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19 July 1978
English

DEVELOPMENT OF HEAVY CLAY INDUSTRY*

DP/LES/74/023

LESOTHO

Terminal report

Prepared for the Government of Lesotho
by the United Nations Industrial Development Organisation,
executing agency for the United Nations Development Programme

Based on the work of William Buchanan, ceramic engineer

United Nations Industrial Development Organisation
Vienna

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SUMMARY

The Project has accomplished its objectives by defining adequate quantities of heavy clays in the districts of Leribe, Maseru Mafeteng, Mohale's Hoek and Qacha's Nek. In addition, high quality heavy clays in Maseru area were found to be suitable for a wide range of bricks from general purpose to facing and engineering class. Ceramic clays discovered in the Mafeteng district were found to be suitable for Stoneware Pottery.

Recommendations have been made on expanding and strengthening the clay based industries in Lesotho. It is considered that sufficient raw materials have been defined in terms of quality and quantity to enable Lesotho to become self-sufficient in the manufacture of bricks and other heavy clay products. A modern brickplant to be established through the Lesotho National Development Corporation will be the first and major step in this direction. UNIDO has been requested to seek financing for technical assistance personnel for this brickplant. It is possible that UNIDO could locate donors of equipment for other small brickplants in Lesotho, e.g. at Qacha's Nek and Leribe.

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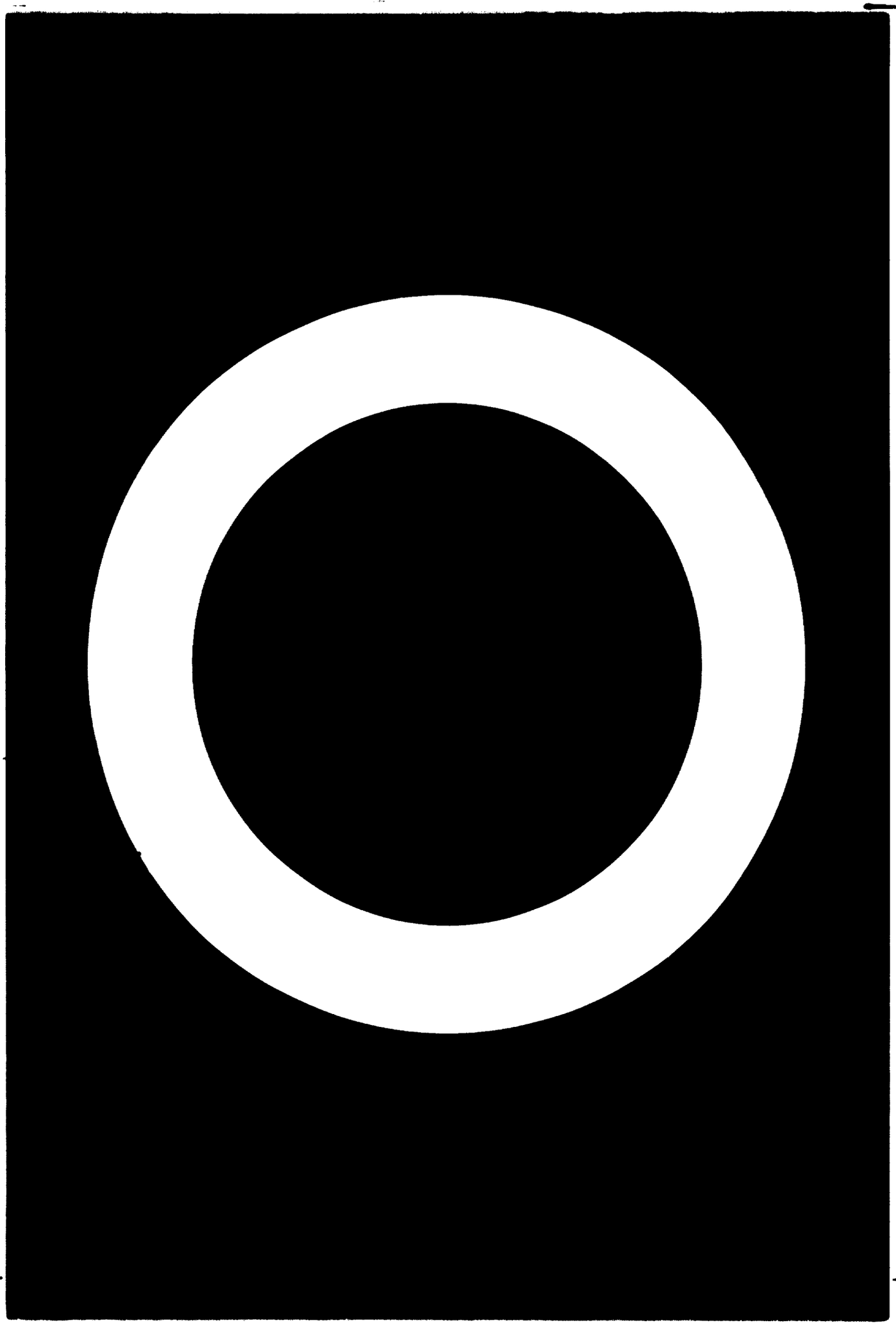

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I. INTRODUCTION

1. Brickmaking in Lesotho is a traditional occupation. Such bricks as are made tend to vary considerably in quality and available quantity, whilst not being generally suitable for many structural and facing applications. At the same time, the supply falls far short of the demand and this has been reflected in increasing imports of bricks and alternative building materials such as cement and steel.

2. Existing brickmakers are often operating within urban areas on ill defined or limited deposits of (usually) silty,.sedimentary clays. Urban development and a shortage of land will eventually further restrict or eliminate raw material availability to these brickmakers.

3. Unemployment, a rapidly growing population, and the migrant labour system are three important factors leading to an urgent need for maximising on locally produced goods, minimising imports and devloping exports where possible. Where such production can be established as a wholly owned local industry, there are additional benefits of profit and salary re-investments within the country.

4. The construction industry in Lesotho relies heavily on the supply of bricks and cement imported from the surrounding Republic of South Africa. Thie supply is sometimes erratic according to the needs of that country, thue the contruction induetry in Lesotho is constrained by factors over which it has no control.

5. The Project for Development of the Heavy Clay Industry was conceived to define suitable deposits of heavy clays in nominated areas, to train staff in testing of such claye, and to give technical advice to Government, para-statal bodies, and the private sector such that the heavy clay industry could be efficiently developed.

6. The CPTC was built and partly equipped in 1974 during a previous UNDP UNIDO Project[1/]. Additional equipment and staff training during the current Project has taken the CPTC to a level whereby basic tests on clays can be effected, and bricks can be tested to standards set by the South African Bureau of Standards (SABS).

7. During the life of the Project, discoveries were made of previously unknown deposits of high quality heavy clays and clays with wider potential for production of such goods as hand made stoneware pottery. These discoveries influenced the work plan of the project and were responsible for an upward reassessment of the potential of the heavy clay industry as opposed to that made in the previous project.

8. The project commenced operations on schedule in May 1975, with an intended life of one year. Following a Tripartite Review in October 1975, several constraints became apparent and the project was extended to a three year life, terminating on 30 April 1978. The constraints referred to were:-

(a) The project was understaffed with the post of Associate Expert being unfilled;

(b) Essential equipment had not been received;

(c) In spite of the previous two constraints, the project work load had been increased.

(d) It was acknowledged that the original estimate of one year to complete the survey of clay deposits could have been over optimistic.

10. Following the Tripartite Review, the post of Associate Expert was changed to that of a United Nations Volunteer and a Geophysicist Geologist was recruited who took up his post on 19 May 1976. At the same time, the project was attached to the Department of Mines and Geology within the Ministry of Commerce and Industry, instead of being directly attached to that Ministry.

1/ DP/LES/71/037 "Brickmaking and building materials".

10. In its original form the project budgets for Government and UNDP were Rand 6.512 and US $ 63,540 respectively. The latest information available reflects a UNDP contribution of US $ 188.529 and an estimated Government contribution of about Rand 20.000.

11. Short term objectives of the project are listed as:-

(a) Assist the Lesotho National Development Corporation (LNDC) by locating a clay deposit for a proposed modern brickplant.

(b) Prospect for and define predefined quantities of suitable heavy clay in prescribed areas in Lesotho.

(c) Give technical assistance to the Basotho Enterprise Development Corporation (BEDCO) and to the small mechanized brickmaking plants in Lesotho on an "Ad Hoc" basis.

(d) Prepare any project proposals for Government, at request, on the clay building materials industry.

(e) Define a suitable site for a Training Centre for teaching the production of high quality hand made bricks and plain tiles.

(f) Train National staff to operate the CPTC by testing clays and bricks within the scope of the available facilities, and to operate a small earth drilling machine.

12. Longer term objectives of the project were to define raw material reserves of heavy clay and this was later ammended to include other clays. Thus Government could plan for the ongoing development of clay based industries.

13. Long term possibilities for the development of clay based industries became apparent during the project life with the discovery of high quality heavy clays, and clays which could have wider potential for other ceramic goods. Thus, although the emphasis remained fixed on the development of the heavy clay industry, the project was sufficiently flexible to diverge (with official approval) into exaining some deposits of ceramic clays.

14. Lesotho is a member of a common Custom Union with South Africa, Botswana and Swaziland, and shares the same currency as South Africa, i.e. the Rand. This has certain benefits in that most locally manufactured goods can be freely exchanged without hinderance of import restrictions or customs duty. However, there is the possibility that Lesotho will follow Botswana and Swaziland in establishing its own currency. At present, Lesotho imports far more from South Africa than is exported. The development of a Lesotho clay industry will have certain obvious benefits:-

(a) A reduction of imports with local produce developing employment opportunities and generating more capital for investment within the country.

(b) Opportunities for development of managerial and other skills.

(c) Elimination of constraints to the building industry caused by uncertain supplies of bricks and other clay based products.

(d) Establishment of an export market which will further enhace the viability of local industry and help to reduce costs through greater economies of scale.

(e) A reduction in the reliance on the migrant labour system by establishment of local industry with employment opportunities as indicated above. That this industry be efficiently and successfully established is most important to its ongoing independence and expansion.

II. FINDINGS.

15. The project has tested clays from all districts within Lesotho (districts here are administrative subdivisions of the country). Prospecting and site investigations have been carried out in the districts of Leribe, Maseru, Mafeteng, Mohale's Hoek and Qacha's Nek. The following table shows the quantitative objectives of the Project versus the findings, whilst Annex IV gives summaries of reports on individual clay deposits.

Clay Survey Objectives and Discoveries

AREA	MINIMUM REQUIRED TONNES	ACTUAL DEFINED TONNES	DEPOSIT NAME
LERIBE	1.000.000	2.109.375	Tsikoane
MASERU	1.000.000	2.604.000	Thetsane
MORIJA	250.000	NIL	Tenane++
MAFETENG	250.000	270.000	Ramahlape
	-	1.160.861	Phoqoane+
	-	14.900	Raseatle+
MOHALE'S HOEK	250.000	444.500	Mohale's Hoek
	-	218.925	Kobotšoeu
QACHA'S NEK	250.000	282.160	Souru
THABA-TSEKA	250.000	NIL	
MASERU	-	148.192	Thetsane No.2+
MAKHALANYANE	-	42.000	Makhalanyane+
Totals:	3.250.000	7.294913	-

+ These were special evaluations on deposits of potential ceramic clays (Phoqoane and Raseatle) and for brickwork sites for BEDCO (Thetsane No.2 and Makhalanyane).

++ Although a deposit was evaluated at Tenane, the clay was found to be of poor quality.

16. In addition to deposits where tonnages have been defined, prospecting in the Mazenod area, some 16 km from the capital Maseru has indicated that other deposits of buff firing clays exist which could have potential for heavy clay or other ceramic wares.

17. The clay deposit at Thetsane, comprising three different types of material, has scope for manufacturing a wide range of bricks from general purpose to facing and engineering class, whilst the Thetsane Upper Clay also has potential for manufacturing high firing earthenware goods. Other products such as pipes and tiles are distinct possibilities from these materials. Annex VII gives draft proposals for the establishment of brick factory at Thetsane although it must be noted that events have overtaken these draft proposals and LNDC has already evaluated potential consultants who would be responsible for final design and implementation of the Thetsane brick factory.

18. The clay deposit at Raseatle has a defined 9.5000 tonnes of clay suitable for producing stoneware pottery.

19. The clay deposit at Phocoane has a large tonnage of white to buff firing clay suitable for either brickmaking or possibly other ceramic wares but more comprehensive testing and specialized evaluation is required for these other ceramic wares.

20. The clay deposit at Souru near Qacha's Nek may require Government aid to exploit it for the benefit of the community, but this could be coupled with the establishment of a training scheme for making good quality hand made bricks and plain tiles as referred to in Paragraph 11. (e).

21. The clay deposit at Teikoane is suitable for producing general purpose of bricks which would serve the needs of the northern section of the country.

22. The clay deposit at Thetsane No.2 site is suitable for the relocation of the BEDCO subsidiary Mohokare Heavy Clay Industry (Pty) Ltd. when that company is displaced from its present site due to the establishment of a water reservoir.

23. The deposit at Mohale's Hoek and Ramahlape are suitable for the production of general purpose bricks and could serve the Southern areas of the country. However, since the requirements of these areas would be small and some mechanization is required to dig and treat the clays, there is a case for examining co-operative ventures in Mohale's Hoek and Mafeteng (Ramahlape) with, in addition, a sharing of certain equipment such as a digger, truck, and crusher.

24. A serious constraint to existing small scale brickmakers is a lack of readily available fuels such as coal dust and ashes. Recommendations on this were made by the writer in 1974 in the final report of a previous project 2/.

25. Contrary to pre-project information, high quality heavy clays do exist in Lesotho, although it is probable that their availability is confined to the western "Lowland" area of the country. In the limited time available it is doubtful if the project discovered all such deposits.

26. Although quantitative information is not available, from visual evidence there has been an upswing in the production of concrete blocks, believed to be influenced by a general shortage of local bricks. At the same time there appears to be an upswing in construction of modern building for the private and public sectors.

2/ Final report on clay building materials in Lesotho, June 1974, p. 12, para e; p. 13, para f; and supplement, p. 1.

27. A capital loan of DM 2,5 million has been approved through the Kreditanstalt Für Wiederaufbau of the Federal Republic of Germany. The loan will be used to establish a brick factory at the Thetsane Clay Deposit (see also annex VII). An official request has been made from Government through the UNDP for UNIDO to locate funds and personnel for the positions of General Manager (5years), plant Engineer (4years), and Kiln Foreman (4years).

28. In considering the future Thetsane brick factory, which will be nearly twenty times the capital value of any other brickmaking facility in Lesotho, the national positions of General Manager and skilled personnel are crucially important for the long term success of the factory.
In considering that the Thetsane factory will be the start of the modern industrialized sector of theheavy clay industry in Lesotho it becomes doubly important that the national staff receive the benefits of adequate training over a suitable period of time. The ability to achieve self development in this industry will then depend upon these national managers serving as a central resource from which the business will expand and from which other managers and staff will be trained.

29. There is a need to set standards for bricks in Lesotho, and to publicise such standards in order that the various brickmakers know what to aim for. The CPTC is well set up to provide a quality assurance service in this respect. The project has stimulated some interest in this sphere, and because of the importance attached to it, highly relevent advice is quoted from a UNIDO document:

'Standardization and quality control

The need for standardization and quality control was considered to be of overriding importance and it was urged that substantial external assistance be given in this sphere. It was, however considered advisable to ensure that, in this initial stages, the standards should not be so stringent as to stifle production.

The quality of indigenous raw materials would also have to be taken into account. The standards for internal consumption might not therefore be as high as those for export. The interest of the consumer might, however, have to be kept in view at all times. It would be important to ensure that testing centres be set up specifically for small scale industries; they should not simply advise whether a particular project was up to the requisite standard, but they should explain what really went wrong with the manufacturing process and what should be done to correct the fault". 3/

30. It was found that by having funds for hiring national staff to operate the earth drilling machine and assist the Government officers in the CPTC, the project had greater versatility than would have been the case if the staff had been hired as casual employees through Government, whilst at the same time Government was relieved of a certain amount of administrative burden.

31. Both LNDC and BEDCO have utilized the project for technical advice and assistance. There will be an ongoing requirement for such assistance in the future, but there is not a case for a full time brickmaking specialist to be attached to either of these Corporations, and in any case National staff from the CPTC and the future Thetsane brick factory will eventually be able to provide such a service. However, there is a strong case for an Industrial Development Section to serve both LNDC and BEDCO. Such a section would comprise a cadre of professional staff in the fields of Business Administration, Industrial Engineering, Mechanical and Electrical Engineering, with other specialist services such as an Industrial Phsychologist being obtained as required on an"Ad Hoc" basis. The section would not replace or duplicate the existing administration but would act as a combination trouble shooting, performance setting/evaluation, and industrial training service. More details are given under "Recommendations."

3/ Industrialisation of the least developed countries. Report of the intergovernmental expert group meeting, Vienna, 15-24 November 1976, page 13 (ID/WG.234/13).

32. There is a need for preventative maintenance training in the brickmaking industry. The training would cover a very diverse range of equipment from simple picks, shovels, wheelbarrows, to extruders, brickmoulds, and vehicles. Such training will lead to reduced downtime through breakdowns increased utilization of equipment, reduction in imports through longer life of existing equipment, a more comprehensive understading of equipment functions, increased productivity, and increased profitability. This is dealt with further under "Recommendations " and linked with the Industrial Development Section.

33. The project has, on average , more than achieved its objectives by defining clay deposits as indicated in the table on page 10. In addition to sinking and testing samples from ninetyfour auger drill holes and seventeen core drill holes, more than three hundred prospecting samples were also evaluated. Some development work was carried out on mixtures from a number of deposits, training was given to the two technical officers who comprise the staff of the CPTC, and a reporting system set up for testing of individual clay samples and bricks. Through the efforts of the project and with Government assistance, one of these technical officers completed a six months scholarship course as a ceramic technician at the North Staffordshire Polytechnic in the U.K. and he will return there in 1978 to commence the final two years of Technical Managers Diploma course. The Thetsane factory, which should be producing by 1980, will be capable of completely eliminating imports of bricks and some other heavy clay wares, whilst also developing an export market.

34. On several occassions, students from within the Lerotholi Artisan Training Centre visited the CPTC where the work of the Project was explained, demonstrations were given on the potential high quality and diversity of Lesotho made heavy clay wares, and questions answered on brickmaking in general.

35. When at the start of the project the drilling equipment had not arrived, a joint evaluation of the Tsikoane Clay Deposit was carried out between the project and a UN/OTC Project for Exploration of Diamonds, Phase II., DP/LES/73/021. (See Annex IV Tsikoane Clay Deposit, and Annex V Tsikoane Clay Deposit). Later, the project assisted the Exploration for Diamond project by drilling some auger holes in soft Kimberlite prospects.

36. The Department of Mines and Geology, with the Commissioner as Liaison Officer to the project Manager, has provided a valuable back up service to the project and working relations have been consistently good. The two technical officers in the CPTC have also performed very well in terms of continued co-operation, willingness to learn, and an increasing capacity to accept responsibility and work independently. Of the four national staff employed directly by the project, three have been employed by the Department of Mines to continue working on a large drilling rig for a coal exploration project whilst the fourth will be employed at the CPTC. In this way, training given to project employed national staff is being built upon by their continued employment by Government.

III. RECOMMENDATIONS

37. The Thetsane brick factory project should continue to receive a high priority. An updated cost-benefit analysis must be carried out in the near future to evaluate (a) LNDC cash flow requirements such that funds can be defined, and (b) evaluate up to date capital costs of the factory since the DM 2,5 million requested in 1977 will likely be inadequate by the time of factory construction in 1979-1980. The location of additional funds could be a time consuming process and might further delay implementation of the project.

Government has requested technical assistance personnel, funded and recruited through UNIDO. The personnel must be properly qualified and experienced with minimum time requirements being as follows:-

General Manager	-	5 years
Plan Engineer	-	4 years
Kiln Foreman	-	4 years.

38.(a) In countries where industry is more developed, experienced professional staff and other skilled staff are available with standards of performance being fairly well defined. Maintenance of, and upgrading of performance of both people and equipment can be tackled at an in-company level, an inter-company level or with the assistance of Government sponsored productivity groups, or other methods. In specialized cases, consultants and professional or institutional bodies are only a phone call away, and may often be only a few kilometres away.

(b) Lesotho industry is still at an early stage of development. Professional managers and skilled personnel are in short supply, and in many cases are either going through a process of improvement through experience, or are at a stage where external assistance is required to enable them to reach their full potential. In addition, parastatal organizations which are involved in sponsoring or developing industrial projects, are not always able to provide technical back up to those companies in which they have a sizeable shareholding. Finally, there is a need to co-ordinate and develop the potential of private businessmen with a view to upgrading general efficiency, solving individual problems, and advising on potential and technology for expansion or introduction of new ventures. Such advice can only be effective if backed up by an efficient "after sales" service.

(c) The above preamble obviously concerns other industries as well as the heavy clay industry. However, the recommendation which is based on the above, will also effect the clay based industries.

(d) It is recommended that an Industrial Development Section be established under the aegis of the Ministry of Commerce and Industry (See also Paras. 31 and 32). It is tentatively recommended that expatriate staff requirements for the section should be as follows:-

Expert in Business Administration	- 5 years
Industrial Engineer	- 5 years
Mechanical and Electrical Engineer	- 5 years
Industrial Psychologist	- 6 months throughout the five year period
Other Specialist Services	- 9 months throughout the five year period.

It is recommended that a consultant be engaged for two man months to examine the above proposals in detail, advise on national staff requirements, define other requirements such as premises and equipment, and to prepare any necessary project document with advice as to possible sources of financing.

39. It is recommended that the existing Clay Products Technical Centre shift its emphasis from clay testing into quality assurance and development work for the clay based industries in Lesotho. It is further recommended that Government consider the long term possibilities of the CPTC developing into a Building Materials and Ceramics Development Centre, with special emphasis on products manufactured in Lesotho.

40.(a) A junior technical officer at the CPTC has been accepted for a second scholarship at the North Staffordshire Polytechnic in the U.K. Financing of this scholarship is through the British Council, and the successful result would be a Technical Managers Diploma in Ceramics. It is recommended that the British Council be requested in advance that should the candidate complete the course with distinction, he should continue his studies for achievement of an honours degree (B.Sc.) in Ceramics (See also Annex IV.).

(b) With the exception of 40 (a) above, there are no national staff who have qualified in heavy clay technology or ceramics. It is recommended that at least two other candidates be sponsored for such training. It is further recommended that the training be carried out at the North Staffordshire Polytechnic in U.K.; that it be in the three stages of Technicians, Technical Managers Diploma, and B.Sc. Ceramics; and that passes with distinction in any one course would be necessary for recommending candidates to continue onto the following courses. The final aim should be to have two national staff educated to the level of B.Sc. Ceramics.

41. It is recommended that Government set up a committee to set standards for heavy clay based building materials; that the committee should take into account Paragraph 29. of this report; and that every assistance be given to Lesotho producers to maintain any atandards which are set. Such assistance could be given through CPTC, and an expert in clay building materials should be engaged as and when required to assist the committee.

42. Considerable development is taking place in Lesotho, with some examples being in the fields of roadworks and bridges; International Airport, Health Services Buildings; Education Buildings; and other Government sponsored buildings. Major projects are planned well in advance and it is therefore recommended that whenever possible such planning should dictate that design should incorporate heavy clay products. In this latter respect, it may be noted that the new Thetsane brick factory should be capable of supplying a range of bricks from general purpose, through facing bricks, to engineering class bricks.

43. It is recommended that, in co-operation with the brickmakers concerned, co-operative ventures should be investigated at Mafeteng and Mohale's Hoek. It is further recommended, if both these centres are willing to establish co-operative brickmaking ventures, that limited mechanization be employed on a shared basis(between the two co-operatives) to excavate and crush clay and transport fuel to the brickmaking sites. UNIDO might be contacted with a view to obtaining second hand equipment, in good condition, from donor sources.

44. The Training Centre for handmade bricks and plain tiles should be installed at the Souru deposit in Qacha's Nek to stimulate brickmaking in that area in accordance with the recommendations made in the report on the Souru deposit (See Annex IV.).

45. UNIDO should be contacted with a view to obtaining assistance by way of equipment to establish a small brick factory at Tsikoane, near Leribe. Such a factory would produce bricks for the northern section of Lesotho, but some technical assistance may be required.

46. It is recommended that the Department of Mines and Geology, either independently or with the co-operation of other geological based projects, continues to prospect for high quality heavy clay in the lowlands areas of the country.

47. It is recommended that the supply of fuel to brickmakers be examined to see what measures can be taken such that they will have readily available supplies in quantities that they can afford to purchase. It is further recommended that the effectiveness and services supplied by existing major fuel (coal and ashes) importers be examined to see if they are providing an efficient service, and if necessary to examine ways in which their service can be improved upon.

48. It is recommended that Government, through its Central Planning and Development Office, and after examining the previous recommendations, makes an early decision on which recommendations it wishes to see implemented, and then prepares a consolidated request for a short term mission to examine proposals in detail, prepare any necessary project documents, and advise upon possible sources of financing.

ANNEX I.

LIST OF INTERNATIONAL AND COUNTERPART STAFF.

A. International Staff.

1. Mr. William Buchanan, (UNIDO) Expert in Clay Survey, and Brickmaking.

Starting Date : 5 May, 1975
Concluding Date : 30 April, 1978

2. Mr. Reuben Kashambuzi, (UNV) Clay Testing Assistant.

Starting Date : 17 May, 1976
Concluding Date : 30 April, 1978

B. Counterpart Staff.

1. Ms. M. Mofolo, Commissioner of Mines and Geology (Government Liaison Officer)

2. Mr. Seth Tseuoa, Senior Technical Officer.

Starting Date : November, 1975
Concluding Date : Continuous.

3. Mr. P.M. Mohale, Junior Technical Officer.

Starting Date : 5 May, 1975
Concluding Date : Continuous

+ Mr. Kashambuzi is a Geophysist-Geologist and was employed mainly on field work rather than in the CPTC.

ANNEX II.

Fellowships.

Name: Mr.P.M. Mohale[$]

Purpose of Training: Upgrading and broadening Technical knowledge with a view to further scholarships if initial course successfully completed.

Course : Ceramic-heavy claywares and refractory Technology.

Place of study : North Staffordshire Polytechnic, Stoke-on-Trent. United Kingdom.

Starting Date : 1 October, 1976

Concluding Date : 31 March, 1977

$ Sponsored by Lesotho Government and British Council.

Note: Mr. Mohale has been granted exemption from year 1 of a course leading to a Technical Managers Diploma. He is scheduled to return to the North Staffordshire Polytechnic in September 1978 to complete the final two years of the Technical Managers Course.

ANNEX III

LIST OF MAJOR ITEMS OF EQUIPMENT SUPPLIED BY UNDP/UNIDO

1. Toyota HI-LUX 1 tonne pickup truck

2. Compression testing Machine (3000 KN) Class 2.

3. Thermal Gradient Furnace

4. Portable augering machine with augers, core accessories, and spare parts.

5. Cutting saw with diamond tipped blade.

6. Camping Equipment.

ANNEX IV.

SUMMARY OF TECHNICAL REPORTS

1. Special Report WB1/JR2, Taikoane Clay Deposit.

Plus two million tonnes of heavy clay located at Taikoane near the district headquarters of the Leribe District. The report indicates that impurities were present in some parts of the deposit which was otherwise suitable for production of bricks, pipes, and plain tiles. The nature of these impurities requires further investigation, before recommending the deposit for any substantial capital investment. The deposit is well situated with regards to road access, water, electric power supply and rail head.

Note: Subsequent investigation confirmed that the impurities were a form of lime and that fine grinding of the material would minimise the harmful effect to within acceptable levels.

2. Special Report WB2/RK1, Thetsane Clay Deposit.

Plus 2.5 million tonnes of heavy clay, subdivided into three categories:- Upper Thetsane Clay, Lower Thetsane Clay and Alluvial Clay. All three materials were considered suitable for brickmaking with the Upper Thetsane Clay firing to a light colour and being of partioularly high quality. In general it was considered that a wide range of heavy clay products could be made from this deposit.

The Deposit is located adjacent to Maseru and some 7.5 km from Maseru rail head.

Note: The Deposit has since been chosen as the site for the Lesotho's first modern brick factory.

3. Special Report WB3/RK2, Tenane (Morija) Clay Deposit.

A formation or bedded deposit of heavy clay material, some 40 km from Maseru and 6.6. km from Morija, lime; soluble salts giving rise to scumming; short vitrification range of the material in most cases, and poor drying characteristics, all combined to suggest that the deposit was not suitable for brickmaking. A strong tendency for the material to bloat above 1050°C suggested that it could be suitable for production of light-weight aggregate.

Note: The area is now confirmed as Woodlot Project and would not be available for alternate exploitation.

4. Special Report WB4/RK3, Ramahlape Clay Deposit.

About 270,000 tonnes of mainly bedded clay material, well located between Mafeteng (District headquarters) and the rail head at Wepener. Lime contamination present in some places but fine grinding of the material would reduce the problem to within acceptable limits. Some level of mechanization required to exploit the deposit, and water supplies have to be defined.

5. Special Report WB5/RK4, Raseatle(Motanyane) and Phocoane (Tebang) Clay Deposit, Preliminary Report.

Two separate deposits of white firing clays in the Mafeteng District. Bulk samples of the Raseatle Clay were favourably assessed as being suitable for stone ware pottery, and although there was considered to be only about 2000 tonnes of this material it is sufficient to supply the two main Lesotho Potteries for a number of years. Immediate exploitation is recommended.

The Phocoane deposit required further drilling to establish qualities and quantities, although it is certainly larger than Raseatle. Further evaluation work was strongly recommended together with the suggestion that a small ceramic factory could be set up at Pilot Plant Level. The white firing material is suitable for hand throwing when mixed with a more plastic clay.

Note: In July 1977 a Project tripartite Review altered the work plan to permit extra time for further drilling - evaluation of the Raseatle and Phoqoane Deposits.

6. Special Report WB6/RK5, Preliminary Report on the survey for Heavy Clay at Qacha's Nek.

Initial survey work was curtailed by bad weather. Numerous small deposits were found, but in most cases these were sub-economic in size and / or seriously contaminated by lime such that brickmaking could not be recommended. Two prospects were defined for further evaluation in November 1977. Assuming that a suitable deposit was eventually defined, it was recommended that Government consider subsidising a small partly mechanized brick-plant. The reasons for this were three fold; due to the nature of the raw material it is likely that some measure of mechanization would be required, the market for bricks is likely to be small initially, and Qacha's Nek is in a difficult geopolitical location.

7. Special Report WB7/RK6, Clay Deposit in Mohale's Hoek.

Two deposits were defined:- Kobotsaou (about 200. 000 tonnes) and Mohale's Hoek Town Deposit (about 440.000 tonnes). The Mohale's Hoek Town deposit was considered to be the most promising taking into account technical factors and geographic location. Even so, the material is tender in drying and precautions should be taken to obviate this problem. Further testing of full sized bricks has been scheduled to gain a more comprehensive picture of drying characteristics. Such testing will be of a qualitative nature since the Clay Products Technical Centre has no equipment with which controlled drying tests can be carried out.

8. Draft Proposals for the Establishment of the Brick Factory at Thetsane :-'Requirements and General Design Data. October 1977.

The proposals give the background, factors affecting final design, future developments and immediate requirements for establishment of the factory. Design is based on using a minimu of mechanization, but where mechanical plant is proposed it should be of modern design to

capitalize on the wide range of products that can be produced bearing in mind the market for such products. Considerations include appropriate tehcnology and international aid to train local staff. An appendix gives details of some Technical data and proposed plant layout.

9. Special Report WB8/RK7, Phoqoane Clay Deposit.

The deposit is subdivided into three areas where drilling has defined that in one area there is 156,520 tonnes of white and buff firing clay, in another area there is more than 45.715 tonnes of white to buff firing material, whilst in the third area it was difficult to differentiate on paper between red, buff, and white firing material but a total quantity of 958,636 tonnes was defined.

The clays would prove useful for brickmaking and possibly other ceramic wares for which further testing(outwith the scope of the CPTC) is recommended.

10. Special Report WB9/RK8, Raseatle Clay Deposit.

The Raseatle deposit is relatively small with a estimated quantity of 9,500 tonnes of buff firing stoneware clay. However, this is sufficient to keep the two exisiting major potteries in Lesotho self-sufficient in clay for some 40 years at their present production rate.

There is scope for a businessman to set up a small enterprise by digging the clay and supplying it to local potteries.

The report also indicates some scope for setting up a cottage industry to utilise some 5,400 tonnes of earthware clay defined during the deposit evaluation.

11. Special Report WB10/RK9, Thetsane No.2 Clay Deposit.

At the request of the Basotho Enterprise Development Corporation (BEDCO) a small deposit of heavy clay was located and evaluated in the Thetsane area, near Maseru. A BEDCO subsidiary, and the only partly mechanized brick factory operating in Lesotho (Mohokare Heavy Clay Industry Pty. Ltd.), is to be displaced from its existing site due to development of a new reservoir. Some 148.192 tonnes of clay was defined with more being available outwith the drilling area. An Appendix gives proposed plant layout and proposed site boundaries.

12. Special Report WB11/RK10, Souru Clay Deposit (Qacha's Nek).

The Souru deposit, comprising a defined quantity of 282.160 tonnes of bedded clay, is suitable for the production of hand made bricks. Some mechanization would be required to dig, crush and mix the clay. Good quality bricks could be made by labour intensive methods, but considerable training would be required for at least one year.

The report recommends that a short term consultant be engaged to evaluate the cost of setting up and operating the brick factory and to prepare a document for financial and technical assistance.


CLAY DEPOSITS – x : approximate locations
for numbers c.f. Annex IV)
LESOTHO
SCALE 1:750,000
Km 10 0 10 20 30 40 50 60 Km
Miles 5 0 5 10 15 20 25 30 35 Miles
27°00
27°30
28°00
28°30
28°30
29°00
29°30
30°00
30°30
30°41
REPUBLIC OF SOUTH AFRICA
Fouriesburg
Caledonspoort
BUTHA-BUTHE
Emmanuel Mission
Ficksburg
Maputsoe
Peka
Kolonyama
Cana
TEYATEYANENG
BEREA
Ladybrand
2 + 11
MASERU
Nº1 & Nº2
Ha Khotso
Mazenod
Roma
MASERU
3
Hobhouse
Kolo
Tše-kholo
Phaqame
Herman
Wepener (Oibing)
MAFETENG
Siloe
Mpharane
MOHALE'S HOEK
MOKHOTLONG
QACHA'S NEK
Phamong
Holy Cross
Heights in feet
4000-6000
6000-8000
8000-10000
Over 10000
LEGEND
All Weather Road
Fair Weather Road
Motorable Track
Mountain Pass
River
Ngoajane
Hotel
H
Prepared from D.O.S 1:250 000 sheet (D.O.S 621)
P.O. Box MS 876 Maseru Lesotho Printed by Government
The boundaries shown on the map
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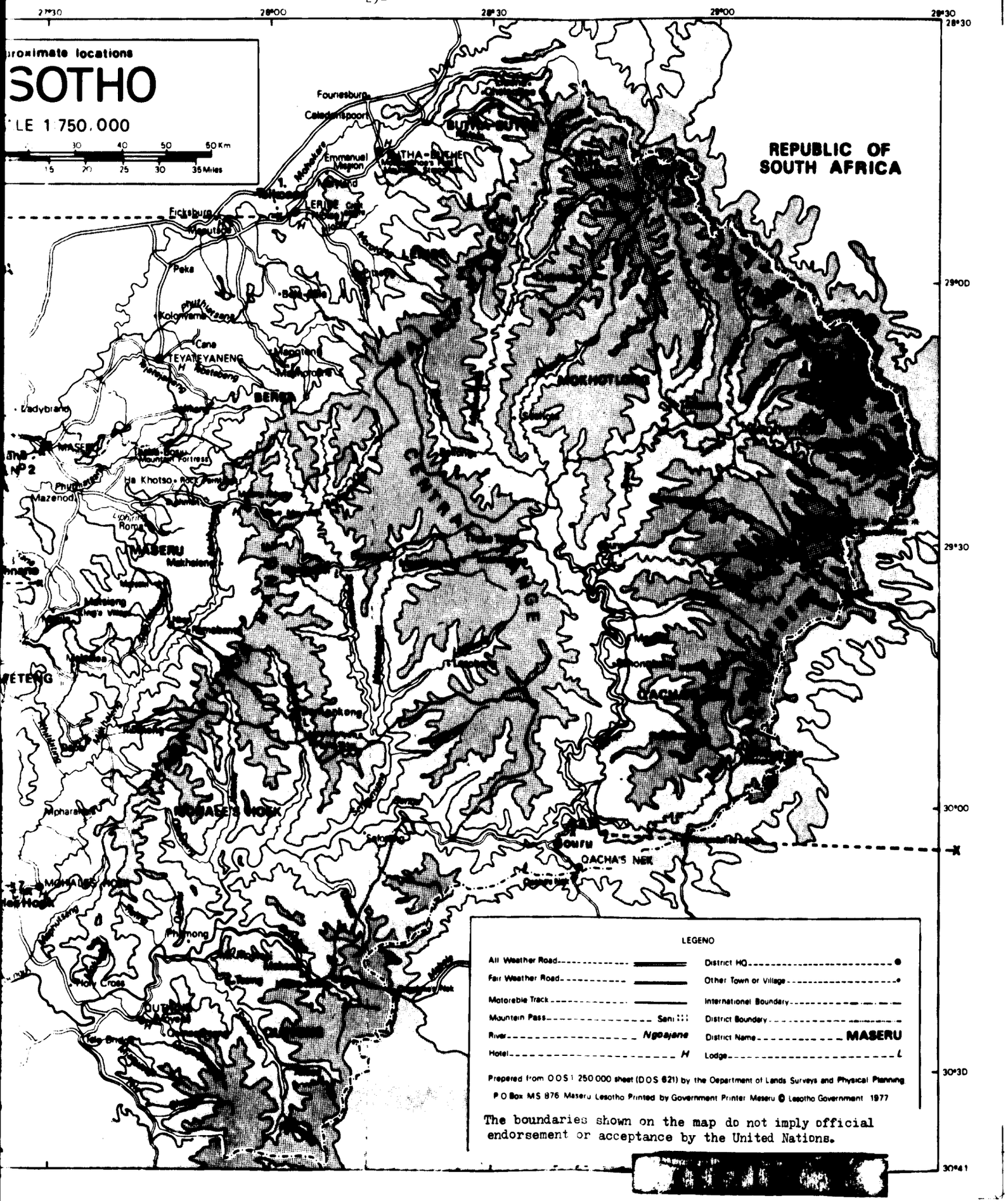
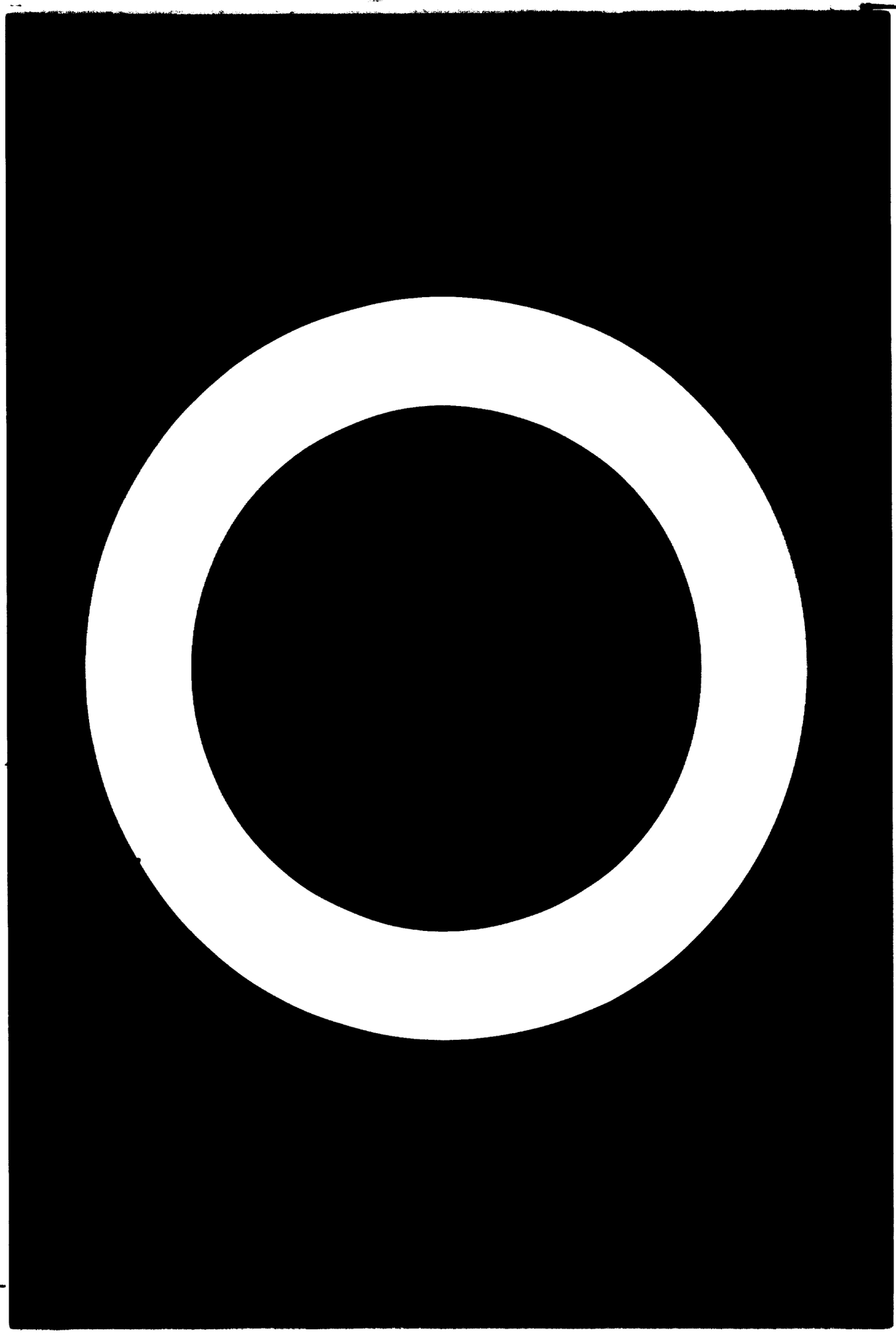

27°30
28°00
28°30
29°00
29°30
30°00
30°30
30°41
roximate locations
SOTHO
LE 1 750 000
30 40 50 60 Km
15 20 25 30 35 Miles
REPUBLIC OF SOUTH AFRICA
Fouresburg
Caledonspoort
Emmanuel Mission
Ficksburg
Peka
Kolonyama
Cana
TEYATEYANENG
Ladybrand
MASERU
Mountain Fortress
Ha Khotso
Mazenod
Roma
MASERU
Matsieng
QACHA'S NEK
MOHALES HOEK
Mohales Hoek
Phamong
Holy Cross
Qacha's Nek
LEGENO
All Weather Road
Fair Weather Road
Motorable Track
Mountain Pass
River
Hotel
District HQ
Other Town or Village
International Boundary
District Boundary
District Name
Lodge
MASERU
Ngoajane
Prepared from OOS 1 250 000 sheet (DOS 821) by the Department of Lands Surveys and Physical Planning
P O Box MS 876 Maseru Lesotho Printed by Government Printer Maseru © Lesotho Government 1977
The boundaries shown on the map do not imply official endorsement or acceptance by the United Nations.



ANNEX V

BIBLIOGRAPHY:

1. Buchanan, W (UNIDO) and Reed, J.J.(UNOTC) - Teikoane Clay Deposit.

2. Buchanan, W (UNIDO) and Kashambuzi, R. (UNV) - Thetsane Clay Deposit.

3. Buchanan, W (UNIDO) and Kashambuzi, R. (UNV) - Tenane (Morija) Clay Deposit.

4. Buchanan, W (UNIDO) and Kashambuzi, R. (UNV) - Ramahlape Clay Deposit.

5. Buchanan, W (UNIDO) and Kashambuzi, R. (UNV) - Reseetle Clay (Motanyane) and Phocoane (Tebang) Clay Deposits, Preliminary Report.

6. Buchanan, W (UNIDO) and Kashambuzi, R (UNV) - Preliminary Report on the survey for clays at Qacha's Nek.

7. Buchanan, W (UNIDO) and Kashambuzi, R (UNV) -Clay Deposits in Mohale's Hoek.

8. Buchanan, W (UNIDO) Draft proposals for the Establishment of Brick Factory at Thetsane :- Requirements and General Design Data, October 1977.

9. Buchanan, W (UNIDO) and Kashambuzi, R (UNV) - Phocoane Clay Deposit.

10. Buchanan, W (UNIDO) and Kashambuzi, R (UNV) - Raneatle Clay Deposit.

11. Buchanan, W (UNIDO) and Kashambuzi, R (UNV) - Thetsane No.2 Clay Deposit.

12. Buchanan, W (UNIDO) and Kashambuzi, R (UNV) - Souru Clay Deposit (Qacha's Nek).

13. Kashambuzi, R. (UNV) A Short Report on the prospecting work done in the Mazenod area.

ANNEX VI.

LECTURES CONDUCTED BY THE PROJECT.

1. October 1976: Lerotholi Artisan Training Centre.

A lecture on brickmaking was given to students of the Ministry of Works Technician Training Course. A basic note sheet was distributed, and a question-answer session held at the end of the lecture. Keen interest was expressed in the potential of Lesotho to manufacture high quality bricks.

2. March 1978: Clay Products Technical Centre.

Students from the Lerotholi Artisan Training Centre from trainee technicians, carpenters, and bricklayers courses visited the CPTC. The work of the project was explained, a wide variety of sample bricks and some pottery was displayed, pipe extrusion was demonstrated, and a variety of bricks were tested for compression strength. Keen interest was expressed in the high quality sample bricks made from Lesotho clays, and a large number of general and technical questions on bricks and brickmaking were answered.

Annex VII

Draft Proposals For The Establishment Of The Brick Factory At Thetsane:-
Requirements and General Design Data

CONTENTS:

A. BACKGROUND

B. FACTORS AFFECTING FINAL DESIGN

C. FUTURE DEVELOPMENT

D. IMMEDIATE REQUIREMENTS

REFERENCES

APPENDIX

TECHNICAL DATA

CLAY WINNING

COAL AND FINISHED PRODUCT HAULAGE

SCHEMATIC DIAGRAM - CLAYWINNING

PRIMARY CLAY STORAGE

CRUSHING AND SECONDARY STORAGE

SCHEMATIC DIAGRAM - SOURING BAYS

SCHEMATIC DIAGRAM - BRICKMAKING SECTION

BRICKMAKING

DRYING AND FIRING

SCHEMATIC - PROPOSED LAYOUT IN BRICKMAKING BUILDING

Thetsane Brick Factory.

A. Background.

1. A shortage of building materials, and bricks in particular, is generally recognised and has led to Government action to stimulate the construction industry. The immediate past result of this in the field of heavy clay wares has been the defining of suitable clay deposits. Taking into account the factors of deposit size, quality, and geo-economic location, the Thetsane deposit has proved to have the most potential to date.

2. The needs of the country have been considered together with the most effective way of establishing the new industrialized sector of the heavy clay industry in Lesotho. Success in this respect will be considered achieved when the Lesotho industry can replace imports, develop an export market, and when national staff can successfully and independantly operate the new industry.

3. The West German Government has offered a capital loan of DM2,5 million to finance a brick factory. The Lesotho Government has decided that the loan will be used to construct a factory at the Thetsane clay deposit, that the factory will satisfy the needs of the local construction industry with respect to bricks and then other heavy clay wares, and that technical assistance will be sought to train national staff. The factory will be established and operated through the Lesotho National Development Corporation,

4. Taking the above factors into consideration, and allowing that the factory should not unduly interfere with existing small scale producers, a factory has been designed which will be capable of producing a range of high quality bricks and

other heavy clay products such as straight pipes, tiles. blocks, etc.

B. Factors Affecting Final Design.

1. The Thetsane clay deposit is located Southeast but adjacent to Maseru, being only 7,5 Km from the Maseru railway station and adjacent to a new proposed industrial area. A report on the deposit (Ref.1) indicates that there are three clay types available, these being called 'Alluvial', 'Lower' and 'Upper' Thetsane clays. The respective tonnages which have been proved are 0,32 million, 1,32 million, and 0,964 million. The upper clay in particular is suitable for a wide range of products from common up to probably engineering quality bricks, whilst the other clays are suitable for at least common bricks, and probably other products.

2. The existing heavy clay industry in Lesotho consists of a number of small producers making bricks by hand or with very simple machinery. The method is extremely labour intensive, and the product varies considerably in quality and availability. More important, all high quality bricks are imported from centres such as Bloemfontein and Johannesburg. Even imported bricks are not always available when required, and this has led to an increasing production of concrete blocks in Lesotho. However, all cement is also imported and again supplies may not be available when required. The obvious result of this is a serious constraint on the Lesotho construction industry. A further, but less obvious factor which influences construction design in Lesotho, is that due to the uncertain quality of local products building design tends to favour re-inforced concrete where architects and engineers can work with a material which has better known and more consistently reliable physical properties. This also results in increased imports of cement and steel.

3. The growth of Lesotho in terms of population and development advancement has led to a natural and accelerating expansion of the construction industry. A lack of timber, abundance of clay, association with a colonialist administration familiar with fired clay bricks, and the influence of a larger and more developed neighbour to whom bricks were both traditional and often prestigious building units, have all combined in creating an atmosphere where bricks are not simply acceptable building units, but when of high quality by modern standards they are the preferred building unit.

4. The nearest 'modern' brick factory to Maseru is the COROBRICK factory near Bloemfontein, some 135 Km away in the Republic of South Africa. Taking into consideration the high weight/cost ratio of bricks, the distance from the COROBRICK factory, and the wide range of physical and aesthetic qualities that can be produced from the Thetsane clay, it may be seen that there is excellent potential to satisfy not only the Lesotho market, but also to develop an export market.

5. As has been indicated, the existing heavy clay industry in Lesotho is at a low level of technological advancement. Coupled with this is a general shortage of experienced national staff from artisan to senior management levels. This must be taken into account when designing any new industrial facility employing high technology equipment from developed countries. The Thetsane brick factory has therefore been designed taking into account the wide range of high quality products that are to be produced, but allowing that mechanization should be minimized in the early years until the national staff have been trained, after which time further mechanization can be employed as and when necessary. At the same time, a relatively labour intensive operation is consistent with the country's need to provide employment for its nationals. Thus the Thetsane factory has been designed such that it utilises modern brick-making equipment where essential to achieve the desired range and quality of products, the equipment used has been chosen for its relative ease of maintenance, and where mechanization

was not essential or could be replaced by a non-mechanized method, then the 'non-mechanized' method was chosen. An example of this is the choice of a grate fired annular kiln such as the 'Belgian' kiln which can be manually fired from the side and is relatively easy to fire up to the maximum desired temperature of 1.150°C. One of the alternatives was a top fired, via mechanical stokers, Hoffman kiln which would have been of more modern design but less versatile and more difficult for inexperienced men to operate.

6. The final factor which had to be taken into consideration was the capital available, i.e. DM2,5 million, or about R900.000,--. This capital sum was decided upon even before the technology has been finalized, and the fact that it may not be available until early 1978 has placed a considerable constraint on the implementation of the factory project.

7. With the capital available, it is doubtful if sufficient artificial drying facilties can be installed to handle total plant output, rated at 6.000 bricks per hour. It is also doubtful if a kiln of sufficient size can be constructed to handle this output. A compromise has therefore been reached whereby some 50% of the production will be air dried and clamp fired, and the remainder will be kiln dried and fired. This may be altered when detailed costs are available for kiln construction. It is likely that alluvial and lower clays, with up to 70% of upper clay mixed will be further mixed with clinker and coal dust prior to being (relatively) soft extruded for air drying and clamp firing. The upper clay will form the basis of a mixture for stiff to semi-stiff extruded products for kiln drying and firing.

8. Due to the relatively soft nature of the upper clay and alluvial clay, plus the well stratified and weathering characteristics of the lower clay, claydigging can be effected by

using a heavy duty front end loader with ripper tines at the rear. This machine has been chosen in preference to face shovel since parts and services are more readily available in or near Maseru. Clay transporting will be by 5 tonne tip trucks, although 3 tonne gravity dumpers would have been preferable had they been available in southern Africa. Clay handling at the brick factory will be by a small two wheel drive front end loader. The flow of materials and general factory layout can be seen in Appendix 1.

9. In concluding this section it is important to stress that the Thetsane factory is the beginning of the development of the modern sector of the heavy clay industry in Lesotho, that a variety of factors have been taken into account to design the factory such that immediate and long term operation will be successful, and that competent technical assistance will be necessary in the initial years of plant operation. Also, in considering any consultancy work up to the stage of commissioning the factory, it must be noted that suppliers will usually provide detailed drawings and information for installation of their products, such services being either free or for a nominal charge.

C. Future Development.

1. Future development of the factory itself will likely be in the form of installation of artificial drying with resultant greater output from the kiln. It will eventually become increasingly attractive to increase kiln firing facilities to the point where all bricks are kiln fired. The kiln itself may be adapted to mechanical stoking.

2. Although single shift working has been envisaged initially, increased output will be fairly simply achieved by going on to two or even three shift production at some later date when conditions warrant it. On three shift production, rated

capacity will be some 40 million bricks per year assuming semi-stiff to stiff extrusion, and higher if less than semi-stiff extrusion is employed. Mechanical handling of bricks from the extruder into the drying section is also a consideration for the future.

3. Although the factory will have an initial emphasis on production of bricks, this will be developed into producing hollow blocks, sill tiles, floor tiles, and roofing tiles, straight pipes, vent bricks, and other clay products. Such production implies an increased capitalization and development of clay bodies. It is therefor preferable that as much of this development as possible takes place during the intial years when technical assistance is available.

4. In addition to the clay haulage vehicles, the factory will have one flatbed truck to be used for bringing coal and coal dust from the rail station, and for delivering some bricks. If it is assumed that the factory starts production in early 1979, and takes two to four years to train staff to maintain a reasonable production level, local transport facilities supported by the brickplant truck should be sufficient to handle plant output. Production would likely increase from some 5 million bricks in 1979 to some 10 million bricks in 1983, assuming that single shift working is maintained. In terms of tonnage, this is roughly equivalent to 15,000 tonnes in 1979 (300 tonnes/week) to 30,000 tonnes (600 tonnes/week) in 1983.

D. Immediate Requirements.

1. The immediate requirements are listed as follows:
   a) Official establishment of the capital loan from the KfW.
   b) Establish if the KfW will finance any necessary consultancy prior to release of the main loan.
   c) Taking into account work already completed such as the

testing and evaluation of the clay deposit, market survey by the Central Planning Office, and decision regarding technology, compile realistic terms of reference for the consultant(s) and advertise these as required.

d) Suggest to the KfW that owing to the relatively small size of the factory and the ever reducing purchasing power of the fixed capital sum, and taking into account the fact that clay samples have been sent to one German and one UK potential supplier, that only limited international tendering be considered.

e) The land requirements as indicated in the report on the Thetsane deposit be allocated without delay.

f) Investigate measures for soils conservation such that overburden stripped off by the factory can be laid down on what might otherwise have been unproductive land, and in this way some of the land used for the factory can be re-established elsewhere in the Thetsane area. Negotiations will also be required in respect of one house which is located on some of the best clay, even although this part of the deposit may not be required for some time.

g) Establish what other industries may be developed on the adjacent industrial site at the same time as the brick factory, and what sharing of services might take place. For example, elctricity and water could be very expensive if the factory must bear the whole cost of their installation, whilst road improvements would also be useful but not entirely essential.

h) Establish the formal Company that is to operate the brick factory with final details of capitalization and source of operating funds.

i) Compile an up to date cost benefit analysis taking into account current costs and benefits, and the information available on buildings, fixed plant and equipment costs. From this a more realistic appreciation of operating capital requirements can be made.

2. These requirements above can be described as 'Pre-Project'

activities in that there is little if any cost involved in their expedition compared to the savings to be made by having them carried out before the capital loan becomes available. All of the activities can be carried out before the start of the project, and for some it is essential. There is little doubt that expeditious action in this respect will help ensure that the best possible equipment can be afforded, whilst undue delay will reduce the overall quality of the factory and its subsequent ability to compete across a broad section of the available market.

3. The design of the kiln has only been specified in a broad and descriptive sense, i.e. that it will be a grate fired annular kiln, probably a Belgian type with 28 chambers and a weekly capacity of about 100.000 bricks assuming drying and firing in the kiln. The next stage is to obtain working drawings and bill of quantities such that realistic quotations can be obtained for its construction. This item, i.e. drawings etc., could cost up to R7.500 (possibly more) and it may be that KfW could be approached to 'pre-finance' it. In the meantime, it is possible for little cost to make enquiries as to a supplier or designer for the kiln. Note that although it has been described as a Belgian kiln, there may be up to date equivalents under different names.

<u>References</u>:

1. Thetsane Clay Deposit, Special Report WB2/RK1, prepared by W. Buchanan (UNIDO) and R. Kashambuzi (UNV), Project For Development of Heavy Clay Industry, DP/LES/74/023, November 1976.

Appendix

1. The following pages give general details of the factory layout and assumed technical data. Individual suppliers who will have tested the clays may be in a better position to give mare accurate data according to the known performance of their own equipment.

2. Clamp fired bricks will have added coal dust and possibly some ash to assist in drying. Kiln fired bricks will rely mainly on the good drying characteristics of the upper clay, but some clinker may be added before crushing if a suitable grog is not available, or until the lower clay becomes available. As is normal, exact mixtures will be developed and refined in detail with factory operation.

Technical Data.

Output per year		13,2 million size B bricks
Working Time (single Shift)		8 hours per shift 5,5 shifts per week 50 weeks per year
Assumed shrinkage:	Kiln Fired	3,5% wet to dry 2,0% dry to fired
	Clamp Fired	5,0% wet to dry 2,0% dry to fired

		Size A mm	Size B mm
Dimensions (approximate)	Kiln fired	215 x 102,5 x 65	222 x 106 x 73
	dry	219 x 105 x 66	226 x 108 x 74
	wet	227 x 109 x 68	234 x 112 x 77
	Clamp fired	215 x 102,5 x 65	222 x 106 x 73
	dry	219 x 105 x 66	226 x 108 x 74
	wet	230 x 110 x 69	237 x 114 x 78
Weight (assumed)	Kiln fired	2,86Kg	3,44Kg
	wet	3,53Kg	4,24Kg
	Clamp fired	2,72Kg	3,26Kg
	wet	3,49Kg	4,21Kg

Note: above data based on mixtures containing +65% upper clay. With -65% upper clay bulk densities would likely be lower and shrinkages could be higher.

: Water content of kiln fired bricks = approx. 18% and loss on ignition = approx. 4,5%

: Assumed that solid bricks are being made, in practice bulk of bricks will be with up to 25% perforation.

Clay Winning.

1. By front end loader with ripper tine(s) at rear, approximately 2 cubic metre rock bucket with teeth, cab and full road equipment, Donaclone or similar air cleaner, four wheel drive, supplier should preferably have agency and hold stock of spares in Lesotho.

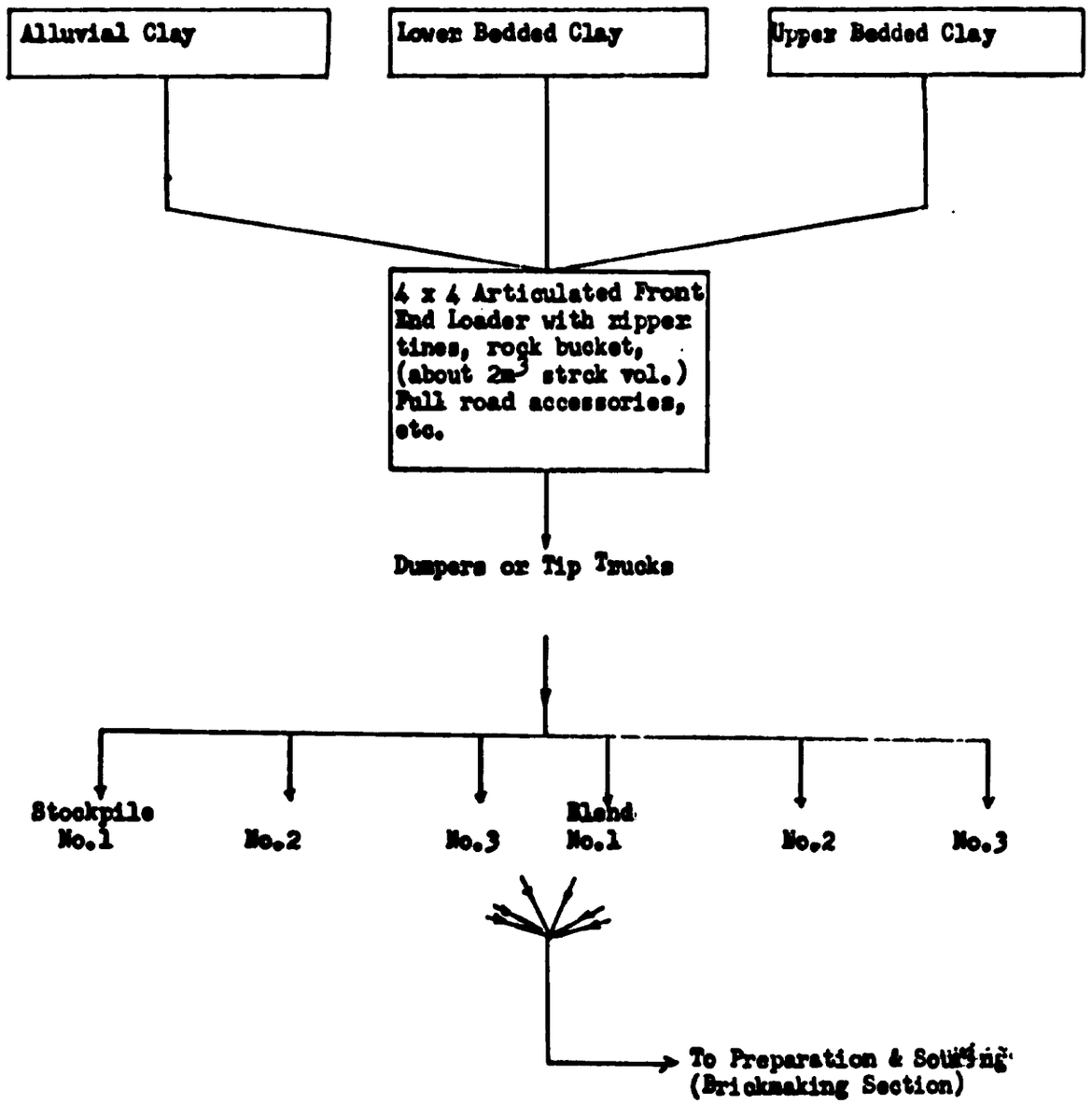
2. Two of 5 tonne tip trucks with full road equipment, hydraulic tip, heavy duty steel body, suitable for short haul site work. Supplier should have agency and hold spare parts in Lesotho.
Alternative: 3 of 3 tonne gravity tip dumper trucks with full road equipment, heavy duty steel dump trays. Supplier should have agency or hold spares stock in Lesotho.

Coal and Finished Product Haulage.

1. One of 9 tonne flatbed truck with full road equipment, 21 ft. 6 in. long body with 3 ft. high sides and removable pillars. Supplier should hold stock of spares in Lesotho.

Notes: The above equipment is quite common in Lesotho and therefore it should be possible to get parts and services. It is assumed that the factory maintenance staff will be trained in preventative maintenance.
: As a Government project, the vehicles could be licensed as 'AX' and be eligble for tax free fuel.

THETSANE BRICK FACTORY ÷ ÷ ÷ SCHEMATIC - - - CLAYWINNING SECTION



Primary Clay Storage.

1. The individual clay types will be stored in open stockpiles near the factory such that a supply is always available even when inclement weather prevents digging from the claypit.

2. Crude blending of clay or other materials can be achieved at the primary stockpile level by laying down in a 'sandwich' fashion, i.e. alternate horizontal layers of the individual materials. These blended stockpiles would then be re-won vertically prior to being taken to the start of the crushing process.

Crushing and Secondary Storage.

1. The clay from the stockpiles may have a high water content, i.e. up to 20%, although this would be unusual. Under normal circumstances it is likely that water content will not exceed 15%, assuming that some drying has taken place in the primary stockpiles. In this latter respect account has been taken of the altitude (1,500 metres) and generally low relative humidity experienced in Lesotho, which combined with the warm day temperatures are conducive to rapid drying.

2. Primary crushing will be by a disintigrator or form of hammer mill or primary rolls type grinder, which will be capable of a throughput of 26 tonnes per hour at a moisture content of 15%. Feed size into the primary crusher will be not more than 250mm equivalent diameter, and output size down to 30mm equivalent diameter.

3. Secondary crushing will be by a differential high speed rolls grinder capable of accepting the rated output from the primary crusher above, i.e. 26 tonnes per hour at a moisture content of 15%, rolls gap being set at 2mm. Provision will be made for water addition to the feed.

4. Product from the secondary crusher will be transferred by belt conveyor to be ploughed off into any selected storage/ souring bay. The proposed design of these bays is shown on the following page but has been left in a general form since the building supplier may be able to incorporate the steel-work supporting the roof into the partition frames.

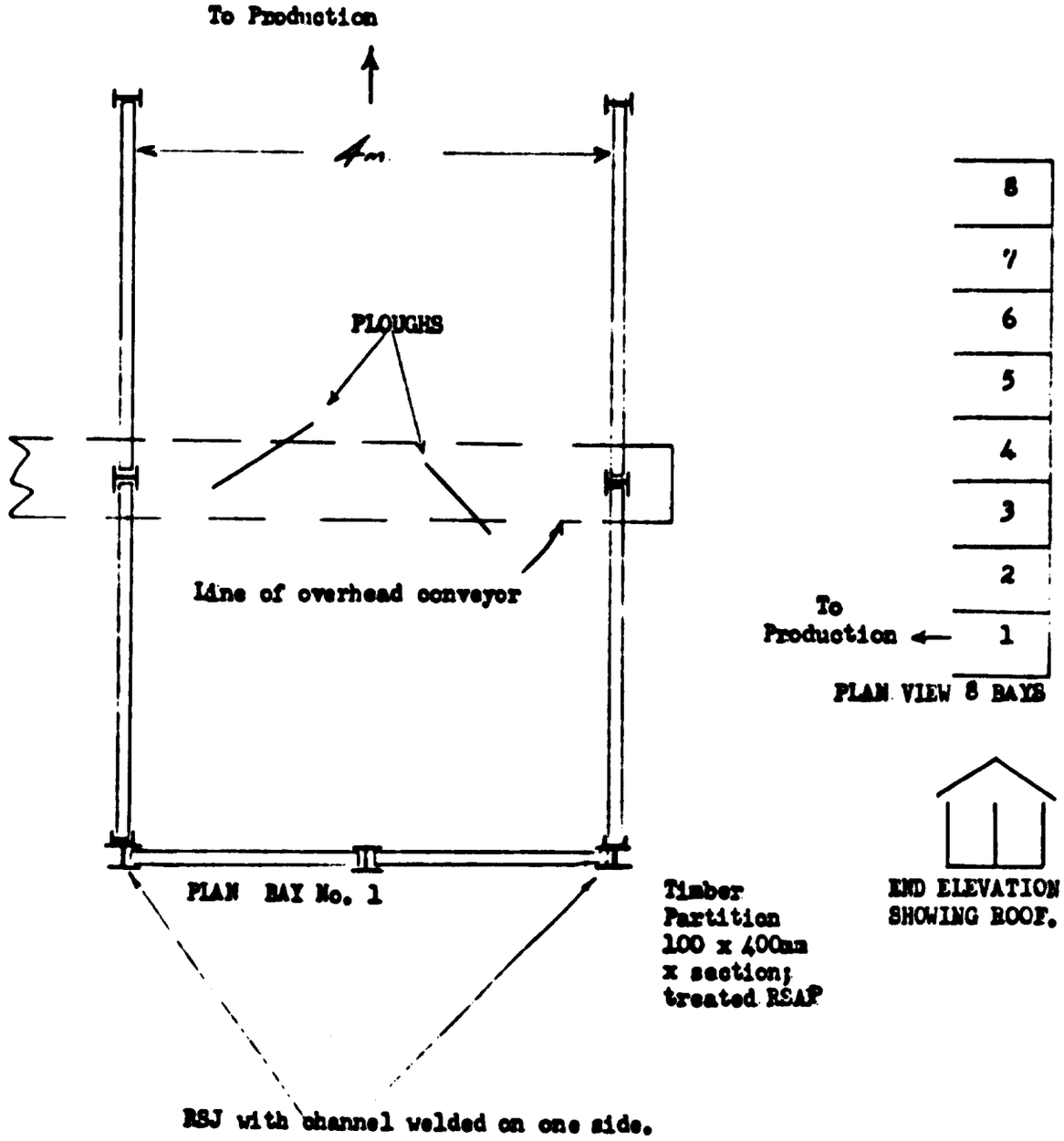
5. The storage bays are of nominal size 6 x 4 x 4 metres with an assumed working capacity of 72 m^3 per bay, there being a total of eight bays to give a total effective storage volume of not less than 576 m^3. The bays will permit some souring of the mixes, and will act as a buffer should clay supply from the pit or primary storage piles be held up, e.g. through wet weather.

6. The above preparation method, taking into account the nature of the raw materials, will be sufficient with only final mixing and water addition, or chemical additive addition, being required.

7. A schematic flow diagram from Primary crushing through to the Brickmaking section is shown on the following page.

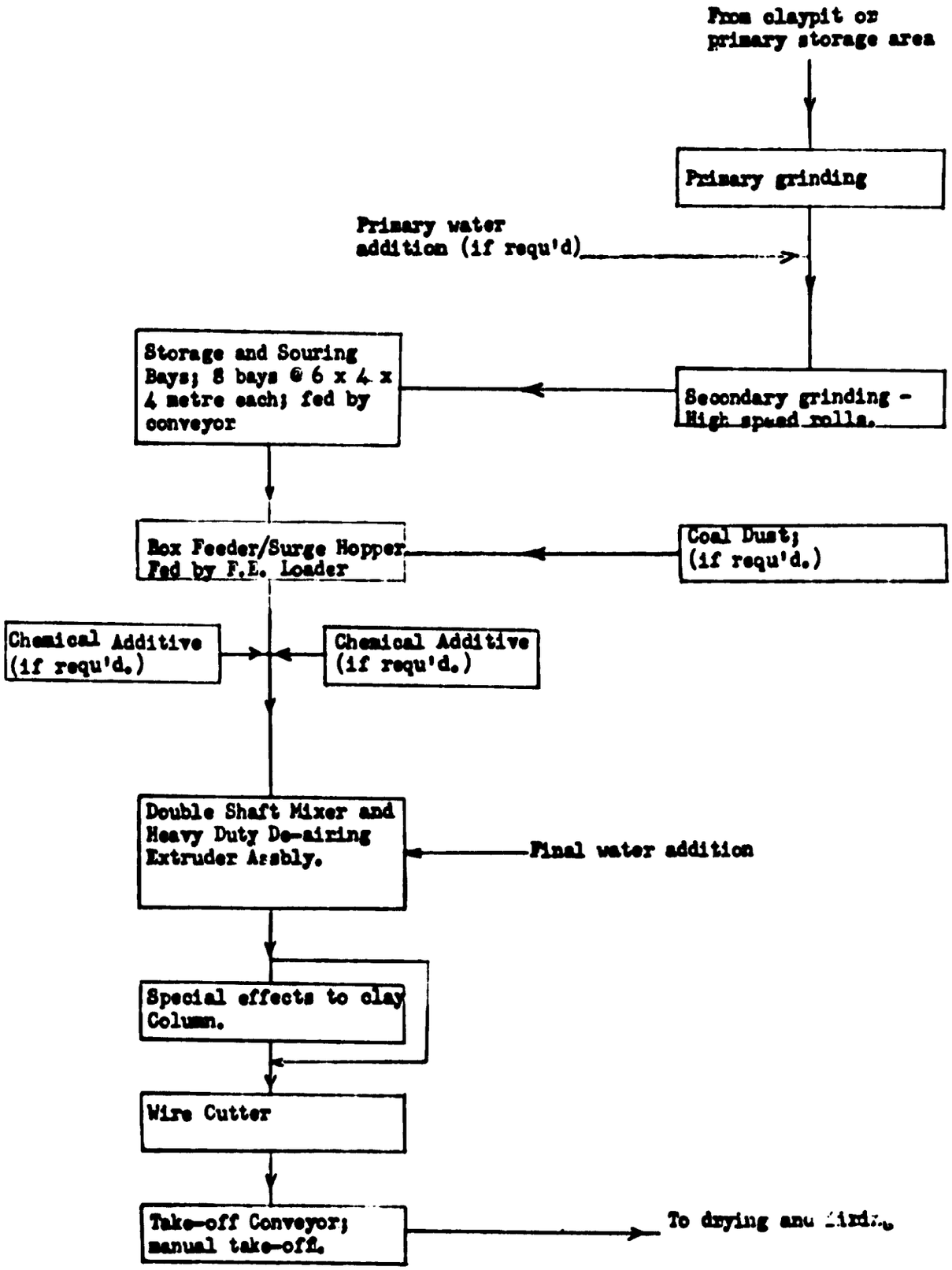
THETSANE BRICK FACTORY - - - PROPOSED STORAGE/SOURING BAYS - - - LAYOUT

DIAGRAMATIC & NOT TO SCALE.



Note: cost of timber partitioning to be evaluated against other materials : each bay of nominal size 6m x 4m x 4m high; struck volume = 96m^3 per bay, allowance of 72m^3 effective working volume per bay. Clay from secondary crusher transported by belt conveyor and ploughed off into bay being served, F.E. loader assists in distributing material inside the bay.

THETSANE BRICK FACTORY - - - SCHEMATIC - - - BRICKMAKING SECTION.



Brickmaking.

1. Transfer of clay from the storage bays will be effected by a two wheel drive front end loader, fitted with toothed rock bucket, full road equipment and cab, Donaclone or similar air cleaner, and weight box at rear. The supplier will have an agency in Lesotho and will hold a stock of spares at the agency. Bucket size will be about 0,5 m^3 struck volume, and operation will be by hydraulics. An agricultural tractor with bucket etc. fitted as an accessory is not suitable. This loader will also be used to assist in feeding the primary crusher.

2. The clay from the storage bays will be fed into an apron-box feeder which will regulate supply to the mixer, and act as a surge hopper. Capacity of the feeder will be not less than 5 m^3 with a feed rate of 30 tonnes per hour.

3. Material from the apron feeder will be transported by conveyor belt to a double shafted mixer passing through a chemical additive station (two stations may be employed). The double shafted mixer will have excess capacity relative to the extruder such that efficient blending and mixing of both final water and additives can take place. Since different suppliers have different sized extruder-mixers, physical sizes are not specified here.

4. Chemical additives such as titanium dioxide or manganese dioxide will be metered onto the mixer feed conveyor by means of a variable speed screw or worm feeder fed from a one cubic metre capacity hopper. Provision will be made for a ladder and platform such that the hopper can be filled manually from bags. Two such feed stations are preferred, but one is an acceptable alternative. The feed rate should be variable from zero up to two tonnes per hour. This method of feeding is relatively simple and accurate and has been chosen in favour of vibro and disc feeders.

5. The blended mixture from the double shafted mixer will pass through a pug sealer into an extruder capable of extruding 6,000 bricks per hour at an extruded size of 234 x 112 x 77mm and a moisture content of 18% on the dry basis. Although the extruded column should be up to 'stiff' extrusion quality, there are varying opinions as to what exactly constitutes stiff extrusion. For the purposes of this factory, an extruder equivalent to the Händle PZVA 60a/50 would be sufficient, this should not be misconstrued as a suggestion that this is the preferred machine. If an extruder producing less than a stiff column, the cost will be less but artificial or air drying of <u>all</u> production will be essential.

6. Ancillary equipment required with the extruder are vaccuum pump, compressor if air activated clutch, special tools and dies for production of solid and perforated bricks. It is recommended that bricks and blocks of the following sizes be produced initially: 225 x 112,5 x 75mm, 222 x 106 x 73mm, and 300 x 100 x 225mm. The latter size which is a block as opposed to a brick would be used for internal walls, or elsewhere, on the assumption that it is to be plastered. The two brick sizes would be for common or face bricks. Consideration would have to be given to producing half blocks and three-quarter blocks of 140mm and 215mm lengths respectively.

7. The extruded column from the extruder may pass directly into a wire cutter, or it may be textured or otherwise treated prior to passing through the cutter. The cutter itself may be a side cutter or reel cutter with provision that it will cut the above sizes of bricks and blocks. The preferred type of texturing device will scarify the surface after which it will apply slight pressure from a roller to give a 'bark' effect, it will also have provision for applying sand to the surface.

Drying and Firing.

1. In considering the drying and firing cycle it must be borne in mind that the greater part of production will be of perforated bricks, i.e. bricks or blocks with up to 25% perforation, and that solid bricks or blocks will only be a small part of production. Where solid bricks or blocks are produced for kiln firing, some measure of pre-drying will be necessary, and such pre-dried product may be set in the bottom courses of the kiln setting. Perforated product will have a quicker drying cycle than solid products and it is based on this that the kiln output of ±100.000 bricks per week will be achieved.

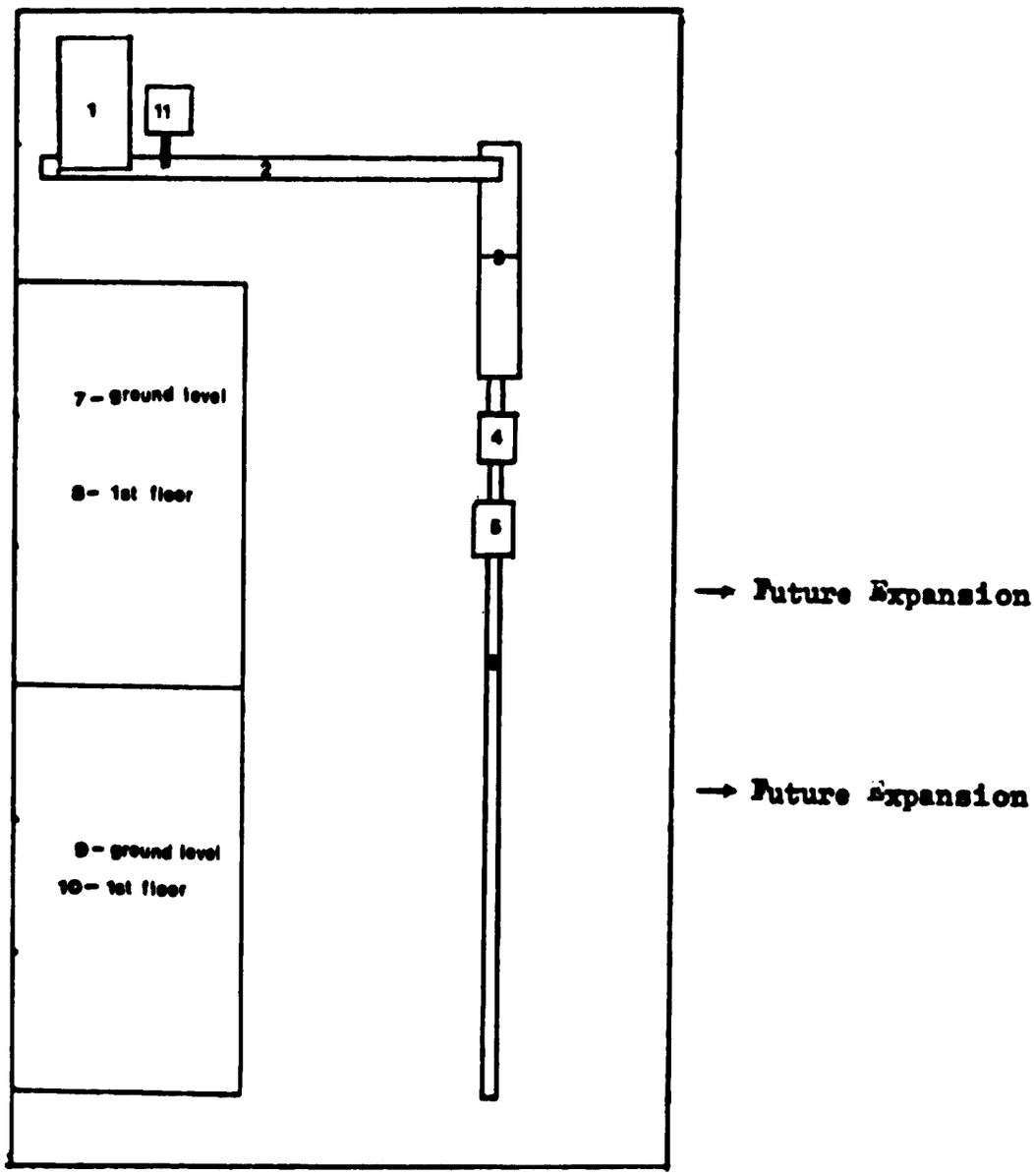
2. Bricks for clamp firing will be taken direct to the hack lines to be set for atmospheric drying. There will be about 700 linear metres of drying lines by 1,3 metres wide. Setting density will be 235 bricks per metre for wet bricks, and 390 bricks per metre for re-set semi dry bricks (i.e. re-set for final drying to 10 high versus 6 high for wet bricks). The capacity of the drying lines is therefore some 164.000 bricks if only wet bricks are considered, but in practice it will be considerably higher. It is not possible at this time to be precise about the drying time for air dried bricks made from Thetsane clays except to say that drying characteristics should be good.

3. The clamps will be built to a size of +500.000 bricks, at which size they will be quite economic to operate. At some later stage consideration must be given to building permanent covers over the clamps, or even from the start if funds are available. Split level loading/unloading must be used to minimize labour requirements, similar to the method now employed at Mohokare Heavy Clay Industry (Pty) Ltd.

Notes: With reference to the perforations in the bricks, the following will apply - 'The holes shall be so disposed that the aggregate thickness of solid material when measured horizontally across the width or length of the brick or block at right angles to the faces shall nowhere be less than 30% of the overall width or length of the brick or block. The area of any one hole shall not exceed 3000mm^2.'(BS 3921:1974)

: With the short production runs associated with making a variety of products feeding two different drying/ firing systems, it would be beneficial to have the extruder fitted with a double hinged mouthpiece to minimise downtimes or overtime associated with die changes.

THETSANE BRICK FACTORY. PROPOSED GENERAL LAYOUT IN BRICKMAKING BUILDING.



SCALE: Approx 1:200

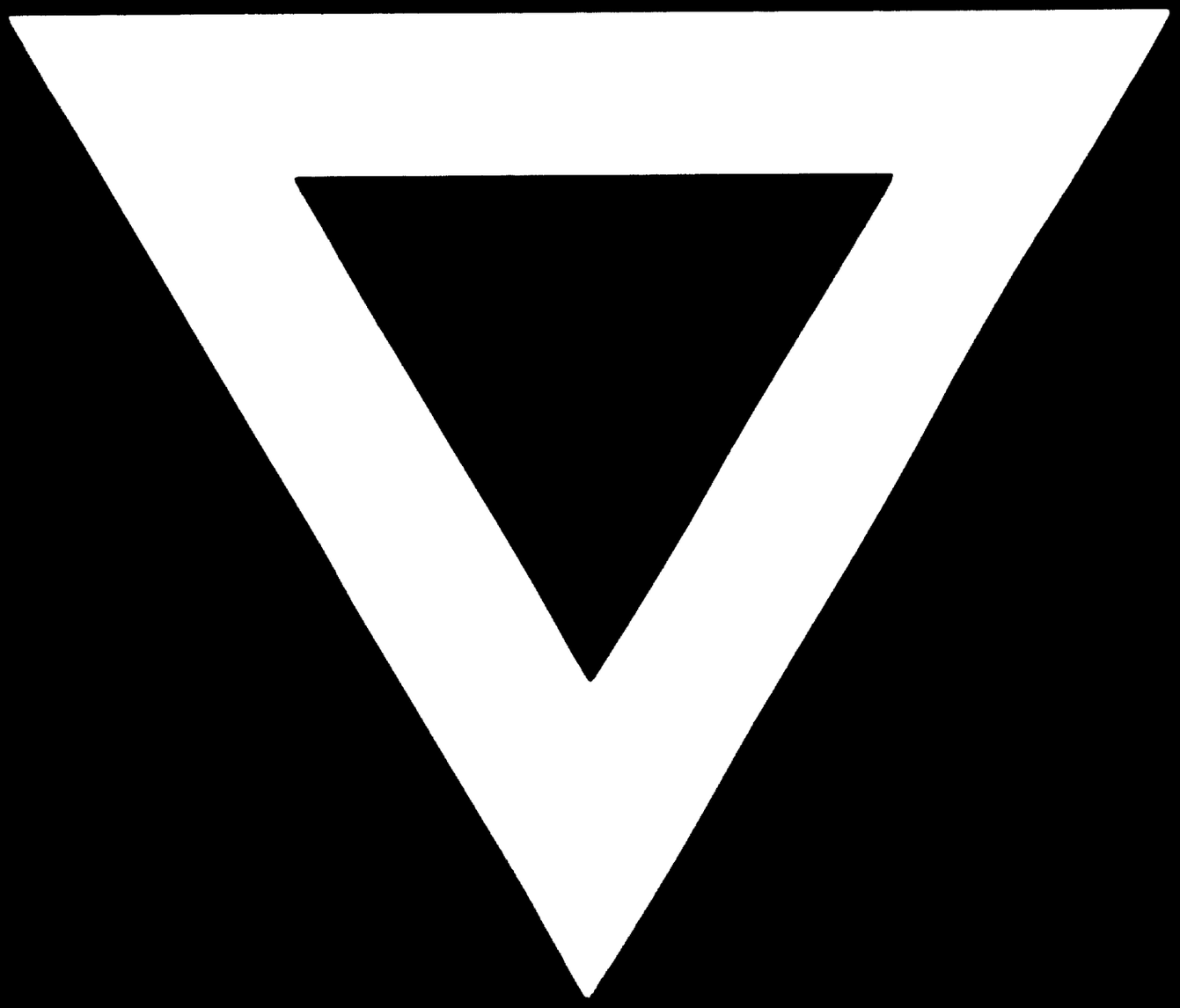
Metal framed, metal skinned building, 34 x 20 metres, floor of 4" single re-inforced concrete, except workshop & store of 6" double re-inforced concrete. Equipment foundations to manufacturers specifications.

For legend, see next page.

1. Apron or Box Feeder.
2. Transfer Conveyor.
3. Double shaft Mixer-Extruder arrangement.
4. Rusticating-Sanding equipment.
5. Automatic wire cutter.
6. Take-off Conveyor.
7. Toilets and Showers.
8. Offices.
9. Workshop and Store area.
10. Mess Hall.
11. Additive Feeder.

Note: Take-off conveyor may be turned at right angles to direction shown, and towards kiln.

C-721



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