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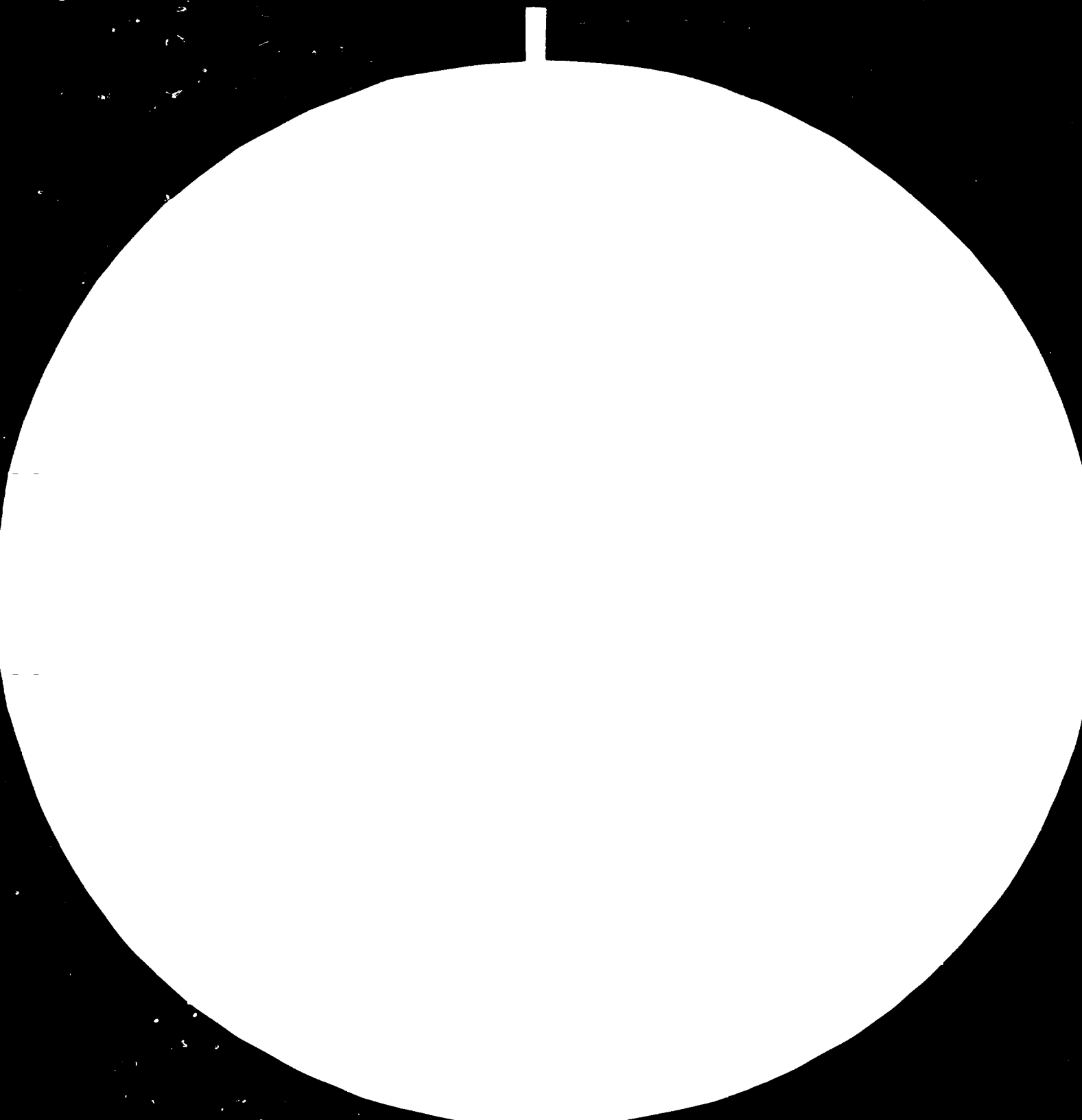
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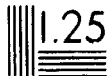
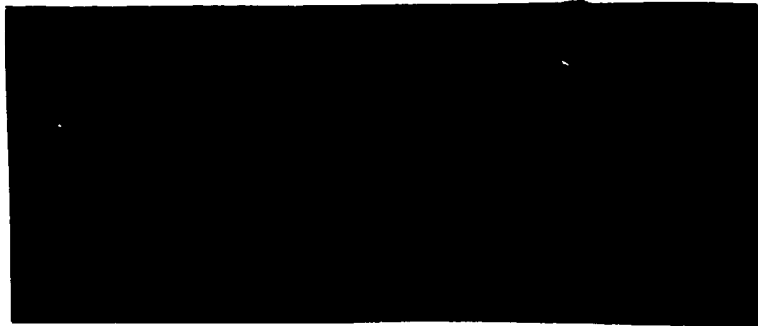


Figure 1. Resolution test targets. The resolution of the image is limited by the resolution of the test target. The resolution of the image is limited by the resolution of the test target.

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MINISTRY OF TRADE & INDUSTRY

Sierra Leone Government

FREE TOWN

STONE CUTTING
AND
POLISHING INDUSTRY

1918

11750

11 May 1982
English

DEVELOPMENT OF STONE CUTTING
AND
POLISHING INDUSTRY
IN SIERRA LEONE
SI/SIL/80/801/11.01/32.1.3

Technical Report

Prepared for the Government
of
Sierra Leone
By
The United Nations Industrial Development Organization
Executing Agency
for
U.N.D.P.

Prepared By Thomas Coleman

This report has not been cleared with the United Nations
Industrial Development Organization which does not, therefore,
necessarily share the views presented.

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Introduction

Stone is the most widespread natural building material available in Sierra Leone. at present. However, its use constitutes a negligible percentage of the building materials used in the country. Cement blocks which are mostly used in construction are manufactured from imported raw materials, resulting in a considerable drain on foreign exchange for the country.

Stone in situ is worth little. It is only when it is quarried and processed and sold that it becomes valuable. The Government of Sierra Leone through the Ministry of Trade and Industry realising the vast stone deposits which are available requested the assistance of UNIDO to establish a stone cutting and polishing industry for the country. Following this request I was selected by UNIDO to visit Sierra Leone and in co-operation with the Ministry of Trade and Industry to undertake the following:-

- (1) assess the availability, quality and development potential of local stone deposits within the country;
- (2) advise on the most important aspects related to the exploitation of the deposits such as extraction and processing technologies, utilisation and marketing;
- (3) prepare a plan for the future development of a stone cutting and polishing industry and the setting up of a pilot plant.

This exploratory mission lasted seven weeks and was carried out from 29th March to 16th May 1982. The Government assisted and co-operated in the mission through:-

- (a) Practical assistance from the Geological Department of the Ministry of Mines;

- (b) Counterpart staff to assist me during my mission;
- (c) Transportation;
- (d) Secretarial and administrative assistance.

The purpose of the Project was:-

- (a) To provide a building material which would raise the standard of housing by making available to a large part of the population durable local material at a reasonable cost.
- (b) To reduce the foreign exchange expenditures through substitution of imported building materials by local stone and to generate foreign exchange earnings through export of high quality stone.

During my mission I visited approximately twenty potential quarry sites throughout the country and examined the stone deposits. A number of these quarries had been worked previously to provide material for crushing purposes which was used mainly in the construction of major roads in Sierra Leone.

The sites visited proved conclusively that there is an abundance of first class rock available in the country ranging from Gabbro deposits in the Freetown area to granite deposits in the Bo and Makeni areas.

A list of the sites visited is attached as Annex I. During the mission it was felt that a small market survey should be carried out within the architectural profession to ascertain their re-action to the use of stone in the future. This exercise necessitated my contract being extended by one week. A list of the architectural firms visited and their views towards the use of stone is attached as Annex II.

I also had the assistance of Mr. Abdul Latiff - a Geologist in the Geological Survey Division in the Ministry of Mines and his report on the Geology of the country is attached as Annex III.

I have also prepared a list of basic equipment required to set up a small pilot plant capable of producing a range of products suitable for the building industry. This list together with the costings of same are attached as Annex IV.

In addition to this, an alternative list of equipment together with costings required to set up a larger manufacturing unit which will make a wider range of stone products available immediately is attached as Annex V. Serious consideration should be given to setting up the pilot plant based on the Annex V list as this plant will be capable of providing a wider range of materials, and will be capable of being worked as a commercially viable operation. It is strongly recommended that this plant be installed as the smaller type plant will only be sufficient for demonstration purposes, and would be really a waste of valuable money. A list of products which can be produced by the larger plant are outlined in Annex VI. This plant also has the advantage of being easily expanded to incorporate additional stone activities once the main plant is working successfully.

Annex VII provides a breakdown of the operational costs of operating the larger plant and also shows the revenue expected from sales of the various stone products. The total cost of running the project is estimated at Le95,000.00 and the sales revenue will amount to Le128,500.00 for the first year's operation.

The infrastructural items which will have to be provided are also detailed and it is most important that this work is undertaken immediately.

It is also important that an early decision be made on the type of machinery to be purchased and specifications and quotations should be sought without delay so that

orders can be placed for the selected machines as soon as possible. By adopting this procedure the machines will be available when the infrastructure is complete and there will be no delay between the completion of the infrastructure and the arrival of the machinery.

The potential contribution of a stone industry to the National Economy of Sierra Leone is considerable, since stone production, and especially stone utilization, is Labour intensive and energy saving. Low Cost Housing and buildings together with the possible export potential are additional factors to be considered in establishing a viable stone industry in Sierra Leone. Once the main pilot plant is set up and operating successfully other plants should be set up at some of the other quarry sites especially at Bo and the Makeni areas as these deposits look very attractive and should have a very good export potential.

Finally I would like to express my sincere thanks to the following people who were most helpful and gave me every assistance during my mission:-

1. Mrs. Mary Chinery-Hesse - Resident Representative, UNIDO
2. Mr. V.T. Collier, Deputy Secretary, Ministry of Trade and Industry
3. Mr. I.F. Contreras, Senior Industrial Development Officer
4. Dr. A.D. Monteiro, UNIDO, Chief Technical Adviser to Ministry of Trade and Industry, Team Leader.

Findings

A short tour of the country carried out to investigate the availability of stone clearly indicated that Sierra Leone is very rich in stone. Granite is the predominant stone available and occupies over half of the country. Large deposits of Gabbro and Laterite were also encountered in the Freetown area.

The use of stone in Sierra Leone at present is confined to aggregates for road surfacing and to manufacture concrete products. Stone was used in the past on a small scale basis for buildings and evidence of this can be seen on many buildings in Freetown where stone rubble has been used in conjunction with other materials. Construction of dwellings using stone exclusively is non-existent. However many of the churches in Freetown are constructed from solid masonry built as coursed ashlar. The stone used in these buildings is the red laterite material which has been dressed by hand and built in courses. The rubble type work which can be seen in the Freetown area is in the Gabbro material mainly and to a lesser extent laterite.

From the information available it is reasonable to assume that there were some first class stone masons in Freetown in the olden days. However the trade is now dead and a new beginning will have to be made to restore this trade.

Stone can be expensive or inexpensive depending on its location, use, availability and related factors. Maintenance costs of construction materials similar to stone and the foreign currency components of cement, make the use of stone attractive and provide economic benefits besides ease of maintenance, aesthetic satisfaction, strength, durability and export potential.

Stone is a material which can be utilized practically without waste, in all sizes, shapes and colours. Architects searching for new materials should be encouraged to use local stone in their quest for a national architecture.

Stone in modern day buildings is no longer a luxury material. Maintenance cost of plaster and similarly coated facades have become prohibitive, while techniques in use to-day have turned stone into a flexible and adaptable material.

Easily workable deposits suitable for dimension stone products were encountered in many areas throughout the country. A number of the quarries visited were used previously for providing crushed aggregates for making the main primary roads within the country. The stone was extracted by blasting.

This has caused considerable damage to the surrounding stone rendering it unsuitable for dimension stone purposes. These quarries could continue to be operated to provide crushed aggregate or random building rubble for house building, retaining walls landscaping or boundary walls.

Many of the sites visited contained large exposures of rock which have not been quarried previously. From these it is possible to select a number of sites where Pilot Plants could be set up successfully. Since the purpose of this mission was to investigate the possibility of setting up a Pilot Plant it was felt that in order for it to be a commercial proposition it should be set up close to where the main building activities are being carried out. For this reason a site was selected at Wellington on the outskirts of Freetown and it is recommended that the Pilot Plant be established on this site.

A brief market survey carried out with the architectural profession in Freetown showed that stone would be most popular if available at a reasonable cost. The architects expressed a tremendous interest in the use of stone and would willingly specify its use if it were available. It was discovered during this survey that there is a grave shortage of chippings and the setting up of a small crushing plant at the quarry could be a very lucrative proposition.

Sierra Leone unlike long existing stone producers has the opportunity to adapt the latest technological methods to local conditions and is less restricted by traditional procedures, Legislature or otherwise. Exploitation and development of quarries are basic requirements to convert the resources into negotiable commodities with fabrication and processing of second importance to raw material supply.

Besides research required to improve technology suitable for local conditions, the opening of other quarries and their subsequent development should be encouraged . The quarries being operated at present to provide stone for crushing have personnel employed who are experienced in quarry techniques such as drilling and blasting. However the extraction of blocks for dimension stone will require a certain amount of training and specially selected persons should be sent to an existing quarry in Europe where this type of operation is carried out.

Recommendations For Setting up and
Operating a Pilot Stone Cutting Plant

Having carefully examined the various deposits of granite available within the country and following a number of discussions with representatives from the Ministry of Trade and Industry together with private entrepreneurs a commercially viable stone-cutting and Polishing plant should be established as soon as possible. I feel the following approach should be adopted. It is important that this venture be undertaken as a private enterprise to ensure its successful operation. A number of discussions and meetings took place during my mission with private business people who have agreed in principle to form a company to undertake the extraction and manufacture of Dimension stone products for building and monumental purposes in Sierra Leone and to operate the plant as a pilot project to demonstrate that local stone can be utilised for a variety of different uses within the building industry and save valuable Foreign Exchange

These business people have also agreed to provide the infrastructure items required to set up a pilot plant.

Objectives

The objective of this project will be to extract deposits of natural granite at Wellington near Freetown and manufacture a range of products for local building and monumental purposes.

Products

Initially the products will be geared towards the building industry and the main products available will be sawn granite slabs 35/40mm thick which can be used for sawn or honed paving and treads, paving setts for

pavements, polished slabs for wall cladding and crazy paving. In addition to this the following items will also be available. Random building rubble, Dressed Ashlar, sawn granite and Laterite Blocks, Granite Bricks. Supplies of polished slabs will also be available for the monumental trade.

Markets

A brief survey carried out during my mission with architects in the Freetown Area confirms that once stone becomes available it will be incorporated by the architects in their building designs. This will mean that the total output of stone products produced by the Pilot Plant will be absorbed by the local market. Further expansion can involve the development of a monumental business by installing a sandblasting machine to cut inscriptions and designs on headstones. The present shortage of granite chippings could be another area of development by installing a small crushing plant to provide chippings to meet the shortfall in present supplies. This would also be beneficial to the quarry operation as the waste from the quarry could be utilised for crushing. Once the quarry operations are well established export markets could then be investigated for sawn or finished granite.

Employment

It is envisaged that twenty people will be employed initially. However as the business expands so also will the number of people employed. A detailed breakdown of the proposed labour force is shown in Annex VII together with details of operational costs, and sales revenue which will accrue from the sale of the various stone products.

Training

Two people should be selected for training immediately the company is formed and work has commenced on the infrastructure. These will be sent to an existing stone

firm in Europe for three months training which will cover all aspects of stone and quarry technology. When the machinery arrives and is ready for erection a quarry supervisor should be recruited preferably from the quarry where training took place to assist and direct the installation of the machinery.

He should then remain on for a period of 3 months total to provide additional training to the local operatives. This will eliminate the necessity of a stone expert for a 6 month period.

Instead the Expert can make a short visit 2/3 weeks when the machinery has arrived to organise its installation. A further short visit should be made by the stone expert 3 months later to enable him assist the company with office and sales procedures and also to help promote the sale of the stone within the building industry. He would also be available at this stage to solve any teething problems which might arise.

Plant & Machinery

The Plant and Machinery should be carefully selected to suit the purpose for which it is intended. If possible similar machines should be inspected in action before a final decision is made. However it is vital that a decision is made as early as possible so that orders can be placed with the suppliers to avoid delays with the arrival of the machinery. A small stock of essential spares should also be ordered so as to avoid any delays should a breakdown occur. Most of the hand tools such as shovels, picks, sledges, hammers, punches wedges, chisels crowbars, levers etc. can be manufactured locally in the National Workshop.

Market Potential

Architects should be encouraged to use stone in all new office developments, especially in the entrance lobbies where granite paving and cladding would provide an excellent finish which would be easy to keep clean.

The use of Granite Rubble should be encouraged for house building and boundary walls and landscaping. The Ministry of works should commence a programme of repairs to footpaths within the Freetown area, using granite setts which will give a permanent finish.

House builders should be encouraged to use Dressed and Sawn Ashlar in house construction and should also use sawn paving for internal floor finishes. The granite crazy paving will provide a hard wearing and attractive finish for external patios, footpaths and driveways. Granite bricks can be used for internal and external feature walls.

When the plant is operational a small press reception would be arranged to which all architects, Quantity Surveyors and Building Contractors are invited, for briefing details on the range of products which will be available. The use of slides showing photographs of the various finishes and should be considered seriously when this stage of the project is reached.

Brochure

The present allocations of money for producing a stone Brochure should be used to purchase additional machinery, as the production of a stone Brochure is of no benefit to setting up a pilot plant which will be commercially viable. Once the plant is operating successfully a simple tyre Brochure which can be used for sales promotion can be produced.

Conclusions

In conclusion I would strongly recommend that this project be carried out in accordance with the attached "Project implementation programme attached as Annex VIII. If this programme is maintained the first Pilot Plant for stonecutting and polishing in Sierra Leone will be in commercial production in May 1983.

Size And Ownership of Pilot Plant

The question of the size and ownership of the proposed Pilot Plant was discussed at great lengths with knowledgeable people and senior Government officials. On the basis of these discussions and the examination of the existing situation and circumstances in the country, the Consultant is of strong view that the Pilot Plant should be of a small size, but it must be technically viable and commercially feasible. Its demonstration features should convince prospective investors that they can successfully establish a small-scale unit of the size and technological characteristics of the Pilot Plant. Furthermore, the Pilot Plant should have all the elements to ensure its continued operation so as to provide confidence in prospective investors.

The issue of the ownership of the Pilot Plant is of crucial importance to primarily its establishment and its continued successful operation. Plants established under the ownership and management of the Government have operated for the time the technical assistance and operating finance was provided by the donors or the Government. They are lying idle since the withdrawal of technical assistance and finances from public funds. Such failures have created just the opposite effect on the confidence of the entrepreneurs compared to what the Pilot Plants are expected to do. The constraints of bureaucracy under which Government run Plants operate are not conducive to profitability and efficiency of such Plants. For the success of the Pilot Plant proposed in the Report, the availability of a quarry in Freetown, accessible road to the quarry, provision of a building, electric power connection and water supply at the site are basic pre-conditions. In addition, a sales organisation and ensured outlets for the finished products are equally important. The commitment for the successful operation of the Plant in view of its profitability will exist at the proposed site of the Pilot Plant. Therefore, the Consultant strongly recommends that the Pilot Plant

11(b)

be established in the private sector. The Government may participate in the Project through the National Development Bank. The equipment proposed for the Project from the UNIDO sources may be channelled through the Ministry of Trade and Industry and the National Development Bank to the Project. The cost of the equipment provided may be treated as a soft loan by the Government and the National Development Bank (NDB) to the Project. An interest of say 2% may be charged by the NDB to meet its administrative expenses to service the loan. Suitable repayment schedule may be established and the fund may be used by the Ministry, the NDB and the UNDP for putting up other Pilot Plants in the future.

ANNEX I
QUARRY SITES VISITED DURING
EXPLORATORY MISSION

(See attached Geological Map for site locations)

SITE NO. 1 - HAMILTON BEACH

Olivine Gabbro is the dominant rock type. The rock has closely spaced joints some of which have been intruded by fine grained dolerite dykes. This quarry is located on the sea shore and has a bad access road. A bungalow is also situated close to the quarry edge. This together with the fact that both the discontinuities and the irregularly oriented dykes make this quarry unsuitable for any large scale operations.

SITE NO. 2 - YORK BEACH

In this area coarse grained Gabbro with Bronzite-Pyroxene was found. The Bronze coloured Pyroxene gave the rocks a Bronze hue. Large Labradorite crystals gave a twinkling effect in areas immersed in water. Much of the outcrop in this area was in the form of loose boulders and as the site was within tidal limits the deposits will be covered during hours of high tide and would therefore be unsuitable for development purposes.

SITE NO. 3 - BIG WATER & KENT AREAS

At Big Water, Anorthosites variably weathered to bauxite blocks were encountered. The stream area itself has mainly loose boulders. Over the remainder of the area, the depth of weathering approached 30 feet and beyond Tombo exposures lay beneath a sandy over burden.

SITE NO. 4 - SONGO AREA

This site is poorly exposed lies 17 km east of Freetown. Pavement exposures over an area of 0.3 km² consist of Ijolite and derived Bauxite material. The Ijolite is massive, medium grained, dark grey with - elongated black Pyroxenes. The Cm-scale banding is due to variations in the ratio of Nepheline to diopsidic Pyroxene. Accessory minerals include magnetite and Zeolites. The greater of the body is at present covered by bullon group of sands to a depth of fifteen to twenty feet and its removal would prove costly.

SITE NO. - OCKRA HILLS

This hill is one of a series comprised wholly or mostly of amphibolites flanking the Kasila Group. The amphibolite is imperfectly segregated into light coloured quartzo-feldspathic bands and dark amphibole rich bands. Differential strength of the two bands has led to quartz rods and boudins. Furthermore tension joints infilled with quartz give the rocks an overall asymmetry. This quarry was used in the past for road construction but is closed down for some considerable time.

SITE NO. 6 - MAGBELE FERRY QUARRY

This quarry was originally used by "VIANINI" (an Italian Consortium) for road aggregates. The rock consists of garnetiferous - Gneiss. The main units are quartzo - feldspathic bands seperated from each other Pyroxene layer. Garnet porphyroblastz with poikiloblasts of quartz are scattered in the quartzo feldspathic bands, especially where necking has not taken place. The segregation lane represents the Plan of easiest parting. The rocks are extremely hard except at fault surfaces.

SITE NO. 7 - AUGEN GNEISS QUARRY

This quarry was originally worked by S.L.D.C. and belongs to deposited Paramount Chief. Modu eyed shaped feldspars (Augen) with equally large pyroxene grains are the dominant minerals in this basic gneiss. There is some layering and decrease in grain size upwards. The rocks were originally Leucogabbroic cumulate rocks. Tension joint and slip surfaces are factors against their use for dimension stone.

SITE NO. 8 - ROFANYA QUARRY (Lungi Road)

This quarry was worked by Whatney during construction of the Lungi airport and is now administered by the Ministry of works. The rocks are principally biotite granites of trondhemitic affinity with a light grey colour. Biotite defines a weak foliation which may not be discerned in a hand specimen. The rock has the look of reconstituted material of the type used for interior wall finishes. (Dr. Stuart's Hospital) aside the foliation there are no other joints or gashes and there is some degree of homogeneity in several selected samples. This quarry could be developed in the future.

SITE NO. 9 - MALEMPE QUARRY - After Mile 91
(Freetown-Kenema Road)

This Quarry is part of the Kaseww Hill formation which occurs in lenses up to 2 km thick within the Rokel River Group. The rocks are spillites of BASALTIC composition extruded in a subaqueous environment. They are fine grained and slippery but extremely hard. Epidotization, (the formation of epidote veins) post-dated the extrusion. This was followed by intruded quartz veins which in part followed the weak epidote veins. The veining together with numerous joints render the spillites unsuitable for dimension stone work. In addition to this, their dull grey-green colour militates against their use for decoration.

SITE NO. 10 - MOKILENDEH QUARRY

This exposure is situated at mile 140 just passed the village of MOKILENDEH on the Taiama - Bo Road. Principally the rocks are quartz - biotite granite - migmatites. Fresh samples could not be obtained and whole boulders at the top of the main dome were partially decomposed. Drilling would have to be carried out to establish the depth of weathering. There is a vast exposure of stone on this site and it is situated close to the main road. The stone tends to be white in colour. This site can certainly be considered for development as a dimension stone quarry in the future.

SITE NO. 11 - BLAMA - KENEMA

A large exposure of rock is visible all the way from MOKILENDEH to Kenema. The rocks are similar to the MOKILENDEH Quarry Rock but their scale and size are smaller.

SITE NO. 12 - BAMBAO - QUARRY (Old Chromite Mines)

The access road to this site is in bad condition. It is understood that the stone used in building the R.C. Cathedral and the Mobil Petrol Station in Kenema were collected from this area. The pits to the old mines have long been closed. Prospecting might reveal supplies of suitable rocks in the area but the cost of extraction and haulage would be prohibitive. It is reported that anthophyllite schists are to be found in the area.

SITE NO. 13 - MILE 91 MATOTOKA

This exposure is a large dome shaped grained body partially covered by Tussock Grass. The Rock is a pink/grey biotite-microcline granite. Patches of neosomes with large K⁺ feldspars suggests the rocks have undergone potassium metasomatism; accessibility to this site is difficult and would be a hindering factor in considering its use for development purposes.

SITE NO. - 14 - CHINESE QUARRY

This quarry contains a large exposure of pink porphyroblastic granite and is being operated at present to produce broken stone for foundations by the Chinese Company who built and operate the sugar cane factory close by. The granite contains microcline crystals which may be anywhere from 3 to 50 cm. The overall trend is of homogeneous patches within an homogeneous darker coloured matrix.

SITE NO. 15 - MAKENI AREA (Mile 108/9)

This quarry contains a very large exposure of rock. The exposure consists of a pink-grey biotite joints spaced at regular intervals which are ideal for ledging and drilling. Felled blocks on the quarry floor are suitable for primary sawing.

The extent of the quarry and the attractive colour of the granite suggests a possible long term commercial application with a good export potential. The quarry is easily accessible and there is no overburden clearance required.

SITE NO. 16 - KAMABAI

The exposures in this area stretch for a distance of 18 mile along the roadside from the outskirts of Makeni to Kamabai. Isolated plutons can be seen all along the roadside forming continuous hills and domes of granite. Granites in this area consist of Porphyroblasts of quartz, oligoclase and microcline in a medium to coarse grained darker matrix of the same minerals. These avoid porphyroblasts (3 to 5m length) contain little mafics chiefly biotite-mica and some accessory muscovite. Varieties exceptionally rich in muscovite and more intensely weathered. This area has tremendous possibilities and will make excellent site for setting up a dimension stone industry in the future.

SITE NO. 17 - WAMBA RIDGE QUARRY

This quarry is owned by the Ministry of Works and is operated at present by Abu construction of Germany since 1975. This is a vast quarry containing Gabbro deposits. The chief minerals are labradoite olivine and augite. Texturally the rock has a decussate texture, characterised by the random orientation of mineral grains over the whole face.

The material is extracted by blasting and drilling and crushed for concrete and road surfacing. A visual inspection of this quarry revealed that considerable damage has been caused to the quarry face due to blasting operations and it would be unsuitable therefore for block extraction for dimension stone purposes. This quarry would however be suitable for producing material for Rubble wall building and Ashlar Work. The chippings from this quarry are sold at 21.50 per ton and it employs 44 people.

SITE NO. 18 - WELLINGTON QUARRIES

This quarry is located on land owned by a Mr. Davis. The exposure is in the form of large hill consisting predominantly of olivine Gabbro outcrops. The rock is a melanocratic greenish holocrystalline olivine Gabbro. The Chief minerals are Labradorite olivine and Augite texturally the rock has a decussate texture characterised by the random orientation of mineral grains over the whole face. Joints and tension gaps are few. There are adequate supplies of stone here to set up a pilot plant. Infrastructure items such as power, water and buildings would have to be provided before the plant could be installed. This site was considered most suitable for the initial pilot plant as it has a good access road leading up to the quarry face, is close to Freetown where the main building activities are going on and is sufficiently iso-

lated so as not to interfere with the inhabitants of the area.

Mr. Davis has a small crushing plant at present in operation close to his residence and uses surface boulders to provide material for crushing.

SITE NO. 19 - LATERITE QUARRIES

These are found along the Freetown Waterloo Road at the Orugu River Bridge. They form surface capping to depths over 20 cm. at Orugu Bridge weathering of Gabbroic Rock has resulted in Pink Red Limonitic residue embedded in soft clayey matrix. Further down at Mile 9 from Freetown whole altered indurated boulders within lateritic matrix are found. The boulders are perforated with holes through which percolating water enter them to continue the leaching process.

SITE NO. 20 - FALSE CAPE QUARRY

This Quarry which is being operated at present consist of loose boulders. The boulders are broken down for crushing and the chippings are sold for building work and road surfacing. The finer aggregates and dust are used to manufacture concrete blocks for the construction industry.

SOME FIGURES
OF THIS DOCUMENT
ARE TOO LARGE
FOR MICROFICHING
AND WILL NOT
BE PHOTOGRAPHED.

ANNEX II

List of Architects, Engineers and Surveyors,
Builders etc. contacted during Market Survey.

<u>NAME OF COMPANY</u>	<u>REMARKS</u>
1. Mr. Jallo Jamboria Chief Architect, Ministry of Works Phone 40239.	Mr. Jamboria welcomed the idea of setting up a stone cutting industry in Sierra Leone. He would be very happy to use stone work if available and if the price was reasonable in the future.
2/ Turma Associates Architects, 26 Percival St. Phone 26048.	Since Mr. Jamboria is a partner in this practice the above remarks apply.
3/ Sierra Scan Cons- truction, Guy Street, Phone 22437.	Spoke to Miss Helena Ayeh in this office. She was very impressed with the idea of setting up a stone for the building industry. If this proves successful it will change the whole face of Freetown. She would be very happy to use stone in her projects of the future.
4/ OluWright &As- sociates Archi- tects & Town Planners 21 Charlotte Street, Phone 26699	Spoke to Mr. Nigel Wakeham who informed me that there was a major shortage of Granite aggregates at present. He stated that a number of projects were held up awaiting supplies of chippings for concrete.

He also was pleased to learn of the setting up of a stone cutting industry and would gladly use stone if available at a reasonable cost on his buildings.

5/ J.R. Jarrett-Yaskey
Architect,
23 Garrison Street,
Phone 25759

Mr. Jarrett-Yaskey said he proposed in a Report he prepared some years ago that stone be developed and stone cutting plants set up so as to make use of the beautiful stone which is readily available within the country. He was very pleased to learn of the Government's present proposals and would welcome the availability of stone so that he could design buildings that he can only dream about at present.

6/ Ed. Davies Associates, Consulting
Engineers,
17 Lab Lane,
Phone 30542

Spoke to Christo Forster. He felt that Stone would prove very attractive to Building Contractors and Architects.

7/ Mackenzie Studd &
Partners, Chartered
Quality Surveyors
2 Larina Sankoh Street,
Phone 23063

Spoke to Mr. Studd who is also the Senior Surveyor in the Ministry of Works. Mr. Studd felt that Stone could have a bright future if the cost can be kept at a reasonable level. He provided some guide prices for alternative building materials.

8/ S.E.L. Luke & Son Ltd.,
Building Contractors,
32 Syke Street,
Phone 40009

Spoke to Mr. J.R. Lasite Luke Managing Director who introduced his three sons. Mr. Luke is very interested in using stone for building purposes. He stated that some time ago himself and his son visited the States to inspect stone cutting equipment as they were interested in setting up a Stone industry mainly for the Export Market. However the investment involved was prohibitive. He was very keen on the idea of the stone industry and would be interested in getting involved in setting up a Business on a Partnership Basis.

9/ Arustan Stone Works
Monumental Stone
Works,
3 Hannah Benka-Coker
Street,
Phone 41473

This business is carried on by two Brothers Frederick and Christian Stanley. They both served their time as monumental Masons and have worked on natural marble. They expressed an interest in getting involved in a stone business & would be keen to be involved in a monumental section of the business. They felt they could secure orders and would be interested in discussing a working arrangement later.

ANNEX IIIGEOLOGICAL FORMATIONS OF SIERRA LEONE

BY

ABDUL LATIFF - GEOLOGISTGEOLOGICAL SURVEY DIVISION

The Geology of the country can be divided on a structural basis into a number of units, with a veneer of sediments along the coast.

The Granites

These being the largest of the units occupy over half of the country and are composed predominantly of granites with migmatites and enclosed metamorphites.

Two groups of granites are recognised: synkinematic (older) and late-kinematic or "younger granites". The synkinematic granites are migmatites with quartz-dioritic to granodioritic melanosomes and approximately granite neosomes.

The "younger granites" are demonstrably younger than the synkinematic granites and their enclosed metamorphites. They are most common around the margins of the sulo-group greenstone belts. Away from the schist belts, large massifs of fine grained granites such as the Tingi Hills, Loma Mountains and Kabala Hills are formed of late-kinematic granite. Small plutons and dykes are found over much of the granite terrain in the rest of the country.

The enclosed metamorphites in the granites are collectively called the Kambui super group. These schistose bodies make up the Sula Mountains, Kambui Hills, Nimini Hills, Loko Hills etc.

In general they graduate upwards from ultrabasic tremolite-talc-anthophyllite schists with relict igneous textures (pyroxenites) to amphibolites bearing vesicles or pillows.

The schist belts and the synkinematic granite constitute the basement complex which is thought to be the oldest unit over which others lie. Structures within this unit generally trend NE to NINE.

Three major units lie adjacent to the basement complex to the west. The structures within these units all have a general NNW trend which parallels the coastline. They form broad belts entering from Guinea in the north. The units are from west to east, the Kasila group, the Marampa group and the Rokel River group.

The Kasila Series

The Kasila group consists of a series of basic, granitic and met-sedimentary granulites flanked by Amphibolites. Much of the group is composed of fine to medium grained basic granulites containing minor horizons of quartz-magnetite, quartz-diopside and sillimanite gneisses. The west side of the group concealed by Phanerozoic epicontinental deposits consists of a gradational series from basic granulites to amphibolites and meta-sedimentary gneisses. Within the basic granulites along the whole length of the outcrop of the Kasila group occur 200m thick, layered anorthositic and leucogabbroic rocks, the metamorphosed equivalents of layered igneous intrusions.

Marampa and Rokel River Groups

The Marampa group is subdivided into a lower, Matoto formation consisting of pillow lavas, serpentinites and andesites; and an upper, Rotokolon formation consisting of psammites, pelites and magnetite-quartzite (Band Iron Stones).

The Rokel River Group is formed of highly contorted rudaceous, arenaceous, and argillaceous sediments with interbedded Kasewe Hills volcanics. The volcanics chiefly of interest are the spillites and keratophyres.

Several other small units are found scattered over the country. These include the Bagbe alkaline complex - composed of Grade A nepheline syenite. The saionyo - scrap series, the Songo Ijolites and the Freetown Basic intrusive complex.

The saionyo-scrap forms a small ingression into Sierra Leone in the north-west composed of horizontally bedded arkoses, grits, and shales, with intruded dolerite sills. The Songo Ijolite has the Ijolite-Melteigite range of rocks.

The Freetown igneous complex forms an intrusive body on the coast, with arcuate outcrop concave towards the west. It is composed of a layered complex of gabbro, norite, troctolite and anorthosites. The layering is almost horizontal and parallel with basal contact. Dips increase seawards.

The layering is divided into 4 main zones, the base of each zone is alone rich and the top anorthositic. Drill holes sited to examine the base of the complex revealed pyroxene amphibolites construed to be part of the Kasila group.

Dolerite dyke swarms cut all these formation and Kimberlite dykes occur in places in eastern Sierra Leone.

The coastal veneer of tertiary sediments (the Bullom group) consist of shallow water sands, silty clays and occasional thin argillaceous limestones, calcareous grits, carbonaceous clays and lignite.

ANNEX IVPILOT STONE CUTTING PLANTSMALL UNIT FOR DEMONSTRATION PURPOSES ONLYLIST OF EQUIPMENT REQUIRED

<u>QUARRY</u> (Equipment for stone Extraction)	<u>US \$</u>
1 Small Mobile Compressor diesel engine 48/60 H.P. @	12,000.00
1 No. Rock Boring Hammer Complete with Drill Bits	10,000.00
10 No. Sets of Plugs & Feathers	200.00
100 No. Hose & Fittings for Airlines	1,000.00
1 No. Set of heavy wedges 12 kg.	75.00
2 No. Crow bars approx. 12 kg.	150.00
4 No. Large Levers, approx. 7.5 kg.	150.00
4 No. Sledge Hammers 2/9kg.2/12 kg.	100.00
2 No. Hand Shovels	45.00
2 No. Picks	45.00
1 No. Small Winch	250.00
	<u>US \$ 15,015.00</u>
	15,015.00

FACTORY (Equipment for Cutting & Polishing)

1 No. Diamond Saw 700mm Diam Blade	25,000.00
1 No. Circular Diamond Tipped Blade	1,500.00
1 No. Jenny Lind Polisher	6,000.00
3 No. Sets of Segments for Granite	50.00
1 No. Small Splitting Machine	7,500.00
2 No. Sets of Blades	150.00
6 No. Punches & Chisels	50.00
Sundry items	500.00
	<u>US\$41,150.00</u>
	41,150.00
	<u>US \$ 56,165.00</u>

ANNEX VPILOT STONE CUTTING PLANTUNIT CAPABLE OF BEING COMMERCIALY VIABLEQUARRYLIST OF EQUIPMENT REQUIREDQUARRY (Equipment for stone extraction)

1 No. 250 C.F.M. Mobile compressor diesel engine 48/60 H.P.	Le15,000.00
2 No. Rock boring hammers complete with drill bits (tungsters tipped)	2,000.00
20 No. Sets of plugs & feathers	400.00
200 M. Lin. Hose & Fittings for airlines	2,000.00
2 No. Sets of heavy wedges 12 kg.	150.00
3 No. Crowbars approx. 12 kg.	225.00
6 No. Large levers approx. 7.5 kg.	225.00
6 No. Sledge hammers 3/9 kg. 12 kg	150.00
3 No. Hand shovels	67.50
1 No. Water Pump	400.00
4 No. Picks & punches	150.00
1 No. Small winch	250.00
1 No. Paving breaker & Chisels	500.00
1 No. Loader for lifting blocks & transport- ing stone to factory	10,000.00
1 No. Small mobile forge for sharpening tools	1,000.00
	<u>US \$ 32,517.50</u>

32,517.50

FACTORY

1 No. Primary saw. (wire saw)	15,000.00
1 No. Diamond saw with rise & fall faci- lities	30,000.00
2 No. Circular diamond tipped blades for granite	4,000.00
1 No. Jenny Lind polisher	7,500.00
3 No. Sets polishing segments	150.00
1 No. Small splitting machine	7,500.00
2 No. Sets of spare blades	150.00
1 No. angle grinder & supply of dises	250.00

C/F

28.

C/F

1 No. Large hand drill with hammer action	300.00
2 No. Small hand drills with hammer action	200.00
supply of drill bits	150.00
1 No. Small hand polisher	1,000.00
1 No. Small dolly machine for texturing	2,000.00
supplies of tungster tipped chisels & punches	1,000.00
Supplies of lubricants	1,000.00
1 No. Forklift truck	10,000.00
Sundry items	1,000.00

US \$ 81,800.00

81,800.00

Total cost of

Equipment = US \$ 114,317.50

= Le 137,181.00

ANNEX VIINTRODUCING SIERRA LEONEAN STONE

Natural stone is an excellent material for the expression of the architects individuality and indeed has no equal in man made products for appearance, durability and ease of maintenance. Stone is the material used by man since time immorial for work of a practical nature such as houses, buildings of worship and the expression of the arts. The Wonders of Greece and the Middle East bear witness to this fact. The stones of Sierra Leone are comparable to the best in the world.

Thanks to the foresight of the Government of Sierra Leone (through the Ministry of Trade and Industry) the architectural profession in Sierra Leone now have an opportunity of using native stone in their buildings of the future. Stone will be available initially in the following forms:-

- (a) Granite blocks sawn on six sides
- (b) Granite blocks sawn beds and joints
- (c) and having a split (concave - convex) face
- () Sawn paving slabs in fixed widths and random lengths
- () Paving setts with split edges
- (e) Random rubble walling
- (f) Coursed ashlar walling
- (g) Sawn steps
- (h) Granite bricks
- (i) Modular pattern ashlar

It is a wise architect therefore who plans for the future now by designing his buildings so as to make maximum use of natural stone in the construction. In addition to the fact that he is using a native material he is also doing away with much auxiliary and time consuming stages during building like form-making, casting and

scaffolding which add considerably to the costs.

The utilization of stone will also improve the balance of payment through import substitution (e.g. saving in cement) and the possible export of stone products. Another cost saving factor which the architect should consider is the low maintenance costs on a stone building. Most man made products require a high degree of maintenance whilst stone because of its durability requires only a periodic wash down with clean water to restore its original appearance.

Five reasons why you should use stones in buildings are:-

- (1) Stone is more beautiful
- (2) Stone is strong and more durable
- (3) Stone needs less maintenance
- (4) Stone renders buildings unique
- (5) Use stone in your buildings and make them beautiful and strong

Wellington Granite Building Blocks (A Home Produced Native Stone That Gives A Luxury Finish)

Product

Laterite and granite blocks sawn to sizes corresponding to the traditional dimensions of concrete blocks will shortly be available to the discerning house builder, architect and building contractor.

The granite will be produced from the Wellington range of quarries and modern techniques will enable the stone to be supplied for a range of uses after initial production gets under way.

The stone will be cut with an electric diamond saw using special diamond tipped discs, and can be supplied in a range of sizes to suit the particular project on hand.

Availability

Laterite blocks can be supplied in standard sizes of 18" x 9" x 6" and 9" x 9" x 6". All exposed faces, beds and joints will have a sawn finish and this will eliminate the necessity of providing special stones for quoins and return ends at door or window opes.

Split Faced Granite Ashlar walling with sawn beds

Wellington granite building blocks are also available for ashlar walling with sawn beds and joints and having a split faced finish on the front and back faces.

Split faced granite ashlar is a rough uneven and broken concave - convex finish produced by a guillotine splitting the stone at pre-determined heights of $2\frac{5}{8}$ ", $5\frac{5}{8}$ " and $8\frac{5}{8}$ ". The lengths will be as for sawn ashlar.

The maximum variation in face outside or inside the wall line will be approximately $\frac{3}{4}$ " in stones $8\frac{5}{8}$ " high. Being a natural material, the variation cannot be determined precisely, but will vary downwards as the stone heights decrease.

Paving

Sawn paving will be supplied in fixed widths up to a maximum of 300mm wide and length will be random. Thickness 40mm nominal.

Setts

Setts can be supplied with either a sawn finish or a rough finish. The sawn setts will have split edges. Rough setts will be roughly rectangular in shape and will be produced by hand.

Random Rubble Walling

This material is suitable for boundary walls and feature walls and for house building. The material which is produced by breaking large boulders into smaller pieces by blasting or sledging will be random shapes and sizes and will be nominal 9" thick on the bed.

Coursed Ashlar Walling

This material is produced by splitting large blocks with wedges. The pieces will be roughly rectangular in shape and will be nominal 6" thick. This material can be built in courses so as to achieve an ashlar pattern.

Sawn Steps

Steps can be supplied solid or in slabs to form a tread and riser. Finish will be diamond sawn.

Granite Bricks

Granite bricks will be produced by splitting sawn off-cuts on a guillotine. Bricks will be generally 40mm high and will be in random length.

Modular Pattern Ashlar (Snecked)

Alternatively blocks can be sawn to produce a modular pattern which may produce a more pleasing appearance. The modular pattern will be based on panels of 3.0 square and each panel will consist of the following number of sawn stones:-

7 No. Blocks	18" x 9" x 6" high
4 No. Blocks	9" x 9" x 9" "
4 No. Blocks	9" x 9" x 3" "
2 No. Blocks	9" x 9" x 6" ""

(Note: All blocks will be supplied less 3/8" in length and height to allow for beds and joints).

Finish

When supplied from the quarry the stone will have been freshly cut and over time will weather. Because of its consistent quality the Wellington stone blocks can be regarded as a most versatile building material in Sierra Leone and can be used in many forms of building development in this country.

Additional colour variation can be achieved by texturing or splitting certain stones within the panel.

Costs

Exact costs have not yet been established but stone will provide an attractive luxury finish at a cost comparable in many instances to man made materials and to concrete blocks which necessitates the importation of large quantities of expensive cement. Granite will also produce a much cooler atmosphere internally than buildings which use concrete blocks.

Where It can Be used

Natural stone has many applications. It can be used for internal and external feature walls and can also be used to construct complete new buildings such as houses, factories, schools, churches, and bridge parapets.

All natural stone work will be selected free from structural defects but may contain veining, which are a characteristic of natural granite but do not constitute structural defects.

ANNEX VIIPILOT STONE CUTTING PLANT OPERATIONAL COSTS
OF PROPOSED PILOT PLANT LABOUR REQUIREMENTS

<u>QUARRY OPERATION</u>	<u>RATE PER DAY</u> <u>(8HRS)</u>	<u>PER MONTH</u> <u>27 WORKING DAYS</u> <u>(8 HR DAY)</u>	<u>PER MONTH</u> <u>27 WORKING DAYS</u> <u>(12 HR DAY)</u>	
2 Drill Operators	3.00 each	162.00	275.40	
2 Rubble Producers	3.00 "	162.00	275.40	
2 Dressed ashlar producers	4.00 "	216.00	367.20	
1 Driver	3.50 "	94.50	160.65	
1 Driver's Assistant	3.00 "	81.00	137.70	
1 Primary Saw Operator	4.00 "	108.00	183.60	
1 Supervisor	5.00 "	135.00	229.50	
		<u>958.50</u>	<u>1629.45</u>	1629.45
<u>FACTORY OPERATION</u>				
1 Diamond Sawyer	4.00	108.00	183.60	
1 Jenny Lind Polisher	4.00	108.00	183.60	
1 Forklift Driver	3.50	94.50	160.65	
1 Assistant	3.00	81.00	137.70	
1 Fitter/Mechanic	4.00	108.00	183.60	
1 D/S Attendant	3.00	81.00	137.70	
1 Yard Supervisor	5.00	135.00	229.50	
		<u>715.50</u>	<u>1216.35</u>	1216.35
<u>OFFICE STAFF</u>				
1 General Manager	8.00	216.00	367.20	
1 Accounts Clerk	5.00	135.00	135.00	
1 Clerk Typist	4.50	121.50	206.55	
		<u>472.50</u>	<u>803.25</u>	803.25
				LE2146.50
				LE3649.05

2146.50 x 12 months = 25,758.00 per annum. Based on 8 hr. Working Day
 3649.05 x 12 months = 43,788.00 per annum based on 12 hr. Working Day

PILOT STONE CUTTING PLANTDIRECT OPERATIONAL COSTS PER ANNUM

	<u>BASED ON 8 HR. DAY</u>	<u>COSTS IN- CREASED BY 70% BASED ON 12 HR. DAY</u>
Labour as per annex VII	25,758.00	43,788.00
Explosives for Blasting	2,000.00	3,000.00
Diesel:- Per day		
Compressor 10 gls.		
Leader 5 "		
Forklift 5 "		
Total 20 " per day		
20 gallons per day x 300 days = 6,000 gallons @ 3.00 Le	18,000.00	27,000.00
Electricity 1,500 units per month x 12 months = 18,000 units @ 20c.	3,600.00	5,400.00
Diamond Blades 4 @ 2,000	8,000.00	12,000.00
Quarry Tools Replacement	1,000.00	1,500.00
Repairs to Plant/Maintenance	2,500.00	3,500.00
Lubricants	1,000.00	1,500.00
Primary Saw Materials (Wire & Carbo)	6,000.00	9,000.00
Office Equipment		
Stationery etc. 300.00		
Telephone 600.00		
Furniture 300.00		
Cabinet 150.00		
Electricity 600.00		
1950.00 (say)	2,000.00	2,500.00
Small Van 10,000 over 3 years	3,330.00	3,330.00
Insurance & Tax on van	150.00	150.00
Petrol 54 gls. p.m. x 12 = 648 @ 3.50 =	2,268.00	3,268.00
	<u>75,606.00</u>	<u>LE 115,936.00</u>
<u>Depreciation On Investment (Page 4)</u>		
Equipment 137,000 x 10% 13.7		
Buildings 15,000 x 5% .8		
14.5	14,500.00	14,500.00
Interest on Working Capital for 3 Months 25,000 x 20%	5,000.00	7,750.00
	<u>95,106.00</u>	<u>138,186.00</u>
Say LE	95,000.00	LE138,000.00

PILOT STONE CUTTING PLANT

(REVENUE FROM SALE OF STONE PRODUCTS AVAILABLE FROM PILOT PLANT)

	<u>BASED ON 8 HR DAY</u>	<u>BASED ON 12 HR DAY</u> <u>PRODUCTION INCREASED 40%</u>
<u>20 mm Paving Sawn Finish</u>		
525 sq.ft. per mth. x 12 = 6300 sq.ft. = 700 sq.yds @ Le25	17,500.00	24,500.00
<u>40 mm Paving Honed Finish</u>		
265 sq.ft. per mth. x 12 = 3180 sq.ft. = 350 sq.yds @ Le40	14,000.00	19,600.00
<u>40 mm Cladding Polished</u>		
300 sq.ft. per mth. x 12 = 3600 sq.ft. = 400 sq.yds @ Le45	18,000.00	25,200.00
<u>Setts</u>		
100 sq.yds per mth. x 12 = 1200 sq.yds @ Le24	28,800.00	40,320.00
<u>Random Rubble</u>		
6 yds. per day = 160 per mth x 12 = 1920 sq.yds. @ Le10	19,200.00	26,880.00
<u>Granite Bricks</u>		
25 sq.yds. per mth. x 12 = 300 sq. yds @ Le12	3,600.00	5,040.00
<u>Dressed Ashlar</u>		
54 sq.yds. per mth. x 12 = 648 sq.yds. @ Le20	12,960.00	18,144.00
<u>Sawn Granite Blocks</u>		
54N° sq.yds. per mth. x 12 = 648N° @ Le3	1,944.00	2,721.60
<u>Sawn Laterite Blocks</u>		
30N° per mth. x 12 = 360N° @ Le2	720.00	1,008.00
<u>Crazy Paving</u>		
30 sq.yds. per mth. x 12 = 360N° @ Le 5	1,800.00	2,520.00

3" Monumental slabs S.A.R.

& Polished on face

4 per mth. x 12 = say 50 @ Le150

Sundry items

Say 128.500.00 Le Per Annum Sales

Total Sales for annum (Page 3)

Total Operational Costs (Page 2)

Estimated Profit for first year operation

BASED ON
8 HR DAY

BASE ON
12 HR. DAY

7,500.00

10,500.00

2,500.00

3,500.00

128,524.00

179,933.60

128,500.00 Le

180,000.00

95,000.00 Le

138,000.00

= 33,500.00 Le

42,000.00 Le

PILOT STONE CUTTING PLANTCOST OF INFRASTRUCTURE

Lands and Buildings	15,000.00 Le
Electricity & Water	<u>25,000.00 Le</u>
	40,000.00
Cost of Equipment	<u>137,318</u>
(As per Annex V)	177,318.00
Total Value of Investment =	177,318.00

ANNEX VIIIPROJECT IMPLEMENTATION PROGRAMME

1. Study and approval of Report By Aug. 1982.
2. Placing orders for machinery by Oct. 1982
3. Training of 2 people by Nov. 1982
4. Completion of infrastructure by Jan. 1983.
5. Arrival of machinery by Jan. 1983.
6. Arrival of Quarry Supervisor
for three months to supervise
installation of machinery Jan. 1983.
7. Arrival of Stone Consultant
to co-ordinate site works and Lay out
foundations 3 week period, Jan. 1983
8. Installation of machinery by April 1983.
9. Return of Stone Consultant to
commission machinery and assist with
sales promotion 3 week period May 1983
10. Commencement of Commercial Production From May 1983

ACKNOWLEDGEMENTS

In addition to the people referred to in my Introduction, I would like to place on record my sincere thanks to the following people who assisted me in various ways during my Exploratory Mission.

Mr. Tunis - Director of Small Industries - Ministry of Trade and Industry

Mr. F. Wallan, Administrative Officer - Ministry of Trade and Industry.

Dr. Waldemar A. Pfoertsch - Associate Expert

Miss Irene Anderson, UNIDO, J.P.O.

Mr. A.E. Agbaje - Deputy Director - Geological Survey Department - Ministry of Mines.

Mr. Abdul Latiff, Geologist, Ministry of Mines.

Mr. Thorpe - Director, Ministry of Transport.

Mr. J.R.L. Luke, Managing Director, S.E.L. Luke & Sons Ltd.,
Building Contractors.

Mr. Jallo Gambia, Chief Architect, Ministry of Works

Mr. Studd, Senior Quantity Surveyor, Ministry of Works.

Miss Helena Aych, Architect of Sierra Scan Construction.

Mr. Nigel Wakeham Architect of Olu Wright & Associates.

Mr. Jarrett-Yaskey, Architect of J.R. Jarrett-Yaskey, Architect

Mr. Christo Forster, Civil Engineer of Ed Davies & Associates.

Mr. Christian Stanley Sculptor of Aruston Stone Works.

