500,000.

The crushing/grinding unit will approximate $200,000.

The balance of $600,000 has been appropriated for 'run in' periods and working capital for the critical market 'break in' period.*

Project Feasibility: Profits

The gross revenues and net profits of the project on an annual basis (at first stage development) are determined by pricing policies in each product area and by fixed/operating costs per unit of product output. These factors are dealt with in some detail in the report, but gross revenues and costs may be summarized here.

Pricing policies have been established throughout on a below-market basis and (with variations in product quality/finishing/colour) are broadly:

Tile at $1.00 per sq. ft., or an output of 1,000,000 sq. ft. per year will yield gross revenues of $1,000,000.

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* The financing and capital structure of the project is set out in the text. Broadly, $1,000,000 in equity capital and $800,000 in borrowing are recommended as appropriate.

Crushed/ground products at an average of $12.00/ton, or on 25,000 tons/year a gross revenue of $300,000.

Split-face 'brick' at an average price of $25/ton, or on 4,000 tons/year a gross revenue of $100,000.

The project's annual gross revenues would thus be $2,400,000.

The combined cost per unit of product output (fixed operating/overhead/sales) is computed in the report on a pre-income tax basis.* In the aggregate, total operating cost - plus interest, depreciation, and pre-profit taxes - will amount to 75 percent of gross revenues.

Total project gross annual costs are estimated at $1,915,740.

Assuming a 48 percent maximum corporation income tax rate in effect in the first full production year,**project net income would be $258,310.

This rate of profit would represent 10.8 percent on sales; 14.3 percent on total invested capital; and 25.8 percent on equity.

These ratios fully meet the criteria of project profitability, and development of the deposit leading to full implementation of the project is recommended.

Some Future Prospects

The project recommended in this report is small. The objective

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* Total unit costs were developed in conjunction with the project's equipment suppliers (acting on a consultative basis) on the first two 'lines'. With full allowances for anticipated waste and consumption of expendables, the maximum unit cost of tile is estimated at $.806 per sq. ft. and on furniture/fireplace material $1.417 per sq. ft.

** A construction start on the plant is asssumed to occur during the third quarter of 1966 with completion assumed in the first or second quarter of 1967. The first full year of production will be 1968. The fiscal year is assumed to be the calendar year.

has been an efficient operation yielding maximum profitability. Its revenue/profit generation potential, however, is substantially greater.

First, prices established for product output have been held at low levels to establish the project firmly within the market.* The aim has been to offer a product range and volume which can be sold.** Nevertheless, when conditions warrant, prices can be adjusted upward on a moderate basis (perhaps 15 percent over three years) to offset any increases in costs and to enhance profitability.

Second, the project is capable of expansion, and a doubling of capacity (overall, but varying among the four product areas) appears warranted at 1970. The project's gross annual revenues would then be of the order of $5,000,000. A large part of the expansion would be financed from depreciation and retained earnings (or their equivalent).

Third, diversification into new marble product areas may be feasible in the 1970-1972 period. The principal area would be the 'structural' products field. This forecast assumes a significant growth in market potential to warrant volume output, and the application of technical improvements in the marble construction industry now known, but not yet fully exploited. A separate (or adjacent) plant would be required, at an approximate cost of $750,000, with gross revenues of

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* Until the early 1960's, the market was held by U.S. producers. Imports (primarily from Italy) were noticeable by 1961 and, by decisively undercutting domestic prices, increased substantially to 1965. Having secured market penetration, Italian suppliers have significantly raised f.o.b. prices in the 1963-1966 period until they have neared former levels. The project would apply essentially the same tactic.

** Discussions have been held with prospective distributors, and the matter is reported in the text.

$2,000,000 a year. As fixed costs are a relatively low proportion of unit cost in this field, this plant should be financed largely through borrowing. Thus, within seven years of full production, the revenue potential of the project would approximate $7,000,000 a year.

The major future opportunity, however, lies outside the marble industry per se: in limestone, lime, and calcine products. Limestone occurs in quantity within the boundaries of the property, and in chemical applications (both as calcium carbonate) both marble and limestone have a wide range of uses. The conditions are not yet appropriate for a line/calcine operation in eastern Nevada, but may well be favourable within the next decade. An operation of this kind (at a capital investment of $10,000,000 to $15,000,000 is a major undertaking. An assessment of its potential is recommended in the 1968-1970 period.

The project outlined in this report is thus the 'leading ore' of a long-term, diversified, and substantial enterprise. Built with care, it offers excellent prospects of significant growth.

SECTION I:

THE FRAMEWORK FOR THE PROJECT

This report deals with the basic factors that determine the design and economic justification of the Nevada marble project. These factors - market supply/demand; production techniques and costs; finance, distribution methods and expansion prospects - are discussed in sequence in Sections II - V.

The project, however, will not be built in isolation. It will produce a commodity (marble) with inherent advantages or disadvantages: built-in consumer attitudes; and a market performance that is static, dynamic or declining. It will enter an industry (the U. S. domestic marble industry) that is competitive or vulnerable; that works to certain standards and efficiencies; and that operates on a basic cost/price structure. It is located in a regional economy (the economy of the project's market area) whose stability, structure and growth rate influence market potential and costs.

These influences establish a broad framework for the project that should be assessed. In this section, the commodity and the industry will be outlined in combination, while an exploration of the economy of the market region will follow.

THE MARBLE INDUSTRY OF THE UNITED STATES

Marble may have an aura of 'romance', but in any investment decision regarding its exploitation it must be treated as a commodity

like any other. This commodity will have certain uses based on its inherent properties. It will also have recorded a performance in the market-place that determines its competitive ability in maximizing its uses/properties, whether through its cost/price structure or the state of its technology.

The properties of marble are well known. These are commonly regarded as relative strength and hardness, density, durability, intrinsic attractiveness, and its ability to take (and retain) a high polish. In essense, the material is used because it is both decorative and durable. These qualities stem from its geology as a metamorphic or crystalline limestone or dolomite, and its 'appeal' in colour, texture, and surface pattern.

The uses of marble have been related traditionally to construction. Marble stone has been quarried for well over three thousand years, and the material has an exceptional longevity in continuous use. In 'dimension' form, marble is still used in its historic applications: structural block; exterior/interior wall cladding; floor and paving tile; furniture; and other decorative purposes. The 'crushed/ground' applications of the material are relatively recent: for construction uses in aggregate/chip/granule form; for chemical and industrial uses in finely ground form as a highly concentrated calcium carbonate.

Trends in the Marble Industry

The performance of marble as a competitive commodity is relevant only in the 1945-1965 period. Previously, marble in dimension form was in strong demand until the late 1920's, then suffered a drastic reduction in consumption during the depression of the 1930's and World War II. In the port-war period, the industry has never recovered from

this decline.* Annual output has not exceeded 160,000 tons nor annual value (at producers' f.o.b. prices) $22,000,000. This volume is less than half the pre-1930 level, and (in view of the major increase in construction volume) marble's share of the building materials market has shrunk to less than ten percent its previous level.

Two cycles identify the material's performance in the post-war period. From 1945-1955, annual production rose sharply, in a recovery from the abnormally low output levels of depression/war. From 1956-1964, annual output has remained relatively static at an average 135,000 tons per year. This period of 'stabilization' appears to be continuing, although moderate gains in annual output may be expected in the period to 1970.

This trend is typical of a 'declining' commodity, for while annual output has remained stable the material's share of the market has been progressively reduced. This decline is due to three inter-related factors.

First, the substitution of alternative materials has made deep inroads into marble's building applications. These materials (stainless steel, glass, aluminium, ceramics, pre-cast concrete, plastics, systhetics) have given architects and engineers a broader range of selection, flexibility, and efficiency in material usage. For marble, this process has severely limited its range of use and the type of building project in which it can be competitive.

Second, the technology of the industry has lagged. The develop-

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* See Oliver Bowles, "Dimension Stone," Industrial Minerals and Rocks, American Institute of Mining, Metallurgical and Petroleum Engineers, New York, 1960. As marble is not an essential or strategic commodity, its wartime consumption tends to fall or be retarded.

ment of new applications of marble in finished form (the most notable being joining marble facing to precast panels for 'hanging') is limited, recent, and only partially exploited. Similarly, the process of the industry in manufacturing and finishing marble remains relatively inefficient. Although efficiency gains are possible through new equipment and techniques, these have not been widespread in the industry.

Third, the cost of marble relative to alternative material remains somewhat high: in total material and installation cost.* Thus, its use tends to be restricted to 'prestige' public, commercial and residential projects; even here it must compete against equivalent materials.

This is a small range of the total construction market on which to base any dynamic prospects for dimension marble. The static pattern of the dimension industry is expressed in production figures for selected years, given in Table I.

Two other broad trends are significant.

First, U. S. consumption of marble has not remained static. It has risen appreciably in the 1956-1965 period, and is accelerating: and apparent total rise in the decade of 50 percent and a current annual increase in the range of six to eight percent. This increase has not been supplied by the domestic industry. It has come from imports (primarily from Italy, but including Portugal, Belgium, Yugoslavia, Bulgaria and Mexico). In the last reported year, imports of dimension marble exceeded $12,000,000 and accounted for 40 percent of total U. S. con-

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* The American Marble Institute of Washington, D. C., is attempting to overcome this cost factor by stressing in its promotional campaigns that marble adds 'only two percent' to total contract cost. The Institute reports, however, that the argument is not making much headway. It sees industry growth dependent upon improved technology.

TABLE II

Production of crushed/ground marble f.o.b., United States, 1963-1964.

SEGMENT/SOURCE	1963	1964	Increase + or -
DIMENSION :			
Domestic (1) (2)	$ 21,002,000	$ 19,245,000	- $ 1,757,000
Imported	$ 11,298,000	$ 12,200,000	+ $ 902,000
TOTAL, DIMENSION	$ 32,300,000	$ 31,445,000	- $ 855,000
CRUSHED/GROUND :			
Domestic	$ 13,565,000	$ 17,448,000	+ $ 3,883,000
Imported	$ 247,000	$ 227,000	- $ 20,000
TOTAL, CRUSHED/GROUND	$ 13,812,000	$ 17,675,000	+ $ 3,863,000
TOTAL CONSUMPTION	$ 46,112,000	$ 49,120,000	+ $ 3,008,000

Source : U.S. Bureau of Mines, "Stone", Minerals Yearbook, 1964.

Notes : (1) The decline in domestic dimension output in 1964 was due entirely to a reduction of $3,459,000 in monumental products, more than offsetting a $1,702,000 increase in building products value, and distorts the year-to-year consumption pattern. In 1965-1966 the monumental decline will be substantially restored.

(2) Virtually all domestic dimension output is available for consumption within the United States. Export volume is slight, and is not reported to have exceeded $400,000 in any recent year.

TABLE I

Production of dimension marble f.o.b. values, United States, 1959-1964.

BASIS	1959	1960	1961	1962	1963	1964
Short Tons	137,000	129,000	157,000	146,000	150,000	130,000
Value	$18,085,000	$17,743,000	$18,566,000	$18,739,000	$21,002,000	$19,245,000
Value per Ton	$ 131.88	$ 137.70	$ 118.40	$ 128.51	$ 140.20	$ 148.50

BASIS	1963			1964		
	Tons	Value	Per Ton	Tons	Value	Per Ton
Building : (1)						
Rough	28,000	$ 1,134,000	$ 40.50	28,000	$ 1,031,000	$ 36.17
Dressed/Sawed	34,000	$ 3,100,000	$ 91.60	36,000	$ 3,888,000	$108.00
Dressed/Cut	46,000	$ 9,474,000	$205.96	48,000	$10,491,000	$218.56
Monumental	42,000	$ 7,294,000	$173.67	18,000	$ 3,835,000	$213.10
TOTALS :	150,000	$21,002,000	$140.20	130,000	$19,245,000	$148.50

Sources : 1959-1962, U.S. Bureau of Mines, "Stone," Mineral Facts and Problems, 1965.
1963-1964, U.S. Bureau of Mines, "Stone," Minerals Yearbook, 1964.

Note : (1) For 1964, 'building' production includes 435,000 cu. ft. (or 37,250 tons) valued at $6,713,000 for interior use; and 882,000 cu. ft. (or 75,000 tons) valued at $8,697,000 for exterior use. Values per cu. ft. were $15.43/ interior vs. $9.86 exterior. For dressed exterior, values will approximate $16.00 - $18.00 per cu. ft.

sumption in value terms and more than 50 percent in volume. Highly competitive in price and available in a rich array of colours and patterns (although frequently in limited amounts), imports have been a principal deterrent to industry growth.* Consumption/import levels are given in Table II.

Second, the 'crushed/ground' sector of the industry has been dynamic, experiencing consistent annual gains in output. Where crushed marble represented a negligible factor in the industry as late as 1945, it now accounts for 94 percent of total tonnage output and 47 percent of total sales value in the industry. The increase has been possible through an 'invasion' of higher-value markets for limestone, dolomite, or line- a process that does not appear to be diminishing. In the last reported year, sales of crushed/ground marble at $17,000,000 were only $2,000,000 below those of dimension material. Recent figures are provided in Table III.

The production of crushed/ground material has been an extremely beneficial development to the industry. It has permitted the recovery of quarry 'waste', on a by-product basis, adding to total revenue. It has stimulated research and technical improvement in the industry, leading to new uses for marble and a wider market horizon. And it has stabilized (and enhanced) industry profits.** In 1966, crushed/ground

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* The American Marble INstitute reports an effort to obtain increased tariff protection from imports of finished marble products. This effort shows little chance of success. Several domestic firms are overcoming a part of their cost/price disadvantage by importing whole blocks from Italy and other sources.

** A prospectus (circa 1958) of the Georgia Marble Co. Ltd., the largest producer in the industry, reported cursched/ground ('calcium products') divisions accounted for 41 percent of sales by value and 54 percent of company net profits.

output will probably exceed 2,000,000 tons and surpass dimension marble by value. Typically in products of low per ton value, this output is not threatened by imports.*

Thus, the Nevada project will operate under three broad national trends:

A stable (but only moderately increasing) dimension marble output, retarded by cost and technological impediments.

A rising consumption of dimension marble, presently satisfied by imported material on a price/range basis.

A dynamic trend in output and consumption in crushed/ground material, based on a successful penetration of markets of alternative materials.

These trends are broadly paralleled in the project's market area (with certain significant modifications), and a more detailed discussion is resumed in Section II.

The Industry: Distribution/Structure

The U. S. marble industry is located in areas where large, high grade, easily quarried deposits occur. As the finest domestic marbles are found in the Appalachian Range, the industry is concentrated in the eastern United States. The bulk of dimension marble production is located at the southern and northern extensions of the Appalachians, and four states - Vermont, Georgia, Alabama and Tennessee (in order of value in 1964) - are estimated to account for more than 80 percent of total output. A third important source is Missouri, the fifth-ranked

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* In the last reported year (1964), imports of marble chips into into the U.S. totalled $220,000, mainly in coloured material.

TABLE III

Production of crushed/ground marble f.o.b., United States, 1963-1964.

USE	1963			1964			Value Change + or -
	Short Tons	Value	Per Ton	Short Tons	Value	Per Ton	
TERRAZO	367,000	$ 4,768,000	$12.99	406,000	$ 5,277,000	$13.00	+$ 509,000
OTHER USES (1)	1,385,000	$ 8,797,000	$ 6.35	1,557,000	$12,171,000	$ 7.82	+$3,374,000
TOTAL	1,752,000	$13,565,000		1,963,000	$17,448,000		+$3,883,000

Source : U.S. Bureau of Mines, "Stone," Minerals Yearbook, 1964.

Note : (1) Other uses include acid neutralization, agriculture, asphalt filler, cast stone (i.e., aggregate panels), mineral food, roofing chips/ granules, roadstone, stucco and whiting. Excluding roadstone (with a typical value of $1.00 - $2.00/ton, the average value of these other uses is in the range of $12.00 to $15.00/ton, and in certain finely ground products will reach $35.00/ton.

ground values range from

TABLE IV

Distribution of U.S. marble production, approximate basis, by major producing states, 1964.

STATE	DIMENSION				CRUSHED/GROUND			TOTAL VALUE
	Rank	Plants	Short Tons	Value (fob)	Rank	Short Tons	Value (fob)	
Vermont	1	8	30,000	$ 7,500,000	11	10,000	$ 200,000	$ 7,700,000
Georgia	2	1	37,000	$ 5,000,000	1	1,200,000	$ 7,500,000	$12,500,000
Alabama	3	2	12,000	$ 2,500,000	2	420,000	$ 6,650,000	$ 9,150,000
Tennessee	4	12	29,000	$ 2,100,000	8	20,000	$ 300,000	$ 2,400,000
Missouri	5	4	10,000	$ 1,800,000	3	140,000	$ 400,000	$ 2,200,000
Arkansas	6	2	7,000	$ 240,000	-	20,000	$ 240,000	$ 480,000
North Carolina	7	1			9			
New Mexico	8	1	5,000	$ 110,000	-	60,000	$ 760,000	$ 1,410,000
Montana	9	1			17			
Colorado	10	1			15			
Washington	11	3			10			
Arizona	12	2			7			
California	13	1			5	30,000	$ 540,000	
Maryland	14	1	*	*	14	*	$ 10,000	$ 10,000
Texas	-	-	-	-	4	60,000	$ 900,000	$ 900,000
TOTAL	14	40	130,000	$19,250,000	20	1,960,000	$17,500,000	$36,750,000

Source: U.S. Bureau of Mines, Region VI, San Francisco, plus corporate and trade sources.

TABLE V

Values per ton (f.o.b. quarry/plant), dimension and crushed/ground marble, United States, by major producing and selected western states, 1963 and 1964.

STATE	DIMENSION			CRUSHED/GROUND		
	Rank	1963	1964	Rank	1963	1964
VERMONT (1)	1	$ 227.00	$ 238.00	11	N/A	N/A
GEORGIA (2)	2	$ 160.00	$ 152.00	1	$ 5.84 (5)	$ 6.00
ALABAMA (2)	3	$ 188.00	$ 219.00	2	$ 9.75	$ 16.00
TENNESSEE (2)	4	$ 66.45	$ 73.00	8	N/A	N/A
MISSOURI (3)	5	$ 148.00	$ 174.00	3	$ 2.74	$ 2.50
TEXAS	-	-	-	4	$ 15.00	$ 15.23
CALIFORNIA (4)	13	$ 11.60	$ 19.50	5	$ 16.41	$ 16.60
MONTANA (4)	9	$ 20.21	N/A	17	$ 18.00	$ 18.00
UTAH	-	-	-	20	$ 25.00	$ 27.56
ARIZONA	12	N/A	N/A	7	N/A	$ 12.61
WASHINGTON (4)	11	N/A	$ 9.89	10	$ 17.69	$ 14.13
TOTAL U.S.	14	$ 140.00	$ 130.15	20	$ 7.74	$ 8.88

Source : U.S. Bureau of Mines, Minerals Yearbook, 1964, state chapters, plus revealable data, Region VI, San Francisco.

Notes : (1) Vermont Marble Co. (2) Georgia Marble Co. as major producer in state. (3) Carthage Marble Co. (4) Per ton value depressed due to high content of dimension 'rubble'. (5) Per ton value depressed due to direct sale at quarry of broken stone for lime, Typical crushed/ ground values range from $12.00 to $35.00/ton.

state. The remainder of dimension production is scattered over nine states, based on small local operations. The production of crushed/ground marble is more widely distributed with 21 states reporting tonnage output in 1964. The dominant producers were located in Georgia and Alabama, followed by Missouri, Texas and California. Remaining output was typically small and localized. Available information on the distribution of the industry is given on Table IV.

Since marble is a 'quality' material, the four dominant states in dimension output also record the highest values on a per ton basis. The highest prices are recorded by Vermont (ranging to $250 per ton), with somewhat lower levels in Georgia, Alabama and Tennessee (averaging $150 - $220/ton). Values of crushed/ground material are based on local competitive conditions rather than quality. Figures on unit values are summarized on Table V.

Two firms dominate the industry. These firms are, respectively, the Georgia Marble Co., Ltd. and Vermont Marble Co., Ltd. The latter firm is based on massive, economic deposits of marble of excellent grade and wide colour range in the vicinity of Proctor, Vt. Formerly the first-ranked producer, it has annual revenues in excess of $22,000,000. Georgia Marble has grown through consolidation of its principal operations at Tate, Ga., with quarries and plants principally acquired in Alabama and Tennessee. It is now the largest producer in terms of employment (2,500 persons) and annual sales, estimated at close to $30,000,000.*

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* Both Georgia and Vermont operate manufacturing/finishing plants (but not quarries) in California. Georgia acquired independent firms in Los Angeles and San Francisco, and Vermont operates a plant in San Francisco. See later discussion in Section II.

The two firms account for the bulk of industry sales in the two largest dimension marble fields - 'structural' (or building) and monuments. While Vermont is a major supplier in eastern Canada and the New England states and Georgia is paramount in the U. S. South-East, both firms compete effectively throughout the Atlantic Seaboard and Mid-West areas. This competition is based not only on price, but on the quality, colour, or pattern of their marbles.*

The third-ranked producer is Carthage Marble Ltd. of Joplin, MIssouri, with annual sales in the range of $7,000.000. Its quarries yield principally light gray marbles, and its output is limited chiefly to interior building applications. Within its range, Carthage is competitive throughout the Mid-West and Gulf areas.

The remaining output (substantially less than 10 percent) is fragmented among a number of small, independent firms located principally within the Appalachian area. These firms typically are marginal and engage in intermittent production. As new entry into the dimension marble industry is extremely rare (and usually short-lived), the number of independent firms continues to shrink. A number have been purchased, either for the particular colour range of their quarries or for

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* Georgia and Vermont are both completely integrated and follow the same basic pattern. As suppliers, they will 'bid' on contract jobs (corporate/bank head office buildings, government buildings, libraries/museums, and the like) to supply all material components in finished form. As contractors, they will also install the material on the job. Vermont's quarries yield marble in white, gray, blue, green and a highly-prized 'verd antique'. Georgia's gray, blue, pink (mainly coarse-grained), and Tennessee pinks and reds, frequently patterned. Both firms import marble in blocks from Europe to supplement any colour deficiencies.

their equipment.*

The three firms - Georgia and Vermont as 'majors' and Carthage as of intermediate size - establish the southern, northern and western axes of the dimension industry. To the west of Missouri, no large or integrated producer exists, and any quarry producing more than a few hundred tons of dimension marble a year is extremely rare. Although specific figures are not available, it is unlikely that dimension output in the whole of the western U. S. exceeds 5,000 tons in any one year (or less than four percent of the national total), and the normal annual volume is likely to be closer to the 2,500 - 3,000 ton range. While six quarries operate on a more or less regular basis, none has the capital or raw material resources to warrant volume output, much less expansion to the status of a 'major' regional supplier.

Instead, the western U. S. is served by individual plants (frequently owned or associated with a 'major'), 'importing' blocks or rough slabs into the region from the eastern U. S. or overseas, and supplying the building market on a job bid basis. In addition, a number of marble monument makers are also established - again importing their raw material to plant site. In essense, the western U. S. is a secondary market for Georgia and Vermont - an outlet for quarried and semi-processed marble, but an area in which the domestic industry has no strong or certain hold. Thus, the industry is liable to (and experiences) severe competition from foreign imports.

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* A concentrated example of this process may be found at Knoxville, Tennessee, a long-established marble production centre. The Tennessee Marble Co., Ltd. was acquired by Georgia and operates as a company division. The Gray-Knox Co., Ltd. was sold to Ver-Mont, and its useable equipment shipped to Proctor. A third firm is presently seeking a buyer, so far without success.

As noted, the distribution of the crushed/ground segment of the industry is somewhat broader. This segment is again dominated by Georgia Marble with crushing and dry/wet grinding plants in both Georgia and Alabama, accounting for perhaps more than 50 percent of total industry output in this range. These plants produce the typical marble crushed products - aggregates for wall panels, terrazo chips and roofing granules - but are also heavily engaged in a broad range of 'calcium' (i.e., calcium carbonate) ground products for whiting, fillers, lime substitutes, fertilizer, agricultural and chemical applications. The same pattern (although on a substantially smaller scale) is pursued by Carthage. Vermont Marble has not entered this segment in any significant way.

The balance of the crushed/ground segment is engaged primarily in the production of terrazo chips, aggregates, and granules (chiefly for roofing and agricultural purposes). As long-distance shipment of these products is prohibitive, regional requirements of these products are met by local marble crushing producers, or from alternative materials (e.g. limestone, quartz, basalt or dolomite). While a greater degree of self-sufficiency in this range exists in the western U. S., the marble industry is operating at less than half its market potential, as based on national consumption averages. Higher-quality products must still be 'imported' into the region, while the lower-value range encounters competition from alternatives.

The Industry: Product Range/Technology

Any meaningful segregation of product output from published data is virtually impossible on a U. S. national basis. Output of dimension marble is classified under 'building' (rough or dressed) and 'monumental'

(rough or finished). Typically, the production and sale of rough building marble accounts for less than 20 percent of tonnage volume; monumental marble products for 20 percent; and dressed building products - whether sawn or cut - for more than 60 percent. The product breakdown in national data for 'crushed/ground' output offers no guidance whatsoever, as all end uses are unsegregated.

Within the dressed (or finished) building materials group, output has remained relatively stable at 75,000 to 80,000 tons a year, and close to $14,000,000 in annual value (at producers' f.o.b. prices). As the industry is engaged typically in the installation of marble components on the job (as well as the supply of the material), this segment is crucial - adding perhaps an additional $10,000,000 to $15,000,000 to industry gross revenues. Given a total value of $25,000,000 in the building field, the production/installation of wall panels, slabs, facings and veneers accounts for annual revenues of $20,000,000 - $22,000,000. The remainder is derived from columns, decorative components, sills, stoops, steps and floor tile.

This pattern is based on the way in which the industry operates. The production of marble building products is regarded as a 'craft' and 'custom' process. As each building is a separate contract, the size, dimensions, volume, even the colours and patterns of the material will vary. Thus, the industry works to 'orders' - and, for all practical purposes, to orders alone* - and the function of the typical plant is to <u>make</u> a marble building. As a result, the industry is not product-

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* An example is the Nelson Structural Division of the Georgia Marble Co., Ltd., inspected for this study, in which a complete "job" is processed, including all marble components. The same type of operation is reported to be conducted at the Proctor plant of Vermont Marble.

oriented, and has not isolated any marble products for separate output on a competitive basis against alternative materials. Thus, there is no plant producing marble furniture material, nor any separate operation producing floor tile for the flooring market. The objective of the industry (and its member firms) is to increase the total use of marble in dividual building projects - thereby enhancing the value of each contract. Full capacity output occurs only when the plant is able to move immediately from one order to the next, and the ratios of product output (wall panels, window sills, floor tiles) will fluctuate accordingly.

What the industry produces, however, it does extremely well. Indeed, the survival of the industry (and its ability to stabilize its annual output at present levels) is dependent on the quality of its material and the calibre of its workmanship. Even here, there are problems and disadvantages. The chief problem (overcome only by the 'majors' with their massive deposits) is lack of colour consistency in major building projects. The principal disadvantage lies in costs: for competent workmanship involves a high labour content.

Estimates of the labour content in total unit cost in the U. S. marble vary, but range from 40 to 65 percent.* Fortunately for the industry, the two major firms are located in regions with wage structures below the U. S. average. This content, however, is sharply above the U. S. industrial average of 20-25 percent in building materials and

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* The American Marble Institute regards 60 - 65 percent as a reasonable estimate of labour content in total unit cost. Based on information supplied by officials of the Georgia Marble Co., Ltd., the labour content at the Nelson Structural Division appears to be in the 40 - 45 percent range. This division is regarded as the most efficient on a production/cost basis of its kind in the world.

construction industries. While new techniques have been applied to certain operation, the 'custom' nature of the work tends to prevent the industry's conversion to a more favourable labour-to-capital ratio.

A discussion of specific aspects and operations of marble production is reserved for Section III. Two points, however, should be made here.

First, the U. S. dimension industry can tolerate its relatively high degree of 'waste' (whether in the quarry or from trimmings and rejects on the production floor) because it has found by-product uses for its material.* Without this alternative outlet, dimension production would be sharply curtailed.

Second, the industry has very little hope of breaking out of its 'custom' or 'order'-oriented pattern (with the attendant disadvantage of a high built-in labour cost) unless it is able to apply available technology to volume production, and offer its products at a lower and more competitive price. For all practical purposes (with certain specific exceptions), the process of the industry has not changed in the last 50 years, nor significantly in the last 100.**

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* Typically, some 50 percent of quarry tonnage is in sound blocks suitable for dimension sawing/processing. A part of the 'waste' may be split into 'brick'; part may be crushed into by-products; while the balance may be sold outright to cement, lime or other industries in the quarry's area.

** The principal exceptions are diamond gang-saw and circular saw teeth and automatic grinding/honing/polishing of the sawn material for the finished surface. The latter represents a major cost breakthrough but cannot be easily applied to custom orders.

The Industry: Outlook/Prospects

To expand in any substantial degree, the industry requires a 'breakthrough' whether in markets or technology. Its present basis of operation tends to restrict it to a relatively narrow scope, dependent for volume/value increases on economic growth, increased corporate/personal incomes, and changes in tastes and material preferences in its favour. There are a number of indications that suggest that marble is now coming back into favour. As noted, however, the real gains in consumption have been satisfied by imports, many of which are in specialized finished form such as furniture material and floor tile. If it were able to standardize its production, the U. S. industry could secure a lower cost structure and major volume gains. All available evidence suggests that it will not do so (preferring instead to increase the efficiency of its 'order' output), and its annual volume/value gains are likely to be moderate.

In terms of the industry's structure, further consolidation of output into the two 'major' firms - Georgia and Vermont - may be anticipated. The position of Carthage Marble is not known, but this firm has entered specific market ventures with Vermont and may become an effective subsidiary. With its series of acquisitions over a 25 year period, Georgia Marble has a substantial debt structure and is likely to concentrate on expansion of its existing plants. Even so, the dimension marble industry may well cease to exist as a separate entity. A recent offer of purchase to Georgia on the part of a large, diversified industrial company was refused by principal shareholders, despite a strong recommendation from management. In any event, the eastern U. S. orientation of the industry is likely to remain (if not intensify).

TABLE VI

Projections of production, imports and total consumption of marble, United States, in 1965 dollars, two bases, 1965 - 1980.

SEGMENT/BASIS	1965	1970	1975	1980	ANNUAL (4) INCREASE
BASIS I : (1)					
Dimension/domestic	$ 20,000,000	$ 22,000,000	$ 25,000,000	$ 28,000,000	+ 2.67 %
Dimension/import (3)	$ 15,000,000	$ 21,000,000	$ 28,000,000	$ 35,000,000	+ 8.86 %
Crushed/Ground	$ 20,000,000	$ 27,000,000	$ 35,000,000	$ 44,000,000	+ 8.0 %
TOTAL CONSUMPTION	$ 55,000,000	$ 70,000,000	$ 88,000,000	$ 107,000,000	+ 6.27 %
BASIS II : (2)					
Dimension/domestic	$ 20,000,000	$ 27,000,000	$ 35,000,000	$ 44,000,000	+ 8.0 %
Dimension/import (3)	$ 15,000,000	$ 20,000,000	$ 24,000,000	$ 30,000,000	+ 6.67 %
Crushed/Ground	$ 20,000,000	$ 27,000,000	$ 35,000,000	$ 44,000,000	+ 8.0 %
TOTAL CONSUMPTION	$ 55,000,000	$ 74,000,000	$ 95,000,000	$ 118,000,000	+ 7.6 %

Notes :

(1) Assumes moderate improvement in technology, equivalent costs, no new significant market penetration, in domestic dimension segment.

(2) Assumes significant improvement in technology/costs, and increased market penetration in domestic dimension segment; modest displacement of imports by domestic building products.

(3) Marble imports include block/slab travertine.

(4) Average annual increase not compounded.

The outlook for the 'crushed/ground' segment of the industry is meaningful only on a regional basis. In the eastern U. S., this segment will continue to provide the 'growth' prospects in revenue and profit terms. The lack of a single, large producer in the western U.S.- as well as severe price competition from substitute materials - suggests less favourable prospects for the regional industry.

As to U. S. marble consumption, the prospects are excellent. The material remains in high relative demand, and a substantial increase is prevented chiefly by its cost/price structure. The dramatic rise in imports has been achieved despite the obstacles of additional cost (to f.o.b. price), frequent unavailability in specific products or colour ranges, and relatively long delivery schedules. On a national basis, consumption is likely to increase by at least 50 percent by 1975, and could be effectively doubled given conditions of competitive prices and material availability.

Projections for production and consumption are offered in Chart II.

THE ECONOMY OF THE WESTERN UNITED STATES

The eleven western United States* form one of the five regions of the United States, joined by a common structure of natural resources, economic base, transport routes (and costs), services and social patterns. The Nevada marble project is located firmly within this region, less than 100 miles west and south of its geographic centre. The peripheries

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* Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. There are four sub-regions: California, Northwest, Southwest, and Rocky Mountain.

of the region in terms of effective transport distance from the deposit extend 600 miles to the west, 750 miles to the east, 750 miles to the south, and 800 miles to the north. Only in the extreme (and relatively unsettled) eastern corners of the region do transport distances exceed 1,000 miles.

These distances determine the market range for the project. While marble has a relatively high value per ton, its density imposes weight limitations on long-distance shipment by land.* For all practical purposes (except in areas adjacent to the region where competitive conditions are exceptionally favourable), the project will function, operate, and be competitive within the region. The economy of the region - its structure, distribution, performance and prospects - will thus have a profound influence on the success of the project.

Trends in the Regional Economy

Over the 1950 - 1965 period, the eleven western states have emerged as the richest regional area in the United States and, therefore, in the world. The region is the most rapidly growing in the U. S., outstripping the rest of the country in annual gains in population, personal income, employment, construction, and industrial expansion. These factors are dynamic advantages to the project. The eleven western states also have (on a regional basis) the highest wage/cost structure in the nation and, therefore, in the world. The cost of labour (primarily in

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* The value per ton on dimension output from the project ranges from $120 to $150. The density of the material at 170 lbs. per cubic foot is relatively high. At present rates (truck or rail) 4 1/2 to 5 cents per ton/mile, shipment over distances of 700 miles is possible only where no alternative supply is available on an equivalent competitive basis.

TABLE VII

Employment by state, and by sector, and principal statistics, major industries, 11 western United States, 1965.

EMPLOYMENT IN REGION BY STATE		
STATE	Employment (1)	Increase 1950-65
ARIZONA	404,000	149 %
CALIFORNIA	5,757,000	79 %
COLORADO	582,000	63 %
IDAHO	177,000	34 %
MONTANA	179,000	20 %
NEVADA	155,000	187 %
NEW MEXICO	261,000	71 %
OREGON	593,000	35 %
UTAH	300,000	58 %
WASHINGTON	888,000	30 %
WYOMING	97,000	21 %
TOTAL REGION	9,393,000	67 %

EMPLOYMENT IN REGION BY SECTOR			
SECTOR	Employment (1)	Increase 1950-65	Share of Total
MANUFACTURING	2,089,000	68 %	22 %
TRADE/WHOL./RET.	2,075,000	55 %	22 %
GOVERNMENT	1,926,000	95 %	21 %
SERVICES/MISC.	1,504,000	110 %	16 %
TRANSPORT./UTIL.	656,000	13 %	7 %
CONSTRUCTION	544,000	40 %	6 %
FINANCE/INSURANCE	482,000	103 %	5 %
MINING	117,000	6 %	1 %
TOTAL REGION	9,393,000	67 %	100 %

Source : Western Bancorporation, "The Dynamics of the West," Annual Report, 1965, Los Angeles; and the United California Bank. Data for 1965 based on U.S. Departments of Commerce/Labor preliminary statistics.

Note : (1) Excludes agriculture.

TEN LEADING MANUFACTURING INDUSTRIES + AGRICULTURE			
INDUSTRY	Employment 1965	Value Added 1963	Industry Share in U.S.
TRANSPORT. EQUIPM'T.(1)	295,000	$ 3,836,000,000	17 %
FOOD/KINDRED PRODUCTS	281,000	$ 3,706,000,000	17 %
ELECTRICAL MACHINERY	208,000	$ 2,391,000,000	14 %
LUMBER/WOOD PRODUCTS	202,000	$ 1,794,000,000	43 %
NONELECTRICAL MACH.	121,000	$ 1,381,000,000	8 %
FABRICATED METAL PR'TS	118,000	$ 1,311,000,000	11 %
PRINTING/PUBLISHING	112,000	$ 1,173,000,000	11 %
ORDNANCE/DEFENSE	108,000	$ 2,007,000,000	34 %
PRIMARY METALS	88,000	$ 1,167,000,000	8 %
CHEMICALS/PRODUCTS	58,000	$ 1,228,000,000	7 %
TOTAL IN REGION	1,591,000	$19,994,000,000	
TOTAL AGRICULTURE (2)	850,000	$ 7,466,000,000	

Notes : (1) Includes aircraft production, ship construction, truck/automobile assembly, etc. Aircraft is dominant component.
(2) 'Value Added' = gross farm income, 11 western states.

California) has been a principal deterrent to any meaningful expansion of the U. S. Marble industry within the region.

The relative importance of the region within the United States may be expressed in terms of three factors, as follows:

FACTOR	REGIONAL TOTAL	SHARE OF U. S.
Population (persons)	31,265,000	16.1 %
Personal Income	$94,107,000,000	17.6 %
Employment (jobs)	10,250,000	15.6 %

It is the rates of growth in the region that best express the dynamic nature of its economy. In contrast to the rest of the United States and total U. S., the 1950 - 1965 averages have been as follows:

FACTOR	REGION	REST OF U. S.	TOTAL U. S.
Population	+ 60 %	+ 23 %	+ 28 %
Personal Income	+180 %	+127 %	+135 %
Employment	+ 67 %	+ 28 %	+ 33 %

Basis: 1950 1965

The principal stimulus to population/income/employment growth has been the diversification of the region's economic base: initially supplementing, then surpassing, the traditional supports of agriculture, mining and forest products. The west now accounts for 12 percent of U. S. manufacturing output, and manufacturing is the leading generator of employment. The employment pattern is set out on Table V and principal statistics of the 10 leading industries in Table VI.

This trend toward industrial diversification is likely to continue, strengthening the region's base. Broadly, the incremental gains in employment are due to industries with highly advanced technology - aircraft/space production, electrical/electronics, defense/ordnance - 'grafted' on to the traditional resource/based foundation. The intermediate industries (steel, metal manufacturing, appliances, automobile production) typical of a mature, self-sufficient economy remain partially developed, creating the need for substantial 'imports' from the eastern U. S.* Gradually, over time, diversification is expected to expand to these fields.

The performance of the region's economy is advantageous to the project for its impact on present/potential consumption levels. A strong and continuous rise in annual consumption is a function of both population and income gains: a compounding of more people with more money to spend. Normally, in either the United States or Canada, annual increase of 2.5 percent in population and three percent in per capita income are favourable in terms of market horizon. The west is running above both levels. Population continues to rise (at 3.3 percent a year) at a rate double the U. S. average, and per capita income in 1965 was 11 percent above the national level. Although growth rates are expected to moderate in the 1966 - 1970 period vs. the 1950 - 1960 'boom', the region will continue to outstrip the rest of the nation in population, income and employment generation.

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* For example, automobiles are assembled in California, but not manufactured; steel production is substantially below consumption; appliance manufacturing is limited. The weight of U. S. manufacturing industry remains fixed in the east, but typically will begin to migrate westward, following population/market growth.

The Regional Economy: Distribution

This regional performance is somewhat misleading. The post-war growth has not expanded at a uniform rate among the eleven western states. As a result, the distribution of the economy is uneven - ranging from sprawling concentrations of population/industry to sparsely settled state-wide tracts. This diversity influences the market for the project, and should be outlined.

The core of the region is California. The state contains 60 percent of regional population; 65 percent of personal income; and fully 75 percent of manufacturing. The locus of the region is Los Angeles, encompassing within its orbit more than 50 percent of the population of the state.

From Los Angeles in a direction NNE the dynamics of regional growth tend to moderate. Three broad patterns may be identified.

First, rapid to moderately rapid growth (exceeding the U. S. average) in the adjacent belt, embracing San Francisco/Oakland/San Jose, and the adjoining states of Nevada and Arizona.

Second, moderate growth in the intermediate belt (conforming to the national pattern); weaker in Washington and Oregon, and somewhat stronger in Utah, Colorado, and New Mexico.

Third, sluggish growth in the outlying states - Idaho, Montana, and Wyoming - with annual population increases sharply below the national average.

This third (or 'slow growth') area remains heavily oriented to the basic resource industries; has the highest 'rural' population content; and records the slowest gain in per capita personal income. In contrast, Nevada and Arizona have exhibited extremely rapid growth rates and

presently lead the region. Comparative data on population and personal income for the eleven states are given in Table VII. The distribution of population is illustrated in Chart III, a pattern that conforms to industrial concentration.

Within this broad pattern, population and economic activity are concentrating heavily into a number of well-defined metropolitan centres. The U. S. Bureau of Census reports 30 standard statistical metropolitan areas in the region (15 percent of the national total), listed in Table VIII. The effective concentration, however, is more pronounced, and will intensify. Broadly, the project will find four basic 'market areas' in its first full year of production in 1968, as follows:

MARKET AREA	Total Population in Area 1960	1964	1968
Seattle/Tacoma/Portland	2,560,900	2,850,000	3,000,000
San Francisco/Sacramento	4,614,392	5,250,000	5,800,000
Los Angeles/San Diego	8,478,400	9,600,000	10,900,000
Salt Lake/Denver	1,899,200	2,250,000	2,700,000

While subsidiary market areas (e.g., Phoenix/Tucson will exceed the 1,000,000 population level, these four basic market areas will account for more than 90 percent of project sales within the region.*

The Regional Economy: Transport

A further determinant on project economics will be the structure

* The project will not maintain warehouses in these centres. Given a build-up in volume in feasible levels, distribution centres would be established in Reno, Las Vegas, and Salt Lake City, for reasons of efficiency and tax savings. This matter is discussed shortly.

TABLE VIII

Population and personal income, 11 western United States, 1963 or 1964.

	POPULATION			TOTAL PERSONAL INCOME		
	Total 1964	Annual Growth		Per Capita Rank in U.S.	Total 1963	Increase 1950-1963
		1950-60	1960-64			
MOUNTAIN :						
Arizona	1,581,000	+ 5.5 %	+ 4.6 %	29	$ 3,340,000,000	+ 65 %
Colorado	1,966,000	+ 2.8 %	+ 2.7 %	18	$ 4,831,000,000	+ 71 %
Idaho	692,000	+ 1.2 %	+ 0.9 %	39	$ 1,366,000,000	+ 50 %
Montana	705,000	+ 1.3 %	+ 1.0 %	28	$ 1,553,000,000	+ 37 %
Nevada	408,000	+ 5.8 %	+ 8.4 %	1	$ 1,246,000,000	+ 75 %
New Mexico	1,008,000	+ 3.3 %	+ 1.4 %	38	$ 1,953,000,000	+ 65 %
Utah	992,000	+ 2.6 %	+ 2.5 %	31	$ 2,083,000,000	+ 65 %
Wyoming	343,000	+ 1.3 %	+ 0.9 %	16	$ 834,000,000	+ 52 %
TOTAL MOUNTAIN	7,697,000	+ 3.0 %	+ 2.7 %	-	$17,206,000,000	+ 65 %
PACIFIC :						
California	18,084,000	+ 4.0 %	+ 3.3 %	5	$52,317,000,000	+ 62 %
Oregon	1,871,000	+ 1.5 %	+ 1.3 %	13	$ 4,568,000,000	+ 56 %
Washington	2,984,000	+ 1.8 %	+ 1.1 %	14	$ 7,575,000,000	+ 49 %
TOTAL PACIFIC	22,940,000	+ 3.4 %	+ 2.8 %	-	$64,460,000,000	+ 61 %
TOTAL 11 STATES	30,637,000	+ 3.3 %	+ 2.8 %	-	$81,666,000,000	+ 62 %

Source : U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1964, Washington, D.C.

TABLE VIII A

Population, rank in U.S., and growth rate, standard metropolitan statistical areas, 11 western United States, 1960.

METROPOLITAN AREA	Rank in U.S.	Population 1960	Increase 1950-1960
MOUNTAIN REGION :			
Albuquerque, N.M.	101	262,199	+ 80.0 %
Boise, Id.	201	93,460	+ 32.3 %
Colorado Springs, Co.	161	143,742	+ 92.9 %
Denver, Colo.	26	972,383	+ 51.8 %
Las Vegas, Nev.	178	127,016	+ 163.0 %
Ogden, Utah	189	110,744	+ 32.9 %
Phoenix, Ariz.	40	663,510	+ 100.0 %
Provo-Orem, Utah	193	106,991	+ 30.6 %
Pueblo, Colo.	185	118,707	+ 31.6 %
Reno, Nev.	209	84,743	+ 68.8 %
Salt Lake City, Utah	62	447,795	+ 46.5 %
Tuscon, Ariz.	100	265,660	+ 88.1 %
PACIFIC NORTHWEST :			
Eugene, Oreg.	146	162,890	+ 29.5 %
Portland, Oreg.	29	821,893	+ 16.6 %
Salem, Oreg.	158	147,411	+ 15.4 %
Seattle, Wash.	20	1,107,213	+ 31.1 %
Tacoma, Wash.	78	321,590	+ 16.6 %
NORTHERN CALIFORNIA :			
Sacramento	45	625,503	+ 74.0 %
San Francisco-Oakland	6	2,648,762	+ 24.0 %
San Jose	42	642,315	+ 121.1 %
Stockton	108	249,989	+ 24.5 %
Vallejo-Napa	126	200,487	+ 32.4 %
SOUTHERN CALIFORNIA :			
Anaheim-Santa Ana	38	703,925	+ 225.6 %
Bakersfield	87	291,984	+ 27.9 %
Fresno	70	365,945	+ 32.3 %
Los Angeles	3	6,038,771	+ 45.5 %
Oxnard-Ventura	129	199,138	+ 73.7 %
San Bernadino	31	809,782	+ 79.3 %
San Diego	23	1,033,011	+ 85.5 %
Santa Barbara	143	168,962	+ 72.0 %

Source : U.S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1964, Washington, D.C.

of transport costs within the region. These may be assessed on the basis of published tariffs for similar commodities, and distances from the project to major market distribution points. Both rail and truck tariffs (typically in rates per 100 lbs.) are filed with the Interstate Commerce Commission in Washington, D. C., and are approximately competitive with each other. Distances from project to distribution point are taken from published data.

The two major 'market areas' for dimension products - Los Angeles/San Diego and San Francisco/Sacramento - are within the tolerable 700 mile radius of the project. The Denver/Colorado Springs/Pueblo concentration exceeds this limit slightly; the Seattle/Portland area (to which may be added Vancouver, B.C.), somewhat more so. These areas may be included as competitive conditions are now favourable to the project, and are likely to be maintained. For illustrative purposes, distances from the project and typical published freight costs are as follows:

DESTINATION	DISTANCE	FREIGHT COST PER TON	
		Dimension	Crushed
Seattle	903	$ 44.15	$ 33.40
Portland	875	$ 42.87	$32.35
Vancouver	1,045	$ 51.05	$ 38.65
San Francisco	554	$ 27.00	$ 20.60
Sacramento	461	$ 23.10	$ 17.05
Los Angeles	593	$ 29.05	$ 22.95
San Diego	713	$ 34.95	$ 26.40
Salt Lake	246	$ 12.05	$ 9.00
Denver	753	$ 36.90	$ 27.75
Phoenix	638	$ 31.25	$ 23.60
Albuquerque	894	$ 43.80	$ 34.65

Basis: Dimension @ steel/flooring rates
Crushed/ground @ cement (bagged) rates.

Two points should be made here.* First, the freight costs shown are based on maximum published rates and not on negotiated charges. These may be assumed to be 20 - 25 percent lower. Second, the freight costs on 'crushed/ground' products exceed in a number of cases the maximum per ton values at the project. Thus, these products cannot be expected to be competitive throughout the region, but will be confined to 'short-hauls' and to those centres where the present competitive supply is weak. In the dimension product field, the U. S. domestic industry is not competitive within the project's product range (see Sections II/III), and pricing policies have been established to offset imports from foreign producers.**

Given adequate volume output (circa 1970-1972), the establishment of three distribution centres to supply the market areas is recommended:

(i) Reno to supply the San Francisco/Sacramento and Seattle/Portland areas and western Canada

(ii) Las Vegas to serve Los Angeles/San Diego and Phoenix/Tucson.

(iii) Salt Lake City to ship to Denver/Pueblo, smaller Rocky Mountain centres, and segments of the Mid-West 'secondary' market where the project is competitive.

Under this system, the project would operate its own truck fleet shipping to these three points, and contract with common carriers to

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* There are no published rates on dimension marble originating from Nevada, nor any rates from Ely, Nevada (the recommended project site). Estimates are based on existing rates for reasonably similar commodities, provided by Wells Cargo Inc. of Reno, Nev. A more precise summary has been provided to the client on a confidential basis.

** As noted in Section II, the delivered cost of imports into West Coast ports is 25 percent (or more) higher than f.o.b. prices Leghorn. Shipments from the project, except in the Pacific Northwest, will land at or within this range on a value basis.

final destination. If favourable truck rates cannot be negotiated, the operation of a basic project fleet is recommended on a lease basis. Shipment by rail appears to offer no competitive advantage, and introduces the problem of possible breakage.

The Regional Economy: Costs

In addition to transport factors, the cost structure of the region is important to the project in two chief areas: wages and taxes. Broadly, labour costs follow the same declining pattern from the California axis as population/economic concentration, and again the state distorts the regional situation. Wage and tax costs in metropolitan areas in California are high (for skilled labor in the $4.50 - $6.00 per hour range), and this factor has prevented marble plants within the state from adequately meeting import competition.

The project's location is well beyond this 'high cost' orbit. Hourly wage rates at the recommended site - Ely, Nevada - approximate $3.00 to $3.25.* Moreover, tax costs are moderate. While the project would face federal income tax/depreciation rates at any point in the region, Nevada imposes no state income tax (on corporate or personal income) and foregoes a number of other tax sources; property taxation is confined to a modest proportion of annual 'net proceeds' from the deposit; and no inventory tax is levied on shipments destined to out-of-

* The Nevada Department of Employment Security reports the following wage rates in force at the Ely operations of the Kennecott Copper Corp.: average $23.00/day; labourers $20.00; drillers $25.00; skilled craftsmen $24.00 to $25.00; relief foreman $28.00. The Department advises that it will be able to meet 95 percent of the project's manpower requirements (i.e., all but highly specialized marble industry skills) within three months of notification.

state points.* This last advantage (or 'freeport' arrangement" is now in force in Utah.

One tax - a two percent sales tax - is added to estimates of project capital cost in Section IV. This tax will also be applied to purchases of expendable items involved in the marble manufacturing process (e.g., abrasive compounds, steel saw blades). The cost of these expendables will be moderate. Steel to the specifications required is manufactured in Salt Lake City, and abrasive/polishing compounds can be 'imported' on a reasonable freight cost basis.

In view of these cost factors, it is recommended that the project be confined entirely within the State of Nevada - plant and distribution facilities at Reno and Las Vegas - with the exception of a third distribution centre at Salt Lake City (with parallel 'freeport' advantages). Any location in the major California market would involve a substantially higher wage/tax cost structure.

THE PROJECT FRAMEWORK: SUMMARY

Normally, an entry into a static industry cannot be lightly recommended. Nor can a location in a high production cost area be proposed. Nevertheless, the route selected for the Nevada marble project threads by these obstacles.

The 'Problems' of the Industry

On its own admission, the U. S. marble industry is in some

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* The State of California imposes a two percent tax on the value of finished product inventory at the close of the state fiscal year. Nevada (and latterly Utah) offers complete escapement of an inventory tax on all products with out-of-state destinations. This provision is a major contributor to the state's present phenomenal growth rates in population and industrial activity.

difficulty. For the last ten years, it has been unable to break through its market ceiling of 160,000 tons, and as annual construction volume increases it continues to lose relative ground. Too many inherent (and interrelated) factors - the unit costs of 'custom' work, the price structure, and the limited avenues for major efficiency gains - restrict the industry's capability to mount the campaign required to win back its traditional markets from its newer and more dynamic competitors.

The industry is responding in two classical ways. It is retrenching in its structure through acquisition, consolidation, and vertical integration. And it is suppressing inevitable cost/price increases in its dimension output through substantial by-product recovery. But the cost/price/technology deficiency remains; and even though the recent plants in the industry can be admired for their efficiency within their range, their duplication at the project cannot now be proposed. The industry must reduce its costs. This reduction seems possible only by product segregation on a feasible market volume production basis: broadening the industry's scope <u>beyond</u> marble's traditional uses, and entering the flooring, furniture, and fabricated panel <u>markets</u> on price/quality terms against presently available materials.

Given this production rationale, the distribution of the industry and the dynamics of the western United States economy are factors highly favourable to the project. The 'major' firms in the U. S. industry (even with manufacturing plants located in the west) compete at a significant disadvantage in the region, lacking a low-cost raw material supply and a favourable wage/cost structure. While imports from foreign producers have accounted for the bulk of rising marble consumption in the U. S. on a national basis, within the region imports have <u>displaced</u>

regional production. Locked in their Atlantic Seaboard bases, the industry's major firms represent little or no direct competitive threat to the project within its proposed range.

The Advantages of Location

Moreover, the location of the project (a function of its required proximity to the deposit) escapes the chief disadvantage of industrial production in the west: the relatively high labour/tax costs in metropolitan California. Even though the project's average hourly wage costs will be 50 percent higher than in the bulk of the U. S. marble industry ($3.00 or $3.25 vs. $2.00 to $2.25 at Tate, Ga., and Proctor, Vt., offset by a lower labour content in total unit cost), the principal operating cost will still be moderate. In addition, the effective net cost of taxation at the project will be comparatively low.

It is the performance of the regional economy - and the promise of increased consumption potential - that is the most exciting factor in the framework. The 'dynamics' of the west may be easily over-stated and misinterpreted. The region is not without problems in maintaining stable, continuous growth, yet these are not sufficient to diminish its status as the most rapidly growing area in the nation in population and income (and, as noted, these twin factors are essential to any dynamic market outlook). The centre of gravity of this growth lies in the southwest segment of the region, and while ideally the deposit should be located in somewhat closer proximity to this centre, the 'growth' areas are those within the most economic reach. Thus, the project secures the combined advantage of industrial location: a relatively low-cost production site, from which its output may be readily shipped into the

principal high consumption markets.*

There is little doubt that the project will encounter a competitive reaction to its output. Despite its distance (in material supply terms) from the region, the U. S. industry cannot be expected to be pleased, nor will foreign producers now serving the market in the project's product range abdicate the base they have successfully established. These matters are discussed in the following Section II analysis. For the moment, it need only be said that the project's prospects would be substantially different were the domestic industry more efficient and broadly distributed, and were the deposit fixed anywhere else than in a competitive locale in the west.

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* Two problems in the regional economy may be isolated. The first is a possible cyclical instability in the major aircraft/space and defense industries in California. Both industries have now stabilized and are again expanding. The second is an intermittent tendency to overbuilding. This pattern is most prevalent in 'tract' housing developments (not presently a dominant outlet for marble output), but is gradually being resolved through financing construction channels. The 1963 - 1964 decline in aerospace/defense production has led to a re-appraisal of the region's economic prospects, particularly in California. State officials and the Bank of America have forecast a slightly moderated rate of growth to 1970, reserving a 'plus' or acceleration factor to what Bank economists term 'Industry X'. It is likely that Industry X will be several regional industries, based on the area's advanced state of education/research/technology and the opportunities for 'import displacement' in a wide manufacturing range. See the Economic Message of the Governor, 1965, State of California, Sacramento.

SECTION II:

THE MARKET FOR THE PROJECT

The market range for the Nevada marble project is determined by the Section I findings on the distribution of the U. S. marble industry and freight costs. The eleven western states will form the primary market. The two western Canadian provinces and the west/central U. S. Mid-West will be its secondary markets. The distinction is necessary because it is only in the primary market that the project will operate at a comparative competitive advantage. It is here that the bulk of its output will be sold. It is also here that the project must strive to secure and retain its market advantage. In the secondary markets, the project's range will be more extended and any advantage it may have will be offset by higher costs of supplying the market.*

Even within the west, the project will not have the market to itself. Nor will total demand be the horizon for its output volume. The volume it can sell will depend on its product range, its prices, its marketing channels, and its product/market development efforts against competing suppliers and materials.

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* This is not to say that the project cannot compete in such major (but more distant) markets as Chicago, St. Louis, and Dallas/Fort Worth. This territory, however, is held by others (see Chart I) sho can serve it more efficiently and at substantially less sales/freight expense. The primary market is estimated to account for 85 percent of output; western Canada 10 percent; Mid-West five percent.

At an initial $2,400,000 a year, the annual output proposed in this report is the equivalent of one-third of present consumption, or one-sixth potential demand. This modest target should be defended. The demand/supply factors leading to its recommendation are set out in this section.

THE MARKET FOR MARBLE: DEMAND

The findings/conclusions of this section are based on three consecutive investigations. First, all available published statistics on marble consumption/production in the market region were gathered from official and industry sources.* This information was supplemented in discussions with the chief data-gathering agencies so that 11 factors

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* For aggregate data, primary reliance was placed on regional offices of the U. S. Bureau of Mines and the U. S. Department of Commerce, both in San Francisco; State of California agencies, particularly the Department of Mines and Geology; state departments in Nevada, Utah, and Washington; and the American Marble Institute, Washington, D. C.

* For trade data (sales, prices, supply sources, etc.), the field trips covered twelve suppliers in Idaho, Utah, Nevada, Oregon, and Washington; and fifteen firms in the San Francisco/Oakland/San Jose and Los Angeles areas in California. The total canvass covered suppliers accounting for 75 to 90 percent of annual volume in their product fields. A list of trade data sources has been provided to the client. Special mention may be made of Musto-Kennan Inc., of San Francisco and Los Angeles (formerly a major supplier in the region, now in voluntary liquidation), which furnished excellent and extremely useful data.

* The two major distributors principally consulted were Western States Stone Products Inc., of Santa Clara, with eight outlets in three states and affiliates throughout most of the region); and Mosaic Tile Inc., of Cleveland, Ohio, with principal outlets in San Francisco, Los Angeles and Salt Lake City. No field investigation was conducted in Arizona or Colorado, but interviews with major suppliers were conducted by long-distance telephone. Aggregate data only was collected for the three remaining states - Montana, New Mexico and Wyoming - while personal interviews were conducted to assess the western Canadian market.

of a revealable nature could be collected. Second, two field investigations - first, in five Pacific Northwest/Rocky Mountain states; second, in California - were carried out among producers, distributors and dealers/importers in the trade. The information secured was supplemented in informal discussions with national/regional suppliers attending the annual convention of the Building Stone Institute of America at Atlanta, Ga., and at Tate, Ga., and Knoxville, Tenn. Finally, a second field trip was made to California, but confined to major distributors (including those recommended as the project's outlets in this report) to establish policies in product range, pricing, and product quality.

The investigation was not re-inforced in three important ways:

First, published or 'revealable' data is not complete. Government agencies are prevented by law from issuing statistics on production/volume levels in states with no more than two suppliers. In the main, this problem was overcome by cross-reference to similar or substitutable materials.

Second, no market research program was undertaken to cover the more than 500 'end-users' of marble (contractors, applicators, and manufacturers) in the region. While extremely useful, this program could not be recommended at the present stage of project planning for cost reasons. Confirming evidence was sought, however, in selected interviews among this group.

Third, nor was any research program developed to determine 'consumer' attitudes to marble (e.g. a statistical sample of architects, designers, and home-owners/consumers), again for reasons of cost. Attitudes among architects/designers were explored on a partial basis.

The findings set out in this section must be taken as estimates only, and not as strictly precise calculations of supply/demand in the market. They are sufficiently complete to yield a reasonable approximation of the market, and afford an adequate basis for project market planning. In the discussion, all revealable sources will be cited.

The Commodity in the Region

First, some points in perspective. While the market for marble conforms broadly to the national pattern (see Section I); the commodity's position should be suggested.

Marble is a curious commodity. It is a fairly common stone (like granit or quartz), yet it is frequently 'unavailable'. It is not especially expensive to produce, yet it holds the upper range of price. It possesses a number of physical properties, yet its uses are almost entirely decorative. It is not impossibly difficult to work, yet its installation costs are high. It is a well-known, even familiar, commodity, yet its market spectrum is limited. No matter how 'permanent' it may be it still wears out, yet its replacement market is largely nonexistent.

Ask the trade:

Who wants marble? Everybody. Who buys it? The rich. What do they use it for? For show. Why isn't marble replaced? It lasts. Why does it cost so much to purchase and install? That's our problem.

Marble is a commodity in need of a revolution. The material is often 'unavailable', for it is offered in an array of colours/patterns; a specific pattern may not be in stock; this requires special quarrying;

this process takes time; the consumer switches to another material.* The material's usage is restricted to decorative applications because marble is sold as a 'prestige' commodity, processed and finished to be 'displayed' to its best advantage. Since the colour/pattern range is so diverse and decorative applications involve substantial custom work, the price and installation cost are high. The replacement market is undeveloped because the commodity is promoted as 'permanent' and the industry does not tend to think in replacement terms.

Thus, marble is (to a considerable extent) a prisoner of its market approach. Its price, its uses, its appeal, its installation cost, its permanence, all conspire to limit its effective market to the 'rich' (or, to amplify on the trade parlance, the 'sophisticate'). Rich people in the region there most certainly are, but they constitute a relatively small segment of both total population and total purchasing power.** Mcreover, this market segment tends to be the most 'discrimi-

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* An extreme example was the case of the Crown Zellerbach Corp. head office tower in San Francisco. The architects (Skidmore, Owings and Merrill) specified a particular green marble, but turned to alternative materials when informed that the order would require one to four years to fill.

** For example, the 1961 California income tax statistics indicate a total of 3,417,944 persons paying tax (more than 1,000,000 did not). Among this total 2,585,000 earned less than $10,000 in the year; 715,000 earned between $10,000 and $19,999; 115,000 earned $20,000 to $49,999; and only 18,000 - the typically 'rich' - earned $50,000 or more. Even if all those earning $20,000 + are taken as marble's effective market (which is doubtful), this group represents less than three percent of the population with less than 10 percent of pre-tax purchasing power. Were marble placed within reach of the $10,000 + group, its potential consumption horizon would be at least tripled.

nating', and the most difficult to deal with.* Marble's mystique - its 'image' - which is still its greatest asset in basic consumer appeal, has also become an impediment to expansion of its market horizon.

There are other problems. These relate to supply. Virtually all dimension marble consumed in the region must be 'imported' (whether from eastern U. S./foreign producers; in raw material, semi-finished, or finished form), and is liable to higher cost, delay, breakage, colour inconsistency, and unavailability. Moreover, the distribution system is imperfect. Only the metropolitan centres on the west coast enjoy a reasonable flow of supply, while throughout most of the interior the material has barely begun to penetrate. Finally, there are problems of product quality and installation. The problem of colour inconsistency has been noted. Furniture material may not be 'filled' or surface treated, and stain or discolour. Floor tile is not supplied in precise, uniform thickness, requiring spot re-grinding on the job. Edge cuts may not be exact, requiring expensive setting and jointing.**

Yet evidence exists of a large, unsatisfied demand. Few commodities have so many obstacles placed on their economic use and accessibility

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* The trade abounds with hair-raising examples of consumer complaints. Architects, designers and individuals have no hesitation in ordering replacement of installed material if the particular marble does not meet exact colour/pattern specifications. Since additional material must be provided from a distant source, the problems (and costs) tend to compound.

** The re-grinding of floor tile when laid costs an estimated $.50 - $1.00 per sq. ft. depending on floor area. The setting/jointing of panels or tile is a substantial component of installation cost. The lack of surface filling or treating in much furniture material is partially responsible for the inroads of 'manufactured' (i.e., synthetic) marble. The production solutions to these problems are discussed in Section III.

to the consumer, yet remain in latent demand. It is the correction of important deficiencies in marble's position in the market that strengthens project feasibility.

The Regional Market: Consumption

The consumer can buy marble* in three ways. First, an architect or owner may specify its application in a construction contract. Second, it may be purchased (in certain forms) at building material dealers' outlets, particularly those specializing in brick/tile/stone products. Third, it may be bought at retail stores, typically as furniture material, or in ornamental applications.

Through these channels, marble enters broad markets encompassing a diversity of products, materials, and alternative outlets for the consumer's dollar. The scope of these markets in 1965 may be summarized as:

'MARKET'	TOTAL VOLUME
CONSTRUCTION:	
Housing (single/multiple)	$ 3,800,000,000
Office/bank/mercantile	$ 1,000,000,000
Additions/alterations	$ 500,000,000
Total, construction:	$ 5,300,000,000
RETAIL SALES:	
Building materials	$ 1,000,000,000
Furniture/home furnishings	$ 1,200,000,000
Total, retail sales	$ 2,200,000,000
TOTAL MARKET VOLUME	$ 7,500,000,000

Sources: California Statistical Abstract; U. S. Department of Commerce, Bureau of Census.

* Marble is both a stone and a commodity. As a commodity, the term is somewhat broader. In this section, marble is taken as crystalline forms and travertine.

TABLE IX

Consumption of marble products (including travertine), 11 western United States, by producers' and final value, six product areas, 1965.

PRODUCT AREA	Products	Producers' f.o.b. Value	Add	Total Value
Building	Slabs, facings, pre-cast panels, veneers, sills, stoops, steps, etc.	$ 4,000,000	Installation cost + 150 %	$ 10,000,000
Flooring	Tile, flagstones, mosaics, etc.	$ 800,000	Installation cost/dealers' mark-up + 100 %	$ 1,600,000
Furniture	Slabs as rectangles, squares, rounds, ovals, for tables, desks, counters, etc.	$ 800,000	Dealer/retail mark-up + 50 % plus installation + 25 %	$ 1,400,000
Fireplace	Hearths, standards, mantles, units.	$ 200,000	Installation/ finishing cost + 150 %	$ 500,000
Monument	Grave/head stones, markers, memorials, special components.	$ 200,000	Finishing cost + 150 %	$ 500,000
Crushed/Ground	Aggregate for wall panels, terrazo chips, roofing granules; grit; filler, whiting, etc.	$ 1,500,000	Installation cost + 100 %	$ 3,000,000
TOTAL :		$ 7,500,000		$ 17,000,000

The commodity's share of this total market volume is miniscule - at producers' f.o.b. prices .001 percent, or with the addition of dealer/retail mark-ups and installation costs no more than .0025 percent. Total supply in the region at producers' returns in 1965 is estimated at $7,500,000 and with final value is set out by major product segments in Table IX. A summary is as follows:

PRODUCT AREA	PRODUCERS' VALUE 1965
Building/Construction	$ 4,000,000
Flooring	$ 800,000
Furniture	$ 800,000
Fireplace material	$ 200,000
Monuments	$ 200,000
Crushed/ground	$ 1,500,000
TOTAL:	$ 7,500,000

Regional Consumption: Product Markets

Among product areas, the bulk of building shipments (perhaps 80%) are directed to new corporate/bank/public construction projects: a further 10 percent in new apartment construction; and the balance in store, residential, and commercial remodelling projects. While the typical contract for the total project will be large, the marble component is generally small - normally between $25,000 and $50,000 installed; rarely above $100,000 - $200,000. The applications are essentially decorative, normally confined to ground level exterior facings and interior lobbies, store fronts, entrances, main halls, and the like. Occasionally, vertical columns extending to the height of the building will be clad in marble (even here, in a 20 - 30 storey building, the installed cost may be only some $250,000); but the traditional 'marble

building' is not now duplicated in new construction, and the material is applied in thin dimension for economy. The office/public building market has been static, but is now growing moderately. The apartment market is accelerating, while recent installations are giving the store/mercantile market new importance. The residential market has hardly been penetrated.

The flooring market (tile, flagstones, mosaics) is composed of new office and residential construction, the latter including both apartments and single-family dwellings. The standard product is 12" x 12" tile. Tile volume in office/public projects is generally a function of the 'building' component in the contract (included in the total bid), although separate flooring contracts are known. This market is growing moderately. The dynamic segment is new housing in which tile usage has increased markedly, especially in the 1963-1966 period. Tile is presently the 'growth' product in the region, and demand is expected to remain strong.

The furniture market consists of two fields. First, individual slabs (polished rectangles, squares, rounds, ovals) are sold to consumers or interior designers for furniture pieces. Second, pieces may be installed as bathroom/kitchen/vanity counters as 'built-ins'. The market is broadening to include apartments/hotels/motor hotels/offices, as well as home furnishings, and is growing strongly following a sustained 1961-1964 increase.

The fireplace segment is treated as a separate market as it is a well-defined outlet based on custom work and craftsmanship. Based almost entirely on housing (primarily single-family dwellings, with a small but growing apartment component), it is one of the few product

areas with any access to remodelling/replacement uses. The relatively low volume at producers' values is a reflection of a high labour/installation component in job costs. Demand is growing despite these costs, and would be substantially greater were these reduced.

The monument market is essentially limited. The bulk of volume in this field is held by granite (in headstones, gravestone, and markers) with marble restricted chiefly to larger or more ornate memorials, and to such specified uses as the U. S. Armed Forces.* Again, the material represents a relatively small component of finished cost, and a substantial (perhaps major) share of the market is held by eastern U. S. producers shipping into the region.

The crushed/ground market is the most diversified in end-used. The bulk of demand is in aggregate for wall/surface pre-cast panels; chips for wall/floor terrazo; and roofing granules. Minor shares are held by chips for agricultural grit/liming; whiting; and chemical/industrial fillers. Since these products are of low unit value (and cannot be transported long distances), they depend essentially on local or sub-regional markets. Consumption and growth rates depend on availability and competitive materials (e.g., basalt, quartz, granite, dolomite, limestone). Generally, consumption growth in coastal areas is moderating following a 1961-1964 acceleration, while demand in interior areas remains strong.

While the pattern of recent consumption among these product areas

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* The national monument market is dominated by Georgia Marble and Vermont Marble. An important use is headstones for deceased U.S. armed forces personnel. Manufactured in Tate, Ga., or Proctor, Vt., they are shipped into the region, as are finished components for private memorials.

has not been uniform, marble as a commodity has exhibited an impressive growth in the region - from an approximate $5,000,000 in 1960 to $7,500,000 in 1965, or an average rate of increase of eight percent a year. As in national consumption trends (see Section I), the gain has been satisfied almost entirely by imports from foreign producers, rising from less than $700,000 in both 1960 - 1961 to close to $2,000,000 in 1964, and an estimated $3,000,000 in 1966.* If realized, this gain would represent an annual average rate of 33 percent.

Over the 1960 - 1965 period, the dynamic area among domestic products has been the crushed/ground field, rising from an approximate $800,000 to $1,500,000. It is probable that consumption of domestic dimension material has declined - from $3,500,000 in 1960 to a present $3,000,000. This decline is due to competitive replacement by imports, and by the entry of crushed/ground products (e.g., aggregate/terrazo pre-cast building panels) into the traditional summarized as follows:

PRODUCT AREA	CONSUMPTION VALUE (F.).B.) 1960	1965	+ Change -
Dimension, Domestic	$3,500,000	$3,000,000	-$ 500,000
Dimension, Foreign	$ 700,000	$3,000,000	+$2,300,000
Crushed/Ground**	$ 800,000	$1,500,000	+$ 700,000
TOTALS:	$5,000,000	$7,500,000	+$2,500,000

* Import statistics for 1965 not yet available, but are likely to indicate value (f.o.b.) of $2,700,000 to $3,000,000. From present/planned import orders, the $3,000,000 will be met, if not surpassed in 1966.

** There is a slight import component in crushed/ground consumption which in any reported year has not exceeded $7,000. These imports are composed primarily of coloured terrazo chips.

TABLE X

Imports of marble/travertine from foreign producers, f.o.b. values, five west coast U.S. customs districts, 1961 and 1964 (actual), 1966 (est.).

CUSTOMS DISTRICT	IMPORTS BY F.O.B. VALUES			Increase 1961-1964
	1961	1964	1966	
San Diego	$ 25,258	$ 127,116	$ 200,000	x 5.03
Los Angeles	$ 575,077	$ 1,426,721	$ 2,100,000	x 2.47
San Francisco	$ 70,806	$ 322,478	$ 600,000	x 4.55
Oregon	N/A	$ 34,914	$ 60,000	
Washington	N/A	$ 18,008	$ 40,000	N/A
TOTAL WEST COAST	$ 671,131	$ 1,929,237	$ 3,000,000	x 2.98

Source : U.S. Department of Commerce, International Trade Division.

TABLE XI

Imports of marble/travertine products from foreign producers, volume/ f.o.b. values, by commodity classifications, U.S. west coast ports, 1964.

COMMODITY CLASSIFICATION	UNIT	VOLUME	VALUE	UNIT VALUE
Marble :				
Block, rough, squared	Cu. Ft.	4,129	$ 33,710	$ 8.14
Sawn/dressed over 2"	Cu. Ft.	790	$ 5,983	$ 7.55
Slabs, not rubbed/polished	Sq. Ft.	385,325	$ 346,138	$ .90
Slabs, rubbed/polished	Sq. Ft.	489,826	$ 516,613	$ 1.05
Articles, not classified	N/A	N/A	$ 461,065	N/A
Total, Marble			$ 1,363,509	
Travertine :				
Not hewn/dressed	Cu. Ft.	25,062	$ 93,608	$ 3.73
Hewn/dressed	Short Ton	3,764	$ 472,120	$ 124.47
Total, Travertine			$ 565,728	
TOTAL, ALL COMMODITIES			$ 1,929,237	

Source : U.S. Department of Commerce, International Trade Division.

The dynamic import factor in regional consumption trends is set out for 1961/1964/1966 by customs districts in Table X. A breakdown by commodity classifications in 1961 and 1964 is given in Table XI.

The Regional Market: Distribution

The distribution of marble consumption in the region closely parallels - even exaggerates - the pattern of population/economic concentration cited in Section I. An evaluation of official/trade data indicates that 80 percent of total consumption in 1965 originated in California, with only 20 percent in the rest of the region. The estimated 1965 consumption by areas is approximated in Table XII. The broad pattern is as follows:

MARKET AREA	VALUE (F.O.B.)	SHARE
Los Angeles/San Diego	$ 4,125,000	55 %
San Francisco/Sacramento	$ 1,875,000	25 %
Rest of Region	$ 1,500,000	20 %
TOTAL:	$ 7,500,000	100 %

The inbalances evident in this pattern are the result of production/transportation/distribution factors.

First, in a low volume commodity (which marble in the region still is), a heavy concentration of population, personal income and economic activity is required to create a viable market. The consumption of marble is well below that of other construction/flooring/furniture materials, and even below that of other stone products (e.g.,

granite).* Its minute relative share of these markets would not permit economic distribution in smaller metropolitan centres in the region, much less in non-urban areas.

Second, the lack of a regional supply of raw material for dimension output prevents any wide distribution of manufacturing/finishing plants outside the major metropolitan centres. Marble processing operations are located within these centres to permit production efficiencies (e.g., the gathering of labor, raw material and services) and to secure major local markets. Fully 85 percent of marble manufacturing capacity in dimension products is located in San Francisco and Los Angeles. Given the level of freight costs in the region (see Section I), these plants have no incentive to extend their market horizons broadly throughout the region.

Third, imported material into the region can only be landed in feasible volume at major west coast ports. While a part of this import volume may be shipped to interior points (e.g. Phoenix, Las Vegas, Salt Lake City), it is extremely unlikely that more than five percent of total imports leaves the coastal states. It is quite possible that imports landed at Gulf or Seaway ports may penetrate as far west as Denver or Albuquerque, but the volume is likely to be extremely limited. The whole of the interior of the region is thus isolated from the prin-

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* In 1964, the production of dimension granite in California totalled 13,007 tons valued at $1,304,264, of which $440,000 was for monumental stone and the bulk of the remainder (some $800,000) for building. Average value was $100.27 per ton. Crushed granite output was 3,981,373 tons valued at $4,174,757. The bulk of output was for roadstone/riprap in highway construction. Granite in dimension form is produced in substantial quantity in the west and consumption is reported to be at or near $15,000,000 a year

TABLE XII

Approximate annual consumption, western United States, by market areas, 1965.

MARKET AREA	DIMENSION			CRUSHED	TOTAL	Percent of Region	
	Imports	Domestic	Total			Popul'n.	Consump'n.
SOUTHWEST : Arizona Nevada New Mexico	$ 100,000	$ 300,000	$ 400,000	$ 200,000	$ 600,000	10 %	8 %
NORTHWEST : Idaho Oregon Washington	$ 100,000	$ 100,000	$ 200,000	$ 250,000	$ 450,000	12 %	6 %
ROCKY MOUNTAIN : Colorado Montana Utah Wyoming	$ 50,000	$ 200,000	$ 250,000	$ 200,000	$ 450,000	18 %	6 %
CALIFORNIA	$2,750,000	$2,400,000	$5,150,000	$ 850,000	$6,000,000	60 %	80 %
TOTAL REGION :	$3,000,000	$3,000,000	$6,000,000	$1,500,000	$7,500,000	100 %	100 %

TABLE XIII

Annual production of dimension/crushed marble, 11 western states, 1964.

STATE (1)	DIMENSION PRODUCTS			CRUSHED/GROUND PRODUCTS		
	Tons	Value	Per Ton	Tons	Value	Per Ton
Arizona	3,057 (3)	$ 89,599	$ 29.30	22,476	$ 275,787	$ 12.25
Montana				4,700	$ 94,755	$ 20.20
New Mexico				*	*	*
Colorado (2)	*	*	*	5,347	$ 48,875	$ 9.10
Utah				1,416	$ 35,400	$ 25.00
Wyoming				1,370	$ 21,827	$ 15.90
California	400	$ 7,800	$ 19.50	34,000	$ 564,400	$ 16.60
Washington	1,527	$ 15,105	$ 9.90	16,967	$ 251,013	$ 14.75
TOTALS :	4,984	$ 112,504	$ 22.60	93,217	$ 1,292,057	$ 13.86

Source : U.S. Bureau of Mines, Mineral Yearbook 1964, plus revealable data, Region VI, U.S.B.M., San Francisco.

Notes : (1) No production reported 1961-1966 in Idaho or Oregon. Minor crushed tonnages from Nevada included as subsidiary operation in California total.

(2) Colorado total includes rubble output classified as 'dimension'.

(3) Dimension output of Arizona, Montana, and New Mexico not revealable by states and is consolidated.

cipal sources of supply.

The distribution pattern, however, appears to be broadening gradually. An indication may be found in the Table X breakdown of imports by west coast customs districts. In 1961, imports were confined largely (over 80 percent) to Los Angeles. By 1964, significant volumes were imported into San Francisco and San Diego, and penetration had begun into Seattle/Portland. The 1966 estimates indicate a continuation of this process: an increased volume along the coast, following the initial Los Angeles beach-head. This process has now extended as well to Vancouver.*

The impressive market penetration by foreign imports expressed in Table X has been accomplished in a relatively short time. While some $500,000 of the import increase has been secured at the expense of domestic output, the result has been a substantial addition to new consumption. Moreover, this consumption has been extended progressively to a broader segment of the regional market. It is quite probable that this process has permitted the domestic industry within the region to stabilize itself at present levels. For the Nevada marble project, the import performance should also be regarded as a net benefit for its impact on consumption levels.

Nevertheless, a significant deficiency in regional consumption remains. The impediment to a more balanced consumption distribution remains the lack of raw material self-sufficiency. Although supply/

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* Functionally, this approach has been perfectly logical. Imported material is landed in either semi-finished or finished form. The semi-finished material requires local manufacturing capacity. The finished product requires adequate distribution channels. Neither requirement has been available until recently outside metropolitan California.

consumption in crushed/ground products is in relative balance, the regional supply of dimension raw material forms a minute (and barely detectible) component of consumption. The 1964 production levels by states are given in Tabel XIII and may be summarized as follows:

PRODUCT AREA	TONS	VALUE (F.O.B.)
Dimension	4,984	$ 112,504
Crushed/Ground	93,217	$ 1,292,057
TOTALS:	98,201	$ 1,404,561

At 1965 consumption levels, these output volumes represent less than two percent of dimension product value and 93 percent of crushed/ground value. Even here, the dimension contribution is over-stated, for a large (if not major) component of volume/value is 'rubble' material of low unit value. Moreover, in the crushed/ground segment, only in Arizona and Washington does output exceed effective state consumption requirements.*

The Regional Market: Potential Demand

The limits on marble consumption in the region are significant.

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* The U. S. department of Commerce does not maintain records of inter-state shipments. Imports into California of crushed/ground products from other states were estimated by officials of the State of California Mines and Geology Department at not less than 20,000 tons (or some $320,000 f.o.b.) in 1965. Probable sources in order of importance are Georgia/Alabama, Arizona and Texas.

The commodity (by and large) is not available in the interior states.* Its penetration in more accessible areas (e.g., Washington, Oregon, Nevada, Arizona) is only modest. The effective market remains the two metropolitan concentrations in coastal California, in which two-fifths of the region's population account for four-fifths of total marble consumption.

For the Nevada marble project, the market must be broadened beyond present consumption levels. The project will correct (within its product range) two regional restrictions on consumption:

(i) Access on a volume scale to coastal markets alone

(ii) A lack of regional self-sufficiency in dimension product material.

The project will also operate in a third way to stimulate consumption, in price reductions and quality improvements. These stimuli are discussed later in this section.

What <u>is</u> the potential market for marble in the region if consumers can buy the commodity readily, and at a competitive price? It is hazardous to make any firm estimate without recourse to a thorough (and statistically sound) market/consumer survey. Nevertheless, some reasonable

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* In the Rocky Mountain market area, trade sources in both Salt lake City and Denver reported significant 'lost' orders for both floor tile and building material because supply could not be guaranteed within the time requirements of contractors. Essentially the same problem was found in Idaho and Nevada, and to a somewhat lesser extend in Arizona. In Washington and Oregon, the most distant markets from present U. S. domestic suppliers, cost and supply present serious problems to the trade. Trade sources report that the supply problem even extends to inland California. Digests of field investigations are given in Appendix A for the Northwest/Rocky Mountain/Southwest areas, and for California in Appendix B.

approximations may be advanced.

The first test is a comparison of per capita expenditures on marble, on a national/regional basis, and by product areas and sources. In 1965, U. S. per capita consumption is estimated at 29 cents vs. 24 cents in the region.

For example:

It was established in Section I that the western United States contains 16.1 percent of total national population, and 17.6 percent of total personal income. It was also suggested that the combining of both population/income factors (each increasing above the national average) gives a momentum to consumption to a commodity such as marble which, for illustrative purposes, gives a weighted share of marble consumption of 18.5 percent.

Applying these factors to national/regional marble consumption patterns, the results are as follows:

BASIS	Regional Share	Regional Consumption Present	Potential	Increase
Population	16.1 %	$7,500,000	$ 8,855,000	+$1,355,000
Personal Income	17.6 %	$7,500,000	$ 9,680,000	+$2,180,000
Pop./Income	18.5 %	$7,500,000	$10,175,000	+$2,675,000

Basis: U. S. consumption = $55,000,000

Taking personal income as a median factor, there is available - immediately in the region - a potential consumption increase of $2,180,000 a year, yielding a total value of $9,680,000.

A second approach (again, confined to present patterns) is a national/regional comparison by aggregate product areas or sources.

Taking approximate estimates on a national basis, the breakdown is as follows:

SEGMENT SOURCE	TOTAL U.S	TOTAL REGION	REGIONAL SHARE
DIMENSION:			
Domestic	$ 20,000,000	$ 3,000,000	15.0 %
Imports	$ 15,000,000	$ 3,000,000	20.0 %
CRUSHED/GROUND	$ 20,000,000	$ 1,500,000	7.5 %
TOTALS:	$ 55,000,000	$ 7,500,000	13.6 %

Applying the personal income factor, total consumption in the region would again be $9,680,000, distributed as follows:

SEGMENT SOURCE	REGIONAL CONSUMPTION Present	National Basis	CHANGE + or -
DIMENSION:			
Domestic	$ 3,000,000	$ 3,520,000	+$ 520,000
Imports	$ 3,000,000	$ 2,640,000	-$ 360,000
CRUSHED/GROUND	$ 1,500,000	$ 3,520,000	+$2,020,000
TOTALS:	$ 7,500,000	$ 9,680,000	+$2,180,000

Three results may be cited:

First, the $520,000 'increment' in the domestic/dimension segment is equivalent to its 1960-1965 decline in volume in the region, resulting from displacement by imports. Nevertheless, it is apparent that - on a national comparative basis - marble building commodities are holding their position well, despite additional costs involved in supply from eastern U. S. sources and the high cost operations/locations of present domestic manufacturing/finishing plants in the region. Were these obstacles to potential demand overcome, volume could be assumed

to rise by 50 percent over present levels to a total of $4,500,000.

Second, the major 'shortfall' in crushed/ground consumption may be isolated to problems of present supply, primarily in California. The state must now 'import' more than one-third of its crushed/ground marble requirements, and for typical applications must turn to alternative materials (e.g., limestone, dolomite, and granite). On a national basis, California's annual consumption in this range should exceed $2,000,000 - a shortfall (see Table XII) of some $1,200,000. The remaining $800,000 gap represents a consumption deficiency in the rest of the region.

Third, the import 'excess' of $360,000 yields a regional consumption 12 percent above the U. S. average. This variance is not significant, for in the whole of the U. S. it is probable that the bulk of import consumption is confined to major metropolitan concentration which are also the material's ports of entry.* As noted (see Tables X and XII), more than 90 percent of present import consumption in the region is confined to the Los Angeles and San Francisco metropolitan concentrations. Since imports have risen dynamically in these centres through availability and price, it is apparent that their market horizon (or that of its domestic equivalent in the region) has by no means been

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* Import statistics by U. S. customs district are available only at regional offices of the U. S. Department of Commerce and consolidated in Washington, and have not been consulted. Industry sources in the eastern United States report heavy (and growing) import consumption in such centres as New York, Philadelphia and Washington on the Atlantic Seaboard; Chicago and Detroit in the Great Lakes/Seaway (as well as Toronto and Montreal in Canada); and New Orleans and other large centres on the Gulf of Mexico. This pattern is broadly re-inforced by the trend in the U. S. domestic industry to increased per capita consumption in regional areas of the major producing firms.

reached.

The present per capita expenditure on imported marble in the two metropolitan concentrations is 22.5 cents - just below the average level for all marble products in the region. Were this equivalent expenditure applied to all 32,000,000 persons in the region, the annual import value would reach $7,200,000. This rate of consumption assumes equivalent prices, availability and distribution effectiveness in the rest of the region. This last distribution factor must be partially discounted when applied to the rest of the region with its greater population dispersal. Nevertheless, since imports into the two major west coast ports continue to increase (with supply rather than demand the determinant of annual shipments), indicating no saturation in consumption, this $7,200,000 level may be taken as realistic.

Before these potential demand estimates may be combined, the question of product/source duplication must be assessed. The Table XI breakdown of imports by commodity classification indicates that in 1964 finished products accounted for $1,450,000 - or 75 percent - of the total, and rough or semi-finished products for $480,000. While a part of finished imports will be in building panels and components, the greater part is estimated to be in floor tile, furniture material, and other products in which the domestic industry in the region is not now a significant supplier. The semi-finished (and rough) products are those purchased primarily by the regional industry for further conversion - the assumed extent of the decline in domestic dimension volume. Thus, duplication between sources in potential demand estimates is likely to be slight.

On these grounds, potential demand in the region may be estimated

at $15,200,000, composed of:

Domestic/dimension	- $4,500,000
Import/dimension	- $7,200,000
Crushed/Ground	- $3,500,000

That the full extend of assumed latent demand could be realized in all three segments is doubtful. The principal example is the crushed/ground range where the 'shortfall' has been met to a substantial extent by alternative materials on a price basis, and where the supplier's market range is more limited. Nevertheless, this potential level gives a market scope for the project and - at the same time - a maximum horizon which it would be extremely dangerous to exceed.

These calculations, based on inference, may be approached in a theoretical way, assuming the stimulus to increased consumption from competitive prices found in the normal supply/demand analysis. The results are illustrated in Chart IV.

The Regional Market: Prices

The project will face a certain horizon in the prices it can set and still permit its output to be sold. Price (despite the importance of qualitative/availability factors) is still the most important determinant of consumption volume - illustrated by the price 'disadvantage' in the static domestic producers in the region vs. the dynamic acceleration of competitively priced imports. This price factor is also crucial to a broadening of consumption toward potential demand levels - a factor that will enhance the project's prospects measurably.

Broadly, there are two price structures in the market.

First, domestic products (essentially in the building or 'structural' field) are priced typically on cost plus margin. The reason is

the nature of the building marble market - the 'package' of material supply plus installation contract, based on competitive bids, from job to job, in which material prices may account for only 40 to 50 percent of total job contract. A bid system does not permit an easy evolution toward a uniform pricing structure: estimating varies; construction cycles may shift; a particular supplier may, for internal reasons, persistently low bid. While suppliers will be extremely close to the 'market' (in terms of what it will bear), the market is narrow, changeable, and frequently impossible to quantify in terms of price levels. Hence, the reliance on the cost plus yardstick.

Second, the imported product is almost wholly price oriented. The reasons are similarly clear-cut: the import is an 'intruder' into a domestic-held market; to secure market penetration, it must enter at a lower price; having secured a marekt base, it must be responsive to consumer/market influences to remain. The import's market, moreover, involves a wider distribution network: agent or importer; distributor or wholesaler; dealer or retailer; whether through all three stages, or telescoped in volume/quantity discount orders. Whatever the distribution route, there is the opportunity for wider market intelligence and, hence, a competitive pricing policy.*

These two price structures are not wholly incompatible. Nevertheless, a high degree of direct domestic vs. import competition does not exist throughout the market product range.

For example:

Imports account for all furniture material and the bulk of floor

* This process requires an initial cost advantage to permit flexibility in pricing policies. This advantage will be demonstrated presently.

tile consumed in the region.

Regional suppliers account for the major share of crushed/ground product sales.

The 'major' producers in the eastern United States provide the bulk of marble in raw material form, in whole blocks or rough slabs, while this type of material accounts for only two percent of total import value (see Table XI).

Thus, the only area of competition lies in the building/structural products field. And even here, since finished imports have a significant price advantage (whether f.o.b. or landed), competition has been moderated by the response of regional suppliers - switching a part of their finished requirements from their eastern parent firms/affiliates (or, indeed reducing their own plant output) to foreign sources.*

Although the mechanism is imperfect, price still regulates the market. It does so in three ways:

First, the import price discourages entry by the domestic industry into the tile/furniture fields. Similarly, imports of crushed/ground products are confined to coloured material not normally available in the region.

Second, as noted previously, price determines the level of consumption among the various products, and the rate of growth or decline.

Third, price established the commodity's competitive relationship to alternative (or substitute) material. This factor is particularly

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* A major petroleum company's head office building in Los Angeles was faced in Roman travertine from Italy, landed in finished form (c.i.f. plus duty and handling) at a unit price 20 percent below the plant cost of the lowest domestic supplier. Following a number of similar experiences, Vermont Marble and Carthage Marble abandoned a joint effort to 'recapture' the west coast market from imports.

TABLE XIV

Producer/distributor prices for selected dimension marble products, at f.o.b. shipping point and San Francisco, 1966.

SOURCE	Shipping Point	STRUCTURAL PRODUCTS (per sq. ft.)		
		Basis	Producer f.o.b.	Distributor S. F.
Georgia Marble Co.	Tate, Ga.	7/8 "	$2.25 - $3.00	$2.75 - $4.00
Georgia Marble Co.	S.F., Cal.	7/8 "	$3.00 - $4.00	same
Vermont Marble Co.	Proctor, Vt.	7/8 "	$2.50 - $4.00	$3.25 - $5.00
Vermont Marble Co.	S.F., Cal.	7/8 "	$3.50 - $5.00	same
Belgium	Antwerp	7/8 "	$1.50	$2.25
Portugal	Lisbon	3/4 "	$1.00 - $1.20	$1.60 - $1.85
		7/8 "	$1.10 - $1.30	$1.75 - $2.00

TYPE	Basis	ITALY (F.o.b. Leghorn)		
		Producer f.o.b.	Landed c.i.f.	Distributor f.o.b. S.F.
Roman Travertine	3/4 "	$1.18	$1.45	$1.85
	7/8 "	$1.29	$1.55	$2.00
Tucson Travertine	3/4 "	$1.21	$1.45	$1.90
	7/8 "	$1.34	$1.60	$2.05
White Carrara 'C'	3/4 "	$1.35	$1.60	$2.05
	7/8 "	$1.50	$1.80	$2.25
Calacata 'B'	3/4 "	$1.81	$2.10	$2.60
	7/8 "	$2.01	$2.30	$2.85
Verde (green)	3/4 "	$1.95	$2.25	$2.80
	7/8 "	$2.17	$2.45	$3.00

SOURCE	Shipping Point	SPLIT FACE 'BRICK' (per ton)			
		Colour	Producer f.o.b.	Freight	Distributor S. F.
Georgia Marble Co.	Tate, Ga.	Gray	$25.00	$25.00	$ 65.00
		White	$30.00	$25.00	$ 72.00
		Brown/Red	$50.00	$30.00	$110.00
		Pink	$75.00	$30.00	$150.00

SOURCE	Shipping Point	FURNITURE SLABS (per sq.ft.)			
		Basis	Producer f.o.b.	Freight/ Duty	Dealer S. F.
Italy	Leghorn				
Travertine		7/8 "	$1.50-$2.50	$.40	$ 3.00-$ 5.00
White		7/8 "	$2.50-$4.00	$.40	$ 5.00-$ 7.00
Beige/Brown		7/8 "	$3.00-$5.00	$.50	$ 7.00-$10.00
Black/Verde		7/8 "	N/A	$.50	$10.00-$15.00

Source : Georgia Marble Co., Tate, Ga., Joseph Musto-Keenan Inc., San Francisco; U.S. Department of Commerce, International Trade Division, import data.

Note : Distributor mark-up normally 30 percent, dealer/ retail mark-up typically 50 percent. All distributor prices f.o.b. San Francisco.

TABLE XIV A

Producer/distributor prices of floor tile, per sq. ft. (3/8" basis), by shipping point and San Francisco, 1966.

DOMESTIC/MINOR FOREIGN SUPPLIERS (F.O.B.)				
SOURCE	Shipping Point	White	Coloured	Distributor f.o.b. (1)
Georgia Marble	Gant's Quarry, Alabama	$1.70	$1.95	$2.50-$3.00
Vermont Marble	Proctor, Vt.	$2.00	$2.25	$2.75-$4.00
Belgium	Antwerp	$1.20	$1.40	$1.80-$2.00
Portugal	Lisbon	$ .70 (2)	$ .90	$1.20-$1.40

Sources : Georgia Marble Inc., Tate, Ga.; Joseph Musto-Keenan Inc., San Francisco, Calif.

Notes : (1) Distributor prices at San Francisco are assumed on basis of freight or c.i.f./duty @ $.20 - $.25 per sq. ft. plus 20-30 percent mark-up. As volume in all cases is slight, published prices do not apply.

(2) Prices assumed for honed/polished tile 'C' (or common) quality.

ITALY (F.O.B. LEGHORN)					
TYPE	Colour	Finish	Producer's f.o.b. Price	Distributor f.o.b. 1-199	Distributor f.o.b. 200 +
Bardiglio Fiorito	Gray Veined	Polished Honed	$ .97 $ .94	$1.67 $1.57	$1.59 $1.49
Calacata	White Gray	Polished Honed	$1.00 $ .96	$1.67 $1.57	$1.59 $1.49
Bianco Carrara	White Mottled	Polished Honed	$ .77 $ .74	$1.37 $1.19	$1.31 $1.13
Porlato Siciliana	Light Brown	Polished Honed	$1.04 $1.00	$1.71 $1.53	$1.63 $1.45
Portoro	Black/ Gold	Polished	$1.35	$2.16	$2.05
Serpeggiante	Light Brown	Polished Honed	$1.04 $1.00	$1.67 $1.53	$1.58 $1.45
Travertino	Beige	Polished Honed	$ .83 $ .79	$1.35 $1.19	$1.28 $1.13
Verde Mongiovet	Dark Green	Polished Honed	$1.36 $1.31	$2.16 $1.93	$2.05 $1.84

Source: Published price list, Mosaic Tile Inc., San Francisco, for distributor's prices; same firm for producers' f.o.b. values Leghorn/Lavarno.

Note : For c.i.f. costs plus duty, landed San Francisco, add $.22½ to f.o.b. Leghorn values.

important in the building field. All major alternatives - steel, aluminium, pre-cast concrete, glass for curtain walls, plastics and synthetics - are produced in the region, from indigenous raw materials. Moreover, other competitive products - vinyls, ceramics, and exotic woods - have established distribution networks. All these products enter one or more of marble's three major 'markets' - construction, flooring and furniture - and, in the main, do so at substantially less freight/tariff cost. In the region (as in the country), it is not so much 'import competition' that has prevented the domestic marble industry from increasing its output level, it is its price compared to that of its alternatives.

The lessons for the project parallel these three influences:

To enter the tile/furniture markets, its products must be priced below imports.

To achieve a significant and growing output horizon, its prices must be able to stimulate increased consumption of the commodity.

To offset substitute competition in marble's broad market fields, its products must become (in turn) 'substitutes' for those materials that now hold substantial shares of annual consumption.

Price data for the region cannot be complete in the building products field, since individual job prices will vary according to product costs and material colours/patterns, but may be approximated on a price range basis. Prices (f.o.b.) were obtained for imported/domestic tile and for imported furniture material. The f.o.b. price for split-face bric- was determined, but is relatively meaningless due to freight costs into the region from the principal supplier. Known prices to 1966 are summarized in Table XIV and f.o.b. and distributor prices for floor tile in Table XIV A.

Similarly, prices for crushed or ground products are not a precise indicator because high freight costs (relative to per ton value) tend to isolate suppliers from each other. Known prices or average values are included in Table XV. Since marble competes in several applications with limestone, production, value and unit values of limestone in California are given in Table XV A.

For all practical purposes, the prices levels the project must be prepared to 'beat' (on a finished product basis) in order to secure market volume penetration may be summarized as follows:

PRODUCT	SOURCE	PRESENT PRICE Fob/Producer	Cif/Distributor
Structural	Italy	$ 1.75 sq. ft.	$ 2.25 sq. ft.
Furniture	Italy	$ 2.25 "	$ 3.00 "
Floor Tile	Italy	$ 1.00 "	$ 1.25 "
Split-face brick	Georgia	$30.00 ton	$55.00 ton
Crushed/ground	Region	$16.00 "	$20.00 "

It will be advanced in Section III that the project (in its initial phases) will be unable to generate the competitive advantage required to enter the building/structural field on a bid/contract basis. The remaining product areas are available, with the addition of fireplace components for which no present price level has been established due to the wide variation between both jobs and suppliers' prices (but for volume consumption may be set at no more than $2.50 per sq. ft.). To ensure market feasibility, the following price levels have been established:

PRODUCT	UNIT	PROJECT PRICE F.O.B. PLANT	LANDED/DISTRIBUTOR
Floor tile	Sq. Ft.	$ 1.00	$ 1.20
Furniture	Sq. Ft.	$ 2.00	$ 2.50
Fireplace	Sq. Ft.	$ 2.00	$ 2.50
Split-face	Ton	$25.00	$35.00
Crushed/ground	Ton	$12.00	$18.00

TABLE XV

Price per ton, crushed marble products, California, 1961-1964 or 1965.

YEAR	Price per ton f.o.b. quarry	
	Terrazo	Roofing Granules
1961	$20.79	N/A
1962	$20.44	$11.05
1963	$20.71	N/A
1964	$20.22	N/A

AGGREGATE	
Type	Price Per Ton
White, common	$20.00 - $21.00
White, high	$28.00 - $30.00
Ivory/Gray	$29.00
Green/Black	$33.00
Yellow/Red	$38.00

Sources : U.S. Bureau of Mines, Region VI, San Francisco; GrassiAmerican Inc., South San Francisco; Premier Marble Products, Inc., Alhambra.

TABLE XV A

Sales of crushed and broken limestone, by uses, California, 1964.

COMMODITY	Volume Short Tons	Value	Per Ton f.o.b. Quarry
Cement manufacture	12,408,995	$ 11,311,347	$ .91
Riprap	197,589	$ 208,716	$ 1.05
Concrete/roadstone/ screenings	1,422,395	$ 1,726,986	$ 1.22
Whiting (paint, etc.)	98,958	$ 140,000	$ 1.41
Lime manufacture	687,183	$ 2,032,335	$ 2.96
Glass manufacture	220,202	$ 1,035,146	$ 4.70
Liming mesh	19,342	$ 132,375	$ 6.86
Granules (white or artif. coloured)	106,525	$ 795,970	$ 7.47
Mineral food (1)	38,360	$ 287,650	$ 7.50
Other uses (2)	287,227	$ 2,380,635	$ 8.29
Poultry Grit	67,824	$ 691,615	$ 10.20
TOTALS :	15,554,600	$ 20,742,775	$ 1.34

Source :· U.S. Bureau of Mines, Region VI, San Francisco.

Notes : (1) Volume not revealable, and is an estimate.

(2) Other uses include specific industrial applications plus terrazo/aggregate.

These price levels will be re-introduced following an examination of the region's present sources of supply.

THE MARKET FOR MARBLE: SUPPLY

While the volume of marble consumed in the region is modest, there is evidence that demand is strong, rising, and not yet fully satisfied. Nevertheless, present consumption is being met - by the existing producers supplying the market. Thus, the Nevada marble project will have competitors, already established in the market, already working through distribution channels. Before any market/output volumes for the project may be set, the present sources of supply must be assessed.

The data consolidated in Tables IX - XIII establish three principal sources of supply.

First, the quarry-based U. S. 'majors' in the domestic dimension field, located in the eastern United States, and shipping material (whether in rough or finished form) into the region.

Second, foreign producers in the dimension field, located primarily in Italy, shipping mainly finished or pre-finished products into the region.

Third, independent producers operating from quarries located in the region, supplying the market with essentially crushed/ground material.

These quarry-based producers (whether U. S., foreign, or regional) are the primary sources of supply. There are, as well, some 20 to 30 secondary manufacturing outlets - purchasing block/slab material from outside the region, and converting it into finished product form for direct sale in the market. These firms (except where noted) are part of the 'market'-customers for the primary sources - and should be regarded separately. The three primary sources will be discussed here in turn.

The Regional Supply: The U. S. 'Majors'

Some $3,000,000 of total regional consumption of $7,500,000 (in finished f.o.b. plant value) is derived from U. S. domestic marble. With the exception of $112,000 in dimension marble output produced from quarries in six of the 11 western states, all domestic material for dimension products must be 'imported' into the region from eastern sources.

As in the nation, the two 'major' producers - Georgia Marble Co. and Vermont Marble Inc. - account for the bulk of domestic supply. Three main channels are available:

First, through shipments of blocks/rough slabs as raw material to wholly-owned subsidiary manufacturing plants in the region - Vermont at San Francisco, and Georgia at San Francisco and Los Angeles.

Second, through similar shipments to affiliated or independent manufacturing/finishing plants (in either the structural or monumental fields) located in the larger metropolitan centres in the region.

Third, through direct shipments in finished product form to projects in the region (typically in the Rocky Mountain states) allocated to home-based plants in the eastern U. S.

Among regional manufacturing capacity, Vermont's plant at San Francisco is the largest with a payroll of some 80 employees and annual f.o.b. material output in the range of $700,000. The two Georgia plants employ together some 100 to 120 persons, and account for a combined output of approximately $1,000,000. Sales to affiliate/independent plants are not known, but the finished f.o.b. value of these operations (from domestic material) will amount to some $700,000 a year. The balance of f.o.b. material sales is distributed among the six small firms with 'dimension' quarries in the region (see Tables XIII and XVII following),

and sales into the region from the main plants of Georgia, Vermont, and Carthage Marble Inc. from its Missouri base. The approximate distribution is as follows:

PRODUCERS	MATERIAL SOURCE	VALUE F.O.B., 1965	
Georgia Marble SF/LA	Self	$1,000,000	
Vermont Marble SF	Self	$ 700,000	$1,700,000
Other Plants: *			
California	Georg./Vt.	$ 300,000	
Rest of Region	Georg./Vt.	$ 400,000	$ 700,000
Direct Sales:			
Georgia/Vermont	Self	$ 350,000	
Carthage Marble	Self	$ 150,000	$ 500,000
Regional Quarries	Self	$ 100,000	$ 100,000
TOTAL VALUE:			$3,000,000

* Finished output from domestic material only.

The subsidiary plants serve two functions. First, they purchase a reasonably steady volume of raw material from their parent companies (perhaps a total of 4,000 to 6,000 tons a year, or 10 percent of total Georgia/Vermont output) for relatively high-value conversion. Second, they add to total corporate annual revenues by engaging in contract/installation work on building projects. This second function is important. Without it, neither firm would be likely to retain any secure foothold in the market.*

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* Vermont's plant was established in the pre-war period. A proposal to build a second plant at Los Angeles was abandoned recently in view of import competition (although not known, possibly a casualty of the unsuccessful Vermont-Carthage market 'drive' in California). Georgia has acquired in the last five years two of its former customers - Dondero Marble Inc. in San Francisco, and Premier Marble Inc. in Los Angeles - both now wholly-owned subsidiaries. Strong affiliations are held with Blaesing Granite Inc. in Portland, and MacDonald & MacDonald Ltd. in Vancouver, B.C., and possibly with Otto Buehner Inc. in Salt Lake City.

These functions are not discharged without certain difficulties. Neither firm operates quarries in the region,* and must absorb long-distance freight costs and (if delays in shipments are to be prevented) block/slab inventory expense. Recently, the regional subsidiaries have been allowed to divert a part of their material purchases from inter-corporate to foreign sources. This precedent is likely to be extended into finished material (in individual components or whole building job orders) with the prospect that annual plant production may decline.

Moreover, both firms report problems of high unit costs (certainly, on a sq.ft. basis, the highest in the U. S.). Labour hourly rates in San Francisco/Los Angeles range from $3.15 for labourers to $6.00 for highly skilled operators, and average rates of $4.00/hour are about twice the levels in either Georgia or Vermont's home-based plants. These wage costs would not be crucial were it not for two factors:

(i) The labour content in total unit cost per sq. ft. in the region is high, due to the prevalence of small to medium-sized custom job work.

(ii) This content (perhaps in excess of 50 percent) is substantially above the level in alternative materials - pre-cast concrete, aluminium cladding, and the like.

As a result, both Georgia and Vermont find their market position eroded, not only by foreign imports, but equally important, from 'substitute' materials to marble.

Finally, installation costs are high. A two man installation

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* Georgia acquired a white marble deposit (quarried until the 1920's) through the purchase of Dondero Marble but has no plans to operate it. Vermont is reported (by the U. S. Bureau of Mines, Region V, Denver) to hold an option on a deposit at Marble, Colo., but no present interest is evident.

team - setter and helper - costs $10.00 per hour. On a sq.ft. basis, installation will frequently run to $6.00 (and typically higher tan material f.o.b. plant cost). This problem must be faced by imports as well; nevertheless, it is a contributor to the restricted prospects for marble as a structural commodity in the region.

These problems in the region are similar to those in the U. S. industry as a whole, only perhaps in more exaggerated form. The reason lies in the structural market. The 'big' marble contract (still a prime source of volume in Tate, Ga., or Proctor, Vt.) is rare in the region, and when it comes (e.g., the Wells Fargo Bank or Crown-Zellerbach Corp. head offices in San Francisco; or Standard Oil of California Inc. or a major museum in Los Angeles), the 'domestic' frequently lose the job to Italian material, or to alternative materials altogether. For the industry, the normal job involves a material/installation package of $25,000 to $35,000 - hardly sufficient to gear up a plant for long, volume runs. The largest contracts are now coming in the high-rise apartment field. Three apartment jobs in San Francisco in 1965 each exceeded $75,000 in total marble cost.

Nor are the Georgia/Vermont subsidiaries alone in the structural field. A number of 'independent' plants exist in both San Francisco and Los Angeles, able to draw on either domestic or foreign material sources. The apparent 'work' breakdown in the San Francisco market area in 1965 may be of interest, and is approximated as follows:

PLANT	SALES VOLUME 1965 Material fob	Installation	TOTAL
Clervi Marble Inc.	$ 120,000	$ 150,000	$ 270,000
Georgia Marble Co.	$ 300,000	$ 400,000	$ 700,000
Musto-Kennan Inc.	$ 160,000	$ 190,000	$ 350,000
Vermont Marble Inc.	$ 400,000	$ 500,000	$ 900,000
Other Plants	$ 120,000	$ 160,000	$ 280,000
TOTALS:	$1,100,000	$1,400,000	$2,500,000

Source: Estimates of own and competitors' volume or position by Georgia/Musto-Kennan/Vermont

In the San Francisco market, the two subsidiaries do relatively well. The locus of 'major' plant capacity is here, conferring a market and cost/service advantage. In the larger Los Angeles market area (with a structural f.o.b. volume in the range of $2,000,000 to $2,200,-000 a year), the majors' share is substantially lower. The Georgia plant is still an important factor, but most 'independent' manufacturing or finishing plants are converting imcreasingly to imported material (facilitated by the establishment of large 'import' storage yards). In both markets, the subsidiaries will still tend to have an advantage in any custom work requiring technical proficiency, yet their own assessment that their share of the structural market is bound to shrink appears realistic.

By and large, both Georgia and Vermont's plants are conducting a holding operation on behalf of their parent organizations. From accidental evidence,* these plants are operating at a profit; they require little injection in new capital expenditures to remain efficient in regional terms; and there is no clear necessity to abandon them. Vermont's decision not to build a plant in Los Angeles (and the failure of Georgia to upgrade the facilities of either plant) is symptomatic of their outlook: while annual marble consumption in the region will grow, the domestic content of total dimension volume is likely to remain constant at $3,000,000 a year until 1970.

On this basis, how are the two 'majors' likely to regard any implementation of the Nevada marble project?

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* Two of the the three interviews at these plants were conducted during income tax 'time'. The rate of net profit cannot be determined, but a profit was earned in each case (and was implied in the third).

It must be said that the advice to the project from Vermont/ Georgia regional executives and owner/managers of affiliated plants elsewhere in the region has been uniform, and freely given: "stay out of the marble business. It stinks."** This advice can be partially discounted on possible competitive grounds, but should be considered - particualrly as it relates primarily to the structural field.

If the project <u>were</u> to enter the structural market, there is little doubt that both Georgia and Vermont would be concerned, and would be likely to react in one of two ways. First, through direct competition on a price basis. Second, by some attempt to 'integrate' the project in its own organization (possibly even to forestall new competition).

This competitive response would probably be weaker than what could be anticipated from foreign producers. Nevertheless, both 'majors' would be tempted to feel (and rightly so) that the structural market could not absorb a new supplier on an economic basis, and that failure of the venture would only be a matter of time. For the location of the major metropolitan markets and the <u>nature</u> of custom contract work

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* The industry does not want a new competitor in the structural field, and in all discussions, representatives tended to overstate their problems. The fact that affiliates in several regional plants are expanding, and the indications of profitability in the subsidiaries, suggest a satisfactory fiscal position. The only producer - Musto-keenan Inc. of San Francisco and Los Angeles - that has been forced to closed its marble operations has done so through voluntary liquidation, prompted by the death of one partner, and ill health by the other. The firm will now concentrate on other fields. Its disappearance from the market will enhance Georgia/Vermont prospects somewhat.

would involve three costs to the project:

(i) Freight to Los Angeles/San Francisco in finished form, probably more than half the two firms' present raw material freight costs.

(ii) A high labour content relative to other product areas, diminishing the plant cost advantage of the project.

(iii) The creation of a separate construction/installation division to create an outlet for material output, a requirement that might be relatively costly to undertake and support.

This report does not recommend, however, any entry into the structural field at this time. Given this assumption, there is no known reason why the project should be regarded as a 'threat', nor why co-operative efforts in certain product fields cannot be undertaken.* In this sense, the presence of the two leading U. S. producers in the region is a positive factor for the project.

The Regional Supply: The Italians

The most dynamic supplier in the region is now the marble industry of Italy, accounting for more than 75 percent of all foreign imports into the market, and by far the most diversified range. In addition to this volume (some $2,400,000 out of total foreign import f.o.b. value of $3,000,000 a year), the market is supplied by material from Portugal (close to 20 percent), and Yugoslavia, Belgium, Spain, Bulgaria, and Mexico (combined, some five percent). Nevertheless, it is the Italian industry that has led the import penetration, and substantially broadened the regional market for marble in the process.

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* Both firms reported that they would be willing to consider purchases of floor title and other material, given competitive price/quality. The chief opportunity, however, lies in ground products (whiting, chemical fillers, powders for industrial use, and the like). This matter is dealt with shortly.

In the U. S. mining industry, marble is a relatively insignificant commodity. In Italy, however, marble is important, ranking among the leaders in production, value, and exports. Comparative tonnage production figures for 1963 are illustrative:

MINERAL	PRODUCTION (metric tons)
Aluminum	770,789
Coal	702,222
Copper (ore)	80,896
Gypsum	2,972,000
Iron (ore)	1,151,000
Lead (ore)	51,117
MARBLE (blocks)	867,000
Sulphur	965,858
Zinc	205,557

Source: U. S. Bureau of Mines, "The Mineral Industry of Italy," 1964.

Although less than one-third of total dimension marble tonnage output was exported (the remainder consumed domestically), marble accounted for four percent of total Italian mineral/metal export value in 1963, making it the sixth or seventh highest ranking export among all mineral commodities. Principal statistics on production, exports, and imports are given in Table XVI.

The Italian marble industry is first-ranked in the world in tonnage output and in value - its output exceeding that of the U. S. industry by 6.5 times and its annual value by 1.8 times. The reason for the output/value disparity is a sharply lower unit value per ton, summarized as follows:

	F.O.B. VLUE PER TON	
BASIS	U. S. (short)	Italy (metric)*
Production	$ 140.00	$ 34.15
Exports	N/A	$ 91.60

*Metric ton = 2,200 pounds.

Since the bulk of Italian marble exports are in finished form (equivalent to the U. S. $140.00 per short ton basis), the industry possesses a decisive cost/price advantage.*

Yet the structure of the Italian industry differs radically from that of its U. S. counterpart in which two or three integrated producers dominate dimension output.

First, the industry is highly fragmented. It quarries 80 different marbles (principally in the Carrara district of Tuscany) from as many as 300 to 400 individual quarries. While the material colour/pattern range is diverse, the typical quarry operation is small, and frequently a family enterprise.

Second, the industry is not highly integrated. Among the 676 sawing plants and 5,000 finishing plants reported for the whole of the Italian building stone industries (in which marble accounts for four percent of tonnage but 44 percent of value), at least one-quarter will be engaged in marble, again largely on an individual, small volume basis.

Third, the sales/distribution functions appears to be largely divorced from production. The typical pattern is one in which large distribution organizations (e.g. Societa Montecatini, a diversified aluminum/steel/chemicals corporation) will gather up the output from several dozen operations for sales within Italy or in export markets - and Montecatini is reported as the largest single factor in export volume to the western United States. Since f.o.b. plant costs are low,

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* Imports have secured their market in the region on a deliberate price basis - setting f.o.b. prices in 1961-1964 as low as at half the comestic equivalent. In 1964-1965, prices on most products have been raised by 10 percent.

Italian export houses are able to combine price flexibility with marketing expertise.

In relation to the market, imports face two costs: ocean freight and tariffs. Freight costs at $15.00 to $20.00 per ton are not excessive, and prohibitive only in the case of most crushed/ground products. Tariff duties, however, are high, and may exceed $20.00 per ton on finished products.* Yet foreign imports are able to meet these freight/tariff costs - adding up to 40 percent to f.o.b. value - and still land at west coast ports well below domestic prices.

Although price is fundamental to import consumption, it is the quality of the product that has permitted the dynamic 1961-1965 volume increase to occur. This quality is not necessarily technical - until very recently, thickness tolerances and edge cuts for ready jointing were frequently imperfect, but are now more precise.** Instead, the quality lies in the richness of colours and patterns - the diversity obtainable from 80 different and distinct marbles, in all hues of the spectrum, solid, streaked, or veined, from pure statuary white to black. Among U. S. domestic marbles, only Vermont green, Alabama white, and Tennessee reds and pinks are regarded in the market as superior to the standard Italian product.

The Italian exporter has been able to make a virtue of this diversity, frequently collecting up pieces from a number of finishing plants

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* For example, the freight/tariff cost on floor tile per ton amounts to $38.50. GATT tariff rates apply on a volume and ad valorem basis (generally 17.5 percent of f.o.b. value). The applicable tariff schedule of the United States rates are set out in Table XVI A.

** For example, Italian floor tile is now uniform in thickness to a 1/12" tolerance. The importance of a more precise tolerance in tile from the project will be reviewed later.

TABLE XVI

Production, exports and imports of dimension marble, Italy, 1963.

FACTOR	Volume (metric tons)			Value (f.o.b. $ U.S.)		
	1961	1962	1963	Year	Value	Per Ton
Production	992,000	889,000	867,000	1961	$ 33,880,000	$ 34.15
Exports (1)	217,357	238,468	251,951	1963	$ 23,000,000	$ 91.60
Imports (2)	63,688	101,403	122,353	1963	$ 11,280,000	$ 92.20
Net Consumption	838,331	751,935	737,402		$ 22,160,000	

Source : U.S. Department of the Interior, Bureau of Mines, "The Mineral Industry of Italy," Minerals Yearbook, 1964.

Notes : (1) Principal markets in order of tonnage shipments : West Germany, 58,490; United States 37,988; France 23,485; United Kingdom 19,730.

(2) Principal sources : Portugal 62,658; Yugoslavia 22,455. Total import value unknown. Estimate of $11,280,000 is extrapolation of known value of imports from Portugal at $5,800,000. Equivalent values from other sources assumed.

TABLE XVI A

Effective rates of duty and value of imports (f.o.b.),basis, Tariff Schedules of the United States (or TSUS) United States, 1961 and 1964.

TSUS CLASSIFICATION			DUTY		IMPORTS INTO U.S. (fob)	
Item No.	Commodity	Type	Measure	Rate	1961	1964
513.21	MARBLE	Chips	Ad Val.	10 %	$ 270,000	$ 227,000
513.34	LIMESTONE*	Crushed/Grnd.	Ton	$.20	$ 443,000	$ 434,000
514.51	MARBLE	Block, rough or squared	Cu.Ft.	$.275	$ 761,000	$ 814,000
514.57	MARBLE	Sawed or dressed + 2"	Cu.Ft.	$.50	$ 104,000	$ 145,000
514.61	MARBLE**	Slabs,tiles not rubbed/polish.	Ad Val.	5.5 %	$1,308,000	$6,532,000
514.65	MARBLE**	Slabs, tiles, rubbed/pol.	Ad Val.	7 %	$2,147,000	
514.81	MARBLE***	Other Prod., not specif.	Ad Val.	21 %	$3,752,000	$4,709,000
515.21	TRAVERTINE	Not hewn or sawed	Cu.Ft.	$.105	$ 165,000	$ 391,000
515.24	TRAVERTINE	Hewn or sawed	Ad Val.	21 %	$ 377,000	N/A

Sources : U.S. Department of Commerce, San Francisco; U.S. Bureau of Mines, Minerals and the New Tariff Schedules of the United States, Washington, D.C., 1964; U.S. Bureau of Mines, "Stone", Minerals Yearbook, 1964.

Notes : * Marble equivalents. ** Includes floor tile. *** Includes furniture.

(which may be no more than family workshops) and forwarding a shipment of 10,000 to 40,000 sq.ft. on an 'as is' basis. The demand in the region for furniture/tile is sufficiently great that dealers and retailers report that virtually every sound piece of any shipment can be sold.

Like the U. S. 'majors', the foreign producer does not supply the market without certain handicaps. These should be cited:

First, ocean freight involves time, and the period required from placement of order to delivery is 60 to 90 days. This lag is impractical for many construction projects, and the problem is compounded in any material 'shortfall' whether from shipment breakage, inferior quality, or under-supply.

Second, imported material (especially in thinner sizes) tends to be more brittle than its domestic equivalent, and cases of severe breakage have been known. To correct this problem, some distributors (or contractors) will 'over-order' in order to avoid further delays from delivery of replacement components. Nevertheless, this additional cost must be passed on to the consumer, or absorbed in the form of lower profit margins.

Third (and previously noted), the range of colours/patterns may also be a problem. Small volume, family-enterprise quarries are not generally equipped to supply large contract orders promptly. This problem, formerly conferring a competitive advantage to massive U. S. 'major' quarries, is now being overcome by the establishment of large 'storage' yards (including whole blocks, rough slabs, and prefinished pieces) in Los Angeles. Nevertheless, there remains a partial lack of flexibility in supply, increasing in the case of finished imports such as tile and furniture material, which can only be resolved by significant dealers' inventories.

At present, imported 'structural' material at $1,500,000 a year is still only one-half the U. S. domestic volume, yet the gap is steadily closing as imports account for the increase in annual consumption. Import consumption of tile and furniture material is in the range of $750,000 a year each, and is increasing rapidly.* Although negligible in previous years, market sources report a moderate increase in imports of coloured terrazo material. Yet these gains have been made despite the restriction of the import market to west coast metropolitan centres, and a distribution system in the market that is only now becoming effective. Given the absense of any viable competitive response by the U.S. domestic industry, imports will dominate increasingly the market for marble in the west.

This competitive response must be based on three factors - price, quality, and availability. It is plainly evident that the U. S.'majors'- handicapped by a distance/cost problem as severe as that facing foreign producers - cannot muster the required effort. The Nevada marble project can do so, on all three grounds. Yet for its sponsors to assume that it can depend on its availability/service advantages from a location within the region - without full competition on a price/quality basis - would be a dangerous illusion.

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* The market for floor tile has only recently begun to be developed. Few dealers have yet approached architects and designers with literature and samples in standard sales 'presentations', chiefly because they were unable to guarantee availability. What has happened in the market is represented by the experience of Mosaic Tile Inc. in San Francisco - an initial order of 7,000 sq.ft. in 1964; an increase to 60,000 sq.ft. in 1965; and a horizon of well in excess of 100,000 sq.ft. in 1966. This horizon for one distributor in one market area is parallel in all major market areas.

The question then arises: if the project is implemented, what will the Italians do? There are two possibilities (perhaps in combination):

First, price reductions below present f.o.b. Leghorn levels might be made, to the extent of rescinding the previous 10 percent price increase. This process may be accompanied by qualitative (i.e. technical) improvements.

Second, the Italian industry may seek to extend control over 'independent' manufacturing/finishing plants in the region, a measure not beyond the financial resources of such firms as Montecatini. Alternatively, guaranteed 'supply' arrangements may be attempted. This course will be more practical in the 'structural' field rather than in tile/furniture product areas where the good-will and sales effort of distributors/dealers is crucial. The most practical approach in these areas would be a regional distribution network of its own (e.g., a Montecatini of America, Inc.).

The project must face the fact that the western United States market is important to the Italian industry. The volume gains in the region cannot be easily shifted elsewhere. Thus, foreign sources will compete against the project in its determined range. It can only be said that the project's competitive strategy be planned with care, permitting flexibility of response. This strategy (outlined in the feasibility summary at the beginning of this report) will be set out in the concluding discussion of this section.

Little has been said about the other import sources, notably Portugal. The reason is that Portuguese marble has become an important source of supply for the Italian industry (see Table XVI on 'im-

TABLE XVII

Regional producers of quarry-based crushed and/or dimension marble, 11 western states, 1966.

STATE	PRODUCING FIRMS			ESTIMATED ANNUAL VOLUME		
	Name	Location	Products	Tons	Fob Value	Market Area
ARIZONA	U.S. Marble Corp. (1)	Phoenix	Terrazo/roofing granules, aggregate	18,000	$225,000	Arizona/Los Angeles
	Dragoon Marble (2) Quarries Inc.	Dragoon	Terrazo/granules	4,000	$ 50,000	Arizona
	Agnes D. Mick	Phoenix	Rough building pr'ts			
	Andrada Marble Co.	Tucson	Crushed/landscaping			
CALIFORNIA	Grassi-American Inc.	South San Francisco	Chips, aggregate, granules, white + coloured	14,000 (3)	$260,000	San Francisco/Bay Area/ Sacramento/Fresno
	Premier Marble Products Inc.	Alhambra	All crushed prod. for terrazo/roofing/ grit/aggregate/whiting	20,000 (4)	$300,000	Los Angeles/San Diego/southern Cal.
COLORADO	Colonna & Co. of Colorado Inc.	Canon City	Terrazo/granules/ aggregate	15,000 (5)	$200,000	Colorado/Utah/Nebraska/Dakotas
	Cowan Bros. Inc.	Canon City	Travertine	N/A	N/A	Colorado
	O.L. Brady	Whitmore	Crushed/terrazo	N/A	N/A	Colorado
MONTANA	Montana Marble Inc.	Carbon County	Crushed/terrazo/ aggregate/rubble	4,700	$ 94,755	Montana
	American Chemet Corp.	Madison County				Wyoming/Idaho
	Livingston Marble	Park County				Alberta
	Montana Travertine Quarries	Park County				
NEW MEXICO	Ultra Marble Inc.	Albuquerque	Rough/finished dimension prod'ts	2,000	$ 60,000	New Mexico/Arizona/ eastern Texas.
UTAH	Utah Quarry & Rock Inc.	North Salt Lake City	Aggregate/chips	1,400	$ 35,000	Utah
	Aggregate Supply Co.	Murray	Aggregate/chips			
WASHINGTON	Manufacturers Mineral Co.	Seattle	Terrazo/granules/ whiting/agricultural/flux/plaster aggregates. Rough building stone.	18,000	$265,000	Washington/Oregon/ Idaho/British Columbia
	North American Non- (6) Metallics Ltd.	Spokane				
	Ralph Kifers	Spokane				
	W.A. Madsen	Spokane				

Sources : U.S. Bureau of Mines, Region V, Denver, Colo.; Region VI, San Francisco, Calif.; Region VII, Albany, Oreg.; plus trade sources.

Notes :
(1) Estimate only. Firm is largest crushed producer in South-west. Head office in Los Angeles.
(2) Production not reported in 1965. Firm reported sold.
(3) Tonnage output excludes 4,000 tons sold in 1965 as highway roadstone @ $1.25/ton at Sonora quarry. Of crushed output, 6,000 sold for terrazo; 4,000 for marble aggregate; and 4,000 for street lighting post surfaces.
(4) Excludes additional output from quarry in Nevada with 1965 volume unknown. Firm is largest crushed marble producer in western states. Quarry at Lone Pine in Inyo County.
(5) Estimate only. Firm is subsidiary of major U.S. distributor of crushed marble products, based in New York. Volume level reflects recent expansion, and firm is largest crushed marble producer in Rocky Mountain states.
(6) Head Office, Vancouver, B.C. Firm also produces dimension stone, and is largest producer in Pacific Northwest region.

ports' into Italy), and common distribution channels may be used. In any event, the Portuguese industry does not possess the financial/quality/distribution strength of its Italian counterpart, and though its products are priced competitively, it is unlikely to enlarge its relative position in the region. The same general situation applies to the smaller Belgian industry, as well as to Yugoslavia and Bulgaria, both closely tied for distribution to Italy. As for Mexico (whose marble is of good grade and should be a logical source of supply), marble production is relatively unorganized, and any attempts by U.S. firms to supply the region from quarries in Mexico have met with disaster.*

The Regional Supply: The 'Locals'

As set out in Table XIII, quarries within the 11 western states produced $1,404,000 worth of marble in 1964 - all but $112,000 in crushed or ground form. This $112,000 volume is essentially rough dimension stone and rubble, and is not considered further, for no existing quarry nor any present producer is equipped with the required deposit or capital resources to enter the dimension field in any significant way. These firms are listed, however, in the compilation of regional quarry-based producers in Table XVII.

In the crushed/ground field, seven of the 12 producers reporting production in 1964 are minor factors in the market - producing only 1,000 to 2,000 tons in a typical year, and operating with extreme inter-

* The most recent example reported in the trade was U.S. Gypsum Corp. which established a high-grade marble/onyx operation in Sonora State in 1962, and closed it down in 1964, writing the venture off as a total loss. The chief factor was an inability to penetrate the market on a competitive basis.

mittency (usually only when an 'order' justifies quarrying). The other five producers are important. In order of tonnage output, they are:

Premier Marble Products Inc. of Alhambra (in Los Angeles County) with principal quarry/crushing operation at Lone Pine in Inyo County, Calif., and a supplementary quarry near Henderson, Nev. Capacity at the Lone Pine plant (supplied by an underground quarry) is 100 tons/day with annual production about 20,000 tons. This firm is the most diversified producer - engaged in dry ground output as well as crushed aggregate, terrazo chips, and granules. Premier conducts an aggressive marketing effort, and has secured several major terrazo supply/installation contracts (e.g., the 1,000,000 sq.ft. Los Angeles International Airport). It has also developed an important market for marble aggregate pre-cast building panels. With additional output in roofing granules and landscaping chips (stored in inventory in bag form at its Lone Pine site), it is the dominant supplier in the whole of the southern California market area. Its principal disadvantage: a lack of any material other than white.

The U. S. Marble Corp. of Los Angeles, with quarry/crushing operations near Phoenix, and sales offices in both cities. This firm presently engages in crushed output (aggregate, terrazo, roofing, landscaping, agricultural). Reported capacity is 80 tons a day, and annual output is in the range of 18,000 tons. Entering the market after Premier, it is the dominant supplier in the three South-west states, and accounts for the greater single share of crushed 'imports' into California. Although no specific information is available, the firm reports that it is doing well, and may be installing additional capacity. The range is essentially in white material. No disadvantages were cited.

The third-ranked producer in terms of tonnage (but first in per ton f.o.b. value) is Grassi-American Inc. of South San Francisco, with quarry/crushing plant in Sonora, California. A two-family firm, it is integrated with a parallel operation, Pre-Cast Concrete Products Inc., a major regional supplier in its field. In 1965, this firm produced 14,000 tons of crushed aggregate/terrazo material - approximately 6,000 in terrazo; 4,000 in aggregate for pre-cast panels: and 4,000 tons of waste was sold at the quarry to the California State Highways Department for roadstone. The high relative value of its volume (between $20.00 and $35.00 per ton) arises from the colour range at its Sonora quarry, and where the full range is not available, it will use an artificial colouring process, or import special chips from Italy. The principal disadvantage: extremely severe competition on a price basis from crushed dolomite produced at Salinas, Calif., by the Refractories Division of Kaiser Industries Corp. The firm is still, however, the dominant crushed marble supplier in northern California.

A subsidiary of a large, New York based marble importer/distributor, Colonna and Co. of Colorado Inc., with Quarry/plant at Canyon City, Colo., is the dominant supplier in the Rocky Mountain area. This firm produces the full range of crushed material (but not ground), and sells as well into the U. S. Mid-west area. Annual volume information was not divulged, but is estimated at some 15,000 tons with an average per ton value in excess of $15.00. The operation is fairly recent (commencing significant output in 1962-1963), and supplies essentially white material. Its principal disadvantage: relatively slow growth in population/housing in its market area.

Finally, North American Non-Metallics Ltd., a Vancouver-based firm

with quarry/plant near Spokane, Wash. This Firm is the leading supplier of crushed material in the Pacific Northwest and also quarries dimension stone for its Vancouver finishing plant. Total output is estimated at 10,000 tons in 1965. The firm also produces certain coarse ground products - including flux, agricultural grit, and whiting.

There is in reality a sixth supplier, already mentioned - Kaiser Industries Inc. Kaiser's Refractories Division operates a major dolomite lime crushing/treating and desalining plant based on its deposit at Natividad near Salinas, Calif. (90 miles south of San Francisco), for a wide range of industrial products. Three years ago, the company decided to market dolomite in crushed form, entering the terrazo/aggregate field in direct competition against marble. By setting prices 30 to 40 percent below marble equivalent (about $12.00/ton f.o.b. plant), it has captured a dominant position in the field, and has increased annual output to the range of 25,000 tons. The material is competitive from Sacramento to Santa Barbara, and an early entry into the major Los Angeles market can be anticipated.*

For Kaiser, dolomite is not a by-product. It is a 'primary' product with its own virtures - low price, ability to take a polish, and an almost pure white colour - an the company provides it with an aggressive sales effort. Barring other developments, the material should have a commanding position in the whole of the California market by 1970.**

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* Kaiser's senior officer in this field was interviewed on the basis of whether the Nevada marble project would have to compete directly with its dolomite material in the region, or whether some form of product collaboration (or supplement) would be possible. Kaiser will be a competitor, but will not be a crucial factor east of Sacramento.

** The entry of dolomite into marble's range was predicted several years ago by Oliver Bowen, Stone Geologist, State of California Mines and Geology Dept. Mr. Bowen suggests that the same process could be applied against dolomite by an aggressive limestone producer in the state, entering the market at $6.00 to $8.00/ton.

The location of five crushed or crushed/ground operations in Arizona, Colorado, eastern Washington, and eastern California poses substantial problems for the project; for there is no important metropolitan market area in the region that cannot now be served from one or more of these sources. This factor virtually destroys the initial 'concept' proposed for the project - a blasting/crushing operation selling marble chips throughout the whole of the 11 western states. Moreover, in the major California market, the aggressive promotion of Kaiser dolomite inhibits inroads into crushed marble's potential market.

Indeed, the only metropolitan area with a population of more than 500,000 in which the project will have a location/freight cost advantage is Salt Lake City - a centre with less than three percent of total regional population. The pattern is illustrated in Chart VI, and may be summarized as follows:

MARKET AREA	SUPPLY SOURCE	FREIGHT PER TON f.o.b. Plant
Denver	Colonna	$ 2.00
Los Angeles	Premier	$ 3.50
	U.S. Marble	$ 5.00
Phoenix	U.S. Marble	$ 1.00
Portland	North American	$ 5.00
Sacramento	Grassi-American	$ 2.00
	Kaiser Industries	$ 3.50
San Diego	U.S. Marble	$ 4.50
	Premier	$ 5.00
San Francisco	Kaiser	$ 2.00
	Grassi-American	$ 3.50
Seattle	North American	$ 4.00

To supply any of these market areas, the project's per ton freight cost will be at least $5.00 higher over its established competitors - an increased cost that can only be absorbed by equivalently lower f.o.b. plant prices.

Nevertheless, there are three market opportunities for the project:

First, in the aggregate/terrazo/granule range, the project will hold a freight cost advantage in three potential consumption areas - Salt Lake City, Las Vegas, and Reno - and be able to meet present competition in such local markets as Boise, Id., and Eugene, Ore. For white material, this area is unlikely to consume more than 15,000 tons per year. Sales beyond these points, however, can be made on a landed price basis.

Second, in the coloured crushed range (primarily for aggregate panels and terrazo), the market is region-wide except for San Francisco/Sacramento, and a latent demand exists. Assuming competitive prices, an annual volume of 5,000 tons would appear clearly warranted.

Third, in the ground products range, the region is largely deficient, and the bulk of marble's potential market is served by limestone. No ground marble plant comparable to Georgia Marble's Calcium Products Division (referred to in Section III) exists in the region, even on a smaller scale, and despite high freight costs, Georgia now ships modest annual volumes into the market - perhaps in the $100,000 range. Nor will Kaiser dolomite present a likely threat: the magnesium content in natural form is excessive for calcium carbonates. Vermont Marble has shown definite interest in a ground marble supplier in the region, as has Georgia by implication. An initial annual volume of 5,000 tons would appear feasible. The opportunities in the calcium products field

may well be dynamic, but require detailed discussions with a 'major' U.S. industry prospective affiliate.

These three opportunities are realistic in view of the product range of the six leading suppliers:

SUPPLIERS	CRUSHED		GROUND	
	White	Coloured	Dry	Wet
Premier Marble	Yes	No	Yes	No
U. S. Marble	Yes	No	No	No
Grassi-American	Yes	Yes	No	No
Colonna	Yes	No	No	No
North American	Yes	No	Yes	No
Kaiser	Yes	No	No	No

As the leveller in crushed white marble market distribution in the region is freight costs, the Nevada marble project is unlikely to evoke any competitive response in Seattle, San Francisco, Los Angeles/San Diego, or Phoenix - simply because it will be unable (except on an occasional basis) to compete. The project should attempt sales in such 'weaker' supply centres as Portland (and possibly Denver in higher-value forms) but by and large it will be restricted to those local markets cited. Unless the deposit yields white crushed marble of unusually high quality, its region-wide market will be confined to coloured and ground material. In both cases, a competitive source of supply would be welcomed by the existing industry.

THE PROJECT MARKET: FACTORS

The annual output by product type recommended in the concluding discussion of this section involves net additions to present consumption levels in the region. Certainly, the policies proposed are intended to displace a part of the import component of consumption in major California markets. Moreover, a substantial part of the increase will

occur in interior and Pacific Northwest markets not now adequately served.

Nevertheless, the project will depend on inroads into potential marble consumption in order to sell its recommended output.* This requirement means that the project will have to enter broad market fields - housing, flooring, and furniture/home furnishings. The trends and outlook in these 'markets' will have a bearing on the dimension output of the project, and are assessed in summary form below.

Project Market Factors: Housing

All products (with the exception of ground) depend in substantial - and in some cases exclusive - measure on new housing. The Trends/outlook in the region should be considered in any realistic assessment of the project's market.

In the 1960-1964 period, housing in the region has been unusually dynamic. There have been two causes. First, population growth remained strong, and both new family formation and in-migration into the region created accelerated housing demand. Second, the lag in apartment construction during population growth in the 1950's produced especially rapid activity in this field. The result was an increase in housing starts over the period of more than 25 percent. The trends in thirteen

* Annual volume depends not only on the quantity that can be sold, but as well on the cost at which it can be produced. This cost (determined in Section III) is a function of machine/plant capacity on a 'least cost' basis. This basis should be reasonably precise, for a factor in the 'problem' of the U.S. domestic industry is that many of its plants are too small or (in certain cases) too heavy in surplus capacity to be fully efficient. In short, the project can readily be competitive in price against present suppliers provided annual volume is adequate. This process works, of course, both ways: a competitive price structure will stimulate increased consumption.

leading metropolitan areas in the region are given in Table XVIII.

The last column in this Table - housing units authorized per 1,000 of population in 1964 - indicates the different rates of housing activity between the various centres: exceptionally strong in the 'growth' areas in California, Arizona and Nevada; still active within Los Angeles and San Francisco core areas; but substantially weaker in outerlying metropolitan centres of the region (i.e., Seattle/Tacoma, Portland, Salt Lake City, and Denver) where population/employment/economic growth has been more moderate. This pattern was outlined in Section I.

These thirteen centres accounted for 55 percent of total regional population in 1964, but 65 percent of new housing units. This pattern reflects the continuing trend toward metropolitan settlement in the region, and identifies the principal market concentrations for the project.

On a state basis, California in 1964 accounted for close to 250,000 housing units authorized out of a regional total of 350,000 - or 70 percent. This 70/30 ratio between California and the rest of the region will decline in the period to 1970, perhaps to a 60/40 balance. The reason is an abrupt decline in the state of new housing starts in 1965-1966, caused by what has now proved to be serious 'over-building' in the previous three years.* The forecast level in the state in

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* In a memorandum entitled "Projections of the California Economy to 1970," the Economic Research Department of the Bank of America, San Francisco, predicts an annual opulation increase of 2.4 percent (vs. 3.4 percent in 1960-1965);in the personal income 5.9 percent (vs. 6.6 percent);and per capita income 3.4 percent(same). The chief contributor to more moderate growth is held to be employment/output declines in the aircraft/defense/space industries. In contrast, a sustained increase in employment is predicted in the government sector and in services. Thus, while growth will be more moderate in Los Angeles, it will remain relatively constant in the San Francisco area, and strong in Sacramento.

TABLE XVIII

Housing units authorized in principal metropolitan areas, western United States, 1960 - 1964.

METROPOLITAN AREA	Housing Units Authorized					Value 1964	Value per Unit	Housing Starts 1964 per 1,000 of population (1)
	1960	1961	1962	1963	1964			
Anaheim-Santa Ana, Cal.	21,607	26,272	33,199	35,062	26,882	$ 375,000,000	$ 13,950	38.1
Denver, Colo.	13,386	19,554	15,994	12,098	9,594	$ 115,000,000	$ 11,990	9.8
Las Vegas, Nev.	3,675	5,521	15,205	11,146	2,813	$ 46,000,000	$ 16,350	22.2
Los Angeles, Calif.	60,069	68,037	81,408	106,437	89,019	$ 1,152,000,000	$ 12,940	14.4
Phoenix, Ariz.	16,320	15,068	14,181	15,022	11,176	$ 92,000,000	$ 8,230	16.6
Portland, Oreg.	6,159	6,273	6.557	7,445	8,416	$ 107,000,000	$ 12,710	10.2
Sacramento, Calif.	11,235	8,743	9,911	14,906	9,127	$ 107,000,000	$ 11,720	14.4
Salt Lake City, Utah	4,117	5,086	5,510	6,626	4,314	$ 58,000,000	$ 13,440	9.3
San Bernadino, Calif.	13,290	12,688	18,001	24,849	22,618	$ 236,000,000	$ 10,430	27.7
San Diego, Calif.	14,407	10,975	9,092	12,770	13,906	$ 176,000,000	$ 13,900	13.5
San Francisco/Oakland, Cal.	27,310	30,621	35,708	40,264	38,277	$ 526,000,000	$ 13,740	14.1
San Jose, Calif.	16,427	15,991	18,880	21,376	14,731	$ 195,000,000	$ 14,730	22.6
Seattle/Tacoma, Wash.	9,890	11,640	17,392	15,275	12,007	$ 166,000,000	$ 12,000	8.6
TOTALS	217,892	236,449	281,038	323,276	262,880	$ 3,351,000,000	$ 12,750	15.8

Source : U.S. Department of Commerce, Bureau of The Census, Statistical Abstract of the United States, 1964.

Note : (1) Population based on 1960 Census, and ratios will be slightly understated.

1967-1970 is 205,000 new units a year, split roughly equally between single-family dwelling and apartment units. This forecast is set out in Table XIX.

Over the period to 1970, however, housing activity will continue in a moderate but steady increase in the rest of the region, rising from 100,000 units in 1964 to an estimated 150,000 in 1970. A forecast is included in Table XIX.

This pattern confers a special short-run advantage to the project in its crucial initial production years. Imports are still confined essentially to major coastal California markets, allowing the project to capture the market in the rest of the region where housing construction will continue to increase. Even in California, however, the outlook is not pessimistic. The 1964-1966 acceleration in marble consumption has been achieved <u>despite</u> a decline in housing activity, and there is no evidence that demand here has yet been satisfied. An annual volume in the state of 205,000 units is still a substantial market basis.

<u>Project Market Factors: Flooring</u>

The flooring market is treated separately from housing for two reasons. First, the project's product in this field - tile - has no other use. Second, tile (unlike furniture/fireplace materials) has wider application beyond housing - particularly, in major office/bank/government/commercial buildings.

Flooring consumption in 1964 may be approximated by reference to construction volumes in sectors applicable to tile materials (excluding industrial, distributive, and utility projects), on an average cost per sq.ft. basis. This approach yields a total volume in the region of

500,000,000 sq.ft., distributed as follows:

SEGMENT	FLOOR AREA
New housing/apartments	400,000,000
Office/public/commercial	75,000,000
Additions/alterations	25,000,000
TOTAL:	500,000,000

While the number of annual housing starts in the region is expected to decline to 1970, the total floor area volume is not, and may well increase. First, the share of higher-value (and therefore larger) housing units will rise. Second, the office/public/commercial construction sector is expected to be dynamic - with major building projects announced for virtually every leading metropolitan centre in the region in the 1966-1970 period. This 'market' would be an important outlet for project output.

The bulk of the flooring market (in excess of 70 percent) is now held by standard materials - asphalt tile, linoleum, and softwood flooring. Medium to higher-value materials (e.g. rubber tile, mosaic, hardwood flooring, vinyl) hold the balance of the market. It is within this latter price range that marble tile falls, and some illustrative quotations, f.o.b. San Francisco, may be of interest:

MATERIAL	PRICE PER SQ.FT.
Asphalt tile	$ .30 - $ .50
Fir Flooring	$ .60 - $ .80
Rubber tile	to $1.00
Mosaic tile	$ .65 - $1.00
Hardwood flooring	± $1.00
MARBLE (white)	$1.31 - $1.37
MARBLE (colours)	$1.49 - $2.15
Synthetic marble	± $1.75
Vinyl tile	$1.25 - $2.00

Basis: f.o.b. distributor, San Francisco

TABLE XIX

Projection of authorized housing units, California and rest of western United States region, 1964 to 1970.

YEAR	CALIFORNIA			REST OF REGION	TOTAL
	Single	Multiple	Total		
1964	102,677	142,692	247,239	95,000	342,239
1965	90,000	85,000	175,000	100,000	275,000
1966	95,000	90,000	185,000	105,000	290,000
1967	100,000	100,000	200,000	115,000	315,000
1968	105,000	100,000	205,000	125,000	330,000
1969	105,000	100,000	205,000	137,000	342,000
1970	105,000	100,000	205,000	150,000	355,000

Source : For California, Economic Research Department, Bank of America, Projections of the California Economy to 1970, San Francisco.

Price is not the only determining factor in assessing marble's place within the flooring market, for one crucial distinction must be made: between 'resilient' materials (asbestos/asphalt/corlon/rubber/vinyl) and 'non-resilient'. Marble tile is hard-wearing, durable, easy to maintain, attractive, and long-lasting, but it is not resilient. Thus, it will be used where it has a practical (as well as a decorative) advantage. These uses in housing will be in entrances, halls and other non-living areas, although applications in kitchens, bathrooms, and living rooms are not unknown. In office/public/apartment buildings, the uses are typically in foyers, lobbies, and hallways, as well as in main floor areas (e.g., banks). In these applications, marble will tend to compete with ceramics, other stone, and even terrazo, as well as the more durable resilient tiles.

The market segment applicable to marble is thus no more than five percent of the total flooring market - or maximum of 25,000,000 sq.ft. This segment (based in substantial part on larger houses and major building projects) is likely to increase more rapidly than the general range of construction, perhaps by 1,500,000 sq.ft. per year to 1970. Again, this trend is advantageous to the project.*

Project Market Factors: Retail Sales

While most of the project's product range will be associated with

* The fastest growing employment sectors in the region are services, finance and government. All will require increased office/administrative space (e.g., banks. Among planned projects: the First National Bank of Seattle (50 storeys); the Bank of America, San Francisco (52 storeys). Moreover, sustained economic/industrial growth in 1960/1965 is creating a 'lag' demand for office space in large corporations. Finally, urban redevelopment funds are available for major projects (e.g. Golden Gate redevelopment project, San Francisco, $80 million).

construction (and its housing/flooring components), the level of retail sales has an important bearing in one product area: furniture material. At present, the bulk of imported marble furniture volume is sold at the retail level - either in slab/round or finished manufactured form. Although the project will seek the 'built-in' housing market (for bathroom/kitchen counters, vanities, and the like), a proportion of its output will be marketed to the end consumer through retail/dealer outlets.

The volume of retail sales in any given year typically ranges between 55 and 60 percent of total disposable, personal income, estimated for the region at $80 billion - and yielding total retail sales of $46 billion. The distribution was weighted in favour of California - at $30.5 billion to $15.5 billion - a reflection of its high per capita income level.

Aside from the general trend, the operative segment to the project is volume in furniture/home furnishings retail sales, normally accounting for 2.5 percent of total volume - or, in the region, some $1.2 billion in 1965.

The trend in retail sales to 1970 in California was also assessed in the Bank of America memorandum. In the state, the forecast volume is $40 billion, an increase of 33 percent over 1965 (vs. 42 percent in 1960-1965). The bulk of this increase will occur in 1967-1970, as retail sales account for a high average 58 percent of disposable personal income.

Sales in furniture/home furnishings stores are expected to grow less rapidly - a result of the reduced pace of house-building activity. This pattern need not apply to the rest of the region, and a gain of

25 percent to $1.5 billion can be anticipated at 1970. This increase should afford sufficient market scope to the project in the 'retail' component of its furniture output.

MARKET VOLUME FOR THE PROJECT: PRODUCTS

The foregoing demand/supply/market factors broadly determine the share of the market available to the project; and, hence, its annual output and volume range. The final discussion will set out annual volumes and anticipated sales by market areas on a product-by-product basis. The requirements of the market - where appropriate in each case - will also be outlined.

The market basis for project products postulates annual volumes that (added to present supply) will represent an excess over present consumption, but still fall short of potential demand. This basis assumes:

First, all new consumption in present 'import' markets will accrue to the project. Moreover, a displacement of a part of import volume is assumed.

Second, the latent demand for marble in the rest of the region will be satisfied by the project alone. Little or no direct competition from imported or domestic sources is anticipated in any event.

Third, consumption of marble as a commodity in the region will remain dynamic, rising more rapidly than the general average in the housing/flooring/furniture fields - on a price/quality basis. This assumption can be made with reasonable safety, and implies the project's ability to 'invade' markets now held by alternative materials.

Given these assumptions, the market basis for the project may be

summarized as follows:

PRODUCT		REGIONAL CONSUMPTION 1965		PROJECT OUTPUT
AREA	UNIT	PRESENT	POTENTIAL	
Structural	Sq.Ft. 7/8"	1,500,000	3,000,000	None
Monumental	Cu.Ft.	10,000	15,000	None
Floor Tile	Sq.Ft. 3/8"	750,000	2,500,000	1,000,000
Furniture	Sq.Ft. 3/4"	300,000	1,000,000	300,000
Fireplace	Sq.Ft. 3/4"	100,000	500,000	200,000
Split-face	Ton	1,000*	10,000	4,000
White Crushed	Ton	80,000**	150,000	15,000
Colour/Crushed	Ton	2,500	20,000	5,000
Ground	Ton	2,500***	20,000	5,000

* Excludes rubble.
** Excludes dolomite.
*** Excludes limestone.

The volumes in products recommended for output will be defended in the separate product market analyses to follow. Except for some remarks below, the monumental field will not be raised again in this report. The bulk of the market is held by granite on a price/preference basis, and present supply is adequate. For the project to enter this field, a separate monumental plant would be required, involving specialized and costly labour content in shaping, finishing, and inscription, and a competitive market basis could not by any means be guaranteed.

The potential level of consumption in 'structural' material is much more promising yet a general condition of over-supply exists until the industry can become fully competitive in material price and installation techniques against competitive materials. A re-assessment of the structural field is recommended for 1968, with a view to possible entry in 1970-1972. An earlier basis is concluded in the Appendix C discussion.*

Product Output: Floor Tile

Total consumption of marble floor tile in 1965 was estimated at $800,000 - with an approximate equivalent volume in sq.ft. measure - at f.o.b. plant vlaues. Imports supplied $750,000 of this total, accounting for some 720,000 sq.ft. The balance was supplied by domestic sources.

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* An examination of past data indicates a degree of volatility in the monumental market on a national basis, with sharp swings in year-to-year output (e.g. 1963 to 1964, see Table I). In the region, in any event, marble demand is limited, supply is adequate, and the bulk of consumption remains firmly held by granite. On a national basis, the monument output of the two 'majors' Georgia and Vermont at their home-based plants - has risen appreciably in 1965-1966. The reason is the casualties among U.S. Armed Forces personnel in South Vietnam. Both plants are producing 100 units per week (at $60.00 per unit with inscription) and there is a requirement for a third 100 per week production. In view of the obvious desire of the U.S. Administration for a just and honourable settlement of the Vietnam conflict, this 'opportunity' may well be short-lived. This market may be re-assessed, if desired, in 1968.

As to the Appendix C discussion (which has been submitted separately and confidentially), it can be suggested that the feasible basis for entry into the structural market in the region involves two factors. First, marble components must be standardized - for certain applications on exterior/interior walls - as pre-fabricated units, and the concept of the 'marble building' abandoned. Second, a guaranteed outlet with a major construction/development company (sufficient to account for the greater part of annual output) would be required to eliminate the costs (and hazards) of

The recommended tile output of the project is 1,000,000 sq.ft. (3/8" basis) per year. This output exceeds total present consumption. Its sale depends on two factors: displacement of imports to the extent of 250,000 sq.ft. a year, and the creation of new consumption of 750,000 sq.ft. per year. The market for tile in the region would double to 1,500,000 sq.ft. per year. The basis is as follows:

		ANNUAL CONSUMPTION BASIS			
SOURCE	VOLUME	PRESENT	+	POTENTIAL	CHANGE
Imports	750,000	500,000			- 250,000
Project	-	250,000		750,000	+ 1,000,000
TOTALS:		750,000	+	750,000	1,500,000

Is this output level feasible? The criterion here is potential consumption.

A case could be drawn that the potential market for marble tile is the equivalent of one sq.ft. per 100 sq.ft. of annual flooring area installed - or 5,000,000 sq.ft. A more appropriate approach is marble's share within the 'non-resilient' flooring segment, in which a 1 : 5 ration would be required to permit a 5,000,000 sq.ft. annual volume. A more realistic ratio is one sq.ft. out of every 10 sq.ft. installed within this narrow range. This yields a potential consumption of 2,500,000 sq.ft. per year. In the period to 1970, this is the market horizon for the project.

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small custom job bidding, and the necessity to 'carry' a separate contracting division in which the project has no competitive advantage.

Needless to say, if the project's sponsors could satisfy these conditions, a $1,000,000 structural mill producing up to $2,000,000 in f.o.b. output a year would be included immediately in the project design.

The marketing of this volume involves several product requirements - in price, quality, range, and availability. The basis would be as follows:

FACTOR	IMPORTS	PROJECT
Price f.o.b.	$ .77 +	$ .90 +
Price c.i.f.	$ 1.00 +	$ .95 +
Thickness tolerance	to 1/12"	precise
Edge cuts sqared	Yes/No	precise
Inventory in region	No	Yes
Delivery (in days)	60 - 90	1 - 14
Pre-cut to blueprint	No	If requested Add $ .10 - .15.

In price, the project's prices on a landed-to-distributor basis should be uniformly five cents per sq.ft. below import. This reduction immediately gives an incentive to the distributor to 'switch'.

It is perfectly likely, however, that Italian producers will meet project prices. The project will then rely on additional advantages.

In quality, it will guarantee a precise and uniform thickness in all tile material (through two-side grinding), and precise square-edge cuts (by diamond saw cutting). The imported material cannot meet these standards.

In the market, these technical factors will reduce setting/laying costs from a present average $ .15 per sq.ft. (not including 'spot' re-grinding or cutting of odd-sized pieces) to $ .075.

In inventory/delivery, the project will have an overwhelming advantage, with subsequent savings to the market in non-breakage, easy

ordering and re-ordering, job scheduling, and inventory costs.

In major building projects, the project should make available one final service: cutting to blueprint. This process involves pre-cutting at the plant for a whole floor area (e.g., a main floor office or apartment building lobby), with subsequent savings on the job. An additional charge of $ .10 to $ .15 for pre-cut pieces would be acceptable to the trade.

What advantages would Italian floor tile retain? There are two.

First, the material now holds the market, and on consumption growth evidence is accepted. The material has a built-in 'prestige' and cannot be completely dislodged without a costly (and perhaps in the market disastrous) 'price war".

Second, the material is presently available in a choice of 18 colours or patterns - a range the project will not be able to duplicate. These variations, however, are based on nine colours: white, gray, beige, brown, pink, red, green, yellow, black. From its own material, the project can supply a total of eight colours. Any deficiencies may be overcome by the purchase of particular coloured material in 'block' form - a device now adopted in 'structural' material in plants in Georgia and Tennessee.*

Nevertheless, the Italian product - mottled, veined, or streaked - is attractive, and will continue to be consumed for this reason alone. The Nevada marbles will be no less interesting and (on the basis of available samples) no less attractive. The likelihood remains that

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* Actually, the project could conceivably operate on a feasible basis without a deposit, purchasing its raw material supply. This approach, however, involves somewhat higher costs and possible supply hazards. Certain 'block' purchases can be tolerated.

they will have to build (as the Italian product before) a preference in the market - and until this process is achieved, it would be unwise not to rely on price/quality/availability factors.

Where will the output sell? Two assumptions can be made. It is expected that the project will capture the bulk (if not the whole) of the interior/Pacific Northwest markets. However, imports will still sell in coastal California metropolitan centres to some 500,000 sq.ft. per year to 1970. The project's market share in these centres will thus be lower than in the rest of the region. Broadly, sales of 500,000 sq.ft. are anticipated in California: 375,000 sq.ft. in the rest of the region; and 125,000 sq.ft. in the two secondary markets - western Canada and the U.S. Mid-West. The breakdown is as follows:

MARKET	AREA	ANNUAL VOLUME (sq.ft.)	TOTAL
INTERIOR	Denver/Pueblo	80,000	215,000
	Salt Lake/Ogden	40,000	
	Las Vegas/Reno	25,000	
	Phoenix/Tucson	50,000	
	Other states/areas	20,000	
NORTHWEST	Seattle/Tacoma	100,000	160,000
	Portland/Eugene	60,000	
CALIFORNIA	Los Angeles/San Diego	300,000	500,000
	San F./Oakland/San Jose	150,000	
	Sacramento/Stockton	50,000	
SECONDARY	Western Canada	75,000	125,000
	U.S. Mid-West	50,000	

These volumes depend on a competitive landed price in each market area plus distributor's mark-up. The landed price will be some five to seven cents above f.o.b. plant (at anticipated truck freight costs). In tile, the project's distributors will also function as

'dealers' (selling directly to architects, contractors, and installers) and a 30 percent 'mark-up' above landed cost will represent the consumer's final price. Thus, to the consumer, the cost of project tile output will be in the range of $1.25 to $1.60. This price level is highly competitive with alternative materials.*

Product Output: Furniture/Fireplace

These two product areas will be taken together. While functioning partially in different markets, they will be manufactured on the same production 'line' - chiefly because of similar thickness.

Furniture Material

The recommended output in furniture material is 300,000 sq.ft. per year (3/4" basis). This volume is equal to total present consumption in the region and - except for an anticipated import displacement of 50,000 sq.ft. per year - will rely on potential demand in the region. In unit terms (each 'piece' the equivalent of eight to ten sq. ft.), the project must make 25,000 to 30,000 individual 'sales' per year.

The projects's furniture output has four potential outlets. In broad terms, and with anticipated volumes, these are:

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* To obtain low unit costs, tile must be produced on a straight-run, semi-automatic basis. 'Line' capacities are 500,000 sq.ft. on a one-shift basis. A two-shift operation at 1,000,000 sq.ft./year is determined as most economic.
A doubling of output to 2,000,000 sq.ft. at 1970 could be anticipated. This increase would be accompanied by a further displacement of imported material. The market for tile is regarded as feasible, and output of 1,000,000 sq.ft. a year is recommended.

SEGMENT	BASIS	VOLUME	UNIT
HOUSING	Sales to contractors for apartment/house bathroom counters, vanities, kitchen slabs. Built-ins.	100,000	10,000
INTERIOR DESIGNERS	Direct sales to designers for hotel/motel/office furniture, as specified	75,000	7,500
FURNITURE MANUFACTURERS	Sale of slabs/pieces to order for assembly.	50,000	10,000
RETAIL STORES	Direct sale to final customer as slabs for coffee, end tables, desks.	75,000	7,500
TOTALS:		300,000	35,000

The housing market consists not only of single-family dwelling contracts, but more fundamentally the larger apartment building and housing development. Within this market, marble would be used for standardized installations - bathroom counters and vanities; kitchen counters and mixing/dough slabs; and bedroom vanity/desk built-ins. The usage per housing unit is assumed at 20 sq.ft. - or on total output of 100,000 sq.ft., some 5,000 housing units a year. Since the regional annual volume to 1970 will be an average 350,000 units, this target is regarded as realistic.

The interior design market has two parts. The first is the contract for the decor/design of a new or existing single family house, a segment not of particular interest to the project. More important is the second field: the interior design of the large motel/hotel/office building project, in which the designer will specify all materials,

arrange their manufacture or assembly, and supervise their installations. In this market, the principal uses for marble are in coffee tables, end tables, and desks, as well as desks/credenzas/conference tables in 'executive' offices. The typical contract will involve ± 100 different room/office units or installations - requiring about 15 sq.ft. of marble each - or 1,500 sq.ft. per 'order'. It is assumed that among the several hundred 'orders' placed each year in the region, the project will make sales to 50 for a total of 75,000 sq.ft.

The furniture manufacturing market consists of direct sales to the furniture industry of the region. The industry employs more than 30,000 persons, but is concentrated in Los Angeles (23,800 employees) and to a lesser extent in San Francisco (4,700 employees). The principal use for marble at present is in tops for smaller end tables and coffee tables, not usually more than four to five sq.ft. each. Annual gross revenues of the industry are not known, but may be assumed to be in the range of $500,000,000. Within this total volume, there is little doubt that 50,000 sq.ft. of marble from the project can be sold.

Finally, the retail market consists of a number of dealer outlets (confined to major metropolitan centres) specializing in marble slabs/rounds. These stores are the outlet for most of Italian furniture material consumed in the region - importing in quantity at prices ranging from $3.00 to $7.00 per sq.ft. landed, then charging a 50 percent mark-up. Although present consumption in volume (i.e. sq.ft.) terms is not known, these outlets will probably sell in excess of 250,000 sq.ft. per year: two-thirds to three-quarters in 'rectangles' and 'squares', and the balance in 'rounds'. As the production of round or oval furniture material is not recommended for the project, the volume will be confined

typically to rectangular pieces 5' x 2' with a number of dimension variations. While this market is competitive, the value per unit is high, and in view of present consumption, the sale or 7,500 units - or 75,000 sq.ft. per year - would appear reasonable.

In two of the above market areas - housing and furniture manufacturing - the latent potential for the project is substantial, even to the point of absorbing total furniture output. Nevertheless, it is recommended that the project operate in all four areas, and install an additional production 'line' when warranted to produce furniture material to order exclusively.

As to the requirements of the market, these can be cited briefly.

In price, an average value f.o.b. Italian prices, and about $ .50 per sq.ft. below landed costs. However, the project is entering new markets for furniture material, and a price incentive will be required to permit it to compete against alternative materials (e.g., exotic woods).

In quality, two requirements are essential. First, in addition to polishing, the surface must be 'filled' and, if necessary, treated to eliminate all possibility of porosity and absorption and - therefore - staining. The ease with which unfilled imported material stains and discolours is a major factor in the market success of manufactured or synthetic marble, now selling on a volume basis close to natural marble's level in the region. Second, the edges must be ground and polished as well as the surface, requiring another operation on the production line. These two requirements are not difficult to meet.

As a general rule, the project should restrict its dimension range of furniture material fairly narrowly. No more than two thicknesses

(3/4" and 5/8" if required) should be adopted. The length per piece should be in one foot multiples, rather than odd dimensions, and a standard two foot width should be pursued. Finally, the colour range should not be diverse and exotic: the standard range of the project will be adequate. These limits restrict the scope for 'special' (and generally costly) orders which the project does not appear to need, and will only lose valuable straight-run production time in undertaking.

In comparison with floor tile, the greater part of furniture shipments are likely to be directed to California. Excellent markets may develop in the leading interior centres, but furniture manufacturing capacity (upon which interior designers and retail sales depend for assembly in final product form) is limited. A decided interest is indicated in the Western Canadian secondary market. If volume warrants (and it may exceed 100,000 sq.ft. per year), the establishing of a small filling/polishing/treating plant in Vancouver to serve this market may be installed. This decision should be made after discussions with prospective distributors for the area.

Fireplace Material

The fireplace mantle/hearth is a traditional use for marble, and several dozen specialized shops in the region undertake custom work in building or remodelling with marble. Each 'job' tends to be different - a little wider or narrower, higher or lower, contemporary or traditional, ornate or plain - and the prices charged per sq.ft. (for both material and installation) can be phenomenal.*

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* A fireplace contractor in San Francisco reports average landed prices for finished material ranging from $4.00 to $14.75 per sq.ft.

Moreover, where the former use of marble was generous (i.e., in excess of 1" thickness), installers will now apply facing to 3/8" thickness.

There is no scope for the project in supplying the 'fireplace' market on custom job basis (or even supplying the suppliers to job order). Yet there is a potential market for the project, and a large one: the pre-cutting of 'packaged' fireplace units for new housing construction.

The 'packaged unit' has never been made available because of the jobber's peculiar attitude toward assuming on individual customer preference in installation (an assumption that creates the opportunity for higher installed prices). Yet the opportunity exists, for under FHA and privately-financed housing development and/or apartment projects, certain standard hearth widths - from 21" to 36" + - are specified. All that is required is designing the complete unit to meet these openings.

The 'package' would consist of mantle, two standards (or upright pieces on either side of the hearth), and the hearth-front itself. These four pieces (e.g. 12" in width, 3/4" in thickness, and from 4' to 6' in length) would enclose the unit. Facing pieces from floor to mantle would be optional, or two sets of packages could be offered.

From prospective distributors, there is little question that units of this type would sell well. The typical unit would consist of 20 sq. ft. without facing - or up to 32 sq.ft. with facing pieces - and, on an annual volume of 200,000 sq.ft., 10,000 separate installations would be required. Again, in view of the scope of the new housing market, this volume would appear quite feasible.

The requirements are essentially simple.

First, the <u>price</u> should be low - set, again, at $2.00 per sq.ft. (3/4" basis) to stimulate consumption in a new field. The typical unit

would thus sell f.o.b. plant at $40.00. The addition of distributor's costs and installation should allow the total unit to be installed for $80.00 to $90.00 in a new housing project - a price fully competitive in the market against alternative materials.

Second, the unit must be easy to install. This report is not competent to propose technical refinements, but the installation techniques adopted (jointing, gluing, hooks, screws for hanging, etc.) should be those that permit efficient, low-cost installation to the contractor. Discussions should be held with prospective distributors as to whether the 'package' should contain mastic and other components, or whether these should be supplied separately.

Third, the dimensions should be standardized, and designs adapted to hearth openings. If (for example) four sizes are offered, these can be made available in six to eight colours, for a combination of choices of no more than 32. Delivery will, of course, be prompt due to plant/distributor inventories.

As to market distribution, the pattern of sales should follow broadly those in new housing, with perhaps greater consumer interest in interior markets where marble has not been available. Sales outside the region into secondary markets are also clearly possible.

Again, as in tile and furniture, a separate fireplace material production 'line' may well be warranted by 1970.

Product Output: Split-Face

The third operation proposed for the project plant is a small 'split-face' processing unit. This product is essentially a marble 'brick', cut to random lengths but to fairly precise widths - ranging 2 1/4" to 5 1/2" to 7 3/4" or in equivalent multiples. The material

is installed as in any standard clay brick, cemented by mortar.

The principal uses of split-face (so termed because a rough slab is laid on its side and fed through a hydraulic splitter or guillotine for face-cuts) are exactly equivalent to those of brick: fireplace facings, exterior walls, garden wall and patios, interior decorative applications, and the like. The principal U.S. supplier - Georgia Marble - reports annual sales in excess of $1,000,000 which on a per ton unit value basis would amount to close to 20,000 tons. Present annual sales of the material will not exceed 1,000 tons in the western U.S. due to high freight rates (at $25.00 per ton) from eastern supply sources.

The market for split-face is unpredictable, for a useful breakdown of production and consumption of standard brick products (with which it will compete) is not available. At a fully competitive price of $25.00 per ton f.o.b. plant for white marble to $40.00 per ton for coloured, prospective distributors indicate substantial latent demand. The recommended volume of 4,000 tons per year is assumed to allow for production increases toward potential annual demand of 20,000 tons.

Product Output: Crushed/Ground

The present consumption of marble in crushed or ground form in the region approximated slightly more than 100,000 tons in 1965 with a value of $1,500,000. The bulk of this consumption - 95,000 tons at $1,300,000 - was supplied by quarry-based suppliers within the region, all but a small part in crushed form.

The remaining $200,000 was distributed between foreign imports of coloured terrazo/aggregate material (less than $5,000) and eastern U.S. shipments of higher-value ground material. These two product areas reflect supply deficiencies in the region.

The output proposed for the project is 25,000 tons per year with an average f.o.b. price of $12.00 per ton - or sales value of $300,000. This output will involve little displacement of existing sources within the region, but will be based rather on regional shortages.

Crushed Products

The major market for white crushed marble (in aggregate/terrazo/granule form) is southern California, followed by the San Francisco/Bay Area concentration. Both markets are presently well served. As project output would face higher freight costs of at least $5.00 per ton to reach these markets, the latent opportunities in California will be taken - for the present - as essentially closed. The project could supply this market, but to do so would be obliged to accept plant returns of $8.00 per ton - a price level that adds no contribution to project profits unless volume output is unusually high.

For white crushed material, the project's market is a triangular wedge based at Las Vegas, Nev.; Portland, Ore.; and Cheyenne, Wyom.; and including Salt Lake City, Boise, Salem/Eugene, and Reno. While the project will encounter competitors in many parts of this area, it will tend to have a raw material and technical quality advantage. To ensure marketing feasibility, the price recommended is $10.00 per ton - screened, sorted, washed, and bagged - or well below present f.o.b. plant levels of $15.00 to $20.00. By multiple screening for various sizes of products to ensure maximum recovery (and maximum market range) the project should be able to dispose of 15,000 tons per year. A part of this output will probably be marketed outside the primary area. The product requirements are outlined more specifically in Section III.

In coloured material, the project possesses a much greater market

advantage, competing against only one regional supplier (with rather limited volume), imports, and artificially coloured alternative materials. Moreover, per ton values are relatively high, while production costs are only slightly greater than in white crushed (chiefly, an assumed higher per ton quarrrying cost which may not arise). Thus, the project will have competitive flexibility. The dominant market will be southern California, and sales may be made through distributors or established white quarry-based producers. At an average, f.o.b. prices in the range of $15.00 per ton are recommended. Latent demand may well be substantial, but initial output should be held to 5,000 tons per year until successful market penetration is secured.

Ground Products

Present consumption of ground marble products is not possible to determine and, in any event, would be essentially meaningless. In the ground range, marble is of value as a highly-concentrated calcium carbonate, in which it serves as an equivalent to limestone. For certain qualities (i.e., brightness, absorption), marble may be preferred, and thus command a higher price. In the west, however, it will operate in the 'limestone market'. Additionally, it may also be a substitute for talc.

The best clue to the scope of the ground products market is found in a U.S. Bureau of Mines study of mineral consumption by the California chemical industry, published in 1965 but based on earlier data.* Chemical firms reported purchases of 11,000 tons of limestone and 13,400 tons of talc in 1960 - principally for whiting, fillers and extenders in

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* U,S, Bureau of Mines, Minerals for Chemical Manufacturing. A Survey of Supply and Demand in California and Nevada, Washington, D.C. 1965.

TABLE XX

Chemical firms with 35 or more employees reporting ground limestone (or $CaCO_3$) purchases, California, 1960.

FIRM	Location	Employees	Principal Products
American Marine Paint Co.*	SF	35	Paints, marine paints, varnishes.
California Ink Co. Inc.*	SF	625	Printing inks, litho inks, varnish.
De Soto Chemical Coatings Inc.*	Berkeley	200	Paints,varnishes,ind. finishes/resins.
Du Bois Chemicals Inc.	LA	100	Ind./instit. cleaning compounds.
Dunn-Edwards Corp.*	LA	250	House paints, ind./comm. paints.
Dunne, Frank W. & Co.*	Oakland	45	Paints, enam., protective coatings.
Fuller, W.P. & Co.	SF	3,000	Paints, varnishes.
Glidden Paint Co.*	SF	250	Paints, enam. lacquers, varnishes.
Henry, W.W., Co.	Hunt.Park	50	Roof coatings, floor adh., paints.
Hill Brothers Chemical Co.*	La Puente	70	Magnesite prod., CaCl, asbestos.
International Paint Co.*	South SF	n/a	Paints.
International Wood Products Co.*	Long Beach	n/a	Wood substitutes.
National Lead Co.	SF	700	Paints, varnishes, spec. finishes.
Pittsburgh Plate Glass Co.*	Berkeley	350	Ind./house paints, enam., lacquers.
Sherwin-Williams Co. of Calif.	Oakland	700	Paints, varn., lacq., insecticides.
Silver Line Products Inc.	LA	55	Friction/bonding materials.
Synkoloid Co.	LA	195	Paints, construct. finishing pr'cts.
Vi-Cly Industries Inc.*	Compton	60	Paints, enamels, varnish.

* Denotes talc purchases also reported.

Source : U.S. Bureau of Mines, Minerals for Chemical Manufacturing; A survey of Supply and Demand in California and Nevada, Washington, D.C., 1965.

paints, putty, and rubber. The usage applicable to marble may well have been substantially greater. A consumption of some 145,000 tons in uses related to chemicals was reported by limestone producers in 1960; and talc producers reported a total of 10,500 tons for paint, 12,000 tons for pesticide manufacture, 3,000 tons for rubber manufacture, and 1,500 tons for toilet preparations (e.g. talcum powder).

Among the 11,000 tons of limestone consumed, the breakdown by type and value was as follows:

TYPE	TONS	VALUE LANDED	VALUE PER TON
Crushed	2,750	$ 22,000	$ 8.00
Ground	8,250	$249,000	$30.00
TOTAL:	11,000	$271,000	$24.60

The value of talc per ton was virtually the equivalent of ground limestone at almost $30.00 - on the basis of 13,400 tons with a total value of $397,000 delivered. The value range for limestone (delivered) was $13.00 to $80.00, and in talc $20.00 to $90.00 - while the freight cost component of landed price was from $3.00 to $8.00. Thus, the average f.o.b. value will be somewhere in the range of $22.00 to $25.00 per ton. Since the bulk of paint/rubber/putty/chemical capacity is in California, and the present suppliers are located in the state, the project must be prepared to sell its ground output at an average price of $15.00 to $18.00 per ton.

Within the total ground calcium carbonate market (which in the west may consume up to 250,000 tons per year), scope will clearly exist for 5,000 tons in annual output from the project. However, in assessing the route to market penetration, some questions arise:

First, specifications tend to be fairly rigid, and are based on the present suppliers' terms. In the U.S.B.M. survey, consumers reported that they required proof of successful use of a new supplier's product. This requirement may well be difficult to meet, although in calcium products rigidity of particle size and chemical composition in the grinding process may overcome this problem.

Second, the market is diverse. Forty-six companies reported purchases of crushed/ground limestone, and fifty-four firms talc (with the major firms in each group purchasing both materials). The list of purchasers is given in Table XX. It would appear that successful penetration of this market would require the services of a competent manufacturer's agent or chemicals distributor.

Third, there is the matter of product quality. In ground marble/limestone, value increases in proportion to the fineness of grinding. There is a minimum particle size, however, that can be achieved through 'dry' grinding - after which a 'wet' ball mill/flotation process must be used to achieve minute micron mesh measures. For example, the Calcium Products Division of the Georgia Marble Co. at Tate, Ga., reports an average f.o.b. price of dry ground of $12.00 per ton and wet ground at $35.00. Typical U.S. average prices for ground limestone, taken from the Oil, Paint and Drug Reporter, were summarized as follows:

PRODUCT	SIZE	PER TON F.O.B.
Natural, dry-ground, air-floated	325 mesh	$10.50
Natural, water-ground	10-30 microns	$ 17.00 - $ 18.00
Natural, water-ground	0.5-10 microns	$30.00
Chalk, whiting	325 mesh	$ 32.00 - $ 34.00
Ultrafine	-	$117.00 - $167.50

TABLE XXI

Summary of annual revenue by product areas, Nevada marble project, 1968.

PRODUCT	UNIT	VOLUME	PRICE PER UNIT	VALUE
Floor Tile	Sq. Ft. (3/8")	1,000,000	$ 1.00	$1,000,000
Furniture	Sq. Ft. (3/4")	300,000	$ 2.00	$ 600,000
Fireplace	Sq. Ft. (3/4")	200,000	$ 2.00	$ 400,000
Split-Face	Ton	4,000	$25.00	$ 100,000
White Crushed	Ton	15,000	$10.00	$ 150,000
Coloured Crushed	Ton	5,000	$15.00	$ 75,000
Ground	Ton	5,000	$15.00	$ 75,000
TOTAL REVENUE				$2,400,000

Given reasonable capital costs, the project should install an integrated crushing/dry/wet grinding unit for maximum per ton values.

In entering the ground $CaCO_3$ market, it would seem highly desirable to secure the affiliation of a major national supplier - preferably Georgia Marble, although the invitation expressed by Vermont Marble to discuss supply possibilities should also be pursued. At present, limited tonnage of Georgia's ground range is entering the western United States, despite a $20.00 to $30.00 per ton freight cost handicap. This volume at least establishes a precedent of usage, and an acceptance in the market. Given conformity to Georgia/Vermont processes and product sizes, any such affiliation should be mutually beneficial. An early discussion is recommended.

THE MARKET FOR THE PROJECT: SUMMARY

The annual output volumes recommended fall in all cases below potential consumption in the region. Why not a higher volume?

This question cannot be answered in precise economic terms. Some grounds can be offered. First, the conversion of marble from a 'prestige' commodity available only to the rich - to a product available only to the rich - to a product available to a wide range of the consumer population - will take time. It would be dangerous, in the interim, to 'flood' the market, and destroy the market base that has already been established. Second, there is the position of the existing sources of supply, especially the Italians. The west coast market is increasingly important to the Italian marble industry, accounting for one-eighth of all exports. Increased volumes would mean a massive displacement of imports. This displacement would not be achieved without a competitive

battle on a price cutting basis. This battle could easily wreck the market.

Above all, there is the general principle that it is not the volume of sales that counts (or the gross annual revenue), it is the rate of profit. The size of the project as outlined in this report permits a satisfactorily profitable operation. When full output in any product area falls below market demand, the operation can be expanded with relative ease and little capital cost. It would appear more desirable to grow comfortably by stages than to over-reach the market in the initial years.

There have been in the foregoing discussions a number of small but intriguing market outlets that have not been raised. For example, candy manufacturers and baking firms have traditionally preferred marble slabs for rolling and mixing their products because of the material's cool, non-sticky surface. The region contains several thousand such establishments. Here is a nice little market that can be developed progressively. In the crushed range, there is the 'landscaping' market, which to the confirmed gardener may simply be a lazy man's excuse for not planting grass, but which in certain areas of the region with high temperature, low humidity, and water deficiencies makes a great deal of sense. A superior white crushed product can overcome freight costs to sell well in southern California/Arizona.

Finally, there is the unvarying criterion that all products selected for output must be capable of standardization - in dimension, thickness, finished size, colour(s), type and usage. There is no profit to be made in a small mill 500 miles away from major markets in custom jobbing work. There is, on the other hand, no mill in the world based on the concept

of the straight-run 'sawmill' - turning out, day in and day out, with minimum variations and machine adjustments, products that can be sold in volume. It is this straight-run basis that makes prices from the project competitive in the market. And it is the willingness of the market to take these products on this price basis that establishes the market feasibility of the project, even though it will rely to a greater extent on potential rather than present consumption.

The product range, annual volumes, and prices proposed in this section yield an annual gross revenue of $2,400,000. The breakdown by product area is given in Table XXI.

SECTION III

THE COSTS OF THE PROJECT

The previous sections have established a viable location and a satisfactory market opportunity for the project. This opportunity, however, rests primarily on price - on the relative cost to the consumer of the project's products vs. competitive materials. The question thus arises as to whether the project can produce at these prices on the basis of unit costs (including a provision for net profit)? The determination in this study is that it can, provided certain conditions are met. These conditions have been suggested previously, but should be noted here.

First, the project should undertake no custom work. It should produce to standard, pre-determined product types and dimensions, on long production runs. The objective is volume output as a guarantee to low total unit cost.

Second, the project must be highly mechanized, substituting durable equipment for labour wherever appropriate. Within the marble industry, labour is the chief component of cost; its cost rate tends to rise more sharply than those of other production factors; and the lack of new technology in the industry has eroded labour's productivity. The injection of a high capital equipment 'content' into the project will lower variable costs.

Third, the production process itself must be continuous, systematic,

and relatively free from interruption. All machines (and all operations) should operate at a high rate of capacity; the various processes should be synchronized to prevent idle machine time; and a systematic flow between operations established. This process is necessary to reduce fixed costs per unit of output.

There is no known marble manufacturing plant in the world that conforms precisely to these conditions. Yet, theoretically, marble need not be a 'high cost' product, or one (as in Italy or Portugal) that is competitive only because low labour rates permit hand operations. Given relative raw material costs, the economics of marble production should be no less favourable than in typical industrial commodities (e.g., steel, pulp, petroleum products) where the total cost of converting one ton of raw material into finished product form runs well below $100.* The marble process itself is essentially simple. All it involves is the progressive reduction of a block of marble into smaller and smaller dimension components for final finishing - a process that conforms almost exactly to that of a sawmill. If a log can be converted cheaply into lumber, why not a block of marble into tile, furniture slabs, or building panels.**

For this study, it has been necessary to 'design' a manufacturing

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* By actual weight in finished form, one ton of floor tile or furniture/fireplace material will be worth at f.o.b. plant prices $374.40. Waste and material 'loss' will occur in both quarry and plant (although recovered for crushing), and may reduce dimension conversion to 40 percent on a per ton quarried basis, or $149.76.

** The block is the equivalent of the log. Where in the sawmill the 'head' saw slices the log into cants, the marble gang-saw cuts the block into slabs. Each mill type has its edge and trim saws. The sawmill 'planer' performs the same basic function as the marble grinding/honing/polishing process.

plant for the project - a design that is little more than a straight-run, mechanized sawmill. No new equipment (undeveloped or unproven) is required, for the essential components are now manufactured.* Nor is there anything revolutionary about the system. It will simply apply techniques adopted in other industries that the marble industry has not yet fully implemented.

The design does not require a heavy capital cost (about $60.00 per ton of annual output, and a maximum of 40 percent of annual sales). Nor does it involve a high labour content - estimated at 25 percent of total unit cost or a satisfactory 3 : 1 capital-to-labour ratio. From all present evidence, the capital/operating costs arising from this design will satisfy the competitive requirements of the project. These costs will be estimated in this section, following an outline of the marble process and the production requirements applicable to the project.

THE MARBLE PROCESS AT THE PROJECT

The making of marble is a slow business. Marble quarries painstakingly in the ground; saws tediously in the block. It takes a five man crew from two to four hours to remove one block from its bed in the quarry, and a large gang-saw anywhere from one to three days to saw it into slabs once it reaches the mill. None of the conventional (and more rapid) methods of shaping basic materials - the shear, the band-saw, the torch, the giant circular saw - can be applied to marble, for they will shatter it from impact, or fracture it from frictional heat.

* In this study, equipment from the Tysaman Machinery Co., Knoxville, Tenn., a subsidiary of Carborundum Corp. of Niagara Falls, N.Y., is specified for all dimension plant installations. This firm has served (without any obligation) in the role of equipment consultants to this study.

Marble cannot be attacked. It cannot even be 'sawn' as the term is known. It is an abrasive stone, and it can only be cut, sliced, or even polished by wearing down.*

The Block Operation

The process begins at the raw material source or, for the project, the deposit. The technique is that of the quarry - typically, a term that denotes an open-pit operation conducted at descending levels or benches, but that may also be applied (as will be the case here) to underground block extraction and explosive blasting for crushed/ground raw material. For crushed material, blasting is the most efficient technique, but must be conducted separately from the block quarry to avoid shock-wave fracturing in the deposit. For dimension material, a great deal more time and care is required, for marble achieves maximum value only when it can be removed in sound, whole block form.

To remove a block** from the quarry bed, only one device suffices. This is the quarry bar, a machine mounted on a long horizontal bar, equipped with a reciprocating drill (or drills) and a 'broaching' bar, both of which travel along the length of the bar as required. The machine, standing on the quarry bench, straddles the outline of the 'cut'

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* With the abrasive process, an essential corollary is water. Used in all production phases (quarry, gang-saw, trim saws, grinding/polishing heads), water has two functions - as a coolant, and as a solvent to wash away the abrased particles.

** The adage in the industry is that the bigger the block the higher the per ton value. For the project this adage is true up to a point. This point is a block dimension of 9 to 9 1/2' long, 5' wide, and up to 6' deep - to form up to 100 individual 1/2" slabs (or 50 one inch slabs) eight feet long by four feet wide. These dimensions offer the most efficient conversion in the mill, and should be adhered to in the quarry wherever possible.

(whether back or one of the two side cuts). The drills cut vertical holes into the marble bed to make the back/side cuts, usually 1 1/4" or 1 1/2" in diameter on 3" centres. The broaching bar follows the drills, removing the thin webs left between the holes, until an entire side is separated. Generally, the back 'cut' is made first, followed in turn by the two sides, as the machine is moved (usually hoisted by a derrick) in each case.*

When the quarry bar cuts have been completed, one further incision into the marble led must be made - along a horizontal line at the 'bottom' of the block, from the 'face' to the back cut. For safety in avoiding material fracturing, this stage is generally conducted by hand-using hammers to drill single bars in a parallel line, and broaching in the same manner.

When all four 'cuts' have been made and the block is separated from its bed, it may be shifted or rolled by pulleys until lines from an overhead derrick may be slung around it for hoisting onto a flat-bed truck for hauling to the mill.

Typically, an efficient crew (five to seven men) can extract up to four blocks of 20 tons each per shift. The dimension plant (including the 'split-face' unit) will require a supply of 64 tons of block

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* Methods of extracting blocks that are feasible in other stone industries are not applicable to marble. For example, a 92" circular saw is now used to cut whole limestone blocks from the ground, but would shatter crystalline marble from impact. An extended wire saw (up to 300' in total length) may be used in granite, but offers no cost/quality/speed advance in marble. A number of experiments have been conducted in the 'pre-split' blasting of various stones. The Colorado School of Mines, Golden, Colo., reports that on the basis of laboratory experiments on marble any application of this technique to the project quarry would probably result in total failure.

material per day, 250 days per year. Thus supply is the equivalent of three blocks 9' x 5' x 6' (the size specified), or assumed to be within the capacity of a single crew on a daily output basis. For a number of reasons, however, the project cannot rely on this rate of output:

(i) The quarry will only be able to be operated up to eight months per year. In the remaining period, shutdown will be caused by snow, cold or (occasionally) extreme heat. Although snow and cold do not prevent quarrying operation, their effect on extracted marble could be deleterious.

(ii) Not all material from the quarry will be extracted in sound block form. A satisfactory rate of recovery is 50 percent in block (the balance in smaller, lower-value block or rubble).* Although the project is likely to exceed this rate, it will by no means achieve 100 percent recovery and a part of the output (perhaps 35 percent) will have to be crushed.

(iii) The output rate assumes surface or open-pit quarrying. The project, however, will quarry a mountain face - extracting its white and white-patterned material from surface into depth, and its coloured marbles by tunnelling laterally into the mountain side.** Thus tunnelling requires 'underground' quarrying, a process that will be substantially slower than surface quarrying.

(iv) Above all, there is the need to quarry with care. The difference between a ton of marble in dimension product vs. crushed product form is 1500 percent - or $150.00 per ton vs. $10.00. Except by blasting, crushed material cannot be quarried economically, and while quarry 'waste' will be recovered for crushed/ground by-products it will add little to project profits. In the quarry, speed is a much less vital criterion than final per ton value.

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* For example, this 50 percent recovery rate is reported (by Mr. Spurgeon Hyatt, Executive Vice-President) to apply to the Long Swamp Valley quarry of the Georgia Marble Co.

** Readers will recognize a similarity in this process to that adopted traditionally in the marble quarries of the Carrara district in Italy. The project's deposit (like the Italian, but unlike Georgia/Vermont deposits occuring in depressions or valleys) is, in effect, a marble 'mountain' and will be relatively easy and cheap to quarry.

To guarantee a constant supply of 64 tons per day to the dimension plant, the quarry during its operating season (eight months x 65 percent sound block recovery) will be obliged to extract seven whole blocks per day. Assuming a 2 : 1 ratio between surface/underground extraction, three quarry bar operations will be required at any one time.*

As to the blasting operation, further geological advice is necessary to determine the precise location, and whether the most suitable (and economic) material lies on surface or underground. The surface quarry is not necessarily the most efficient - impurities may be present to a greater extent in the material; dirt and other substances may have to be eliminated in the crushing/grinding process; and colour consistency is not always possible. Whatever the type of operation, it appears to be well within the bounds of cost tolerance, and capable of supplying the crushing/grinding plant with the required initial 100 tons per day. Again, seasonal factors will arise and the output rate will be closer to 150 tons.**

The equipment requirements for both block/blasting quarries will be approximately as follows:

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* An eight month operation raises a major problem: what to do with the quarry crews during the winter? For an important part of the quarry operation will be a steady, efficient crew that works well together. During the winter, work can go forward in development for the next season's work; underground block extraction may possibly be undertaken; or a part of the crew transferred to the splitface or crushing plants (which can increase output during the period).

** An underground operation is conducted by Premier Marble Products Inc. at Lone Pine, and by Georgia Marble Co. (in both marble and limestone at separate operations), the latter a highly efficient project. Given underground operation, quarrying can be conducted on a year-round basis.

BLOCK		BLASTING	
Machine	Number	Machine	Number
Quarry Bars	3 - 4	Blasting Drill Unit	1 - 2
Derrick	1	Loaders	1 - 2
Flat-bed truck	1	Dump truck	1 - 2

In addition, the combined operation will require a water system (served by wells or reservoir); lighting plant; and compressor. While accessible, the quarry site is removed from any settlement area and the project will be obliged to provide its own basic services.

For purposes of illustration, the nature of the quarry operation may be inferred from drill core logs and is approximated in Chart VI.

The Slab Operation

As the block reaches the dimension plant, it is lifted off the truck by an overhead gantry crane and set down in the block storage yard.* As required, it is hoisted again and set lengthwise on a block cart, and the cart is wheeled under a gang-saw frame. At this point, the manufacturing process begins.

The function of the gang-saw is to slice the block into slabs. The slabs may be thick (up to 4") or thin (down to 1/2"), and the thickness is determined by the distance at which the individual saw blades - secured at either end of the gang-saw frame - are set apart. Once the

* As in a lumber sawmill or pulp mill 'log pond', a block inventory is required to guarantee steady production. In addition, marble is a compressed crystalline stone and may be subject to internal stresses and strains when 'freed' from the deposit. Time should be allowed (normally up to a month) to permit any re-adjustment of the internal molecular structure in the block.

block is rolled into place and the saw blades set, the gang-saw is started - moving rythmically back and forth across the length of the block. The direction of the movement is horizontal, as the blades make vertical cuts into the block, sawing from top through the depth to the bottom.

The saw blade itself has no teeth serrated in its edge. It is not a band-saw. It is simply a piece of alloy steel - from 16' to 20' long , 3" or 4" wide, and up to 3/16" thick - touching the block on the blade, but one of three substances:

(i) Diamonds in the form of individual 'teeth' attached to the blade, rubbing back and forth against the marble in the groove, with excess heat from the friction moderated by a constant flow of running water.

(ii) Silicon carbide, carried in solution into the grooves between the slabs, acting as an abrasive through the pressing action of the straight-edge blade against the material.

(iii) Sand (or silica sand), used in the same way as silicon carbide, as an abrasive substance in solution.

For speed, diamond sawing is by far the fastest method; sand the slowest. For prescision, all three methods yield tolerably even cuts on both faces of the slab. For thickness, diamonds are restricted to slabs 2" + in thickness: the diamond saw action is a straight horizontal notion at faster speed, and no method has yet been developed (or is in prospect) by which the blades can be tightened for adequate tension and straightness in saw-cuts to the frame for thinner slabs. For slabs 7/8" (and certainly for 1/2" thick slabs to yield 3/8" tile material) silicon carbide or sand (with the gang-saw frame moving in a 'swinging' motion) is essential.

At the project, the diamond method may be used on the split-face unit for rapid, straight, low-cost sawing of 'brick'. For the dimension

plant output (tile, furniture, fireplace material), the silicon carbide method is recommended for its greater speed. The relative speeds are as follows:

METHOD	RATE OF CUT	
	Per Hour	Per Block
Diamond	3" - 4"	24 hours
Silicon Carbide	1 1/2" - 2"	48 hours
Sand	1/2" - 1"	96 hours

When the block is 'sawn' through, the outcome is a set of parallel slabs, smooth on both faces, but jagged around all four edges. The cart is wheeled out of the gang-saw through, and the slabs hoisted by overhead crane onto storage racks until called upon for conversion into finished product form. In the meantime, the gang-saw is re-adjusted (if necessary, the blades are also replaced or turned over); a new block is wheeled in; and the process starts agains.

Typically, gang-saws are installed side-by-side in a long shed or building, covered by a roof but open at the loading side to permit block 'feeding' by the crane, Since the sawing of the block by any method will take a minimum of 18 to 24 hours, the gang-saw unit will operate on a three-shift basis. The gang-saw requirements will be as follows:

PRODUCTION UNIT	Slab Thickness	Method	Number/Gangs
Floor tile	1/2"	Silicon	5
Furniture/Fireplace	1"	Silicon	3
Split-face	2 1/4"	Diamond	1
TOTAL:			8

Additionally, the gang-saw unit will require replacement components

and supplies. Among these: silicon carbide blades require turning every block, and will wear out after two to three blocks. Gang-saw blade 'dogs' may have to be replaced once a year, while the basic machine normally lasts up to 40 + years. Finally, silicon carbide abrasive must be purchased in quantity. While recirculated during the sawing/abrasion process, each machine must be charged from time to time per block. The costs of these 'expendables' is raised shortly.

The Finishing Operation

The marble slab is the equivalent of the sawmill 'cant', and must be edged, trimmed, and surface finished for final use. These operations are carried out in the manufacturing or finishing segments of the project's dimension plant.

While the quarry bar and the gang-saw are traditional methods (and have not been superceded in efficiency by any alternative process), substantial technical advances have been made in recent years in finishing operations. Two pieces of equipment have occasioned the principal breakthroughs:

First, the diamond circular saw.

Second, the automatic grinding/honing/polishing line.

The circular saw (like the gang-saw blade) no teeth. It is a round plate of alloy steel to which diamond teeth are affixed. It is a functional device because marble in slab thickness (to 2") will saw comparatively rapidly - from 12" to 240" per minute depending on thickness - for trimming and slicing. Moreover, on wide slabs, two or more saws may be used to make parallel cuts simultaneously.

The automatic line consists of a long, enclosed conveyor unit on which are mounted a series of cylindrical 'heads' - normally nine, with

three faced for grinding, three for honing, and three for polishing. The slab is inserted at the grinding end, and travels at a uniform speed through the unit until it emerges in finished form at the polishing end. The rate of throughput varies, but will be taken at 18" per minute.

Both operations are completely appropriate to the 'design' of the project for their benefits (or savings) in speed, increase in rate of machine capacity, and reduced labour/handling costs. Moreover, it is the integration of these units that affords the opportunity to the project of installing a plant that will meet fully the requirements of competitive production costs.

The Present Process

Any comparison with present finishing processes in existing U.S. marble plants is unfair as the operation (even in the most efficient mills) has been geared to custom 'structural' output, and the project's plant is designed exclusively for standardized production. Nevertheless, for the project a comparison may be valid. The present process may be summarized as follows:

(i) A slab is lifted off a storage cart by overhead hoist and placed by hand on a saw table.

(ii) A circular saw (normally operating on the basis of one at a time) trims off the rough slab edges, one side at a time. The slab is turned manually at each 'pass'.

(iii) The saw unit then cuts the slab into pieces of pre-determined size (i.e., panels to length and width as specified by order), on the basis of maximum possible recovery.

(iv) The finished-size pieces are loaded on carts and wheeled to a grinding unit. This unit consists of a cylindrical head, powered by machine, but directed by hand control over the surface.

(v) The ground piece is moved to a honing unit, operated on the same principle.

(vi) If specified, the honed piece is moved again to a similar polishing head machine.

(vii) The polished piece is stored for packing or crating to order shipment.

In certain installations,* an automatic line may be used in place of individual grinding/honing/polishing head machines. Even though the structural process permits the use of less than 25 percent of line capacity, the unit represents a major gain in efficiency. The diamond circular saw unit achieves a slightly higher capacity, but the combining of several operations on one unit (with the attendant handling of the material) necessitates substantial idle machine time.

The Project Process

The project design converts the major operations of the finishing process into three stages.

First, a diamond circular saw (called the 'trim saw') will be used to trim the rough slab edges. There will be two motions or 'passes' through the slab the first lengthwise, cutting the two sides to exact width of the automatic polishing line (about 49" for the tile line; about 25" for the furniture/fireplace line); the second requiring a turn of the slab 90° to permit two saws to trim the edges, and the third to slice the slab into two smaller slabs roughly 4' x 4' each.

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* For example, the Tennessee Marble Division of the Georgia Marble Co., Knoxville, Tenn. This mill undertakes structural work, but still runs individual pieces or panels through the line. Certain problems arise that will be eliminated in the project's design: when the piece is less than line width, it may shift and grind unevenly, or have to be run at slower speed to ensure uniformity; alternatively, two pieces may be run through side-by-side, and may knock together and 'chip'. Even so, a substantial cost saving is reported.

Second, the automatic line will receive the trimmed slabs which will have been cut to fit the line width guides (whether 49" or 25"). The various heads will finish the surfaces in turn, running at a uniform rate throughout.

Third, a second diamond circular saw (called the 'sizing saw') will cut the finished/polished slab into precise product size - operating with up to three parallel saws at a time. Thus, a 49" x 49" slab will be reduced in two 'passes' (requiring a 90° turn in the interval) into 12" x 12" tile - first lengthwise, then widthwise, the difference in the dimension accounted for by the thickness of the saws themselves, causing a certain removal of material.

These three operations will complete the tile manufacturing process. They will be followed by the loading of sized tile onto a conveyor belt for inspecting, grading, and packing. When packed (normally, 10 tiles to a carton, or 100 sq.ft.), the output will be transferred by fork-lift truck to the inventory/shipping area of the mill. In the furniture/fireplace line, however, one further process is required - the grinding and polishing of the edges. Again, this process may be undertaken in a single unit, involving gritting/honing/polishing heads.

In addition to this basic process, a further 'improvement' will be adopted, in order to achieve <u>precise</u> thickness of all product output by means of two-side grinding. Marble cannot be ground from underneath (a roller or head will travel unevenly across the surface, and be corroded by the constant flow of water), and an overhead process must be used. Thus, the slab will enter the line 'bottom-first', be ground and then turned over by a raising/lowering device, to be ground/honed/polished on the top side. The additional cost (less than two

cents per sq.ft.) is extremely moderate, and represents a major gain in product quality, particularly in terms of installation cost.*

Equally crucial is the trimming of the slab to exact polishing line width. The precise width will be slightly less than 49" depending on the thickness of the circular saws recommended by the equipment supplier on the 'sizing saw' unit. Whatever the width, it can be built to specification to prevent slippage, uneven surface finish, and shipping.

The Project Process: Advances

As suggested, the project will be unable to make any meaningful advances (at this stage of industry technology) in either quarry or gang-saw operations. The chief cost reductions will occur in the manufacturing/finishing phases, as noted. In this operation, chipping/breakage will be largely (if not completely) prevented; labour handling between operations will be reduced to a minimum; and machine capacity operating rates will be increased dramatically.

As examples of this last advantage:

The automatic polishing line will operate at or about 100 percent capacity. Travelling at 18" per minute, one slab sill follow another - butt to butt - while the machine is in operation.

The first diamond unit - the 'trim saw' - will operate at 80 to 85 percent capacity. There will be a certain time loss in 'turning' the slab on the table the 90° required between the first and second

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* On the basis of known installations, it will be virtually impossible for the Italian marble industry to match this thickness precision. To do so, it will have to mechanize, thus losing a part of its labour cost advantage.

'passes'. Loading and unloading time will be reduced significantly by a device proposed by the equipment suppliers: a second slab table. Thus, while the trimmed slab (on its table) is being wheeled the few feet to the automatic grinding/polishing line, a second table containing a new rough slab will be set immediately in its place. The addition of this second table is reported to be the equivalent of 60 percent capacity of a second diamond trim saw unit (at present industry efficiency standards).

The second diamond saw unit - the 'sizing saw' - achieves efficiency gains through the use of up to three parallel saws, requiring two 'passes', and interrupted only by a 90° turn of the saw turntable (the two slab table system need not be used here; a self-locking turntable is faster and more efficient). As with all operations, the sheer weight of the material (each floor tile 12" x 12" will weigh 5.3 pounds), and the use of water functioning in part as an adhesive will 'hold' the slab to the table even after the first 'pass' is made, assisted by edge guides.

Even in the final stage of the furniture/fireplace process - the grinding/honing/polishing of edges - the system is essentially mechanized, and the individual piece or slab may be turned or adjusted automatically along the line to eliminate manual labour.

A simplified plant 'design' is set out in Chart VII. Equipment requirements are noted on the chart.

The Split-Face Process

The recovery of split-face brick (or 'ashlar' indicating a rough-face dimension marble stone) was pioneered by Georgia Marble as an outlet for reject blocks from its base quarry. The process is essentially

simple, and will be duplicated at the project. The stages are as follows:

First, the rough block (usually of uneven or smaller size) is mounted on a diamond gang-saw, and cut into slabs in multiples of 2 1/4" - or 2 1/4", 5 1/2", and 7 3/4".

Second, the slabs are laid flat and fed through a hydraulic splitter or 'guillotine' which splits off a length of solid stone.

Third, this length is trimmed to random (but manageable) size and fed through a facing unit that rough smooths the face. The individual 'bricks' are then stored for bulk shipment.

The unit is extremely low in total capital cost (about $7.50 per ton of annual output) and represents a cheap but effective outlet for quarry waste at a value double that of crushed/ground material.

The Crushing Operation

For the project, the model for the crushed/ground plant is again a Georgia Marble installation - the Nelson, Ga., plant of its Calcium Products Division. The precise size and features of the project's operation cannot be proposed until a detailed market evaluation for dry/wet ground products is carried out in concert with a 'major' supplier (e.g., Georgia or Vermont).

The crushing plant will consist of jaw crushers, screens, 'washing' units, hoppers, and bagging machines. Grinding is carried out in ball mills with the 'wet mill' adding water grinding, flotation units, and drying kilns. For project output of 25,000 tons a year initially, mill throughput will average only 100 tons per day. In view of the low capital cost involved (about $10.00 to $12.00 per ton of

annual output), production may be concentrated during fall to spring months to permit off-season work for quarry employees.

Given this operating basis, a plant capacity in excess of 100 tons per day (eight hour shift) would be required. As market development efforts and regional growth are likely to permit a substantial increase in annual crushed/ground output by 1970, installed capacity of 250 tons per day is recommended. The capital cost (about $10.00 to $12.00 per ton of initial annual output) will still be sufficiently low to warrant economic production on a first-stage basis.

For project engineering, the critical factor will not be merely the size of plant but the degree of fineness or mesh size for each product type. Full data supplied by Georgia Marble has been provided to the client, The pertinent factors are summarized for crushed products in Table XXIII and for ground products in Table XXII A.

THE LOCATION OF THE PROJECT

An important influence on project costs (and indeed economics) will be the location of the various operating units. The choice of location will also integrate the basic units into a functioning enterprise, and should be attempted on a 'least cost' basis. This basis must take into account the following factors:

(i) The site of the quarry, or alternative raw material sources.

(ii) Transport costs to established industrial centres vs. the cost of establishing and servicing plant facilities as the quarry site.

(iii) Market distribution and access to principal market areas for the project's finished output.

(iv) The determination of sites in each case that most economically permit the gathering of the various production factors (i.e., raw material, labour, and plant supplies/services).

These matters are discussed briefly below.

Raw Material Supply

The foundation of the project is its marble deposit. While it will be suggested that the project may possibly be feasible without a captive raw material source, the ownership of the deposit will give a major asset to the enterprise and offer (assuming appropriate geology) the lowest block costs on a per ton and per unit basis.

Although the deposit is situated in an unpopulated area, it is by no means inaccessible. An important state highway is located seven miles from the site at Boone Springs, Nev., and a basic road system to the deposit is already installed. Moreover, the deposit is situated only 36 miles (accessible to road) to the nearest rail point at Currie, Nev. Nevertheless, there is no established settlement within 40 miles of the property and the nearest incorporated/industrial centre is Ely, Nev. - a distance of 73 miles away.

This situation is not uneconomic in terms of transport/servicing costs, but cannot be regarded as ideal. Typically, the most economic marble operations are located at or near an established municipal area (frequently close to an important metropolitan centre), involving low-cost transport to integrated manufacturing complex.*

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* The Vermont Marble Co. operations at Proctor, Vt. were founded in the previous century on its high-value quarry, and a townsite expanded and developed as a result. Even so, the general area was already well settled. The Georgia Marble operations at Tate and Nelson, Ga., were furthered by established local agricultural/lumber settlement, and in any event are located 50 miles from Atlanta, Ga., the major business/financial centre of the U.S. South-East. Similarly, marble plants in knoxville, Tenn., are based on deposits located within 15 miles of the metropolitan area. The area in which the project's property is located - the boundary of White Pine and Elko Counties - is mountainous, unsettled, to a large extent barren, and occupied only by small ranches and the occasional very small-scale mining operation. Without ready and installed access to road/rail favilities, the location would be extremely unfavourable.

Yet, on all present evidence, the overwhelming probability is that the deposit must be quarried. The reasons are not defensive, but rather positive. The fact remains that the deposit may well be unique in the western United States region - in terms of massive tonnage, grade, quality, colour range, and low quarrying cost. These advantages are so great as to more than outweigh the cost of transport to an efficient manufacturing site.

Why not establish a manufacturing complex at or near the quarry site? This possibility was advanced by the client, and studied. What leads to its rejection is the sheer cost of establishing a new townsite for some 400 persons, on the following basis:

SEGMENT	NUMBER
Direct employees	100
Employee dependents	250
Indirect workers/families	50
TOTAL:	400

From comparative examples obtained from the Nevada Department of Economic Development, it is apparent that the project would be obliged to bear the major (if not the full) cost of housing, roads, services, and a part of education/health costs. On known townsites established by major mining companies in Nevada, it is evident that the minimum population size to permit economic investment and the recovery of capital costs is 2,000 persons. For the project, the assumed cost would be not less than $2,500,000. A size of 400 persons is not sufficient to permit any reasonable ratio between direct/indirect employment (normally 1 : 1.25 plus families) as commercial/service facilities would find the consumer market too scant for economic operation.

In contrast, the transport cost to a manufacturing plant site at Ely would involve:

73 miles x 2.5 cents per ton mile = $1.825 or, $1.83 per ton on the basis of self-owned trucks. Given the apparent soundness of the deposit material and its intrinsic value, this cost can be readily absorbed.

Nevertheless, a captive raw material supply is not necessarily essential to the feasibility of a manufacturing operation. It must be remembered that the design of the project's dimension plant will permit low-cost operation (on an equivalent f.o.b. price basis about half the present Georgia/Vermont level on floor title). Provided the plant is situated outside the high-cost metropolitan California area for labour/tax/service cost reductions, it can withstand raw material costs of as much as $40.00 - $45.00 per ton. A location in Reno, Nev., might well permit the economic gathering of block supplies from U.S. domestic and foreign import sources. As this higher raw material cost will be virtually double landed costs at Ely from the deposit, this alternative is raised only if the deposit is found unsuitable.*

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* This basis for the project rests solely on its comparative production costs. The raw material cost to the dimension plant from the quarry (gross) will range to $25.00 per ton. A part of this cost, however, will include amortization of quarry development: the 'purchase' cost from its present owners; annual property taxes on the basis of 'net proceeds' from the quarry; and per ton royalty.

It may well be possible to purchase blocks from a number of sources (including quarries in the region that may be expanded or re-activated) on a fixed price contract basis. If the deposit is unable to meet the full supply requirements of the project, its output may be supplemented from other sources on the basis of $25.00 to $30.00 a ton plus freight. Even with higher raw material costs, the project would still operate at a reasonable profit in the dimension field.

Given all known present factors, the deposit should be developed for quarrying as rapidly as possible to form the raw material base for the project.

The Dimension Plant Site

The major operation in the project (accounting for four-fifths of total annual finished value) is the dimension products plant. Its economic location is thus of crucial importance to project profitability. Three sites were assessed for this plant:

(i) Salt Lake City, Utah.
(ii) Reno/Sparks, Nevada.
(iii) Ely, Nevada.

As an industrial site, Salt Lake City offers the largest metropolitan centre within reach of the project: an excellent rail/highway transportation network; and favourable labour/tax/service costs. It is located, however, 175 miles from the quarrry site, requiring transport costs for raw material of $4.25 per ton. While this cost could be tolerated, the direction of movement would be eastward - away from the major coastal consumption areas - and finished product landed costs in these areas would be correspondingly higher. For this reason, this site was rejected.

The second site - Reno/Sparks - is a rapidly growing distribution/industrial centre, based on convenient access to major market areas, and furthered by an extremely favourable state taxation structure. It lies more than 300 miles from the project, however, an extreme distance for overland raw material supply, and would require additional trucks because of extended round-trip times. If the project were to depend only partially on blocks from the deposit (securing the remainder from

eastern, regional, and import sources) there is little question that Reno would be the recommended site. Given the present project design, this site was also rejected.

The most economic site is Ely. Several factors enter into its selection:

First, it is reasonably close to the deposit. A 146 mile round trip (requiring three to 3 1/2 hours) on a good paved highway adds supply costs, but not to any serious extent. No other incorporated municipal area is available within any shorter range.

Second, it offers an efficient gathering point for production services. A pool of industrial labour exists (the result of a stable and huge operation of Kennecott Copper Corp. on which the community is now based). Water, electricity, and municipal services are readily available at reasonable cost. And social capital expenses (e.g., schools and hospitals) have already been met by the existing population.

Third, the site possesses superior transportation facilities. While the only rail line (the Northern Nevada Railway, a subsidiary of Kennecott) runs northward and is not feasible to the project, the shipment of finished products will in any event be made by road. Here the location is ideal. Three main arteries extend from the community:

(i) West to Reno, then to San Francisco/Sacramento, or north to Portland/Seattle.

(ii) South-west to Las Vegas, then to Los Angeles/San Diego, or south to Phoenix/Tucson.

(iii) North-east to Salt Lake City, then east to Denver, or branching off to Boise.

Indeed, to reach the major coastal markets, any output from the quarry itself would have to pass through Ely en route.

The cost of production services (i.e., water and electricity) are moderate, and ample water from the municipal system is available to the project. The cost of labour was reported earlier (see Section I), and will be developed on an operating cost basis shortly. There will be no property tax as such on the dimension plant - either for land or building. The quarry, however, will be 'taxed' on the basis of a fraction of its annual net proceeds. Given the rapid growth rate of the State (and the corresponding pressure that will arise from expanded municipal services), some form of property tax may be required within a few years, and for safety will be included in the Section IV financial analysis.

Basically, a location in Ely yields the tax advantages of Nevada; an efficient shipping point; and a basic labour pool. Moreover, there is little doubt that the project will be welcomed in the community. Ely is a 'one industry' town, concerned with broadening its economic base (even though Kennecott has assured the community of a long term enterprise), and has experienced a static rate of population increase over the last decade. Thus, it is anticipated (by state officials) that the community will give the project every co-operation. Nor will the dimension plant be likely to be the only 'new' industry. A promising oil field (with five producing wells already drilled) has been developed in the vicinity, and new mining projects are under consideration. This hopeful climate will be useful to the project.

Some community statistics and local costs are given in Table XXIII. The Acreage suggested for the project by the Nevada Department of Economic Development is outlined in Chart VII.

It should be noted here that the 'split face' unit is likely to be

an adjunct of the dimension plant, and the same advantages noted above will apply in its case as well. As to the acreage that should be purchased, the low present tax/land costs (from $200.00 to $500.00 per acre unserviced) permit acquisition for future plant expansions. The minimun purchase recommended is 10 acres.

The Crushing Operation Site

Some uncertainty remains as to the most economic site for the crushing/grinding plant - essentially as the composition (and relative per ton values) of project output. A raw material supply distance of 73 miles to an Ely operation involves a freight 'penalty' of close to 20 percent on low-value crushed output. On the other hand, the installation of this unit at or near the quarry presents difficulties in housing or transporting crews, and in seasonal operation.

For the present, an Ely location will be tentatively recommended for the major unit. As the installation of a 'pilot' crushing plant at the quarry is proposed (to utilize waste marble material during quarry development), it may be useful to retain this unit at site for operation during the annual quarrying period, while higher value crushed products (e.g. coloured aggregate/terrazo) and ground output is processed adjacent to the dimension plant in view of region-wide distribution.

These matters should be assessed in more detail following negotiations with prespective affiliates or distributors in this field.*

Assuming the foregoing pattern, the basic geographic structure of the project and the transportation network it would adopt are outlined in Chart VIII.

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* By mutual agreement with the client, the question of negotiations was deferred until geological/engineering work is completed.

THE CAPITAL COSTS OF THE PROJECT

The estimate of this report is that a maximum capital expenditure of $1,200,000 will be required to establish the project. This sum will cover all costs of quarry development and equipment (including an initial 'pilot' plant); the land, service, building, equipment, and installation costs for the dimension plant; and the housing/equipment for the crushing and grinding plant.

The distribution is as follows:

UNIT	ITEM	AMOUNT	TOTAL
QUARRY	Development exp. Quarry equp. Pilot plant	$200,000 75,000 25,000	$300,000
DIMENSION	Land/building Equipment cost Installation	$200,000 400,000 100,000	$700,000
CRUSHING	Housing/services Crushing unit Grinding unit	$ 50,000 75,000 75,000	$200,000

In these estimates, quarry development expenses include all initial outlays for the project (e.g., incorporation, administration, studies and reports, and option payments); the land/service cost is consolidated under the dimension plant as is the split-face unit; while the crushing plant assumes a complete processing unit.

Further initial outlays will be required to operate the project in the form of working capital reserves. This outlay must be sufficient to:

(i) Permit the building of a block inventory from the quarry, equivalent to at least two months' plant supply in the project's colour range.

(ii) Allow a reasonable 'run in' period in the dimension oper-

ation (and, if necessary, the crushing/grinding plant as well) up to three months, during which time some finished inventory would be accumulated.

(iii) Provide for the acquisition (by purchase, lease or contract) of trucking services for shipment of finished products to market outlets, perhaps on a lease/purchase plan.

(iv) Undertake essential sales and promotion/advertising programs in the development of the project's markets.

(v) Meet debt service costs accruing from borrowed capital, by capitalizing debenture/bond amortization up to nine months, and depreciation for three months, whether these sums are actually paid during the period or not.

These expenses involve a maximum outlay of $600,000. The distribution is broadly as follows:

AREA	COST ITEM	BASIS	AMOUNT	TOTAL
QUARRY	Block Inventory	3500 tons @ $25.00	$ 87,500	$100,000
	Crushed Inventory	2500 tons @ $5.00	$ 12,500	
PLANTS	Run-in Costs	Three months equivalent	$150,000	$500,000
	Finished Inventory	At cost, net of above	$250,000	
	Debt Service	Interest @9 months; dep. @ 3 months.	$100,000	

The total initial investment in the project will thus by $1,800,000. The elements of capital cost are cited briefly.

Capital Costs: Quarry

The deposit at present is little more than an undeveloped mound of marble, concentrated in two masses. As a viable raw material supply is basic to the enterprise, the deposit must be converted into a working, efficient quarry. A number of consecutive steps are involved.

First, further geological work should be conducted to locate specifically and block out the highest and most economic grades of marble in the deposit. While some considerable diamond drilling has already been undertaken, this work should be supplemented to complete the investigation.* Other work as recommended by the project's consultants should be pursued.

Second, once the segments of the deposit selected for extraction are blocked out, the necessary surface blasting or material removal and any required underground tunnelling should be undertaken. In the case of white (and white patterned) marble, removal by quarry bar at the outset may be most feasible.

Third, the block quarry is developed in a series of benches, with sound material extracted and held for block inventory. At the same time, the crushed material quarry is also developed. This operation necessitates the purchase of quarry equipment (including quarry bars, derricks(s), compressor, diesel plant, trucks, loaders) and the installation of a water and electrical system.

Fourth, since the dimension plant will take up to six months to complete and the crushing/grinding plant perhaps an equivalent time, the installation of a 'pilot plant' at the quarry site is recommended. This plant would consist of a small crushing unit to process white marble rubble, and a gang-saw unit to convert selected blocks into slabs for further manufacture into market samples. The samples may be made

* The diamond drilling program is not complete, and is confined chiefly to one segment of the deposit. Moreover, the drilling was not conducted for marble, but for silver. The remarkable range and quality of the marble in the drill cores extracted suggests the desirability to the project of undertaking further exploration on the single ground that the deposit may be even more valuable than is now assumed.

elsewhere by arrangement, or a small trimming/grinding/polishing unit installed at site. Thus, crushed products would move onto the market immediately to earn some return to the project, while the market development process would be 'telescoped' with the production of product samples.

Moreover, the quarry is taken as the bearer of the initial development costs of the project not chargeable to other components (e.g., plant engineering). These costs include financing charges and administration/promotion expense. It is the value of the deposit as an asset that yields substance to any initial security offering by the holding company, and these costs represent a fair charge against it.

The capital 'budget' for the quarry is set out in summary form in Table XXIV.

Capital Costs: Plant

For purposes of capital budgeting, all processing plant units of the project are assumed to be located on a single site at Ely. Five separate cost items arise:

(i) The purchase cost of land for the plant site.

(ii) The cost of installing services at the site, site preparation, and plant design/engineering.

(iii) The purchase cost of equipment, basis f.o.b. manufacturer.

(iv) The installation cost of equipment, including freight to the project site and such special requirements as circulating systems for gang-saws and other machines.

(v) The cost of buildings, including office/administrative and service/storage space.

The total capital cost of plant for the above items is $1,000,000 - $700,000 for the dimension plant (including the split-face unit) and

$300,000 for a complete crushing/grinding plant. In addition, a further $150,000 in working capital has been assigned for plant 'run in' costs.

The lowest cost item is land. While firm quotations have not been sought (to avoid any small possibility of speculation at this stage), the maximum estimate of $500 per acre of the Nevada Department of Economic Development is taken. For an initial ten acres, the cost will be $5,000.

The costs of site services include paved access/service roads, water mains, sewerage disposal, drainage, power connections, and landscaping. Site preparation costs are not known, but in view of the flat, firm site proposed are not likely to be high. Plant engineering and architectural costs will be modest, as both the equipment supplier and the proposed building fabricator will be able to recommend basic layouts. For safety, these various costs are assumed to total $45,000.

The floor area of the dimension plant building will be divided into two units in either a 'T' or 'L' shaped design. The smaller unit will house nine gang-saws: five cutting 1/2" slabs for the floor tile line; three producing 1" slabs for the furniture/fireplace material line; and one processing reject dimension blocks for the split-face unit. The longer unit will accommodate the two major production lines, and reserve space for the split-face unit. A total of 20,000 sq.ft. (including provisions for office and warehouse space) will be required. This floor area will also permit a later installation of a third parallel 'production' line to avoid undue expansion costs. While detailed estimates have not yet been sought, the advice of industrial building contractors suggests an allowance of an average $7.50 per sq.ft., or

a total cost of $150,000.*

The housing for the crushing/grinding plant will be substantially less elaborate. Approximate cost is $50,000.

The largest single item in capital expenditure will be the purchase cost of dimension plant equipment. Based on quotations from the recommended supplier, the cost per 'line' is as follows:

OPERATION	LINE 1 Floor Tile	LINE 2 Furniture/ Fireplace	TOTAL
Gang-saws	$ 92,885	$ 55,505	$148,390
Diamond 'trim saw'	$ 10,640	$ 10,640	$ 21,280
Automatic grinding/ polishing lines	$ 92,920	$ 42.400	$135,320
Diamond 'sizing saw' machines	$ 10,640	$ 10,640	$ 21,280
Pedestal mounted polishing machines	$ 5,400	-	$ 19,650
Automatic edge polishing machine	-	$ 14,250	
TOTALS:	$212,485	$133,435	$345,920

This total cost of $345,920 is exclusive of a two percent State of Nevada sales tax - at $6,918.40 - which with additional apparatus (chiefly, two gantry cranes with tracks on a used equipment basis) is assumed to yield a full purchase cost of $365,000. The cost of the split-face unit is taken at $35,000 - with $20,000 for a diamond gang-saw; $10,000 for hydraulic splitter, and $5,000 for the facing machines.

For the dimension plant, the equipment investment will thus approximate $400,000. Detailed equipment specifications and machine cost

* Reference Dominion Construction Ltd., Vancouver. The recommended supplier is Butler Manufacturing Corp., a fabricator of efficient, low-cost metal buildings. Data may be obtained through its Canadian subsidiary, Butler Manufacturing Company (Canada) Ltd., Burlington, Ontario.

estimates for the two dimension production lines are summarized in Tabe XXV.

As stated previously, the equipment purchase cost for the crushing and grinding units have not been estimated in any detail. Assumed costs are $75,000 per unit, for a total of $150,000, including sales tax and plant 'set up' expense.

A provision of $100,000 for all installation costs for the dimension plant is regarded as adequate. Shipment of equipment will be by truck f.o.b. Knoxville and is not expected to exceed $25,000. Further costs will arise in the installation of special water circulation/pumping systems to serve all sawing and grinding/polishing machines, assumed at a total of $25,000. The balance of $50,000 is expected to cover all labour/supervision/ancillary costs of machine installation.

Capital Costs: Working Reserve

The project must build inventory in two ways. A raw material supply equivalent to two months' plant requirements is necessary in block form to provide an adequate colour/pattern backlog for dimension output, and to permit any internal strains in each block to be adjusted. In addition, all plant units must accumulate finished inventory to supply distributor stocks and to provide a reserve for orders.

To a very considerable extent, this inventory will be accumulated during quarry opening and plant installation. The quarry is expected to yield sound, whole blocks in a relatively rapid time following initial development. These may be held at the quarry site for later shipment to the plant. In the dimension plant installation process, the gang-saw unit will be completed first and may begin to process slabs. As the two production lines are installed, finished product inventory

will begin to accrue. Thus, from stage to stage, material stocks will be available.

Nevertheless, the production of this inventory must be financed, and it will require a capital appropriation (whether equity or borrowed, or a combination of both) to do so. The net production cost of this inventory is assumed to be $350,000.

Moreover, a provision for plant 'run in' time must be allowed. It may well be that the dimension and crushing units will be fully operative on installation, yet it would be unwise to plan on this event. Any machine can develop operating 'problems', or be capable of improved facilities. Skilled operators must become familiar with their machines, or be trained to run them to most efficient advantage. Finally, the plant 'design' - the production system - is new to the industry, and must be fully integrated and synchronized. During this time, wages must be paid; operating supplies purchased; water and power used. These direct costs (over and above the production cost of inventory) are taken at $150,000.

Finally, a period of time will elapse between the receipt of borrowed funds and the date when capital investment in the project yields sales revenues. The depreciation of building and equipment will commence. Assuming amortization costs of $75,000 over a nine month period and deprecision over three to four months of $25,000, a further $100,000 is allotted.

The distribution of the financing of the total $1,800,000 capital investment between equity and borrowed capital is proposed in Section IV. The <u>initial</u> private equity financing will be obliged to cover all quarry development costs; the purchase and servicing of land; and per-

haps an initial deposit on purchased equipment. These costs are expected to approximate $400,000.

The building/equipment costs of all plant is assumed to be financed largely through borrowed funds (e.g., mortgage or title bonds or secured debentures) of $500,000 and subscription of public shares of $300,000.

The working capital appropriation of $600,000 is taken as arising in equal shares from bank short-term loans and public share subscription.

The basic financing would thus be as follows:

SOURCE	AMOUNT	TOTAL
EQUITY:		
Private shares	$ 400,000	
Public shares	$ 600,000	$ 1,000,000
BORROWED:		
Long-term	$ 500,000	
Short-term	$ 300,000	$ 800,000
TOTAL:		$1,800,000

THE OPERATING COSTS OF THE PROJECT

The capital costs above are the measure of the investment required to equip the project as a productive enterprise until it begins to generate sales revenues. While the economic raising of capital funds and their efficient application is of paramount importance in the development phase, it is the cost of operating the project that will be of primary concern thereafter. These operating costs are usually calculated on an annual basis. As the market feasibility rests on price, however, it is equally essential to calculate total costs on a unit output basis.

Two classifications of operating cost will arise: fixed and

variable. Fixed costs originate with capital investment, as interest on borrowed funds, amortization (where appropriate), and depreciation/depletion.* Variable costs are those which differ according to the rate and volume of output - labour, production supplies, services (i.e., water and electricity), freight, and sales/administrative expense.

Operating Costs: Comparison

The Nevada marble project involves two distinct (although integrated) processes:

(i) The primary extraction of raw material from the ground.

(ii) The secondary manufacturing of this material into finished product form.

As separate and individual cost streams enter each process (e.g., a quarry bar is not used in a dimension plant), the calculations of operating cost should be made in sequence. All costs at the quarry (including freight to the plant) should be charged as raw material costs, and not be posted under such general headings as 'labour' or 'overhead'. This raw material cost will then become a cost item in the manufacturing process. When all costs are computed, any residue in net profit may be distributed on a pro rata basis among the various operations.

The operating costs of the project's plant may be compared in broad terms with the apparent pattern in the U. S. marble industry, and with an amalgam of standard equivalent manufacturing industries.

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* Taxes on property (i.e., land/buildings/machinery) are usually regarded as a fixed cost since they are determined on the value of the investment. The State of Nevada levies no property tax per se, but rather an output tax on the 'net proceeds' of a mine or quarry. Since this tax will vary with output levels, it is taken here as a variable component of operating cost.

In terms of percentage contribution to total cost, the breakdown would be approximately as follows:

COST AREA	STANDARD INDUSTRY	U.S. MARBLE INDUSTRY	PROJECT	
			Dimen.	Crushed
Raw Material	45	20	26	50
Labour	20	50	33	18
Overhead*	20	20	33	15
Interest	5	3	3	7
Depreciation	8	6	5	10
Pre-profit taxes	2	1	-	-
TOTALS:	100	100	100	100

* Includes Administration/Sales

Taken as a whole, the project conforms more closely to the standard manufacturing industry than to the pattern in the U. S. marble industry - particularly in labour cost content. These cost proportions, however, are based on percentage contribution to total cost, rather than on an actual cost basis. Since project unit costs will be substantially below those in the industry, the labour cost deviation is under-stated. For example, in floor tile material the actual cost breakdown would be approximately as follows:

COST AREA	COST PER SQ.FT. (3/8")	
	PROJECT	INDUSTRY
Raw Material	$.168	$ .25
Labour	$.256	$ .60
Overhead	$.228	$ .30
Fixed	$.057	$ .05
Admon./Sales	$.041	$ .10
TOTAL COST	$.75	$1.30

This comparison is not strictly fair as the typical U. S. marble mill is geared for custom structural work and is not equipped for straight-line tile production. Nevertheless, it illustrates the magnitude of the cost reduction at the project - with attendant savings in labour, raw material waste, and overhead.

The elements of operating cost will be estimated now on annual and unit cost bases, and will be consolidated at the conclusion of this discussion.

Operating Costs: Raw Material

The project's output is 25,000 tons (net) in crushed/ground products; 4,000 tons (net) in split face 'brick'; and 1,000,000 sq.ft. (3/8") in floor tile plus 500,000 sq.ft. (3/4") in furniture/fireplace material. These output levels must be converted into raw material consumption volumes before raw material costs may be calculated.

The least raw material waste (and thus the highest conversion ratio) will occur in crushed/ground. A 20 percent allowance for waste should be sufficient. The material loss in split-face should also be moderate as rough edge material may be used. A loss factor of 25 percent should be adequate. The highest raw material losses will occur in dimension output, and only 30 to 40 percent of all raw material 'consumed' for these products will be recovered.

Dimension Recovery Factors

The weight per sq.ft. in finished product form will be 5.3 pounds in floor tile and 10.6 pounds in furniture/fireplace material. The annual finished tonnage - by weight - will amount to 2,656 tons in each case, or a total of 5,312 tons.

The raw material consumption by weight, however, will be substantially higher. Three separate 'losses' will occur in each rough block supplied from the quarry:

First, the 'trim' waste from all six rough sides per block, removed by the diamond trim saw operation (four sides" and the gang-saw (two sides).

Second, the grooves between each slab (or saw kerf), removed by the width of the saw blade.

Third, a part of the surface thickness of each finished unit, removed by the grinding heads on the automatic polishing line.

The trim waste will be the most severe. The reduction of a rough block 9' x 5' x 6' into trimmed slab equivalent involves the removal of six inches of rough, serrated material from all six sides. The loss is as follows:

Rough block	9' x 5' x 6'	270 cubic feet
Trimmed block	8' x 4' x 5'	160 cubic feet
TRIM LOSS:		110 cubic feet

This loss will not be altogether in solid weight, but for safety will be assumed. Nevertheless (and even though slab waste will be recovered for crushing), the loss amounts to 40 percent per block.

The 'saw kerf' loss will amount to a maximum of 1/4" per groove and, therefore, per slab. For a 1/2" floor tile slab, the loss will be 33.3 percent. For a 7/8" furniture/fireplace slab, the loss will be 2/9 or 22.2 percent.

Finally, the grinding unit will remove 1/8" from the top/bottom surfaces of each dimension product. The loss in floor tile will be 25 percent, and in furniture/fireplace one-seventh, or 14.3 percent.

In both sawing and grinding operations, material removed cannot be recovered and is total 'waste'.

On these grounds, the conversion of 2,656 tons into finished product form in floor tile and furniture/fireplace material will be 8,852 tons and 6,636 tons respectively. The conversion factor in each case is as follows:

PRODUCT	FINISHED WEIGHT (TONS)	WASTE/LOSS FACTORS			RAW MATERIAL WEIGHT
		Trim	Saw Kerf	Grinding	
Floor Tile 12"x12"x3/8"	2,656	$\times \frac{100}{60}$	$\times \frac{3}{2}$	$\times \frac{4}{3}$	8,852
Furniture/ Fireplace 12"x12"x3/4"	2,656	$\times \frac{100}{60}$	$\times \frac{9}{7}$	$\times \frac{7}{6}$	6,636

The recovery rate per raw material ton in dimension product form is 30 percent in floor tile and 40 percent in furniture/fireplace. From each block, however, 40 percent of the original material will be recovered in rough slab form for crushed/ground by-products. Nevertheless, by determination, 50 percent of floor tile raw material will be total waste, and 25 percent of furniture/fireplace materials.

In estimating raw material costs, these recovery factors will be taken into account. Costs cited will be for sound, recoverable volume equivalent on the following basis:

First, all variable costs - labour, overhead, and freight expense - will be computed first on the basis of gross tonnage, and converted to net tons.

Second, all fixed costs - capital cost recovery, depreciation, depletion and royalty - will be based on net tons, as recoverable raw material alone contains maximum dimension value.

Third, recoverable 'waste' will be assumed to be 'sold' by the dimension plant to the adjacent crushing/grinding operation at a flat charge per ton. This basis will also hold true for split face 'block' material quarried as dimension 'waste'. These sums (at the equivalent recovery rate) will be deducted from unit costs.

Dimension Material Costs

The raw material requirements of the 'tile' production line will be 35 tons per operating day, and the 'furniture/fireplace' line 27 tons. The basis is as follows:

FLOOR TILE : 8,852 tons ÷ 250 days = 35 tons/day
FURNITURE : 6,636 tons ÷ 250 days = 27 tons/day

The average daily supply from the quarry, however, must be substantially higher than the combined total of 62 tons - even in gross tonnage form. The main reason has been cited previously: a restriction in all surface workings to an eight month operating year. The quarry output level, therefore, must average:

$\frac{3}{2}$ x 62 tons = 93 tons/day.

This volume is the equivalent of four blocks 9' x 5' x 6'. It is known, however, that in any quarry an indeterminate (but usually small) proportion of blocks extracted are liable to later internal stresses and fracturing - even though moderate, possibly sufficiently to relegate them to lower-value production. This 'degrade' volume, for example, is intended as the chief raw material supply for split-face output, and is taken at 25 percent, or the equivalent of a fifth block.*

* It should be noted that this 'fifth block' does not include quarry 'rubble'. This rubble will be of little value and is regarded as total waste in this analysis.

To extract five blocks per operating day, a conservative estimate in output rates would be two blocks per quarry bar on surface workings, and one block per quarry bar underground. Although not all bars would be operating at any one time, it is recommended tentatively that two units be located on surface, and two underground, with the equivalent of three full crews (plus supervision) distributed among them. This basis would lead to the following labour/overhead costs.

For labour, a three-crew operation would involve the following requirements, by skills:

SKILL	NUMBER	PER HOUR	PER DAY
QUARRY BARS:			
Operators	3	$4.00	$ 96.00
Ass't op'ts	3	$3.25	$ 78.00
Drill men	12	$2.75	$264.00
DERRICK?PLANT			
Operator	1	$4.00	$ 32.00
Ass't operator	1	$3.25	$ 26.00
Helpers	2	$2.75	$ 44.00
SUPERVISION			
Foreman	1	$5.00	$ 40.00
TOTAL DIRECT LABOUR	23	$3.15	$580.00
TOTAL PER YEAR	$580.00 x 167 days = $96,860		

This daily cost of $580.00 would be charged entirely against the 93 tons (gross) in dimension product raw material. The 'fifth' block of 23 tons for the split-face operation will be deducted at plant. The dimension material labour charge would be:

$580.00 ÷ 93 tons = $6.235/ton

or, rounded, $6.25. This cost is for gross output. Applying the dimension product recovery estimates, the net raw material cost will be taken at:

FLOOR TILE	:	$6.25 x $\frac{10}{3}$ = $20.83/ton (net)
FURNITURE/FIRE.	:	$6.25 x $\frac{10}{4}$ = $15.63/ton (net)

Less these costs appear excessive, it should be stressed that they are developed on net weight. A ton of finished product will contain 374 floor tiles and 187 sq.ft. of furniture/fireplace material. The direct raw material labour costs per unit will then be:

FLOOR TILE	:	$20.83 ÷ 374 = $.055 sq.ft.
FURNITURE	:	$15.63 ÷ 187 = $.083 sq.ft.

Among overhead costs will be included all parts, supplies (e.g., drills), the costs of providing water and electricity, fuel, maintenance/repair, and pro rata share of project administration costs. In addition, since the crew may not be housed at the quarry site, further expense will arise in travel time and employee non-labour costs at site. Alternatively, if trailer or other accomodation is installed, these costs will go into overhead.

These costs have not been calculated by detailed estimate, but are taken at $60,000 per year, or on 167 operating days - $359.47 or, rounded $360.00. Given 93 tons average output per day, the gross cost per ton would be:

$360.00 ÷ 93 tons = $3.88 per ton.

The same ratios of finished product recovery may be used to determine net costs per ton, as follows:

FLOOR TILE	:	$3.88 x $\frac{10}{3}$ = $12.93/ton (net)
FURNITURE	:	$3.88 x $\frac{10}{4}$ = $ 9.70/ton (net)

On a unit basis, raw material overhead costs will amount to $.035 on floor tile and $.052 on furniture/fireplace material, per sq.ft.

The freight cost per ton from quarry site to the Ely plant location

was previously estimated at 73 miles at 2.5 cents per ton/mile, or $1.825 per ton. This cost (which includes truck, driver, fuel, etc. on a self-owned basis) is a gross ton estimate, and must be converted into net recovery costs. The basis is again as follows:

FLOOR TILE	:	$1.825 x $\frac{10}{3}$ = $6.08/ton (net)
FURNITURE	:	$1.825 x $\frac{10}{4}$ = $4.56/ton (net)

On a finished unit basis per sq.ft., the raw material freight cost would be 1.62 cents for tile and 2.43 cents on furniture/fireplace material.

The capital cost of the quarry involves a number of fixed costs - including amortization of all quarry development expenses; depreciation on equipment and any buildings (i.e., machine sheds); depletion on the worth of the deposit itself; and a per ton royalty to the previous owners of the property. These costs should all be calculated on a net ton basis.

An initial cost of $300,000 was estimated for quarry development. This cost should be borne entirely by dimension output for which it will be (in the main) expended. A five-year 'payback' period is assumed, or $60,000 a year. Moreover, as risk equity capital will have been involved, a 10 percent allowance for interest will be made, for a total of $66,000. Given net dimension recovery of 5,312 tons, the cost would be:

$60,000 ÷ 5,312 tons = $11.15 per ton.

This charge will apply equally on tile and furniture/fireplace material, as the same finished annual output by weight is involved. The unit costs will be $.03 per sq.ft. on floor tile and $.06 on furniture/fireplace.

For depreciation, an annual allowance must be made for all operating equipment and any buildings. Given a total investment of $100,000 (including pilot plant), $75,000 is reckoned as chargeable to dimension output. Straight-line depreciation is taken at 15 percent a year, or $11,250. The per ton cost (net) would be:

$11,250 ÷ 5,312 tons = $2.10

For depletion, the U. S. Internal Revenue Service permits two approaches at applicable rates. The approach taken here will be the five percent of 'gross income from mining' allowed on illustrative limestone and shale quarry examples.* Provided the composition of the material mined is not altered (as marble at the project will not be), the IRS may permit gross income to mean gross sales revenue on dimension products, or $2,000,000 a year. At five percent depletion per year, the per ton cost (net) would be:

$2,000,000 x .05 = $100,000 ÷ 5,312 tons = $18.82/ton.

The unit 'cost' (recovered from raw material expense) would be $.05 on floor tile and $.10 on furniture/fireplace material.

Finally, the present agreement regarding the acquisition of the project's marble property calls for a $1.00 per ton royalty plus a $.25 per ton 'override' to a third party. This agreement was negotiated during the initial 'concept' of the property as exclusively a crushing aggregate/terrazo operation. A revised basis has been proposed during this study - at $1.00 per net ton on dimension output and $.25 percent on crushed/ground. This basis is assumed, and is added into raw material costs.

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* See U.S. Treasury Department, Internal Revenue Service, Document No. 5050, "Depreciation, Investment Credit, Amortization, Depletion," Washington, D.C. The relevant examples may be found on pp. 16-17.

These variable/fixed costs may be computed on an annual, per net ton, and per unit basis, and so appear in Table XXVI. The unit raw material cost is crucial, and may be summarized as follows:

COST AREA	COST PER SQ. FT.	
	Floor Tile	Furniture
VARIABLE:		
Labour (direct)	$ .055	$ .083
Overhead (est.)	$ .035	$ .052
Freight	$ .016	$ .024
FIXED:		
Amortization/ depreciation	$ .036	$ .071
Depletion/royalty	$ .052	$ .104
TOTAL COSTS:	$ .194	$ .334

Other Product Material Costs

The raw material costs for crushed/ground and split-face output will be developed in summary form. The recovery factors previously cited - with 20 percent 'comsumption' increase added to crushed/ground finished output and 25 percent to split-face - will be used here to develop net ton estimates.

The variable costs only are charged against split-face material, as all fixed costs (e.g., amortization/depletion) have been assumed on a net cost basis in dimension raw material output. The variable costs are:

COST AREA	PER TON	ADD	NET COST
Labour	$ 6.25	+ 25%	$ 7.81
Overhead	$ 3.88	+ 25%	$ 4.85
Freight	$ 1.83	+ 25%	$ 2.29
TOTAL:	$11.96	+ 25%	$14.95

This per ton cost of $14.95 will be entered in final unit cost in

split-face output, and will be deducted from dimension finished product costs presently.

In crushed/ground output, the raw material consumption is taken at 25,000 tons per year plus 20 percent 'loss' - or 30,000 tons/year. As a separate blasting/quarry operation - sufficient distance from the dimension material quarry to prevent fracturing - will be required, fixed costs (as well as variable) must be charged where appropriate. The variable costs will again consist of labour, overhead, and freight. The fixed costs applicable are depreciation on equipment (15 percent straight-line on $25,000); depletion; and royalty.

Before costs may be assigned, it is necessary to determine the raw material supply available from flock 'trim' waste at the dimension operation, calculated at 40 percent of total gross tonnage, or:

15,488 tons x .4 = 6,195 tons.

As this volume again is based on gross consumption, the net recovery factor should be applied, yielding:

$$6{,}195 \text{ tons} \times \frac{5}{6} = 5{,}162 \text{ tons}$$

or, for safety, 5,000 tons. This volume will be 'bought' from the dimension plant (see below), and implies that 20,000 net tons - or 24,000 tons gross - must be produced at the quarry site. On the basis of 167 operating days, the daily output will be 120 tons (net) or 144 tons (gross).

The labour requirements involved in this output are relatively modest. A six man crew is proposed, on the following basis:

SKILL	NUMBER	PER HOUR	TOTAL PER DAY
Foreman	1	$ 5.00	$ 40.00
Explosive men	2	$ 4.00	$ 64.00
Helpers	2	$ 2.75	$ 44.00
Loader operator	1	$ 4.00	$ 32.00
TOTAL:	6	$ 3.75	$180.00

Assuming 120 net tons per day, the direct labour unit cost will be $1.50 per ton.

All overhead costs are taken as proportionate to payroll costs in the dimension vs. crushing material quarry operations, yielding:

$$\$60,000 \times \frac{\$180}{\$580} = \$\$18,620$$

Applying net output levels, and eight months' operation, the unit cost would be as follows:

$18,620 ÷ 167 days = $111.50/day ÷ 120 tons = $.92 ton.

This $.92 estimate is adopted as realistic.

The freight cost will be equivalent to that cited in the dimension analysis, or $1.825 per ton (gross). The cost per net ton would be:

$$\$1,825 \times \frac{6}{5} = \$2.19 \text{ per ton (net).}$$

These labour/overhead/freight results yield total variable costs of $4.61 per net ton.

There remain three fixed costs. Depreciation on $25,000 equipment chargeable to the crushed/ground output would be applied at 15 percent per year, or $3,750. At 20,000 net tons, the unit cost would be $.1675 or, rounded, $.17. The depletion allowance output will be worth on a 'gross income' basis $300,000 a year, and assuming its application to the 20,000 net tons quarried, the following basis for calculation can be suggested:

$300,000 x .05 = $15,000

$15,000 ÷ 20,000 tons = $.75 ton

Finally, there is the royalty payment. Certainly, at any stage of project development, a $1.25 per ton royalty would be excessive and uneconomic on crushed/ground material - even on a net tonnage basis, and would prevent entry into diversified product/market fields at a later

date. For present purposes a $.25 per ton (net) royalty is proposed, or on 20,000 tons, an annual total of $5,000.

The annual costs of the crushed/ground quarry operation are included in Table XXVI. The unit cost (per net ton of finished output) is as follows:

COST AREA	PER TON
Labour (direct)	$ 1.50
Overhead	$ .92
Freight	$ 2.19
Depreciation	$ .17
Depletion	$ .75
Royalty	$ .25
TOTAL:	$ 5.78

This raw material cost will be re-introduced as $5.80 per ton at the conclusion of the analysis.

There remains, however, the readjustment to the dimension unit costs from the 'sale' of 4,000 net tons of split face and 5,000 tons of crushed/ground raw material at plant. The sales 'revenue' would be as follows:

PRODUCT	TONS	PRICE PER TON	TOTAL VALUE
SPLIT FACE	4,000	$14.95	$60,000
CRUSHED/GROUND	5,000	$ 5.80	$29,000
TOTAL:	9,000	$ 9.89	$89,000

Converted into unit recovery value, the reduction in unit costs would be 2.6 cents on floor tile and 5.4 cents on furniture/fireplace.

The net raw material costs would then be as follows:

FLOOR TILE	($.194 - $.026)	=	$.168
FURNITURE	($.334 - $.052)	=	$.282

These costs will be carried into the subsequent analysis.

Operating Costs: Labour

The direct labour costs taken in this analysis are those arising in manufacturing production only. The labour cost at the quarry has been included in raw material expense, and in freight in a similar way. All administrative/sales/clerical salary cost is also treated separately from direct labour. While all wages and salaries will be combined on an annual basis among project total costs, the segregation is important as the production of marble has been traditionally a labour-intensive process, requiring modifications.

Dimension Labour Costs

In the dimension plant, labour costs begin with the hoisting of a marble block off a flat-bed truck, and cease when finished products (in packaged form) are loaded onto a delivery truck for hauling to market/distribution points. Four separate crews will be required:

(i) For the gang-saw unit, operating three shifts per day.

(ii) For the tile manufacturing line, at two shifts per day.

(iii) For the furniture/fireplace manufacturing line, at two shifts.

(iv) For the warehouse and shipping area, operating one shift per day.

Over and above these production workers, the plant requires supervision, and a small but efficient maintenance crew. The total plant personnel requirements (exclusive of clerical) are set out in Table XXVIII, including a brief description of functions in each case. The crew sizes and per day complements are as follows:

PLANT AREA	MANPOWER REQUIREMENTS			TOTAL PLANT AREA
	Per Shift	Shifts/Day	Total/Day	
GANG SAWS:				
Full shift	6	2	12	
Relief shift	4	1	4	16
TILE LINE:				
Trim saw	4	2	8	
Polish. line	2	2	4	
Sizing saw	3	2	6	
Packing line	3	2	6	26
Fork lift	1	2	2	
FURNITURE:				
Trim saw	5	2	10	
Polish. line	2	2	4	
Sizing saw	2	2	4	
Edge line	2	2	4	
Packing line	3	2	6	30
Fork lift	1	2	2	
SHIPPING	3	1	3	3
MAINTENANCE	3	1	3	3
SUPERVISION				
Superintendent	1	1	1	
Shift foremen	1	2	2	
Ass't foremen	1	3	3	6
TOTALS:	47	1.78	84	84

These estimates are based on maximum allowances, and certain operations may be capable of reduction. For safety in calculating costs, these requirements will be taken.

To establish labour costs - per day, annual, or per unit of output - hourly wage rates or (in the case of supervisory personnel) annual salary levels must be set out. These will be taken by plant area.

In the gang-saw unit, the highest-paid worker will be a 'chief operator'. At $4.00 per hour, he will also be the highest-paid hourly employee in the plant. Two assistant operators will be required per shift, each at $3.25 per hour. Three helpers per shift will be paid

$2.75 per hour. For the third shift, one operator, one assistant operator, and two helpers will be required - at $3.75, #3.25, and $2.75 respectively. It is assumed that the third shift will serve in part as a training ground for workers to move into higher-paid jobs on the regular shifts. The gang-saw labour costs would thus be:

SKILL	MANPOWER NUMBER		WAGE COSTS		PER YEAR x 250 Days
	Shift	Day	Per Hour	Per Day	
Chief operator	1	2	$4.00	$ 64.00	$ 16,000
Ass't operator	2	4	$3.25	$104.00	$ 26,000
Helpers	3	6	$2.75	$132.00	$ 33,000
Night operator	1	1	$3.75	$ 30.00	$ 7.500
Ass't operator	1	1	$3.25	$ 26.00	$ 6,500
Helpers	2	2	$2.75	$ 44.00	$ 11,000
TOTALS:		16	$3.12	$400.00	$100,000

The wage costs per shift are $150.00 on each of the full or 'regular' shifts, and $100.00 on the third or 'relief' shift. The hourly rates taken are maximum allowances, and include provision for such benefits/costs as compensation, social security, and the like. Thus, these rates reflect <u>costs</u> to the project rather than necessarily income to the man.

The function of the gang-saw crew will be to operate the bank of nine saws - five for the 'tile' line; three for the furniture/fireplace line; and one for the split-face plant. The annual labour cost per saw will be $11,100. The charge against the three product areas will then be:

FLOOR TILE : 5 saws x $11,100 = $55,500
FURNITURE : 3 saws x $11,100 = $33,300
SPLIT FACE : 1 saw x $11,200 = $11,200

The tile line will require 13 men per shift, or 24 per day. The highest-paid worker will be the operator in charge of the automatic

grinding/honing/polishing line at $3.75 per hour. The operators of the two diamond saw units - trim and sizing - are costed at $3.50 per hour. The assistant operator of the polishing line and the grader/inspector are set at $3.25 per hour each; a fork-lift driver per shift at $3.00 per hour; and all helpers or packers at $2.75 per hour. The tile line labour costs are as follows:

SKILL	MANPOWER NUMBER		WAGE COSTS		PER YEAR
	Shift	Day	Per Hour	Per Day	x 250 Days
Trim saw:					
Operator	1	2	$3.50	$ 56.00	$ 14,000
Helpers	3	6	$2.75	$132.00	$ 33,000
Polish. Line:					
Operator	1	2	$3.75	$ 60.00	$ 15,000
Ass't operator	1	2	$3.25	$ 52.00	$ 13,000
Sizing saw:					
Operator	1	2	$3.50	$ 56.00	$ 14,000
Helpers	2	4	$2.75	$ 88.00	$ 22,000
Packing:					
Grader	1	2	$3.25	$ 52.00	$ 13,000
Packers	2	4	$2.75	$ 88.00	$ 22,000
Fork-lift	1	2	$3.00	$ 48.00	$ 12,000
TOTALS:	13	26	$3.05	$632.00	$158,000

The furniture/fireplace line is laid out in basically the same way, with the exception of an additional (and smaller) grinding/honing/polishing edge line. The wage rates for the trim saw, automatic polishing, and sizing saw operations are the same as above, as with the packing line. The operator of the edge polishing line is costed at $3.50 an hour. An assistant operator is charged to the trim saw at $3.00 per hour. Although this man may not work at all times at this particular operation, the position will be required for advancement to full operator status at any diamond saw unit. On this basis, the furniture/fireplace labour costs are as follows:

SKILL	MANPOWER NUMBER		WAGE COSTS		PER YEAR
	Shift	Day	Per Hour	Per Day	x 250 Days
Trim saw:					
Operator	1	2	$3.50	$ 56.00	$ 14,000
Ass't. optr	1	2	$3.00	$ 48.00	$ 12,000
Helpers	3	6	$2.75	$132.00	$ 33,000
Polishing:					
Operator	1	2	$3.75	$ 60.00	$ 15,000
Ass't optr	1	2	$3.25	$ 52.00	$ 13,000
Sizing saw:					
Operator	1	2	$3.50	$ 56.00	$ 14,000
Helpers	1	2	$2.75	$ 44.00	$ 11,000
Edge line:					
Operator	1	2	$3.50	$ 56.00	$ 14,000
Helper	1	2	$2.75	$ 44.00	$ 11,000
Pack. line:					
Grader	1	2	$3.25	$ 52.00	$ 13,000
Packers	2	4	$2.75	$ 88.00	$ 22,000
Fork-lift	1	2	$3.00	$ 48.00	$ 12,000
TOTALS:	15	30	$3.06	$736.00	$184,000

All warehouse/shipping and plant supervision costs are assumed to be borne equally by the two dimension lines - with a small pro rata allowance for supervision of the split-face plant (the shipping costs will be cited separately).

In warehouse/shipping, one shipper and two fork-lift driver/loaders are assumed as adequate to handle all dimension product inventory and shipment - on 2,656 tons (net) per year in each line, and 250 days, an average dimension shipments of 10.62 x 2 or 21.24 tons per day. This is the equivalent of one fully loaded truck per day. On this basis, a one shift operation will suffice. The shipper is costed at $3.50 an hour, and the two loader/drivers at $3.00 an hour each. The costs will be as follows:

SHIPPER	:	1 x $3.50 x 8 hrs. x 250 days = $ 7,000
LOADERS	:	2 x $3.00 x 8 hrs. x 250 days = $12,000

In addition to warehouse/shipping costs at $19,000 per year, supervision costs must also be accounted. The plant will require a superintendent, one foreman and assistant foreman per full shift, and an assistant foreman per full shift, and an assistant foreman for the third shift. Supervision costs are estimated as follows:

POSITION	NUMBER	ANNUAL SALARY	TOTAL
Superintendent	1	$12,000	$12,000
Shift Foreman	2	$ 9,000	$18,000
Ass't Foreman	3	$ 7,500	$22,500
TOTAL:	6	$ 8,750	$42,500

Finally, labour costs will arise in plant maintenance. A maintenance/repair crew of three is regarded as appropriate to the plant, based on a chief millwright at $3.75 per hour, and two mechanic/electricians at $3.50 per hour. The costs of maintenance (the equivalent of a one-shift operation) would be as follows:

CHIEF MILLWRIGHT : 1 x $3.75 x 8 hrs. x 250 days = $ 7,500
MECHANIC/ELECTR. : 2 x $3.50 x 8 hrs. x 250 days = $14,000

The total labour maintenance/repair cost would be $21,500. While major maintenance programs will be required (proposed during an annual vacation shutdown), these additional costs are reckoned under 'overhead'.

In the development of total annual and unit labour costs, all supervision costs except a pro rata share charged to the split face unit on a basis of relative number of workers. The split face crew at five men will represent eight percent of total production workers at the plant, and the supervision cost would accordingly be $4,200. An allowance of $4,500 is made, resulting in $48,000 supervisory cost to be charged equally between the tile and furniture/fireplace lines.

The annual and unit costs in the two dimension product areas may now be assessed as follows:

COST AREA	TILE LINE		FURNITURE LINE	
	Annual	Per Sq.Ft.	Annual	Per Sq.Ft.
GANG-SAW	$ 55,500	$ .056	$ 33,300	$ .067
PRODUCTION	$158,000	$ .158	$184,000	$ .368
SHIPPING	$ 9,500	$ .01	$ 9,500	$ .019
MAINTENANCE	$ 10,750	$ .01	$ 10,750	$ .021
SUPERVISION	$ 22,000	$ .022	$ 22,000	$ .044
TOTALS:	$255,750	$ .256	$259,550	$ .519

These labour costs of 25.6 cents and 51.9 cents per sq.ft. respectively will be carried over in the calculations of final unit cost.

Split-Face Labour Costs

Two elements of labour cost in the split-face unit have already been established - $11,200 chargeable from gang-saw labour and $4,500 in supervision. A separate maintenance crew is not charged, as the requirements will be slight and can be undertaken by the operators themselves. A separate shipping charge will not arise, although the output of 16 tons per day will involve the loading of trucks at the average rate of two vehicles every three days.

Basically, the unit costs of two splitting machines and a facing machine. Fork-lift loading of slabs and pallet stacking of brick is proposed. The manpower requirements and wage costs would be as follows:

MANPOWER REQUIREMENTS		WAGE COSTS		
Skill	Number	Per Hour	Day	Year
Chief Operator	1	$3.75	$ 30.00	$ 7,500
Splitter operator	1	$3.50	$ 28.00	$ 7,000
Facer operator	1	$3.25	$ 26.00	$ 6,500
Helpers	2	$2.75	$ 44.00	$11,000
Fork-life driver	1	$3.00	$ 24.00	$ 6,000
TOTAL:	6	$3.16	$152.00	$38,000

The total labour cost may now be computed, involving all direct charges as:

COST AREA	TOTAL COST	
	Annual	Per Ton
Gang-saw	$11,200	$ 2.80
Production	$38,000	$ 9.50
Supervision	$ 4,500	$ 1.12
TOTALS:	$53,700	$13.42

Crushed/Ground Labour Costs

The labour costs of the project's crushing/grinding plant will be exclusive of those in the dimension plant. No sharing is proposed in supervision or production workers, in raw material loading or finished product shipping. A dove-tailing of maintenance may well be possible, and work required on the crushing plant will be slight.

In view of the maximum allowance for crushed/ground raw material cost, labour costs at the plant will have to be closely controlled. With a market volume (initially) of 25,000 tons per year at an average price of $12.00 per ton, the average daily output would be only 100 tons, with a total value of $1,200. As close to $600 of this value would lie in raw material cost (including freight from quarry to plant, Ely site assumed), the maximum labour cost allowance should be 20 percent or $240.00 per day. A crew can be designed on this basis, but until market penetration in the crushed/ground range warrants a higher average daily output (closer to 200 tons/day), it is proposed that the project explore carefully the alternative of accelerating output during the four winter months when the quarry crew will be largely idle: first, to guarantee year-round employment; and, second, to reduce unit labour

costs of finished output.

The two bases - a full year and partial year operation - will be examined here.

In either case, the four basic operations will be the same. They are:

(i) Feeding the crushed; operating the jaw crushed, washing plant and screens.

(ii) Operating the grinding unit ball mill and selector screens and (if wet ground output is warranted) the drying unit.

(iii) Bagging the output of both crushed and ground products.

(iv) Warehousing and shipping the finished products.

The optimum crew size (on a one shift basis) is 12 men, including a foreman who will share operating tasks. The distribution would be as follows:

PLANT AREA	MANPOWER REQUIREMENTS		TOTAL PLANT AREA
	JOB SKILL	NUMBER	
CRUSHER	Operator, crusher Operator, wash./screen Baggers/helpers	1 1	5
GRINDER	Operator, ball mill Ass't operator Bagger/helper	1 1 2	4
WAREHOUSE/ SHIPPING	Shipper/loader Fork-lift driver	1 1	2
SUPERVISION	Foreman	1	1

As to wage costs, the foreman (doubling as chief operator) is taken at dimension plant equivalent, or on $9,000 per year, at $4.50 per hour. The crusher and ball mill operators are each costed at $3.75 per hour; the screen/washing plant operator at $3.50; the grinding unit assistant operator and shipper/loader at $3.25; fork-lift driver at $3.00; and

all other at $2.75. The variable in annual costs will be the duration of output over the year. Since the plant is designed to 250 tons/day capacity, two bases will be adopted - 12 months and six months - for illustrative purposes. The results are as follows:

SKILL	WAGE COSTS		OUTPUT LEVELS	
	Per Hour	Total/Day	12 Months	Six Months
Crusher:				
Operator	$3.75	$ 30.00	$ 7,500	$ 3,750
Screen operator	$3.50	$ 28.00	$ 7,000	$ 3,500
Baggers/ helpers.	$2.75	$ 66.00	$16,500	$ 8,250
Grinder:				
Operator	$3.75	$ 30.00	$ 7,500	$ 3,750
Ass't optr	$3.25	$ 26.00	$ 6,500	$ 3,250
Bagger/ helper	$2.75	$ 44.00	$11,000	$ 5,000
Shipper	$3.25	$ 26.00	$ 6,500	$ 3,250
Fork-lift	$3.00	$ 24.00	$ 6,000	$ 3,000
Foreman	$4.50	$ 36.00	$ 9,000	$ 4,500
TOTALS:	$3.23	$310.00	$77,500	$38,750

Assuming 25,000 tons/year output in both cases, the labour cost per ton would be:

OUTPUT	LABOUR COST	PER TON
12 months = 100 tons/day	$77,500	$3.10
6 months = 200 tons/day	$38,750	$1.55

The $3.10 per ton rate does not meet the profit criteria of this study and (when added to other plant costs, including fixed and overhead plus raw materials) would permit a net profit after taxes of some $10,000 per year, or three percent on sales. The $1.55 per ton cost would increase net profit to 10 percent after tax, and should be sought. Under these conditions, it is proposed - pending annual output increases -

TABLE XXIX

Total annual payroll costs, by production division and personnel classifications, Nevada marble project, 1968.

PRODUCTION AREA	ANNUAL SALARIED PERSONNEL					HOURLY PAID WORKERS			TOTAL PAYROLL COSTS
	Administrative	Sales Staff	Clerical	Prod. Superv'n	Total***	Skilled	Semi-Skilled	Total	
QUARRY				$13,360	$ 13,360	$ 54,776	$ 58,784	$113,560	$126,920
FLOOR TILE*				$22,000	$ 66,960	$110,862	$113,448	$224,310	$291,270
FURNITURE*	$49,500	$30,000	$28,400	$22,000	$ 66,960	$124,416	$103,664	$228,080	$295,040
SPLIT-FACE*				$ 4,500	$ 9,000	$ 25,888	$ 23,222	$ 49,110	$ 58,110
CRUSHED/GROUND**				$ 4,500	$ 17,980	$ 17,500	$ 16,750	$ 34,250	$ 52,230
TOTALS :	$49,500	$30,000	$28,400	$66,360	$174,260	$333,442	$315,868	$649,310	$823,570

* Hourly paid totals include gang-saw skilled and semi-skilled labour, as 'charged' to product area. Skilled hourly totals for tile/furniture include $10,750 each for maintenance personnel.

** Six months' operating basis per year assumed.

*** Includes pro rata distribution of administrative/sales/clerical salary expense according to annual sales per product area. Quarry not charged.

to operate the plant on a partial basis (and with minimum crew) over eight months of the year and to run at full per day capacity during the remaining eight months. On this basis, per ton costs may be held at $1.55

For purposes of information, the total direct labour costs of the project (including dimension, split face and crushing/grinding) plus the labour cost content of raw material should be compiled to yield an annual project payroll. This summary is contained in Table XXIX.

Operating Costs: Overhead

Overhead costs are all those expenses required to support and service the primary functions of labour, raw material and capital investment in plant. The elements of overhead adopted here will be:

First, production expendables or non-durable components, or machine parts with a relatively short life. Included will be such components as gang-saw blades; occasional replacement of steel splitter blades in the split-face unit; replacement of jaws or screens when required in the crushing plant.

Second, production materials other than raw material. In the dimension plant, these will include abrasive compounds for gang-saw and polishing units, and any chemicals required in the grinding unit. Packaging materials (cartons for tile; multi-wall paper sacks for crushed/ground products) are also included under this category.

Third, production services, primarily electricity, water and other utilities; fuel; annual maintenance programs (not previously included under labour cost), and the like. For purposes of this study, the single state tax that will apply on project output - the 'net proceeds from the mine' property tax - will also be included, as it relates to munici-

pal services.

Project administration and sales expenses, including salaries for all non-production personnel, head office rent, and the like, are sometimes accounted as overhead, but will be cited under a separate cost classification.

Normally, overhead costs account for 18 to 20 percent of total unit cost in the typical industrial enterprise. The costs cited in this discussion provide for maximum allowances, and in dimension output exceed this level, while falling below this range in crushed/ground and sharply below in split-face output.

Dimension Overhead Costs

The two major overhead costs in the dimension plant will be outlays for gang-saw blades and gang-saw abrasive compound (i.e. silicon carbide). In addition, expenses will arise for polishing compound, packaging materials, water and electricity services, and a provision for annual maintenance during vacation shutdown. Finally, the net proceeds tax will be charged against the dimension output on a net income basis. The basic breakdown will be as follows:

COST CATEGORY	DIMENSION OUTPUT COSTS		TOTAL
	FLOOR TILE	FURNITURE/FIREPLACE	
EXPENDABLES	$100,000	$ 46,000	$146,000
MATERIALS	$ 90,000	$ 75,000	$165,000
SERVICES	$ 25,000	$ 25,000	$ 50,000
NET PROCEEDS TAX	$ 12,500	$ 12,000	$ 25,000
TOTALS:	$227,500	$158,500	$386,000

Among expendables, a substantial outlay will be required for gang-saw blades. The 'life' per blade is short - no more than three large blocks - and while the blade may be turned over once so both edges are used, the friction between steel and marble is severe. The annual consumption will thus be heavy. Assuming 64 blades per block (spaced over 48" on 3/4" centres to cut slabs 1/2" finished thickness) for floor tile, and 32 blades per block on furniture material, the requirements would be as follows:

PRODUCT AREA	BLADE LIFE IN BLOCKS	BLADE CONSUMPTION			TOTAL PER YEAR
		Blocks/ Year	Blades/ Block	Number Gangs	
FLOOR TILE	2	62.5	x 64	x 5	20,000
FURNITURE	2	62.5	x 32	x 3	6,000

The blades will be uniformly 20' long by 4" wide by 3/16" thick. The weight is 2.55 lbs. per lineal foot, or 51 lbs. per blade. Low carbon flat steel of the type required should be available in Salt Lake City (e.g., United States Steel Corp.), and cost per pound will range about 6.5 cents, or $3.32 per blade, f.o.b. mill. Landed cost at the plant will not exceed $3.50, or a total annual cost of $91,000.

In addition, blade dogs, blade drills, and other components will be required, as will occasional replacement of pipes, hoses for solution compound and the like. These total costs are not expected to exceed (or reach) $10,000 on tile output and $5,000 on furniture/fireplace. The cost of gang-saw expendables would thus be:

FLOOR TILE:		
Gang-saw blades - 20,000 x $3.50	= $70,000	
Other expendables/parts	= $10,000	$80,000
FURNITURE :		
Gang-saw blades - 6,000 x $3.50	= $21,000	
Other expendables/parts	= $ 5,000	$26,000

TABLE XXX

Cost comparisons, in gang-sawing marble, silicon carbide vs. sand, combined U.S. industry experience.

BURDEN ASSUMED $/Gang/Hr.	TOTAL BURDEN TO CUT BLOCK		BURDEN, $/Sq.Ft.		ABRASIVE COST $/Sq.Ft.		TOTAL COST, $/Sq.Ft.	
	SIC (32 hrs.)	SAND (64 hrs.)	SIC	SAND	SIC	SAND	SIC	SAND
1.00	32.00	64.00	.025	.050	.06	.026	.085	.076
2.00	64.00	128.00	.05	.100	.06	.026	.11	.126
4.00	128.00	256.00	.10	.200	.06	.026	.16	.226
6.00	192.00	384.00	.15	.300	.06	.026	.21	.326
7.75	248.00	496.00	.194	.388	.06	.026	.254	.414
8.00	256.00	512.00	.20	.40	.06	.026	.26	.426

Source : Tysaman Machine Company, Knoxville, Tenn.

Basis : Block 8' long x 4' high sawed with 40 blades.

The cost per sq.ft. would thus be $.08 on tile and $.052 on furniture/fireplace material.

Among other expendables, purchases will be required on a replacement basis for circular saw blades, diamond saw teeth, grinding/polishing faces, and parts replacement. The anticipated costs of servicing each line are $20,000, or $.02 per sq.ft. on tile and $.04 on furniture/fireplace. These provisions are expected to cover all contingencies.

In production materials, three expenses will arise. The chief cost will be purchases of silicon carbide as gang-saw abrasive compound. The estimated 'charge' per block will be 300 lbs. on tile slabs and 150 lbs. on the thicker furniture/fireplace slabs. At $.40 per lb. (delivered) and 2,000 wq.ft. slab area and 1,000 sq.ft. on tile and furniture blocks respectively, the unit costs will be $.06 per sq.ft. in both products. Total annual consumption will be:

FLOOR TILE:	.15 lbs. x 1,000,000 sq.ft.	=	150,000 lbs.
FURNITURE :	.15 lbs. x 500,000 sq.ft.	=	75,000 lbs.

The total annual cost will be 225,000 lbs. x $.40, or $90,000.

This cost of $.06 per sq.ft. has also been determined through industry experience, and recurs despite the variations in total sawing cost 'burden' at industry plants. The experience is summarized in Table XXX.

The second material cost will be in polished compound, required on both lines. The annual consumption per line is reckoned as equivalent (while surface sq.ft. in furniture is one-half that in tile, the edges must also be polished), at 40,000 lbs. Cost per lb. delivered is $.42 1/2 or $17,000 per line - or with freight allowance, landed at $20,000. Unit costs will be $.02 on floor tile and $.04 on furniture/

fireplace, and annual cost will total $40,000.

The third requirement is in packaging materials. All dimension output is proposed as packed in cartons - '10 pack' (or 10 sq.ft.) in tile; separate box cartons for furniture slabs: and 'packaged' fireplace units. In tile, at 10 per carton, 100,000 package units will be required, or assuming $.10 per carton, a total cost of $10,000 or $.01 per sq.ft. The carton cost per sq.ft. in 3/4" material is expected to be proportionately higher, and is reckoned at $.05. Total cost will be $35,000.

In production services, water and electricity consumption have only been crudely calculated and applied against current rates at Ely. With fuel and other services, utilities expense is not expected to exceed $30,000 a year. For maintenance/repairs costs (other than those previously cited), an allowance of four percent of equipment capital cost is made, or $20,000. The service overhead 'budget' is thus taken at $50,000 per year, distributed equally between the two product areas. Unit costs will be $.025 on tile and $.05 on furniture/fireplace material.

The pro rata charge for the net proceeds tax is added after all other costs have been computed, and net income before federal U. S. income tax determined. Tax returns must be made to the state semi-annually, on the same basis as tax on any other form of property. As a number of separate valuations will enter in to the tax base, the actual rate will have to be negotiated with the Nevada Tax Commission.* For

* Discussions were held in Carson City with officials of the Nevada Department of Finance, and the project will find the general tax climate extremely favourable. For a general guide, see Nevada Department of Finance, "Assessment and Taxation of Net Proceeds of Mines." Virtually all possible costs are permitted as legitimate deductions, and as a property tax, the basis appears very fair.

purposes of analysis, this rate is assumed to be the maximum rate (taken without prejudice), or five percent of net proceeds of $500,000 on dimension output, or $25,000 - divided equally between the two product areas. Unit costs will be $.025 on tile and $.05 on furniture/fireplace.

The overhead costs in dimension product output may now be tabulated on annual and unit bases. The annual estimates are included in Table XXXI. The unit cost breakdown may be summarized as:

COST TYPE	COMMODITY/ SERVICE	UNIT COSTS PER SQ. FT.	
		FLOOR TILE	FURNITURE
EXPENDABLES	Gang blades	$ .07	$ .042
	Gang parts	$ .01	$ .01
	Line expense	$ .02	$ .04
MATERIALS	Silicon carbide	$ .06	$ .06
	Polish compound	$ .02	$ .04
	Packaging	$ .01	$ .05
SERVICES	Water rates	$ .015	$ .03
	Electricity/fuel		
	Maintenance	$ .01	$ .02
	Net Proceeds Tax	$ .013	$ .025
TOTAL OVERHEAD COSTS:		$ .228	$ .317

Other Product Overhead Costs

Overhead costs will not arise to the same extent in the split-face and crushing/grinding plants. Neither unit requires heavy expendable purchases, and little materials cost. Service expenses will be moderate, and the effect on the net proceeds tax will be slight.

The principal expendable costs will arise in replacement purchases. While made of strong alloy steel, the split-face splitter blades and scoring faces will wear gradually. Fork-lift pallets will be required for shipping, and occasional machine parts replaced. An annual provision of $1,500 should be more than adequate. In the crushing/grinding plant, replacement from time to time will be required for jaws, screens,

washing unit pipe, and grinding balls. A maximum annual allowance would be $5,000.

No production materials expenses are anticipated for the split-face plant. The only anticipated expense at the crushing/grinding plant will be in packaging - preferably in 100 lb. capacity multi-wall sacks. This cost will be assumed for total output, but may not be required in all products. Assuming a unit cost of $.04 per 100 lbs. the total annual cost would be $20,000.

In services, the split-face plant will require no water and electricity cost should not exceed $1,500 per year. The service budget for the crushing/grinding unit should be held to $5,000 a year. The net proceeds tax will not arise in initial output from the split-face unit. At a maximum five percent rate, a provision is made for the crushing/grinding plant of $2,500.

The annual and unit costs in each unit would be as follows:

COST AREA	SPLIT FACE		CRUSHING/GRINDING	
	Annual	Per Ton	Annual	Per Ton
EXPENDABLES	$1,500	$.375	$ 5,000	$ .20
MATERIALS	-	-	$20,000	$ .80
SERVICES	$1,500	$.375	$ 5,000	$ .20
NET PROCEEDS TAX	-	-	$ 2,500	$ .10
TOTALS:	$3,000	$.75	$32,500	$1.30

The annual costs are included in Table XXXI.

Operating Costs: Fixed

The two fixed costs arising from the project - depreciation allowance and interest on borrowed funds - will be taken in combination.

Both costs cannot be determined precisely without negotiation: depreciation with the U. S. Internal Revenue Service, and interest with lending institutions.* Discussions of a general nature have been held in each case, and the results are sufficient to permit working estimates.

Dimension Fixed Costs

The weight of project fixed costs will fall on dimension output. The plant accounts for more than 75 percent of annual depreciation, and the bulk of annual interest costs. The depreciable assets arising against each product area may be taken as follows:

ASSET	PRODUCT AREA		TOTAL
	Floor Tile	Furniture	
BUILDING	$ 75,000	$ 75,000	$150,000
EQUIPMENT	$212,485	$133,435	$345,920
INSTALLATION	$ 50,000	$ 50,000	$100,000
TOTALS:	$337,485	$258,435	$595,920

A number of methods are permitted in calculating annual depreciation - with the straight-line and declining balance methods cited as most prevalent. For simplicity, the straight-line method will be adopted throughout in this analysis, and is recommended in practice for the project for each flow generation for sustained expansion. As to depreciation rates, five percent a year will be taken on building and 12.5 percent a year on combined equipment/installation (i.e., plant)

* Discussions of an information nature were held with the U. S. Internal Revenue Service, San Francisco, and forms and documents obtained. More detailed interviews were conducted with the First National Bank of Nevada, Reno; and the Bank of America, San Francisco. The First National of Nevada is recommended as the primary source of borrowed funds.

cost. The results are as follows:

ASSET	PLANT PRODUCT AREA		TOTAL
	Floor Tile	Furniture	
BUILDING	$ 3,750	$ 3,750	$ 7,500
EQUIPMENT	$26,650	$16,680	$43,330
INSTALLATION	$ 6,250	$ 6,250	$12,500
TOTALS:	$36,650	$26,680	$63.330

The unit costs in depreciation would thus be $.037 in floor tile and $.053 in furniture/fireplace material.

The calculation of interest depends on the application on funds as well as on effective interest rates. As to rates, six percent per annum will be assumed on the $500,000 issue of debenture (or secured mortgage) bonds, and eight percent on working capital loan of $300,000. In the debenture issue, $200,000 will be applied to each product 'line'. In working capital, run-in and development/inventory costs are expected to be higher in furniture/fireplace output vs. floor tile in a 2 : 1 ratio - or $200,000 in furniture vs. $100,000 in floor tile. The annual interest costs would thus be as follows:

SOURCE OF FUNDS	PLANT PRODUCT AREA		TOTAL
	Floor Tile	Furniture	
DEBENTURE	$12,000	$12,000	$24,000
WORKING	$ 8,000	$16,000	$24,000
TOTALS:	$20,000	$28,000	$48,000

The unit costs per sq.ft. would then be $.02 in floor tile and $.056 in furniture/fireplace material. The total fixed cost component of unit operating cost would then be:

COST AREA	FLOOR TILE	FURNITURE
DEPRECIATION	$.037	$.053
INTEREST	$.02	$.056
TOTALS:	$.057	$.109

These estimates will be carried into calculations total unit cost.

Other Product Fixed Costs

The split-face plant is assumed to be installed through equity capital, and will not be subject to interest. Depreciation will fall on the $35,000 worth of equipment - taken at 15 percent straight line - and will amount to $5,250 a year, or $1.06 per ton.

In the crushing/grinding plant, equity financing is assumed at $100,000 of installed cost, and debenture funds for the remaining $100,000. Annual interest at six percent would be $6,000. No working capital provision from borrowing is anticipated.

As in the dimension plant, the building for depreciation is taken at five percent, and the equipment at 12.5 percent. The results are as follows:

ASSET	VALUE	ANNUAL RATE	ANNUAL DEPRECIATION
BUILDING	$ 50,000	5 %	$ 2,500
CRUSHING UNIT	$ 75,000	12.5 %	$ 9,375
GRINDING UNIT	$ 75,000	12.5 %	$ 9,375
TOTAL:	$200,000	10.1 %	$21,250

The combined fixed costs would then be $26,250, or $1.05 a ton,

equivalent to the split-face fixed cost. The two estimates will be carried into final tabulations.

Operating Costs: Administration/Sales

The final component of operating cost is administrative and sales expenses. Under administration, all salaries (except labour and sales) will be taken with all elements of office/overhead expense. Sales costs will include salaries (or commissions), office expense, and promotion/advertising/marketing expenses, including travel. As distributors are assumed in project merchandising, no deductions will be made for manufacturers' agents commission.

The chief administrative cost will be salaries. Excluding sales staff, the salaried personnel of the project at the outset are assumed at nine persons - a president, production manager, secretary/treasurer, and their office staff. The sales manager and staff will be accounted separately, but at five persons, bring the total to 14. The breakdown and salary costs are as follows:

POSITION	SALARY	TOTAL
PRESIDENT	$ 16,000	
Secretary	$ 4,800	$ 20,800
MANAGER, PRODUCTION	$ 13,500	
Secretary	$ 4,000	$ 17,500
MANAGER, SALES	$ 13,500	
Secretary	$ 4,000	
Sales Representative	$ 9,000	
Sales Representative	$ 7,500	
Stenographer	$ 3,600	$ 37,600
SECRETARY/TREASURER	$ 12,500	
Accountant	$ 7,500	
Payroll/Personnel Clerk	$ 5,000	
Stenographer	$ 3,600	
Stenographer	$ 3,600	$ 32,000
TOTAL:		$107,900

The administrative cost component in total salary expense would be $70,300.

Further costs would arise in office overhead/expense. Office 'rent' must be charged, whether staff leases space or occupies a part of the project's building. Utility expense (light, heat, telephone, telex), employee benefits (pension, medical, etc.), and office equipment/supply costs must be charged. A travel budget should be provided, and legal/audit fees allowed. Certain costs will arise in the publication of annual reports, information to shareholders, and annual meetings. Directors of the Board must be permitted an honorarium; a provision made to the Chairman; and costs of directors' meetings included. A provision should be made for industrial and scientific research. The breakdown would be as follows:

COST ITEM	BASIS	ANNUAL COST
Office 'Rent'	1,200 sq.ft. @ $4.50	$ 5,400
Utilities	$150 month x 12	$ 1,800
Employee Benefits	5 % of total salaries	$ 3,500
Office Equipment	Annual amortization	$ 3,000
Office Supplies	$300 month x 12	$ 3,600
Legal/audit fees	$1,800 x 2	$ 3,600
Travel/Conventions	Excluding sales	$ 3,500
Directors' Fees	Chairman + 6 Directors or 6 x $100/month + 1 x $250/month	$10,200
Shareholder costs	Annual report/meeting	$ 1,200
Research Provision	Industrial/scientific testing and studies	$15,000
Contingency Reserve	Misc. travel, etc.	$10,000
TOTAL:		$60,000

The combined costs of salaries and overhead/expense total $131,108 - or for simplicity, $132,000 - and represent 5.5 percent of annual sales

revenue and 7.2 percent of total cost.

The sales expense will consist of salaries, office overhead, travel costs, and promotion/marketing expenses. Salaries will be taken as cited; office rent/utilities/equipment/supplies will be taken on the same basis as administration; and maximum probable allowance for travel/promotion. The annual cost would be approximately as follows:

COST AREA	BASIS	ANNUAL COST
SALARIES	As cited	$37,600
OFFICE	Pro rata admin.	$ 9,600
TRAVEL	$6,000 per man	$18,000
PROMOTION	Brochures/advert. Trade shows, etc.	$25,000
MARKETING	Special efforts	$ 5,000
TOTAL:		$95,700

Total sales cost will be taken at $96,000, or four percent of annual revenue and 5.5 percent of cost.

The combined administrative/sales costs of $228,000 should now be distributed among the various product areas. This will be done on a pro rata basis according to annual sales volume. In each case, the standard proportion of annual revenue will be taken. The results are based on the Table XXI annual revenue summary, and are as follows:

PRODUCT AREA	ANNUAL SALES	ADMIN. EXPENSE	SALES COST	TOTAL COST
Floor Tile	$1,000,000	$ 55,000	$40,000	$ 95,000
Furniture	$1,000,000	$ 55,000	$40,000	$ 95,000
Split-Face	$ 100,000	$ 5,500	$ 4,000	$ 9,500
Crushed/Ground	$ 300,000	$ 16,500	$12,000	$ 28,500
TOTALS:	$2,400,000	$132,000	$96,000	$228,000

The unit cost calculation may be made on the same basis. The breakdown would be as follows:

PRODUCT AREA	UNIT	ADMIN. EXPENSE	SALES COST	TOTAL COST
Floor Tile	SQ.Ft.	$ .055	$ .04	$ .05
Furniture	Sq.Ft.	$ .11	$ .08	$ .19
Split-Face	Ton	$1.375	$1.00	$2.375
Crushed/Ground	Ton	$ .66	$ .48	$1.14

The summary of total annual and unit costs may now be made, and cost estimates correlated with annual/unit revenue estimates to yield assessments of project profitability.

Project Costs: Total

The total annual cost of the project is the sum of all the foregoing operating factors. The total is reckoned at $1,915,740. Tabulated by cost are product areas in Table XXXI and it is distributed as follows:

PRODUCT AREA	ANNUAL COST	PERCENT OF TOTAL
Floor Tile	$ 804,000	42.0 %
Furniture/Fireplace	$ 708,500	37.0 %
Split-face Brick	$ 130,240	6.9 %
Crushed/Ground	$ 271,000	14.1 %
TOTAL:	$1,913,740	100.0 %

These estimates* should be converted into a unit cost basis, and

* These estimates are bases on maximum allowances throughout, and will permit a moderate inflation in wage/material costs. Basis of 1968 is assumed.

TABLE XXXI

Total annual costs, by product and cost areas, Nevada marble project, 1968.

COST AREA	PROJECT PRODUCT AREAS				TOTAL ANNUAL COST	PERCENT OF TOTAL
	Floor Tile	Furniture	Split-Face	Crushed/Grnd.		
RAW MATERIAL*	$168,000	$141,000	$ 59,800	$145,000	$ 513,800	26.8 %
DIRECT LABOUR	$256,000	$259,500	$ 53,680	$ 38,750	$ 607,930	31.8 %
OVERHEAD	$228,000	$158,500	$ 3,000	$ 32,500	$ 422,000	22.1 %
FIXED COSTS	$ 57,000	$ 54,500	$ 4,240	$ 26,250	$ 141,990	7.4 %
ADMIN./SALES	$ 95,000	$ 95,000	$ 9,520	$ 28,500	$ 228,020	11.9 %
TOTAL COSTS**:	$804,000	$708,500	$130,240	$271,000	$1,913,740	100.0 %

* Raw material costs include quarry labour, overhead, fixed costs, etc. on consolidated basis. For labour segregation, see Table XXIX.

** Certain annual costs will vary very slightly from estimates used in text due to correlation with computed unit cost estimates. These errors are insignificant, and may be ignored.

matched against unit prices to yield an assessment of cost feasibility. The unit results by cost areas are given in Table XXXII and may be summarized as follows:

PRODUCT AREA	UNIT PRICE	UNIT COST	NET BALANCE	COST AS % OF PRICE
Floor Tile	$ 1.00	$ .804	$ .196	80.4 %
Furniture	$ 2.00	$ 1.417	$ .583	70.9 %
Split-Face	$25.00	$32.56	-$7.56	130.2 %
Crushed/Ground	$12.00	$10.84	$1.16	90.3 %

The cost/price ratios (calculated before income tax) have a direct impact on product and project feasibility. The disparities in these relationships are immediately obvious, and comment is required.

The first disparity is the cost/price ratio on floor tile vs. furniture/fireplace material. Two factors have led to this gap:

(i) Higher relative raw material costs.

(ii) Higher relative overhead costs.

The greater 'block' cost in floor tile is due to higher material 'loss' in sawing 1/2" vs. 1" slabs - a loss that is unavoidable. This gap of 5.4 cents will be reduced somewhat by a factor previously ignored (because of a certain unpredictability in block size and shape) : the higher by-product recovery in block 'waste' in the gang-saw operation where five gang-saws will be devoted to tile slab output and only three to furniture/fireplace. Since this waste will be 'sold' to the crushing/grinding plant,the net returns in tile raw material will be somewhat higher.

The higher overhead costs in tile output are due again to the gang-

TABLE XXXII

Total unit costs, by products and by cost areas, Nevada marble project, 1968.

COST AREA	FLOOR TILE	FURNITURE	SPLIT FACE	CRUSHED/ GROUND
RAW MATERIAL :				
Direct Cost	$.194	$ .334		
Less By-Product 'Sales'	-.026	- .052	$14.95	$ 5.80
Net Cost	$.168	$ .282		
DIRECT LABOUR	$.256	$ .519	$13.42	$ 1.55
OVERHEAD	$.228	$ .317	$ .75*	$ 1.30
FIXED COSTS	$.057	$ .109	$ 1.06	$ 1.05
ADMIN./SALES	$.095	$ .190	$ 2.38	$ 1.14
TOTAL COSTS :	$.804	$1.417	$32.56	$10.84

* This cost is arbitrarily low, and ignores the cost of blades and diamond saw teeth for the split-face unit gang-saw, totalling $5,000. As the life of these components will exceed one year, they are not taken as 'expendables' in normal overhead costs, and are assumed to be an initial capital cost (specifically included in the 'pilot plant') financed through equity capital. The 'true cost' of split-face overhead in subsequent years would be $2.00 per ton.

sawing process in which a greater amount of abrasive compound (i.e., silicon carbide) and saw blades as expendables will be required vs. furniture/fireplace. The smaller thickness of the tile slab prevents reduction in this overhead cost.

Nevertheless, the tile line represents an economic undertaking. Indeed, the costs cited throughout in both dimension product areas are charged with equivalent administration/sales costs (despite the more complex and varied markets for furniture material), further savings in tile output may result.

The second disparity is in the cost/price relationship in crushed/ground output, offording a pre-tax return of only 9.7 percent. While costs (especially raw material cost) may well be less than the maxima taken, the chief cause in this relatively low return is the initial annual output level of 25,000 tons. As the plant itself is designed for an annual capacity of 250,000 to 300,000 tons - and can operate at this level on the labor basis cited - unit costs will fall as annual output is increased. This probability of increased output is accounted in the Section IV estimates of future profitability, and combined with selective future price increases, makes the plant a viable undertaking.

Moreover, it will be recalled that a part of crushed/ground raw material cost lies in 'purchases' of slab waste from the dimension plant. Were this recovery not available, the cost of this waste would have to be charged back to tile/furniture output - at $ .026 and $ .052 respectively. The plant is thus important to the integrated operation.

The greatest disparity lies in the negative costs os the split-face unit. This total cost of $32.42 per ton - resulting in a unit 'loss' of $7.56 - is to a certain extent arbitrary. Nevertheless, the

installation and operation of the unit (even on this 'loss' basis) is still recommended, for it is cheaper to implement it than to eliminate it from the project.

The reasons are as follows:

First, the largest single cost in split-face is raw material at $14.95 per ton. This cost reflects the variable costs of dimension block output (for what was termed the 'fifth' or reject block per day for the quarry). This is not a 'fair' cost. Nevertheless, were it not recovered the costs of dimension output would be inflated; and could not be recouped in 'sales' to the crushed/ground plant at $5.80 per ton. The net benefit to the project (after deducting the $7.56 'loss' per ton in split-face output) is thus $7.39 per ton. This is the 'saving' that results from finding an alternative use for this raw material.*

Second, the split-face unit is charged with maximum labour costs of $13.42 per ton on a year-round basis. Again, this estimate is arbitrary: the use of idle quarry personnel during winter months has been awarded the crushing/grinding plant (with subsequently lower unit labour costs). It is quite possible to operate the split-face unit on a partial year basis, rather than the crushing plant, but no gain to the project would result.

Within the context of the integrated project, the split-face unit

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* The diversion of split-face raw material to the crushing/grinding plant instead would have the following results:

Raw material cost:	$14.95 - $5.80 =	$9.15
Plant unit profit:	$ 1.16 - $9.15 =	- $7.99

This course would be more expensive to the project by $.60 per ton.

can still absorb these relatively high costs, and yield a net saving to the enterprise as a whole. The overwhelming probability remains, however, that the $7.56 per ton 'loss' will be temporary - likely no more than two years in duration. Two factors would convert this loss into a net return:

(i) An increase in per day output on a year-round basis, over the estimated 16 tons/day.

(ii) An increase in unit prices over the cited $25.00 per ton.

It is estimated that the 'break-even' point at the $25.00 price level is 12,000 tons per year. With aggressive market/product development, this level should be achieved within two years. The effort is proposed rather than an immediate price revision to $35.00 a ton since (for all practical purposes) the product has not been available in the region, either in quantity or at an economic price. As shall be suggested in Section IV, the growth potential in split-face brick - on both a volume and price basis - is extremely favourable. Given time and effort, the unit will become an important contributor to project profits, and should be included at the outset.

PROJECT TOTAL COSTS: PROFIT SUMMARY

To conclude this section, total annual costs can be included in a preliminary project pro forma to yield an estimate of net profit after all expenses, including taxes. This pro forma is offered as Table XXXIII and has been developed along conventional lines.

The three classifications of 'profit' that may be cited are:

(i) Operating profits before deduction of depreciation, interest, and pre-income taxes.

(ii) Net profit after these 'fixed' expenses but before income tax.

TABLE XXXIII

Preliminary pro forma, profit and loss account, Nevada marble project, 1968.

INCOME FROM SALES :			
Floor tile - 1,000,000 sq.ft. @ $1.00	:	$ 1,000,000	
Furniture/fireplace - 500,000 sq.ft. @ $2.00	:	$ 1,000,000	
Split-face products - 4,000 tons @ $25.00	:	$ 100,000	
Crushed/ground products - 25,000 tons @ $12.00	:	$ 300,000	$ 2,400,000
EXPENSES FROM OPERATIONS :			
Wages and salaries, total payroll	:	$ 823,570	
Materials and supplies purchased	:	$ 416,460	
Services, incl. freight/maintenance expense	:	$ 253,370	
State taxes, royalties and other undistributed costs	:	$ 77,510	- $ 1,570,910
GROSS OPERATING INCOME :			$ 829,090
PROVISION FOR FIXED EXPENSES :			
Depreciation on fixed assets, total	:	$ 104,830	
Depletion on mineral deposits	:	$ 115,000	
Interest on borrowed capital	:	$ 54,000	
Amortization, quarry development expense	:	$ 69,000	- $ 342,830
TAXABLE INCOME FOR YEAR :			$ 486,260
PROVISION FOR FEDERAL INCOME TAX :			- $ 226,900
NET INCOME FOR THE YEAR AFTER ALL DEDUCTIONS :			$ 259,360

(iii) Net profit after income tax, a residual that may be segregated into dividends to shareholders and retained earnings.

This classification is followed in Table XXXI. The important results are net profit before and after income tax, and these are developed here.

The pre-tax profit of the project is the residue of annual revenues less total costs, or:

Annual Sales Revenue	:	$2,400,000
Less Total Annual Cost	:	- $1,913,740
Pre-Tax Profit		$ 486,260

This sum of $486,260 is 20.26 percent of annual revenues. In terms of rate of return, it is equivalent to 27.0 percent on total invested capital (including working reserve), and 40.5 percent on fixed capital investment. As a typical criterion in corporate investment decisions is a pre-tax profit equivalent to 15 percent on sales, the project is seen to be immediately feasible.

This pre-tax profit becomes the taxable income of the project. Two U. S. tax rates apply to this income, derived from the basis of general U. S. corporations,* as follows:

A basic tax of 22 percent is levied on the first $25,000 of taxable income.

Above this amount, a 'surtax' of 26 percent is levied in addition to the basic tax, for an effective rate of 48 percent.**

* The basis followed is that outlined in Form 1120, "U.S. Corporation Income Tax Return - 1965", U.S. Treasury Department, Internal Revenue Service, and "Instruction for Form 1120 - 1965". Special reference should be made to forms under Code 1410, for corporations in the stone, sand, and gravel industries.

** There has been considerable discussion in government, financial,

Applying this computation to project taxable income, the net profit after tax would be:

TAXABLE INCOME :	$486,260	$486,260
PROVISION FOR INCOME TAX :		
$25,000 @ 22 %	- $ 5,500	
$461,260 @ 48%	- $221,400	- $226,900
		$259,360

The net annual income of $259,360 represents net profit of 10.8 percent on annual revenues. In terms of rates of return, it is the equivalent of 21.6 percent on fixed capital; 14.4 percent on total invested capital; and 25.9 percent on equity.

Against economic criteria, the project is regarded as feasible on all grounds.

While the project has the capacity to generate net profit at these ratios, and is taken as appropriate for equity investment and for the application of borrowed funds, all calculations in Sections II/III have been made on the basis of the first full fiscal year of operation. To the enterprise, a number of relevant considerations arise regarding financing; cash flow; expansion prospects; future profitability; and capital appreciation. These matters are dealt with in summary form in Section IV. Questions of a management/administrative nature - including senior personal, project development, distribution, and operating policies - are raised in Section V which concludes this report.

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and economic circles in the United States regarding the desirability of a corporation tax increase as a means of retarding inflation. At present writing, neither a decision nor a meaningful 'concensus' has emerged on this question. The likelihood, however, would appear to be no increase in present tax rates pending the 1966 Congressional elections, with a re-assessment in early 1967 leading to a maintenance of existing rates.