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AN ANALYSIS OF LOCA TIONAL FACTORS

IN THE

QUEENSLAND CEMENT INDUSTRY

by

Ian McLaren

DISSERTATION
submitted for

MASTER OF ARTS (QUALIFYING)

in

GEOGRAPHY

University of Queensland
1965
PREFACE

The study presented here developed out of an assignment undertaken as part of a course in economic geography. The assignment involved making a case study of an industrial plant and the plant chosen was the Darra works of the Queensland Cement and Lime Company.

This case study and the brief survey of geographic literature which provided background for the study brought to the fore two points. First, the importance of portland cement to our modern civilization can hardly be overstated as it is the most important non-metallic construction material. Second, geographic literature seemed to have little to say about portland cement. An article by Lukerman, to which reference is made several times in the following pages, affirmed the above observations and prompted further investigation of the locational aspects of the cement industry in this state.

I am most grateful to Dr. Craig Duncan for several years of instruction in economic geography and for his interest and enthusiasm throughout this project. I must also thank Professor R.H. Greenwood for his help in bringing this study to its final form.

Grateful acknowledgement must also be made to several other people whose assistance has been most welcome. The interest and co-operation of officers of the companies concerned was much appreciated and I am particularly grateful to Mr. L.J. Jones of the Queensland Cement and Lime Company, Messrs H.R. Davies-Graham, W.M. Besser and F. Aylmer of North Australian Cement Limited and Mr. R. Pitkeithley of Central
Queensland Cement Pty. Ltd.

Acknowledgement is also made to Mr. Arch. Fraley for the photograph on page 75 and to the "Courier Mail" for those on pages 49 and 54.

I. McL.
## CONTENTS

<table>
<thead>
<tr>
<th>Chapter</th>
<th>INTRODUCTION</th>
<th>THE ESTABLISHMENT OF THE INDUSTRY</th>
<th>THE DEVELOPMENT OF THE INDUSTRY</th>
<th>GEOGRAPHIC DIVERSIFICATION WITHIN THE CEMENT INDUSTRY</th>
<th>SUMMARY AND CONCLUSIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2. Divergent theories on locational factors</td>
<td></td>
<td>2. The first plant</td>
<td>2. The need for increased capacity</td>
<td>2. Features of the location decision in Queensland</td>
</tr>
<tr>
<td></td>
<td>3. Scope of this study</td>
<td></td>
<td>3. The location decision</td>
<td>3. The location decision for the new plant</td>
<td>3. Conclusion</td>
</tr>
<tr>
<td></td>
<td>5. Outline of argument to substantiate thesis</td>
<td></td>
<td>5. Summary</td>
<td>5. Establishment of the Parkhurst plant, Rockhampton</td>
<td></td>
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<td>2. Divergent theories on locational factors</td>
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<td>2. The first plant</td>
<td>2. The need for increased capacity</td>
<td>2. Features of the location decision in Queensland</td>
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<td>2. The first plant</td>
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<td>3. The location decision</td>
<td>2. The need for increased capacity</td>
<td>2. Features of the location decision in Queensland</td>
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<td>3. The location decision</td>
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<td>4. Statement by the company</td>
<td>3. The location decision for the new plant</td>
<td>3. Conclusion</td>
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<tr>
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<td>4. Statement by the company</td>
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<td>5. Summary</td>
<td>4. Establishment and development of the Stuart plant</td>
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<td></td>
<td>5. Establishment of the Parkhurst plant, Rockhampton</td>
<td>5. Establishment of the Parkhurst plant, Rockhampton</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td>1. Prior Market Conditions</td>
<td></td>
<td>1. The first plant</td>
<td>I. Growth of new market conditions</td>
<td>1. The Present Situation: the producers and the market they serve</td>
</tr>
<tr>
<td></td>
<td>2. The first plant</td>
<td></td>
<td>3. The location decision</td>
<td>2. The need for increased capacity</td>
<td>2. Features of the location decision in Queensland</td>
</tr>
<tr>
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<td>3. The location decision for the new plant</td>
<td>3. Conclusion</td>
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<td>5. Establishment of the Parkhurst plant, Rockhampton</td>
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<td>2. Features of the location decision in Queensland</td>
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<td>4. Statement by the company</td>
<td>3. The location decision for the new plant</td>
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<td></td>
</tr>
</tbody>
</table>

- Page numbers: **1, 18, 32, 63, 88**
MAPS and DIAGRAMS.

Australian cement plants, 1964  
Queensland cement imports, 1900-1914  
Location factors in 1914  
Flow sheet  
Factors affecting the regional distribution of markets  
Queensland cement supply, 1900-1964  
The location of the Darra plant  
The site of the Darra plant  
The location of the Stuart plant  
The site of the Stuart plant  
The location of the Parkhurst plant  
The site of the Parkhurst plant  
Diagram of distances from Maryborough  

TABLES

Analysis of a typical portland cement  
World cement production  
Regional distribution of cement sales  
Regional distribution of population in Queensland  
Australian production and imports of cement  
Government purchases of cement in North Queensland  
Limestone Analyses  

PHOTOGRAPHS

Cement using industries  
Coral dredging and transport  
Queensland Cement and Lime Coy. works at Darra  
North Australian Cement Ltd. works at Stuart  
Central Queensland Cement Pty. Ltd. works at Parkhurst
CHAPTER 1
INTRODUCTION

"Pronouncements on the locational character of the cement industry are not lacking in geographical literature...... However there is no consensus: no one seems to know exactly what the conditions of cement production are, nor why the industry is located where it is."

F. Lukerman, "The Geography of Cement?"

1. PORTLAND CEMENT

Since man first started to build, he has endeavoured to find a material that would bind sand and stones into a solid formed mass. In the ancient riverine civilizations of the Assyrians and Babylonians, clay was used for this purpose. The Egyptians discovered that lime and gypsum could be used as cementing agents to bind bricks and blocks of stone. The Romans, over two thousand years ago, manufactured a cement by mixing slaked lime with volcanic ash and the efficacy of this cement is demonstrated by the fact that certain of the buildings, bridges and aqueducts constructed with this material are still standing today.

Lime cements continued to be the main type of cements until the Industrial Revolution. In 1756 John Smeaton, while engaged on the construction of the Eddystone lighthouse, noted that the best hydraulic limes were those made from limestone with an appreciable clay content. However it was not until 1796 that Parker in producing "Roman cement" heated the raw materials to just short of vitrifying temperature. Frost in 1822 produced his "British cement" and Aspdin in 1824 produced the first so-called "Portland cement", but both of these could be better described as hydraulic limes since the raw materials were heated only to calcine the limestone and not to clinkering
temperature. The name was given to the cement because of the resemblance of the set product to a natural stone quarried at Portland, England. However the modern portland cement is rather different from that which Aspdin first made. About 1845, I.C. Johnson "produced a cement of the modern portland cement type by burning the raw materials 'with unusually strong heat until the mass was nearly vitrified', and this clinker when finely ground made a cement which was far in advance of the ordinary type produced at that time."¹ Since then the main advances in cement production have been in the introduction of new machinery for the transporting, crushing, pulverizing and burning of the raw materials, and in the chemical control of the constituent elements to utilize a wider range of raw materials and to produce a range of varieties of the basic type of portland cement. Since the beginning of this century portland cements have been the principal cementing material used in construction, although some use is still made of cements having similar properties such as natural cement and blast-furnace slag cements or pozzolan cements.²

Portland cement is made today by burning a mixture of calcareous and argillaceous materials to clinkering


²Pozzolan cement is usually a mixture of slaked lime and granulated blast furnace slag. The name is derived from Pozzuoli in Italy from whence volcanic ash, variously called pozzolana, poszuolana or puzzolan, was obtained for hydraulic cements. Some pozzolan cements are made from similar volcanic ash occurring elsewhere. (see p.75)

Natural cement is made by burning a marl known as cement rock which has satisfactory proportions of the necessary chemical ingredients for the production of a cementing material. By contrast, in the production of a portland cement, greater attention is given to the exactness of the proportions of the ingredient elements.
temperature and grinding the resultant clinker. The mixture may be a natural one or an artificial one using limestone, chalk or coral for the calcareous material and clay or shale for the argillaceous material. After the clinker has been ground, gypsum (calcium sulphate) is added to act as a retarder to prevent the too rapid setting of the cement. The resulting cement is then composed of the oxides of calcium, silica, aluminium, iron and sulphur plus minor amounts of other impurities (see Table 1).

**TABLE 1**

<table>
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<tr>
<th>Analysis of a Typical Portland Cement</th>
<th>(After Lea &amp; Desch)</th>
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<tbody>
<tr>
<td>Lime</td>
<td>CaO</td>
</tr>
<tr>
<td>Silica</td>
<td>SiO₂</td>
</tr>
<tr>
<td>Alumina</td>
<td>Al₂O₃</td>
</tr>
<tr>
<td>Iron Oxide</td>
<td>Fe₂O₃</td>
</tr>
<tr>
<td>Sulphuric Anhydride</td>
<td>S₃O₃</td>
</tr>
<tr>
<td>Other</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Suggested Composition</th>
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</thead>
<tbody>
<tr>
<td>4CaO·Al₂O₃·Fe₂O₃</td>
<td>9.5%</td>
</tr>
<tr>
<td>3CaO·SiO₂</td>
<td>42%</td>
</tr>
<tr>
<td>3CaO·Al₂O₃</td>
<td>6.7%</td>
</tr>
<tr>
<td>2CaO·SiO₂</td>
<td>34%</td>
</tr>
</tbody>
</table>

Portland cement is a generic name for a number of varieties which are made by varying the proportions of the main ingredients. Each variety possesses qualities which suit it for some special use. The High Early-Strength portland cements have a higher than usual tricalcium silicate content and are more finely ground. These have, as well as the property of rapid hardening, a greater resistance to the
action of sea water and better refractory properties, but the disadvantage of a higher heat of hydration which makes them unsuitable for use in large mass concrete structures such as dams. High alumina cements possess similar properties. Low heat cements were first developed for use in the Hoover Dam and have low tricalcium silicate and low tricalcium aluminate proportions. The other main variety of portland cement is sulphate resisting cement which has a higher than normal proportion of both silicate fractions. Special cements such as white and other coloured masonry cements are not strictly portland cements, and as they are not produced in Australia do not merit fuller description.

The word cement, when used in this study, refers to portland cement unless otherwise specified. This is sanctioned by common usage where the word, particularly if it is unqualified and used in connection with building and engineering, refers generally to portland cement. This usage stresses the fact that portland cement is the most important cement used at the present time, the world's output amounting to over three hundred and fifty million tons per annum. Of this total Australia produces almost three million tons per annum. (see Table 2).

**TABLE 2**

<table>
<thead>
<tr>
<th>World Production</th>
<th>Metric Tons</th>
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<tr>
<td>World Production</td>
<td>358,000,000</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>58,937,000</td>
</tr>
<tr>
<td>U.S.S.R.</td>
<td>57,328,000</td>
</tr>
<tr>
<td>Japan</td>
<td>28,787,000</td>
</tr>
<tr>
<td>West Germany</td>
<td>28,593,000</td>
</tr>
<tr>
<td>Italy</td>
<td>20,157,000</td>
</tr>
<tr>
<td>France</td>
<td>16,852,000</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>14,253,000</td>
</tr>
<tr>
<td>China</td>
<td>9,000,000</td>
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5.

Most of the cement is used in making concrete which occupies a dominant position in modern construction. Concrete consists of a paste of water and cement binding inert aggregates (sand, gravel or crushed rock), into a rocklike mass as the paste hardens through a chemical reaction of the cement with water. Concrete is used in urban construction, in building highways, bridges and dams, in irrigation, water supply and sewage facilities, in airport runways, docks and harbours and in a variety of other projects. As well as this primary use in concrete construction, cement is also used in "cement products" most of which are in turn used in construction. Some of the more important of these are concrete masonry, cast stone and concrete pipes and asbestos-cement sheeting and shapes.\(^3\) Cement consumption is in fact a useful indicator of activity in the construction industry and, because of this, a useful indicator of economic activity as a whole in a modern industrialized economy.

Modern cement production requires a large investment in capital equipment and the plants making cement are invariably large scale units. The industry as a whole is widespread throughout the world but production is markedly concentrated in the countries which are more advanced industrially.

Production figures for the world and for the leading producing nations have been given in Table 2. Of the total annual production the United States and the U.S.S.R. each produce about 16 per cent, Japan and West Germany each produce about 8 per cent and Italy and France each about 5 per cent. Altogether over fifteen countries produce more than 1 per cent of the world total but, of these, the leading

\(^3\) Probably 25% of the cement produced annually in Australia is now used in "asbestos cement goods" and "other cement goods." If "ready mixed concrete" is included with "asbestos cement goods" and "other cement goods" as it is in Commonwealth statistical publications, then these bulk consumers now use almost 50% of the cement produced annually in Australia. (Secondary Industries Part II, Bulletin No.55, Bureau of Census and Statistics).
four countries together produce 50 per cent of the total, and approximately 75 per cent of world production is concentrated in Europe and North America. Australia produces just under 1 per cent of the world total.

2. DIVERGENT THEORIES ON LOCATIONAL FACTORS

As has been pointed out, the cement industry is one in which the volume of production is quite large: in fact the weight of cement produced each year is approximately equal to the weight of steel produced and is greater than the production of all the metals other than iron together. The industry produces one of the most important of constructional materials, and, because of this, is a valuable indicator of economic activity. Moreover, as it is an industry which has emerged since the Industrial Revolution, it is one in which technological advances have been extremely important. Although the industry is widespread it does, because of the nature of the product, exhibit sharp localizations. These features would seem to indicate that the industry deserves rather more attention from economic geographers than it has received in the past.

However the industry receives only scant attention in many geography texts and other studies of economic activity. When such references as can be found are investigated further, it is noted that there are marked differences of opinion on the reasons for the location of the cement plants. Inukerman's words "Pronouncements on the locational character of the cement industry are not lacking in geographical literature. Because of the industry's widespread distribution in both pioneer and advanced societies, and in industrial and non-industrial economies, most surveys in economic geography contain comment on the production pattern of cement as to its occurrence and areal relation-
However, there is no consensus: no one seems to know exactly what the conditions of cement production are, nor why the industry is located where it is. 4 Lukerman illustrates this contention by quoting from five economic geography texts, divergent statements on the locational character of the industry. Reference to these and other texts reveals that the pronouncements on the locational character of the cement industry are even less prevalent and even less adequate than Lukerman suggests. Such reference however affirms Lukerman's contention that there is no consensus of opinion.

Very few texts give an unqualified statement that one locational factor alone is dominant, but most of the texts state that two or more factors are of importance. However contradictions between statements in various texts were noted. Only one text attempted to distinguish between location factors influencing choice of situation and those influencing choice of site.

The types of orientation which were given most prominence were orientation to raw materials, to markets and to transport facilities although Lukerman 5 also notes certain historical factors. Capital and labour requirements were not stressed though the immobility of fixed capital in plant can be subsumed in the above mentioned historical factors. No reference was found which distinguished between factors involved in the decision on the original location of

4F. Lukerman: "The Geography of Cement?", Professional Geographer, Vol.XII, No.4, July 1960, p.1. In this article Lukerman has attempted only to draw attention to the problem, to collate opinions and reformulate the original geographic questions which provoked such a diversity of opinion. No attempt is made to provide definitive answers. Apparently very little attempt has been made by other geographers to provide answers to the questions that he has raised. In this study it is hoped to analyse in a particular context of time and place, the locational factors which have operated in the establishment and development of this industry.

5Ibid, pp.4-5.
the plant and those factors which ensured the longer term viability of the plant (unless a reference to the adequacy of the size of the original limestone deposit can be counted as such). No mention was made of taxation, land costs or wages as locational factors and no indication was given as to the reason for this omission: either they are only a small part of the total product cost or they may be assumed to be areally undifferentiated. Energy requirements and costs were mentioned in only one of the texts investigated.

Raw material orientation was mentioned in most of the references and, in at least three texts, the statement of raw material orientation was unqualified: i.e. raw material requirements were stated to be the dominant locational factor. The bulk and weight of the raw materials to be used and their low value were the main reasons given for their importance in the location decision. All of these references were, by nature of their excessive simplification, unsatisfactory. More satisfactory references distinguishing between the various raw materials, the relative amounts required and the costs of these, and their relative ubiquity or scarcity were rarer.

The simplest, and least satisfactory, theories of raw material orientation are demonstrated by the following statements:

(1) "Owing to the bulky nature of the raw materials, cement manufacturing plants are commonly located near the source of their raw material and not necessarily within the market area."\(^6\)

(ii) "Since the raw materials are of heavy weight in proportion to value, cement factories tend to be localized."\(^7\)

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(iii) "Since limestone is the most important constituent of cement, cement plants are located usually where a plentiful supply of limestone is available."\(^8\)

A far more satisfactory discussion of the role of raw material considerations in the choice of the site of the plant is given by E. Willard Miller whose discussion of the factors involved was probably the most satisfactory of those referred to.

(iv) "Of the raw materials limestone exerts the greatest influence on cement plant location. Clay or shale is usually available in most localities and even if they are not available locally only about one-third as much clay or shale as limestone is needed. Coal normally moves toward the limestone because much less coal is needed than limestone and coal deposits are more geographically restricted. Although deposits of limestone are widely distributed not all are suitable for cement manufacture. A cement limestone cannot contain more than about 10% magnesium carbonate or improper ratios of aluminium, silica and iron oxide, or excessive impurities such as silica, iron pyrite or sulphur. Other factors to be considered in regard to limestone are the size of the deposits (to assure several years of operation), the method of mining that can be employed and especially the location of the deposit in relation to convenient transportation lines and the cement market."\(^9\)

Opposed to the direct unqualified statement of raw material orientation, as presented in references (i), (ii) and (iii) above, is the following direct statement of market


orientation which argues the near-ubiquity of suitable raw materials and fuel:

(v) "Fortunately limestone and clay (or shale) are to be found in every state. There are few areas where at least one fuel - coal, oil or gas - cannot be obtained for industrial use. Therefore cement plants are located close to the market, the distribution of plants roughly coinciding with the distribution of population."  

The following quotation illustrates the unresolved conflict between these assessments of orientation:

(vi) "Proximity or lowest cost access to markets is the major location factor for cement plants since the heavy, bulky and low value product cannot stand the cost of expensive haulage. In addition plants must be strategic for the assembly of raw materials and fuel which may be coal, oil or natural gas. The most critical raw material is the limestone which must contain less than 3 per cent magnesia - a stipulation that excludes many lime rock deposits. Consequently cement plants are generally located either near the markets or adjacent to a major limestone quarry."  

The following quotation also illustrates the same conflict but does little to resolve it as it evades the issue by referring to the "ideal location". However it does mention the importance of economies of scale (though it does not examine the full implication of these economies) and the importance of a low cost route of transfer.

(vii) "Because of the low value of cement in relation to weight, because it is made from heavy raw materials, and because considerable fuel is used, not much can

---

be shipped far from the factory unless the plant is on or very near navigable water. Hence it is one of the most widely distributed of all industries. Moreover since cement is produced most profitably on a large scale, the distribution of cement mills is proportionate to the distribution of population. The ideal location is one where raw materials and fuel are in close proximity both to one another and to a large market. Some such locations do exist."

As indicated above probably the most satisfactory discussion of the factors involved is that by H. Willard Miller, who points out the differing effects of these factors on situation and site decisions.

(viii) "Cement is a cheap heavy commodity, manufactured from bulky raw materials and using considerable fuel. It can be produced profitably only on a fairly large scale. Consequently the ideal location for a cement plant is one where supplies of raw materials and fuel are found in close proximity to each other and to a large market. Thus, ideally, the sites of the plants are raw material oriented and the regional location of plants is market oriented."

The importance of market orientation is given further stress in the following statement:

(ix) "However since about 1920 there has been a tendency to locate plants in regard to their market areas with the availability of raw materials playing a relatively secondary role. Many large plants are now constructed on the out-skirts of cities. This has been especially

...desirable where navigable waterways give cheap transportation to distant raw materials. The large urban area not only provides a market for cement, but a convenient assembly point for raw materials."\(^\text{14}\)

It will be noted that although the references quoted have dealt with raw materials and fuel, markets and transportation, no mention has been made of ancillary power requirements. Only Miller made reference to the importance of the use of electric power which is used in cement works chiefly for driving ancillary equipment especially in the grinding of the raw materials, coal and clinker. Perhaps in the United States the availability of power and power cost differentials are such that omission of a discussion of power costs is excusable, but this is certainly not the case in Queensland. Miller states that:

\((x) \) "Since the economics of production favour plant location close to markets, it is evident that cement mills will have widely differing energy costs, depending on the level of fuel costs in each region."\(^\text{15}\)

The passages that have been quoted here serve to illustrate the divergence of opinion in standard texts. To attempt to explain this divergence is a useful exercise which reveals much about this subject on which a wide range of geographers have made such conflicting statements. The exercise brings to the fore three facts.

1. Distinction must be made between locational factors operative in site determination and those setting the regional situation. These two terms "site" and "situation" are used in this essay as a precise and a general description of location respectively, in accordance with the usage of the terms commonly found in geographic writings. By site is meant the exact position of the

\(^{14}\text{ibid, p.426}\)

\(^{15}\text{ibid, p.427}\)
plant with regard to the precise features, both physical and man-made, of the local environment. By situation is meant the location of the plant in the wider regional setting.

2. Likewise distinction must be made between factors which are involved in an original location decision and those which ensure the long term viability of the plant. 16

3. Great caution must be exercised by the geographer wishing to make a general statement on the locational character of an industry if the situation that is apparent in this case is to be avoided. The statements quoted above tend to emphasize indiscriminately certain relevant factors. They therefore are not incorrect statements but partial statements which, although correct in certain contexts, can be completely misleading in other situations.

Further consideration makes apparent the need for case studies in particular contexts of time and place. To be a useful contribution to the body of theory of economic geography such case studies must offer general conclusions, but these general statements must be qualified as being applicable only in situations very similar to that described in the case study.

At this point it is well to consider Ackerman's contention that the paucity of knowledge in geography at this stage is such that fundamental research must be disaggregative. It is not yet at a stage where the integration of data on processes and site may be considered. 17 The

16 For a full discussion of the margins of viability approach to location studies see W. Rawston, "Three Principles of Industrial Location", in Transactions of the Institute of British Geographers, 1958. J.W. Alexander in Economic Geography, Prentice Hall, New Jersey, 1963, pp.351-352 makes a similar distinction between initial and survival location factors, but his survival factors do not encompass changes in the initial factors and adjustments made to compensate for these changes.

17 E.A. Ackerman: "Geography as a fundamental research discipline", University of Chicago, Department of Geography, Research Paper No.53, 1958.
implications of this for the methods of study of economic geography cannot be fully discussed here but it is felt that the research strategy outlined by Ackerman may err on the side of excessive caution. The formulation of generalizations can not wait until all the available data has been compiled. A more satisfactory and practical approach may be that suggested by McCarty. McCarty suggests the formulation of areally-restricted or topically-restricted hypotheses which, if shown to be valid, could then be more generalized as more data became available from other studies to allow the formulation of broad principles of economic geography.

3. Scope of this study

In this study an analysis is made of the location factors which have been of importance in the locational decisions made at the time of establishment of the cement plants in Queensland, and those factors which have been involved in subsequent decisions to expand production or to establish new plants. It is planned to cover both of the aspects of locational analysis which seem to be important in such a study. An attempt will also be made to distinguish between factors relevant to the location decision at the general regional level and those relevant to the choice of a particular site. The period under investigation will be from the beginning of this century to July 1964.

4. Statement of thesis

It is proposed to demonstrate in this study the over-riding importance of the market factor in the location of the cement industry of Queensland. No specific claim is made for the general application of the findings of this investigation in other situations. However the thesis can

be adequately substantiated as an explanation of the locational character of the Queensland cement industry and it seems that there is a fair measure of coincidence with the situation in other areas.

Briefly, it has been observed that the industry is primarily market oriented and, at the regional level, this fact broadly determines situation. The location of the plant then depends upon accessibility to raw materials and fuel. Site requirements are not excessively demanding and the exact site is chosen upon the availability of a suitable area of ground with clay and water supplies and transport facilities.

It is proposed to argue that:

(i) The establishment and development of the Queensland cement industry has been consequent on the growth of established local market demand.

(ii) Lowest cost access to markets has been the major locational factor in the establishment and development of the industry. The bulky, low value and perishable nature of the commodity is responsible for this attempt to minimize transport costs to the market. The predominantly urban use of cement and the economies available from location near a major urban centre have reinforced the attraction of large urban markets.

(iii) On the other hand, the economies due to large scale production have, until recently, prevented a geographic diversification of cement plants in Queensland and these plants are still limited in number and highly selective in location.

(iv) A further locational consideration in the establishment of the various plants has resulted from an attempt
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to minimize the cost of assembly of raw materials and other inputs - the most critical of the raw materials being the limestone.

(v) The sites of the plants have been determined by the existence of a suitable area of land with available clays and water supply and with access to both rail and road transport.

5. **OUTLINE OF ARGUMENT TO SUBSTANTIATE THESIS**

In substantiating elements of the thesis as outlined, the following sequence will be adopted: first, to consider conditions leading to the establishment of the industry and the location problem of the first plant; second, to consider how changing conditions affected the viability of the plant in that location; and third, to consider the locational factors which were operative in the recent period of geographic diversification of the industry.

The first stage in the development of the Queensland cement industry was the establishment of the Queensland Cement and Lime Company's plant at Darra. The growth of the Queensland market to a size that warranted the establishment of this plant will first be investigated. The production factors - the sources and relative importance of the raw materials, and the other input factors of fuel and power, labour and capital - will then be analysed to ascertain their relative importance in the original location decision. The suitability of the Darra site and location will then be evaluated in the light of these location factors and the reasons given by the company for this choice.

During the subsequent years productive capacity at the Darra plant was continually expanded. At first this was compelled by the need to seek economies of scale and permitted by the excess of market demand over local
supplies, but later expansions indicate that the plant continued to be viable at this site. During this period there were many changes in the nature, magnitude and extent of the market and changes in the production factors. These latter changes involved a radical reorganization of the raw material supply situation. The importance of these changed factor supplies will be analysed to evaluate the continued suitability of the site to serve the Queensland market.

Although expansion continued at Darra after 1943, by this time it was obvious that a new set of conditions had developed which required geographical diversification of production rather than increase of production at the established site. The North Queensland market had grown to such a size that it warranted the establishment of a new cement plant. The motives for the establishment of this plant, the market conditions and transport costs of the period will be analysed to establish the locational factors involved in this decision to install the new productive capacity at Stuart rather than at Darra. The substitution problem was between additional outlays on transport and reduced outlays on production due to economies of scale for the Darra plant on the one hand and additional outlays on production and reduced outlays on transport for the proposed Stuart plant on the other. The impact of the locational factors involved here and the effects of governmental and social pressures and incentives will be analysed. A similar situation arose some years later in respect of the central Queensland market and a similar analysis of conditions in this case also will be made.

Finally, an attempt will be made to collate the locational factors revealed as significant by these analyses, and to demonstrate that the stated thesis can be substantiated as an explanation of the locational character of the Queensland cement industry.
I. Prior Market Conditions

Until 1917 the Queensland market for cement was supplied entirely by shipments from overseas and interstate sources. Cement consumption in Queensland had risen gradually to 13,500 tons in 1910. A little more than half of this was supplied by direct imports from overseas while the remainder was imported through other states, the greater part being shipped from New South Wales. In 1910, of the 6,200 tons from New South Wales only 120 tons was of Australian manufacture.

![Graph showing Queensland Cement Imports 1900-1914]

By 1914 the local demand was in excess of 25,000 tons per annum which made the establishment of a cement plant in Queensland a commercial possibility. Several companies were formed to investigate the possibility of
the establishment of such a plant. Because the Queensland Government was interested in the possibility of a plant being established, information on deposits of suitable cement making materials had been collected by the Government Geologist. This information was "available for the use of persons who desired to engage in the industry." Although the party in power was willing to leave the establishment of such a plant to private enterprise, a member of the Labour opposition in the Legislative Assembly did suggest the "establishment of a State factory for the manufacture of cement" but to little effect.

The general public, encouraged no doubt by the success of cement works in other States, was only too willing to subscribe to an enterprise of this type. In fact it was stated in a pamphlet circulated prior to the establishment of the Queensland Cement and Lime Company that "factories have been successfully established in New South Wales, Victoria and other States and in New Zealand, all of which are paying handsomely while the demand is greater than the supply." Queensland investors would also

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1 Statements recorded in Queensland Parliamentary Debates and in the "Daily Courier" of 1914 indicate the interest felt by many persons in the venture. Full details of the plans of companies other than Queensland Cement & Lime Coy. for the establishment of a cement works would offer valuable information on approaches to the location problem as seen in 1914. Unfortunately the only references discovered to another such company was that the Queensland Portland Cement Coy. Ltd. was registered on 29-1-1913 (Statistics of Queensland, 1913) and that this company was struck off the register by the Attorney General in May, 1914 (Queensland Government Gazette, Vol. CII, 1914).

2 Statement by the then Minister for Mines, Mr. Appel. The Daily Courier Thursday, April 2nd, See Appendix 1.

3 Mr. Barber, Member for Bundaberg, Queensland Parliamentary Debates 1914, p1537.

4 Ibid, p.1537. Mr. Barber quoted from a pamphlet by a Mr. Morry which was circulated in early 1914. In the Queensland Cement & Lime Coy. history published in 1951, the credit for the selection of the Darra site, on which the company established its works, is given to Mr. Morry. (see page 29).
have been aware of the results of a governmental inquiry a few months previously in New South Wales into the affairs of the Commonwealth Portland Cement Company. This company had a paid up capital of £100,000, and in 1913 had distributed a profit of £60,000, and over a nine year period had distributed profits of £400,000. Such knowledge may have also "inspired the small number of public-spirited men in Brisbane to form a syndicate to finance and explore the possibilities of establishing a works in this state." In a realistic survey of factors in the establishment of a plant by private enterprise, it is necessary to consider not only the fact of the existence of a demand but also the possibility of that demand being profitably exploited. It would appear in this case that the demand existed and the interested parties were certain that it could be profitably exploited. This supports the first proposition of the thesis being argued here that the establishment of the industry was consequent on the growth of established local market demand.

2. **The first plant.**

In June 1914 the Queensland Cement and Lime Company Limited was established "to acquire from Mr. A.C. Elphinstone and others an option of purchase of certain mineral leases and freehold lands, and to carry on the business of manufacturers of, and dealers in, cement lime and other commodities." Prior to the establishment of the Company Mr. Morry had made proposals either for the establishment of "a works capable of turning out 20,000 tons per annum" in which case "the capital required to accomplish this would be about £60,000" or for a more

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5 ibid., p.1537
7 Investment Service, Research & Statistical Bureau, Sydney Stock Exchange, Q2, October 1958.
modest scheme involving an investment of £40,000 to erect a 10,000 ton plant. The plan which was finally accepted was a far larger scale one.

In the early months of 1914, Krupps of Stuttgart were operating in Australia and this company tendered to the Queensland Cement and Lime Company to erect a plant of 30,000 tons capacity for a cost of £150,000 half of which was to be in the form of shares in the company. Although this tender was accepted the outbreak of war prevented this scheme from eventuating. This necessitated "a complete change of programme and the calling of tenders throughout the world. Another contract resulted, at a much enhanced price, for plant drawn from various sources and after many vicissitudes including the sinking and seizure of many units and the internment of the Works manager," the plant was built at Darra by 1916 and the company's manufacturing operations began in 1918.

3. The location decision.

In establishing a cement plant in Queensland the company had to make location decisions at both the broader regional level and at the level of choosing the exact site. The second proposition of the thesis being argued here is that the industry is, at the broader level, primarily market oriented. Although there exist no statistics of consumption of cement by regions in Queensland to verify the concentration of the major part of the market in any particular portion of the state, it is obvious that it was in south-east Queensland close to Brisbane. The

8. Queensland Parliamentary Debates, 1914, p.1537. The proposals were made in the pamphlet referred to in ref. 4 above.

Location factors in 1914 - transport lines, sources of raw materials and power.

- Railway lines in 1914 (Queensland Yearbook, 1912).
- Electricity Towns with electric power.
- Coal Coalfields being worked in 1914.
concentration of population in this part of the State, particularly the concentration in the metropolitan area and the importance of the use of cement in urban construction all indicate that this area was in 1914, as it is today, the major section of the Queensland market. Because of the need to serve this market in competition with imported cement arriving at the port of Brisbane, it is obvious that a location in south-east Queensland, preferably close to Brisbane, would be desirable. Reinforcing the attraction of Brisbane as a location for the plant would be those agglomeration economies which can be gained from a location near a major urban centre. Such a location allows the use of the many facilities (transport, power, water) and specialized and auxiliary industrial and repair services available in large urban centres, and makes available a more economical, and often more assured, supply of many production inputs.

To proceed to an evaluation of the location chosen for the plant it is necessary to investigate more closely the production factors involved. These production factors may be conveniently treated under the broad groupings of raw materials, power and fuel, labour and transport costs.

Portland cement can be produced from a range of raw materials containing calcium, silica, aluminium and iron oxides provided they can be proportioned in such a way that the desired chemical combination by heat is possible. The proportions of the materials used have not varied significantly in the past fifty years. The raw material from which calcium is obtained is some form of calcium carbonate such as limestone, the source of silica may be sand or the siliceous fraction of clay or shale, which substances are usually also the source of the aluminium and iron oxide.
In order to make one hundred tons of cement, approximately one hundred and forty tons of calcium carbonate, about six tons of argillaceous material such as clay and some eight tons of arenaceous material such as sand are required. The product of chemical combination and fusion is known as clinker and in the final processing after grinding the clinker, about four tons of gypsum (calcium sulphate) are added. The other requirements are about one hundred tons of water and about thirty tons of coal. These latter may be distinguished as ancillary rather than basic raw materials. In the process of grinding and moving the production materials at the plant approximately 120 kilowatt-hours of electric power per ton of cement are consumed.

Although all of the raw materials which must be assembled in order to produce cement are fairly widespread, the limestone is perhaps the most critical of these raw materials. There are two aspects to this: the limited occurrence of suitable deposits and the amount used in the process. In Weberian terms, the limestone has a locational pull almost five times that of coal which is the next heaviest material used. Further, in the production process there is a weight loss associated with the limestone of approximately 50 per cent. Despite these facts the plant was not located close to the limestone supplies which were at Gore to the west of Warwick. Three miles from the Gore railway station a quarry had been in operation for some years. The reports of the Government Geologist indicated that the limestone was part of a very large body of remarkably pure limestone.

10 For further discussion of other aspects of the weight loss theory see W. Isard, Location & Space Economy, Technology Press of the Massachusetts Institute of Technology, N.Y., 1956, p. 225.

11 See section 4 of this chapter for a statement by the Company on the selection of the Gore limestone. See also Appendix II for a comparison of the main limestones available.
The obvious source of coal for the plant was the West Moreton field. A situation on the railway line to the west of Brisbane would therefore offer a convenient assembly point for the two heaviest ingredients, the limestone and the coal. If the location decision involved simply a case of transport orientation then substitution analysis would yield Gore as the transport optimum site along this railway for the location of the plant. However as has been stressed the decision is limited primarily by the market-oriented nature of the industry. The site eventually chosen had to be as close to Brisbane as would be compatible with the assembly of the other production inputs. This involved choosing a site of a suitable area (at least fifteen acres) with adequate clay and shale deposits and access to a large supply of fresh - but not necessarily potable - water. The water was needed simply for mixing with the crushed raw materials since the plant was to use the "wet process" of cement manufacture.\textsuperscript{12}

In 1914 electric power was available only in very restricted areas of Queensland. There were only eight "Electric Power and Light Manufactories" in the State. Two of these were in the metropolitan area and there was one in each of the following towns: Ayr, Charters Towers, Rockhampton, Thargomindah, Toowoomba and Warwick.\textsuperscript{13} It will be noted that, of these, the last two are on the railway line to the west of Brisbane between the mining sites for the coal and the limestone. A situation near either of these towns could offer an economic assembly

\textsuperscript{12}In the "wet process" the finely crushed raw materials are mixed in water to form a slurry which is then pumped in to the kiln. In the "dry process" there are large heat economies as the water does not have to be driven off, but there is rather more difficulty in controlling the proportions of the ingredient raw materials and ensuring their thorough mixing.

\textsuperscript{13}Statistics of Queensland, 1914.
point for the coal and the limestone (cheaper than assembly near Brisbane) and both of these towns could have provided adequate power, water and labour supplies. But the disadvantage in either of these locations would have been the problems of distribution and marketing.

Note that it is the problems of distribution and marketing and not merely the costs involved in transport of the product to the market. Analysis of the various sets of transport inputs in ton-miles involved in each case show a Brisbane location to be at a disadvantage. Even if the freight rates on cement were 50 per cent higher than those for the bulk commodities, limestone and coal, a Brisbane location would only barely be more satisfactory than the Warwick location. And even assuming the freight rate on cement to be 75 per cent higher, then the Toowoomba location would still be more favourable.

The problems in distribution and marketing arise from the perishable nature of the commodity and the need for the supplier to be in close contact with the consumers to ensure that the market can be supplied whenever the cement is needed. The setting up of supply depots in Brisbane by a Toowoomba or Warwick based plant would not solve the difficulty as the increased terminal charges involved in the double handling of the finished product would soon consume any cost advantage gained from direct transport costs.

As a result, a location near Brisbane, although slightly less favourable in terms of the transport costs of assembly and distribution, offered advantages of close and direct contact with the greatest part of the market.

The final stage of the manufacturing consists in grinding the clinker together with a retarder which prevents the too rapid stiffening of the cement paste. Gypsum is
used as the retarder and, as none was mined in Queensland at that time, it had to be imported through the port of Brisbane. This minor factor would also have reinforced the attraction of Brisbane as a location.

The labour requirements of the works were not excessively large and labour costs do not represent a sufficiently large proportion of the final cost of the cement to make the labour factor of any great importance in the location decision. The plant in 1920 employed only one hundred men and a labour force of this size could be found quite easily close to Brisbane but would be increasingly difficult and increasingly costly to obtain in smaller centres away from the metropolis.

To place one ton of cement on the market involves the assembly of three tons of raw materials for its production and then the distribution of that ton of cement. During the early years of the operation of the Darra plant a production of 20,000 tons of cement using Gore limestone and Ipswich coal would create more than five million ton-miles of traffic. Obviously the plant had to have direct access to a route of easy transfer which would be capable of handling a large volume of bulky, weighty, low-value goods. Rail transport in 1914 was the most satisfactory solution available to the problem, and a site on a railway line was of prime importance. When the site at Darra was chosen as having the necessary clays and water beside the railway line a spur line was built into the works from the main line.

There is no reason to suppose that the site chosen at Darra was the only site that would have been suitable along the five or six miles of railway from Goodna to Oxley. The availability of certain blocks of land was probably the deciding factor and when the articles of association of the company were drawn up it was stated that the company would
buy certain blocks of land which were held under option by Mr. Arthur Morry and certain other pieces which he was under contract to buy. These blocks form the basis of the company's holdings today although the company has since acquired other small sections for its private road. The above mentioned articles also state that the mineral rights and leases at Gore were held by Mr. Morry.

4. EVALUATION OF LOCATIONAL FACTORS - A COMPANY STATEMENT

The preceding discussion has attempted to consider the relationship of certain factors involved in the successful location of plants to the location decision made with respect to a particular plant. It has also been an attempt to reconstruct the conditions surrounding the establishment of the plant. It is not possible at this stage (some fifty years later) to describe how the decision was made. Instead it is only possible to consider the factors which are known to be relevant and to offer a rationale for the location which was chosen.

The Queensland Cement and Lime Company, almost forty years after its establishment, published a small history of cement production in Queensland. In this publication is the following statement on the decision to locate the works at Darra:

"The site for the works and the materials to be used were, in the main, those selected by the late Arthur Morry, an engineer in the Department of Agriculture and Stock, whose dream it had been to see Queensland making its own cement. The works site was Darra, chosen because it was on the railway, within the 10 mile radius of Brisbane, and contained many of the main cement ingredients, with the further advantage of being in close proximity to the Ipswich coalfields. There being no processible limestone in

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14 Company papers filed with the Registrar of Companies.
15 From Titles Office records.
sufficient quantities nearer than Gore, this was adopted as the quarry site, but as it entailed a 200 mile rail haulage to the works, it was the one weak link in the plan of operations.\footnote{History \textit{Production \& Utilization of CEMENT in Queensland, Queensland Cement \& Lime Co. Ltd., 1951, p.1.}}

5. SUMMARY AND CONCLUSIONS

Thus it may be seen that in the first decade of this century the demand for cement in Queensland increased rapidly until it was large enough to support a works of a size which was considered economical at that time. The raw materials and fuel necessary were available although they were not located in such easy proximity as to make the establishment of a cement works an obvious possibility. Thus it was not until the demand was established that the possibility of profits inspired any entrepreneurial activity.

This activity resulted in the decision to build a plant and it is at this point that the location problem becomes relevant. The major portion of the market was in southeast Queensland, in particular in Brisbane, and was supplied largely through the port of Brisbane. The decision to locate the works close to Brisbane indicates a primary market orientation for the industry at the broad regional level. The location of the plant was then decided more exactly. The existing railway line and the location of the limestone and coal deposits must have made obvious the desirability of a location on this line to the west of the city. But having decided on the general situation on this line with access to limestone and coal, an exact site had to be chosen considering the need for suitable clays or shales and a certain water supply and the need for electric power and labour. The site chosen at Darra fulfilled all of these requirements.
In the following section the development of the industry will be traced to investigate the changes in marketing conditions and in raw material and fuel supply, and the way in which these changes affected the original location decision and the long term viability of the plant.
CHAPTER III

THE DEVELOPMENT OF THE INDUSTRY

1. SOME ASPECTS OF CEMENT PRODUCTION AND MARKETING

The first proposition of the thesis being argued here is that the establishment and development of the Queensland cement industry has been consequent on the growth of established local market demand. It has been shown in the previous chapter how establishment of the first plant awaited the development in Queensland of a market that could absorb at least 25,000 tons of cement annually. Quotations from statements made by people interested in the possibility of cement production at that period stress that this was an important consideration. But it is important to realize that, until recently, a similar consideration was of the utmost significance in determining if and when increases in the production of cement would be made.

For an understanding of the development of the Queensland cement industry during the last fifty years this fact is of the utmost importance. It is the result of both the nature of the industry itself in terms of plant (and therefore capital requirements) and productive efficiency, and of the nature of the market being supplied. Both of these factors need to be described in more detail before proceeding to a description of the developments that have taken place in the industry in this state.

First, it is generally recognized by economists that economies of scale are possible in capital intensive industries and the cement industry is usually considered in this class. Cement plants are usually large scale units and evidence on the economies of large scale production is found in writings on the cement industries of both the
United States and the United Kingdom. If these economies are real then the first inference is that a suitably sized established market is needed to warrant the building of a cement works which will be able to produce cement economically. The second inference is that increments in production will be large and expensive. Consequently the attitude of the entrepreneurs to the future prospects of the market will be of major importance in any decision to increase plant capacity. A decision to increase production at a site is therefore virtually a vote of confidence in the existing location of the plant.

Two modifications of the foregoing discussion on capital requirements are necessary. First, although a cement plant is centred on the kiln, other ancillary equipment is vitally necessary for production. Available figures indicate that production expansion involving kiln equipment necessitates very large capital investment, but when production is limited by ancillary handling equipment, expansion of production for a much lower investment is possible. Second, economies due to large scale production may be achieved only when the productive capacity of the plant is fully utilized. Apparently, when production is substantially below capacity, manufacturing costs rise drastically because of the high capital consumption charges which continue regardless of the level of output of the plant. An investigation of whether a plant will be able to produce to capacity inevitably leads to a consideration of market conditions.

In traditional economic analysis a market is treated as existing at a single point. In a small compact national area where highly developed forms of transport


2Developments in Australian Manufacturing Industry, Department of Trade, 1957/58-1963/64.
minimize transport costs and "spatial friction" a national market may reasonably be regarded as a single market for certain easily transported commodities. However for a bulky, low value, perishable commodity in a country as large as Australia it is not wholly reasonable to speak of one market. The federal political structure reinforces the effect of distance in making the Australian market a set of markets interdependent only to a marginal extent.³ The individual State governments over the past decades have vied one with another in attracting new industry and fostering the growth of existing ones. Any treatment of the development of an industry in Australia cannot ignore this fragmentation of the market due to political structure and the basic spatial separation of the concentrations of population.

Another aspect of marketing conditions that should be stressed is related to the nature of the product itself. Cement has to be produced to certain standardized specifications on which there are rigid governmental controls so as a result there can be no product differentiation in competition for markets. Only three varieties of portland cement are produced in Australia - Ordinary, Low heat and High early strength. Within any one of these types the consumer has no preference for any particular brand of cement except on the basis of price. Therefore market boundaries, assuming rationalization of consumer behaviour, can be fairly simply determined. The delivered cement price at any point will basically be the factory price plus handling charges and transport costs.

At no time in the history of cement production in Queensland have conditions existed where the price of

³However interstate cement shipments enjoy some advantage because of constitutional provisions regarding interstate trade (but also because of the lower charges associated with transport contracts for bulk shipments.)

cement could be determined by the intersection of a simple set of supply and demand curves relating to supply by the local producer and the local demand. An investigation of the plants in the Queensland cement industry at the time of their establishment is at the first of the Weberian levels of inquiry at which locational analysis is possible; i.e. at the level of "the small individual producer who has a negligible influence upon prices (with the exception of the price of his own product), the locus of consumption, the supply costs and sources of factors, transport rates, agglomeration economies and other locational variables". For such a producer entering into an established market where there is no other producer but an outside source of supply, the ruling market price is already set by the trade conducted to serve that market. The importance of this established trade is of great importance in the case of the Queensland market. As Isard has stated "(1) location cannot be explained without at the same time accounting for trade, and (ii) trade cannot be explained without the simultaneous determination of location."

Briefly it may be stated that, if a region where a certain sized market exists is served from outside production sources, then the price of the commodity in that region is determined unless artificial barriers such as tariffs are imposed. A plant capable of serving that market can be established in the market area provided

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4. Isard, "Location and Space Economy", Technology Press of the Massachusetts Institute of Technology; New York: John Wiley & Sons, 1956, p.92. It is realized that long after the locational decision was made by the Queensland Cement & Lime Co. that some major cement users established plants close to the Darra works. This is, in some degree, an effect on the locus of consumption; but it is a small one and is not relevant at the time of making the original location decision.

5. Ibid, p.207
that the scale of production allows the commodity to be produced at a price at or below the prevailing market price.

In the case of the establishment of the Darra plant it will be seen that a significant increase in the price of cement, due to the disturbance of trade caused by the First World War, helped the struggling new company to establish itself firmly in the Queensland market. In the case of the later plants, an isolated regional market was to be served and the price of cement in that region was high due to transport costs. The high rail freight component in the retail price of cement offered adequate margins for a small local producer to compensate for the loss of margins due to large scale production. Therefore a small scale plant was an economic proposition. Thus in the Queensland case the economies of large scale production could not completely dictate the necessity of large scale plants. Rather, the distance between regional markets favours the establishment of smaller plants with a higher production cost structure, but a production level geared to the requirements of the regional market.

2. THE QUEENSLAND MARKET

In the case being examined here the Queensland market must be recognized as a market area relatively separated from the rest of Australia. This market area is not undifferentiated as this would imply that there is one price ruling throughout and that transport costs within the market area can be assumed to be zero. Such is far from being the case. The Queensland market is itself a set of regional markets that have been served from one supply point as a single market only under unusual conditions.  

6 It seems that the isolated, fragmented Australian market shows several examples of this phenomena in other states than Queensland, suggesting that the concept of economies of scale in the Australian cement industry is of limited applicability in view of the size of the markets to be served and their geographic separation.

7 For example, during the depression of the early thirties and during World War II and the immediate post war years.
Factors affecting the regional distribution of markets.

The core of the problem of regional markets is basically one of accessibility. Hence in Queensland the main bulk transport lines, the State Railways, have to a large degree predetermined the regional markets. The pattern is in contrast to that in New South Wales where the rail system converges on Sydney and the main cement producers are centred around Sydney. In Queensland the main railway is the coastal one with secondary lines to the interior from Brisbane, Rockhampton and Townsville. Given this threefold market pattern it is easy to understand the general locations chosen for the plants of the Queensland cement industry. The first plant was established close to Brisbane and was able to supply this first region and, under certain circumstances, was able to serve the whole state from the capital. Subsequent growth of cement consumption led to plants being established in these other regional markets. Note that the growth of cement consumption did not create the regional markets but merely made it feasible to establish plants in them.

Another special circumstance that must be considered is the set of tariffs and taxes that act as a barrier to overseas trade and as an aid to interstate trade. Tariff protection has in recent years been of importance in protecting the newly-established North Australian Cement Company at a time when it would have been particularly vulnerable to the dumping of foreign cement.8 The interpretation given to Section 92 of the Commonwealth Constitution has helped the Queensland Cement and Lime Co. to capture a large market in northern New South Wales, but of course there are other economic and geographic reasons why the Darra plant should be able to supply areas of New England and the Northern Rivers.

8This point is discussed in more detail in Chapter IV.
An element of the market that requires special attention is the proportion of the total production of cement utilized by a limited number of large consumers. The "asbestos cement goods" and "other cement goods" industries now annually absorb almost half of the total production, and State government works and contracts also absorb a large proportion. 9

An important and interesting feature of the cement industry, in view of this dependence on a limited number of large scale outlets for production, is the lack of vertical integration in the industry. It could be suggested that this is related to the lack of competition in the Queensland market due to the monopolistic control of the market by the Queensland Cement and Lime Co. for many years. However it is noted that a similar lack of vertical integration has been characteristic of the Australian cement industry as a whole even in states where there are several competing producers. 10 It should also be mentioned that both the Queensland Cement and Lime Company and North Australian Cement Company have for short periods ventured into cement brick making but in both cases the venture ceased upon the entry into the field of another brickmaking firm. In each case an official of the company concerned stated that "it was not the company's policy to compete with customers." 11

9 The two industry groups in 1960-61 absorbed 47.8% of the total production (Secondary Industry, Part II, 1960-61, Bull.55, Bureau of Census & Statistics, Canberra, p.65). The proportion used by major governmental agencies is rather more difficult to assess. This is due to the variations from year to year in actual purchases as one project is completed and another begun, and also to the fact that many governmental works are let to private contractors.

10 The one instance known of vertical integration was the take-over in 1960 of Standard Portland Cement Ltd. by Concrete Industries Ltd. (Investment Service, Research and Statistical Bureau of the Sydney Stock Exchange.)

11 Private communications.
Graph 1. Queensland Cement Supply, 1900-1964: Production and Imports from Overseas

Tons

- 450,000
- 400,000
- 350,000
- 300,000
- 250,000
- 200,000
- 150,000
- 100,000
- 50,000

Production in Queensland - N.A.C. Ltd.
Amounts shown are cumulative.

Production in Queensland - Q.C. & L. Ltd.

Imports into Queensland.
Amount shown is superimposed.

Sources: Overseas Trade, from 1908 to 1962-63
Statistics of Queensland, Qld. Parliamentary Papers, to 1914
Annual Reports of the companies concerned
R. S. B. Investment Service.
3. **DEVELOPMENT AND CHARACTERISTICS OF THE QUEENSLAND MARKET**

In the past fifty years the annual consumption of cement in Queensland has increased approximately twenty fold from about 25,000 tons to almost 500,000 tons. (See Graph 1). This rise in consumption has not been a steady one. In the absence of firmly established local supplies consumption was forcibly lowered during the disruption of overseas trade caused by World War I. After a rapid regrowth consumption again declined during the depression years of the early 1930's. Annual consumption continued to rise until the early war years. Then followed a period of cement shortages and unsatisfied demand but since 1949 there has been a steady rise each year except for a minor drop due to the 1961 credit restrictions. This drop would have been more serious if it had not been for the additional purchases for the construction of the Mt. Isa railway line financed from Government revenue.

This great increase in the magnitude of the Queensland market has been accompanied by many changes but it is doubtful if there has been any significant change in the areal distribution of the market. It has not been possible to obtain figures for cement sales by regions in Queensland over the whole of the period under consideration but certain figures are available for selected years from 1945-46 to the present. (See Table 3)
TABLE 3

REGIONAL DISTRIBUTION OF CEMENT SALES

<table>
<thead>
<tr>
<th>DISTRICT</th>
<th>Percentage of Total Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1945-46 (a)</td>
</tr>
<tr>
<td>1. South Queensland (south and west of Gympie)</td>
<td>75.66%</td>
</tr>
<tr>
<td>2. Central Queensland (Maryborough to Rockhampton and west)</td>
<td>6.61%</td>
</tr>
<tr>
<td>3. North Queensland (north and west of Mackay)</td>
<td>17.73%</td>
</tr>
</tbody>
</table>

(b) History production and Utilisation of CEMENT in Queensland, 1952.

NOTE: In 1945-46 and years 1959-62 there were no imports of cement. In 1949-50, 29,303 tons were imported. These are included in total sales.

The figures available suggest that the distribution of the cement market in Queensland is closely related to the distribution of population. (See Table 4)

TABLE 4

REGIONAL DISTRIBUTION OF POPULATION IN QUEENSLAND

<table>
<thead>
<tr>
<th>DISTRICT</th>
<th>Percentage of Total Population at Census, 30th June</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1921</td>
</tr>
<tr>
<td>South Queenslanda</td>
<td>66.4%</td>
</tr>
<tr>
<td>Central Queenslanda</td>
<td>14.9%</td>
</tr>
<tr>
<td>North Queenslanda</td>
<td>18.7%</td>
</tr>
</tbody>
</table>

*aDistricts are defined as in Table 3.

The population of Queensland, as revealed in the census figures from 1921 to 1961, has been distributed in a pattern that seems fairly stable. Approximately 68% are resident in Southern Queensland, 14% in Central Queensland and 18% in Northern Queensland. Comparison with the figures shown in the previous table reveals a high degree of correlation. Discrepancies such as the abnormally high percentage of sales in Northern Queensland in 1961-62 are probably due to the existence of Government construction projects in this area during the credit restrictions discussed earlier. Because of the high degree of correlation of the cement sales distribution figures and the population figures for the period since 1945, the distribution of the Queensland market may be regarded as having been fairly stable over the whole period since 1920. In this time there has been a great increase in population, industrial development and major public works in south eastern Queensland; this reinforcement of its position as the main focus of the market has ensured the viability of the Darra works and has given the Queensland Cement and Lime Company no inducement to make a major locational shift.

The greatest changes in the market have been the developments in the cement using industries. The most significant of these are the growth of the asbestos cement and other cement products ventures and, in recent years, the large growth of the ready mixed concrete firms. These developments are not so much a change in the final uses of cement but the intercession of a whole range of intermediary firms between the cement makers and the building and construction industries. The main significance of these intermediary firms is that they have become the greatest single outlet for the product of the cement firms and, since these intermediaries are, in the main, large scale units, they have considerable bargaining power in
ROCLA CONCRETE PIPES LTD, GAILES.

JAYWOTH INDUSTRIES, DARRA.
the matter of the price at which they buy cement.

Although in Queensland each plant is the sole producer in its own market area and so has no need to reduce its price in order to compete for markets this price distinction between consumers still applies. The pricing policy of the Queensland Cement and Lime Company distinguishes between two sets of consumers. Just under half of the production is sold to distributors and the rest to "Preferred users." These are the large customers and large bulk buyers - the various cement goods industries and the Government.

Paralleling this development of the cement goods industry and not unrelated to it is the trend towards the marketing of cement in bulk. This of course is also a result of a totally independent set of circumstances: the technological advances in road transport and the development of steel bulk cement railway wagons.

The above changes in the marketing of cement have had the effect of strongly reinforcing the original locational considerations that led to the establishment of the Queensland Cement and Lime Company plant at Darra. Most of the cement products firms have established in the metropolitan area, some of them close to the cement works, although some, such as the ready mixed concrete firms, have been established in the larger cities of the state. However the development of bulk transporting methods have allowed the more distant bulk markets to be reached more easily.

4. EXPANSION OF PRODUCTION AT DARRA

The initial capacity of the Darra plant when it came into operations in 1916 was 30,000 tons, but various

12Information for this section has been obtained from various company publications and Annual reports, from the R.S.B. "Investment Service", and from interviews with the General Manager of the company.
technical difficulties prevented the plant from working to
capacity and by June 1922 only 70,000 tons of cement had
been produced. As will be seen from Graph 1 pre-war
overseas imports of cement had been of the order of 25,000
tons but from 1917-18 to 1921-22 only 1,000 tons were
imported. The shortage resulted in a much higher price
for cement. For example, in 1919-20 only 4 tons of cement
were imported at a cost of £70, this being a sevenfold
increase in price from the pre-war cost of a little over
£2 per ton. These prices are values declared for customs
purposes so the cost to the consumer would have been higher.
Despite the absence of competition from overseas suppliers
and the increase in price, the company sustained substantial
losses in its first years of operations. The company earned
its first trading profits in 1920-21 and in 1922 the capacity
of the works was increased to 60,000 tons to bring production
up to a more economical level. This increase in capacity was
accomplished by improving and extension of handling facilities
without necessitating the construction of an extra kiln.
During the succeeding six years the accumulated losses were
extinguished.

During this period it became increasingly obvious
that the most unsatisfactory link in the company's operations
was the two hundred mile haulage of limestone from Gore near
Warwick. Rail freight costs were high and supplies were
often uncertain due to shortages of rolling stock, delays
and breakdowns. In this period although the company
produced up to 50,000 tons of cement annually, at the same
time direct overseas imports amounted to from 5,000 to
8,000 tons annually. The company's high cost structure due
to the expensive long haul of limestone and high rail freight
limited the spatial extent of the market which the Darra
plant could supply. Overseas cement was able to compete
in northern coastal Queensland.
By the end of the decade, a coral and calcareous algal formation near Mud Island in Moreton Bay was brought to the company's notice. A survey by Professor Richards, Department of Geology, University of Queensland, was conveyed to the company in 1931, and verified the suitability of this deposit as a source of lime. However this was the period of the depression and the Queensland market for cement declined to one-third of its former size. No cement was imported for at least three years and local production was reduced seriously. The increase in the demand for cement was slow after the depression and the directors were understandably cautious about future market prospects. By 1936 the demand for cement had exceeded 60,000 tons annually and when arrangements had been made for the dredging transport and works handling of the coral a second 150 foot kiln was added to the plant increasing its capacity from 60,000 tons to 150,000 tons per annum. Since 1938 the company's cement has been made entirely from the new coral source. In the early war years the company produced and sold approximately 100,000 tons of cement per year, but by the end of the war was working to capacity (about 150,000 tons per annum). The new cost structure and the absence of competition\(^{13}\) from overseas allowed the increased productive capacity to be fully utilized to capture the whole of the Queensland market and the increased market of the war years.

Because of the increasing size of the Queensland market the company realized that more expansion was needed but recognizing the geographic extent of this market decided against the full expansion being made at Darra. North Australian Cement Company Limited was floated as a public company in 1948-49 and a cement works with a capacity of 60,000 tons was built at Townsville.\(^{14}\) However by 1951

\(^{13}\)No cement was imported after 1940 until some 4,000 tons were imported in 1948-49.

\(^{14}\)See Chapter IV.
the Darra plant was increased to a capacity of 250,000
tons by the addition of a third rotary kiln 350 feet long
to the previous establishment of two 150 foot kilns. This
expansion was to provide the needs of a growing market due
to a growing population and an increasing per capita
consumption for which new governmental development works
and new uses for cement (e.g. concrete blocks) were partly
responsible.

After 1951-52 when overseas imports reached a peak
of 54,000 tons, imports have declined rapidly and since
1957-58 there has been no significant entry of foreign
cement into Queensland (except, of course for quantities –
usually less than 1,000 tons p.a. – of special cements.)

In 1956 a minor expansion to give a total of
300,000 tons capacity was made by a change from old to new
plant seeking the economies of technical efficiency. A
second 350 foot kiln was added and the small kilns were
then used only occasionally.

During this period of expansion of production the
company was able to make a significant expansion of its
markets into Northern New South Wales. It was enabled to
do this by several factors:

(i) Because of its position this area is in many ways
tributary to Brisbane.

(ii) Brisbane cement prices were, and still are, the
lowest for any capital city in the Commonwealth since
the favourable cost structure of the company gave it
a low production cost. Cement from Darra was there­
fore better able to stand the increment in price
due to transport costs.

In 1961 after the landing of 300 tons of cement at Cairns
from Japan the two Queensland Companies made a concerted
protest to the Tariff Board which found that the cement
had been "dumped" and ordered a special tariff to be
imposed. See Chapter IV, page 78
MUD ISLAND, MORETON BAY.

M.V. CEMENTCO
(iii) The New South Wales plants in general experienced a rather difficult time financially in this period. Plant had suffered from the ravages of the war years and the subsequent boom and was rapidly becoming obsolescent. Following this period all of the New South Wales works made major changes in plant. During this period the nearest competitive plant, that operated by the Sulphide Corporation at Cockle Creek, closed down.

(iv) The provisions of the Commonwealth Constitution as they have been interpreted regarding road tax, and the advantages of road over rail transport in serving this part of New South Wales, combined to make transport rates more attractive.

In 1960 the next large addition was made when a 465 foot kiln was installed and the two small kilns withdrawn from use. The capacity of the plant was then 500,000 tons per annum, but since the new kiln could supply 250,000 tons of this and as sales from 1959-60 to 1962-3 were of the order of 300,000 tons even the two 350 foot kilns are not fully utilized. However this is desirable since the new kiln with its heat exchangers and generally improved design is far more efficient than the older ones.

During 1959-60 the two Queensland companies conjointly formed a new company, Central Queensland Cement Pty. Ltd. to market cement in the Rockhampton area. By April 1963 a grinding and bagging works had been built and began to grind clinker sent by rail from Darra and to produce cement. Work is continuing to construct the primary stages and kiln of a plant which will have a capacity of 60,000 tons per annum.

During 1963-64 the Queensland Cement and Lime Company placed orders for additional equipment worth £1,500,000 to ensure that no "bottlenecks" in raw material supply occur,
thereby to ensure the productive capacity of 500,000 tons per annum. This equipment includes a new cement grinding mill, a two mile long coral conveying belt to carry coral from the Brisbane River to the works and a coral carrying vessel.

It is not yet certain whether there will be any further extension to the size of the Darra plant. This is not because a further growth of the market in Southern Queensland is not foreseen, but because of the attractions of an alternative site. Present capacity is considered adequate for some 6-8 years but then extensions will have to be made. These extensions will have to be of about 200,000 tons per year capacity due to the economies of scale necessary in modern plants. These extensions can be made at Darra but the company is also considering the construction of a new works at Cleveland. This new site may offer certain fuel and raw material transport cost advantages but may also be faced with certain legislative and social prejudice problems.

5. SUITABILITY OF DARRA FOR THE CONTINUED SUPPLY OF THE MARKET

In this chapter the nature of the Queensland market and the way in which it has changed over the years has been discussed and a brief outline given of the main developments that have taken place at the Darra works.

It is now necessary to examine further whether changing conditions of the past fifty years have changed the locational circumstances under which the plant was established, and to assess whether or not the original location has continued to be a suitable one. The fact that the plant is still in operation can not, by itself, be taken as evidence that the location is entirely suitable. The immobility of invested capital in plant and buildings tends to favour continuation of production at the same site
until the unfavourable nature of the location raises the costs of production and distribution to such a level as to cause production at the site to be discontinued. Also the immobility of fixed capital will result in a continuation of production in a site simply because there is no significantly better site although several equally as favourable may exist. The position is further complicated when a company accelerates its depreciation charges in years of good profits and so has plant still in operation after it has been written off. The capital consumption charges are high in a capital intensive industry and the amount allowed for depreciation may equal up to 20% of the total of other manufacturing costs. This means that a company that had completely written off all equipment and that did not have to make allowances for depreciation could then afford to pay a penalty incurred by unfavourable location of up to 20% on costs of raw materials, fuel, labour and management. Obviously the margin of viability is broad in such a case.

Some of the major changes in the industry have been the changes in the markets and in marketing methods. As has been shown earlier the changes in the market have served only to reaffirm the suitability of the original location for the supply of the regional market. Related to the changes in the market are the changes in the transporting of the cement away from the works.

For the local market mainly road transport is used but the company considers that both rail and road transport facilities are desirable. This is obviously related to the extent of the market which the Darra plant serves. The mode of transport utilized depends on the customer, the destination of the product and the nature of the purchase. Almost all of the cement used within twenty miles of the plant (estimated at 50% of all sales) is
transported by road, though some Queensland Government purchases are transported on the Queensland Government Railway. For reasons explained above the northern New South Wales market is also served by road. Altogether over two thirds of the cement leaving the plant does so by road and half of this is in bulk form. As has been explained the company sells directly only to large consumers and to wholesalers, the cement being transported by hire trucks to the wholesalers' depots. The company therefore has no direct concern with distribution, though of course, access for consumers to the plant is equally as important a site consideration as if the company was itself distributing its product.

Rail transport is used to send clinker to the Rockhampton plant, for consumers in distant parts of the market area and for almost all of the Government purchased cement. In major development projects (such as the Leslie or Herang Dams in recent years) bulk rail transport is the obvious choice.

Upon consideration of the marketing and transport requirements and the position and marketing and transport facilities of the Darra site, it can be said that there is no significantly better site for the plant and that the company has no reason on these grounds to consider a locational shift.

Probably the most important changes in the location factors are those relating to raw materials and of these the greatest change has been that from limestone to coral. The Queensland Cement and Lime Company was able to improve the whole cost structure of its operations when it did away with the long rail haulage of limestone from Gore. The coral is dredged, transported by water up-river to the company wharf and taken from there by truck to the plant.16

16 Plans were announced in early 1964 for the construction of a conveyor belt to carry the coral from the wharf to the plant. Developments in Australian Manufacturing Industry, 1963-64, Department of Trade, Canberra, p.35.
It will be noted that in Chapter II above, in the discussion of the 1914 location decision, there was no reference to the possibility of using the Brisbane river as a transport route. Thus it can be seen that although under the previous set of conditions location on the railway to the west of Brisbane was desirable, the fact that the plant was close to the river by which coral could be brought 40 miles from Mud Island has been, to a large extent, fortuitous and has made the site continue to be satisfactory. Its satisfactory nature is indicated by the fact that there has been a more than eight-fold increase in plant capacity from the "pre-coral" days until the present.

The Queensland Cement and Lime Company has a dredge stationed at Mud Island and two coral carriers. Each of the three vessels was originally an Army invasion vessel and each has been rebuilt for its present function. Each is of medium draught (ten to fifteen feet) which is satisfactory for work in the lower Brisbane River. The larger of the two coral carriers, the "Cementco" is a particularly interesting vessel almost 200 feet long and able to transport 2,000 tons (wet weight) of coral. Her six screws and six rudders give a very desirable manoeuvrability for work in the restricted Brisbane river.

In the production of over 300,000 tons of cement in recent years, over 600,000 tons (wet weight) of coral has been carried each year along the forty mile trip from Mud Island to the Oxley Wharf. The need for a cheap route of bulk transfer is obvious and so the company was fortunate not merely to be near the Brisbane river, but to be near it at a point which could be reached by large vessels.

Changes in the types, and methods of use, of power and fuel supplies have been small during the half century of operations but there has been a big change in the
importance of these requirements as location factors. In the original location decision the availability of electricity was a restricting factor, as was the need to be on the railway line to the west of Brisbane in order to have low cost access to coal from the West Moreton field. Today both of these sources of energy may be regarded as ubiquities for a plant locating in the general Brisbane area. In the case of coal the Queensland Coal Board sets the price and usually gives instructions as to the supplier. Further this means that economies in fuel can not be gained by bargaining for a lower price or by contracting with a company for a given price. Economies then can only be gained by technological improvements, e.g. "heat economies". Another consequence is that the supplier of coal is usually the mine or mines closest to the consumer. At present the Darra works are supplied from the Rylance mine at Dinmore and from the Rhondda Mine, and from both of these all of the coal required comes by road. Under such a controlled system of production and pricing coal loses its importance as a locating factor.

However, as mentioned above, the future development of the Darra plant will depend on the possibilities for development at Cleveland. One of the possibilities of the Cleveland site would be that it might be possible to utilize heavy residuals from the Lytton Oil Refinery now under construction. This fuel could come by direct line to the Cleveland plant, and would be made cheap by the fact that it would otherwise have to be dumped as there is no other likely market in south eastern Queensland other than Queensland Cement and Lime Company.

The electricity used at the plant is purchased from the Southern Electric Authority. Being able to purchase electricity instead of having to generate it is,
in one sense, what Isard has called an urbanization economy (an economy affected by location near an urban area - a type of external economy of scale). However the wide area over which the Southern Electric Authority grid extends means that electricity may now be treated as a ubiquity in any location analysis within this area.

Although the changes in the locational pull of the energy sources do not favour the continuation of production at Barra, neither do they indicate any necessity to shift to another site.

Only minor changes have occurred in the supply of other raw materials. The argillaceous material is still obtained from the weak tertiary shales mined at the works site. The arenaceous material was obtained in the past from the works site also; but since the installation of electrostatic precipitators to clean the air from the kilns a new source of arenaceous material has been utilised. The coal used is sub-bituminous with an ash content of about 25%. Since the ash is largely siliceous material it can be used as a substitute for sand. The advantages of using it, since it has already been purchased, transported to the site, pulverized and, when swept from the emitted kiln gases, pre-heated, need not be elaborated further.

For the iron bearing material which is required for admixture to the slurry whenever analysis shows that it is necessary, the company utilizes the residue from A.C.F. and Shirleys Fertilizers Pinkenba works. This item is an insignificant component of the final cost, and as its cost would not vary significantly in the Brisbane area it can be ignored as a location factor. The gypsum used as a retarder is purchased in bulk from Steenhouse Bay in South Australia and arrives at the port of Brisbane by sea. In recent years the company has used annually some 12,000 tons of gypsum. Although the gypsum represents a more significant component of the final cost than the iron its
LOCATION

The location of the Darra plant of the Queensland Cement & Lime Coy., its principal market, the source of its most important raw materials and the major transport routes.

Railways
Main Outlet Roads
Other Main Roads in Darra Area
Private Road of Q.C. & L. Coy.
Main Built-up Area of Brisbane
Source of Coral
Route followed by Coral Carriers
Q.C. & L. Coy. Works Site

To Ipswich, Toowoomba and N.S.W.
The site of the Darra plant of the Queensland Cement & Lime Coy. : its road and rail transport facilities, the movement of materials and product, the utilization of the site by the company, the location of certain industrial users of cement near the plant and other clay quarrying industries of the area.
cost would not vary greatly within the Brisbane area and so it also may be ignored as a location factor.

The present scale of production at the Darra plant involves an annual consumption of over 60,000,000 gallons of water. As this is only equal to Brisbane's consumption of water on a summer day it would impose very little strain on the Brisbane City Council's water supplies if it had to be purchased. However in the present location the water can be drawn directly from the Brisbane River.

The total labour force involved in the production at the Darra works is about 470 - a not inconsiderable number but one which can easily be obtained at a location close to any large town in the state. The labour requirements are not highly demanding with respect to skill of labour and the labour costs represent only about 15% of final production costs. Even this percentage could be significant if labour costs showed a high degree of areal differentiation in Queensland. However under the present arbitration system wage level variations can be considered as insignificant as a location factor. Of greater areal differentiation, and therefore greater significance, would be costs other than wages involved in obtaining labour. These costs could arise from the need to provide housing or other facilities if the plant were located in a remote and isolated area, but for any location in easy commuting distance of Brisbane such considerations do not arise.

A consideration of capital as a location factor involves two aspects of capital only one of which is significant. First the capital market in Australia is nation-wide so fluid capital can be regarded as completely mobile, or as a ubiquity in the regional location decision. On the other hand fixed capital in plant and machinery is almost completely immobile and, for the reasons outlined on page 52, tends to cause production to continue at an established site.
The only other factors which it is felt could be of importance are legislative and social factors. No municipal zoning ordinances existed when the Darra plant was established but since that time other industry has sprung up in the Darra area which is now firmly established as an industrial area. Although the present city planning ordinances are not a positive factor for the continuation of location at Darra, they could conceivably become so in the event of the company wanting to shift to a new location. Related to these legislative factors are the social attitudes which give rise to them. Objections have already been raised by local residents concerning the company's proposals for the Cleveland works. In the past cement works have been notoriously objectionable because of the dust (almost entirely coal ash) from the kilns. However the ash at the Darra works is electrostatically precipitated and this could presumably be done at a new site. But, regardless of whether the social attitude is justifiable or not, it can be definitely stated that a company would be distinctly limited in its choice of location by the existing social prejudice against the industry.

In summary then it can be stated that technological advances have freed the "wessenland Cement and Lime Company from some of the restrictions involved in the original location decision. Fixed capital immobilities set aside, the company is now less tied to the Darra site. However, as it continues to be favourable and as there is no real incentive to shift from Darra, the immobility of fixed capital should result in a continuation of production at the present site. On the other hand, if economies of fuel and raw material transport costs could balance the dis-economies of smaller production, the company would be free to establish extra capacity elsewhere.
### TABLE 5

PRODUCTION OF CEMENT IN AUSTRALIA AND IMPORTS OF CEMENT INTO AUSTRALIA, 1904-1963

<table>
<thead>
<tr>
<th>Year</th>
<th>Production '000 tons</th>
<th>Imports '000 tons</th>
<th>Year</th>
<th>Production '000 tons</th>
<th>Imports '000 tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1904</td>
<td>n.a.</td>
<td>28</td>
<td>1934-35</td>
<td>550</td>
<td>5</td>
</tr>
<tr>
<td>1905</td>
<td>n.a.</td>
<td>35</td>
<td>1935-36</td>
<td>645</td>
<td>14</td>
</tr>
<tr>
<td>1906</td>
<td>n.a.</td>
<td>40</td>
<td>1936-37</td>
<td>720</td>
<td>15</td>
</tr>
<tr>
<td>1907</td>
<td>n.a.</td>
<td>26</td>
<td>1937-38</td>
<td>852</td>
<td>12</td>
</tr>
<tr>
<td>1908</td>
<td>n.a.</td>
<td>46</td>
<td>1938-39</td>
<td>868</td>
<td>9</td>
</tr>
<tr>
<td>1909</td>
<td>n.a.</td>
<td>42</td>
<td>1939-40</td>
<td>865</td>
<td>3</td>
</tr>
<tr>
<td>1910</td>
<td>n.a.</td>
<td>81</td>
<td>1940-41</td>
<td>860</td>
<td>-</td>
</tr>
<tr>
<td>1911</td>
<td>n.a.</td>
<td>83</td>
<td>1941-42</td>
<td>890</td>
<td>-</td>
</tr>
<tr>
<td>1912</td>
<td>n.a.</td>
<td>130</td>
<td>1942-43</td>
<td>730</td>
<td>1</td>
</tr>
<tr>
<td>1913</td>
<td>n.a.</td>
<td>125</td>
<td>1943-44</td>
<td>693</td>
<td>3</td>
</tr>
<tr>
<td>1914-15</td>
<td>n.a.</td>
<td>70</td>
<td>1944-45</td>
<td>694</td>
<td>-</td>
</tr>
<tr>
<td>1915-16</td>
<td>n.a.</td>
<td>76</td>
<td>1945-46</td>
<td>723</td>
<td>-</td>
</tr>
<tr>
<td>1916-17</td>
<td>n.a.</td>
<td>8</td>
<td>1946-47</td>
<td>882</td>
<td>-</td>
</tr>
<tr>
<td>1917-18</td>
<td>n.a.</td>
<td>-</td>
<td>1947-48</td>
<td>1,013</td>
<td>2</td>
</tr>
<tr>
<td>1918-19</td>
<td>n.a.</td>
<td>n.a.</td>
<td>1948-49</td>
<td>1,031</td>
<td>34</td>
</tr>
<tr>
<td>1919-20</td>
<td>n.a.</td>
<td>6</td>
<td>1949-50</td>
<td>1,167</td>
<td>92</td>
</tr>
<tr>
<td>1920-21</td>
<td>n.a.</td>
<td>27</td>
<td>1950-51</td>
<td>1,235</td>
<td>46</td>
</tr>
<tr>
<td>1921-22</td>
<td>n.a.</td>
<td>24</td>
<td>1951-52</td>
<td>1,237</td>
<td>104</td>
</tr>
<tr>
<td>1922-23</td>
<td>n.a.</td>
<td>44</td>
<td>1952-53</td>
<td>1,439</td>
<td>106</td>
</tr>
<tr>
<td>1923-24</td>
<td>492</td>
<td>29</td>
<td>1953-54</td>
<td>1,700</td>
<td>56</td>
</tr>
<tr>
<td>1924-25</td>
<td>578</td>
<td>26</td>
<td>1954-55</td>
<td>1,920</td>
<td>138</td>
</tr>
<tr>
<td>1925-26</td>
<td>605</td>
<td>23</td>
<td>1955-56</td>
<td>2,035</td>
<td>27</td>
</tr>
<tr>
<td>1926-27</td>
<td>638</td>
<td>19</td>
<td>1956-57</td>
<td>2,173</td>
<td>9</td>
</tr>
<tr>
<td>1927-28</td>
<td>754</td>
<td>23</td>
<td>1957-58</td>
<td>2,291</td>
<td>3</td>
</tr>
<tr>
<td>1928-29</td>
<td>708</td>
<td>22</td>
<td>1958-59</td>
<td>2,481</td>
<td>4</td>
</tr>
<tr>
<td>1929-30</td>
<td>697</td>
<td>14</td>
<td>1959-60</td>
<td>2,632</td>
<td>9</td>
</tr>
<tr>
<td>1930-31</td>
<td>389</td>
<td>-</td>
<td>1960-61</td>
<td>2,860</td>
<td>7</td>
</tr>
<tr>
<td>1931-32</td>
<td>247</td>
<td>-</td>
<td>1961-62</td>
<td>2,781</td>
<td>9</td>
</tr>
<tr>
<td>1932-33</td>
<td>321</td>
<td>1</td>
<td>1962-63</td>
<td>-</td>
<td>12</td>
</tr>
<tr>
<td>1933-34</td>
<td>410</td>
<td>2</td>
<td>1963-64</td>
<td>-</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER IV

GEOGRAPHIC DIVERSIFICATION WITHIN THE CEMENT INDUSTRY

1. GROWTH OF NEW MARKET CONDITIONS

During the war years and immediate post war years cement production for the whole of Australia declined and imports were negligible. The main reason for the decline in production from 1941-42 to that in 1944-45, was the difficulty experienced in keeping plant and machinery operational. However the Darra plant, which had undergone expansion of capacity and had changed to the use of coral immediately before the war, had not the same difficulties as some of the older plants in New South Wales. Production of cement in Australia did not exceed the 1941-42 totals until 1947-48, and in this year the production was 10% above the previous figure. However the Darra plant in the same time had expanded production just over 50% and was producing to capacity (150,000 tons). This high, and highly profitable, level of production was maintained until 1951 when the capacity of the works was further increased.

During this period, demand continually exceeded supply. The entire Queensland production of cement was used within the State except for small amounts (in all years less than 200 tons) exported to Australian Territories and the Pacific Islands. It was not possible to obtain imported cement until 1948-49 and in the immediate post war years the shortage was acute, even public works being affected.

Some record of the shortage, which occurred in the supplies of almost all building and constructional materials, can be found in the debates and questions of the Queensland Legislative Assembly. In this time one of the members who was most persistent in raising this question in the house was Mr. Aikens, the member for Mundaburra whose electorate
includes much of Townsville. This would seem to indicate that the shortage in North Queensland was more acute than elsewhere in the State. On one occasion Mr. Aikens had to make representations to the minister concerned on behalf of a local authority for a supply of cement to complete vital works before the onset of the wet season. On another occasion Mr. Aikens' question was merely an attempt to bring to the notice of the government the "delays being caused in North Queensland due to the cement shortage". On this occasion the Hon. E.M. Hanlon replied that "delays were being caused in North Queensland, Central Queensland and Southern Queensland" indicating the widespread nature of the situation.

As early as 1946 suggestions had been made regarding the construction of a cement plant somewhere in north Queensland. In August 1946, Mr. Decker, the member for Sandgate, had asked "has any approach yet been made to the government by the local authorities concerned for technical and financial assistance in establishing a cement works to service North Queensland?" and "would the government be sympathetic to such a request?" However the reply was that it was not the government's practice to announce matters of policy in reply to questions, and no further record can be found of this interesting suggestion in the parliamentary records or in the local press.

In 1948-49 the first overseas supplies of cement became available. Of the 4,000 tons imported in that year almost 1,500 tons were imported directly through the ports of Cairns and Townsville, but there is no record of any amount imported elsewhere and redistributed to north

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2 *ibid* Vol. CLXXXVIII, 1946, p.1236
3 *ibid* Vol. CLXXXIX, 1947, p.193
4 *ibid* Vol. CLXXXVII, 1946, p.112
Queensland. The following year, 29,303 tons were imported and this amount, together with the production from Darra, made a total supply for Queensland of over 180,000 tons. Cement sales in and north of Mackay totalled almost 33,000 tons (see Table 3, p.42).

2. THE NEED FOR INCREASED CAPACITY

As has been stated the plant at Darra was producing to capacity, the demand for cement exceeded the available supply and it was certain that the market for cement would continue to expand. The Queensland Cement and Lime Company recognized that extra capacity was needed and planned by 1951 to increase the capacity of the Darra works by the installment of its first 350 foot kiln. The company apparently also recognized that cement works in North Queensland would be able to serve that market with less cost of transport. However it can be suggested that the company was also motivated by the need to inaugurate the establishment of a plant so as to prevent an opposition project being established in the area.

This suggestion is based on four sets of facts. First, the north Queensland market in 1949-50 did not exceed 33,000 tons and the market for the whole of Queensland north of Gympie did not exceed 46,000 tons per annum. Secondly, the company's investigations as early as 1948 were based on the possibility of establishing a plant of 60,000 tons capacity. Thirdly, the plant was not brought into production until the end of 1954 and this lengthy period for establishment was publicly queried at the time. Finally in the new company's first full year of production, the plant produced almost to the planned capacity of 60,000 tons. Actual sales were


6 Mr. Low questioned in the house the length of time proposed for the establishment of the plant. He quoted two current projects of similar capacity, one in N.S.W. and one in New Zealand, which were to be in operation within 18 months. Queensland Parliamentary Debates, CXCVII, 1949, p.1562.
58,524 tons and the following year sales were made of 69,241 tons plus an extra 3,995 tons which had to be drawn from the Darra plant.

From a consideration of these facts it seems that the Queensland Cement and Lime Company had accurately forecast the size of the North Queensland market in 1954 and that the plans to establish a plant were based on this forecast. Thus it also seems that the claim made above is not an unfair one and that the Queensland Cement and Lime Company proposals in 1948 were as much motivated by the need to forestall competition as by the need to establish a plant.

This issue has been raised not as an opportunity to discuss the ethics of business competition but in order to clarify the position with regard to the first proposition being argued here. As has been shown (see pages 32 and 33) production costs can only be minimized when the plant is working to capacity, and this is of particular importance in this case involving the establishment of a small scale plant in a regional market being supplied from outside sources. The judgement of the Queensland Cement and Lime Company is vindicated by the fact that the plant, when it came into operation as planned, was able to produce cement economically and substantial reductions in the price of cement in North Queensland were able to be made.7

Thus although the plant was projected as early as 1948 when the market was much smaller, its actual establishment was not completed until 1954 when the local demand was established at a sufficient level. This supports the first proposition of the thesis.

7The first full year of production was 1955-56. In January, 1959, and again in August 1959 the company reduced the price of cement to consumers; by 10/- per ton each time. In late 1960 the company made a further reduction of 10/- in the selling price of cement at Stuart. Investment Service, Research and Statistical Bureau, Sydney Stock Exchange, №54.
As indicated above, and detailed in the previous chapter, the Queensland Cement and Lime Company planned to increase capacity from 150,000 to 250,000 tons in 1951. To finance this expansion it issued, in December 1949, 245,061 20/- ordinary shares to its stockholders. With this need to call for capital for the planned expansion of the Darra works the company did not wish to finance alone the projected North Queensland plant. Consequently it proposed to the government that a new company be formed to which the government would guarantee a loan and for which the Queensland Cement and Lime Company would act as supervising engineers and consulting chemists until the plant was established. The company also decided to maintain a substantial holding in the newly formed company.

3. THE LOCATION DECISION FOR THE NEW PLANT

In evaluating the location decision for the Stuart plant a statement by the company is available that is more definite and authoritative than was the case for the Darra plant. From this statement made during the period of the establishment of the plant we learn that "the chief factors which caused the selection of Stuart as the site for a new works were:

1. An annual consumption of cement in the area north of Mackay, which would be supplied by a works at Stuart, sufficient to support a works economically;

2. The availability of an excellent area of land on which already existed buildings, railway sidings, and roads suitable for use in a cement works;

3. Proximity to ample supplies of the raw materials required for the manufacture of cement;

4. Suitability for distribution, Stuart being at the junction of the North-South and Mount Isa railway lines and only six miles from Townsville."\(^8\)

No attempt has been made in the above statement to rank these factors in order of priority. Discussion with officials of the companies concerned confirmed that the order of priority suggested in this thesis is correct. Obviously if a market extending from Mackay to Cairns and from Townsville west to Mt. Isa was to be served, and given the existing railway system, then a location close to Townsville would be a central one from which to serve the market. Provided then that the required raw materials and fuel (particularly the limestone and coal) could be assembled satisfactorily, a site could be found for the works.

A suitable deposit of limestone was available near the Calcium rail siding 34 miles from Townsville on the Mount Isa railway line. The deposit was 2 miles by road from the Calcium siding. The location of this deposit near Townsville was extremely fortunate as the only other suitable deposit known to the company was on the Atherton Tableland. If a deposit had not existed near Townsville the conflict between raw material orientation and market orientation would then have been a most interesting one. The difference to the cost structure of the proposed plant engendered by the long rail hauls for either limestone or cement would probably have meant that a plant could not be constructed until the demand for cement in North Queensland was much greater. More probably though, further examination would have been made of the possibilities of using coral, of which there are known deposits near Townsville and for the use of which the Queensland Cement and Lime Company could offer invaluable information gained from its own experience. Detailed surveys after the establishment of the plant indicated that the limestone deposits though still adequate are less than previously thought. The possibility of a future usage of coral exists but there are many problems.
LOCATION

of the North Australian Cement Ltd. works at Stuart.
The market it serves and the main transport routes.
Sources and movements of raw materials.
The coral is alive, unlike the Mud Island deposits, and the problems of the smell nuisance it would create and the problem of salt removal are serious obstacles to its utilization.

The source of coal chosen was the Bowen Consolidated (subsidiary of Mt. Isa Mines) open cut mine at Collinsville. For a production of 60,000 tons per annum, approximately 13,000 tons of coal would be needed and, for a production of 100,000 tons, some 22,000 tons of coal would be required. The chosen source of fuel involved a rail haulage of over 200 miles to the Townsville area adding considerably to the delivered price of the fuel. However, this large generation of rail traffic and the revenue it created for the Queensland Government would have been one factor of considerable benefit to the company when it sought tariff protection in 1961 against the dumping of Japanese cement in north Queensland. (see p.78)

Against this "tactical" reason for the use of coal, however must be weighed the economic reasons for using fuel oil which apparently would be a less costly source of power. However, as active government assistance was to be obtained during the establishment of the plant, coal was used as the primary fuel.

At this stage the location problem was narrowed considerably by this setting of the parameters of primary market orientation and sources of coal and limestone. Given first the necessity of locating near Townsville, the limestone to come from Calcium on the Great Northern Railway and the coal to come from Collinsville along the North Coast Line, the problem was to choose a site where transport outlays could be minimised while still being consistent with other locational requirements.
At this point the reasoning followed by the company seems to have departed from the deductive process followed so far. Instead, as the site eventually chosen for the works was available and was obviously attractive, it was tentatively chosen and its advantages and disadvantages balanced against those of other possible sites. The junction of the North Coast Line and the Great Northern Railway is at Stuart, six miles to the south of Townsville. At this junction was an available site with sidings and buildings which could be utilized and with water, clay and electric power readily available. Some of the advantages of the site as seen by the company have already been enumerated on page 67.

The main focus of the market was Townsville and the major axis of the market lay along the coastal strip with the minor axis following the railway line to Mt. Isa. A position on the North Coast Line on the southern outskirts of Townsville would be able to serve this market efficiently and would be conveniently located for the assembly of the coal and limestone both of which were available to the south of Townsville. Given the relative weights and distances involved, location at the source of the limestone is yielded as the transport optimum point for the assembly of the coal and limestone. But, as has been stressed repeatedly, the primary orientation of the industry is to markets and not to raw materials, and only 15% of the market lies beyond Calcium along the route through the minor axis of the market. The other 85% of the cement would have to be transported to the junction at Stuart from where 70% would have to be transported to Townsville and further north. Further, location at Calcium, 34 miles from Townsville, would raise additional problems, the main ones being related to the availability of labour and to the need for close direct contact with the "consumers". If the labour and product

9 The consumers of cement as far as the operators of the works are concerned are not necessarily the final users of the cement but those to whom the company sells - the big users and wholesale distributors.
distribution problems are to be overcome, then the site chosen cannot be the transport optimum point but must be one closer to Townsville. However although location is not at the transport optimum point, the need to minimize transport outlays would still operate to prohibit unnecessarily long haulage of the limestone.

The choice of locations is then narrowed to a small area close to the existing rail lines within three or four miles of the junction at Stuart. To go further north than this area would be to enter the already closely settled Townsville urban area. To go further south than this would be to lose the advantages in labour availability and marketing given by a near urban site. But within this area, provided a suitable area of land with clay and water supplies could be found, then the plant could be constructed without any significant difference to the cost structure of production.

The available land at the junction at Stuart between Stuart Creek and the main road and railway line, with already laid spur lines and available buildings and with alluvial clay and sand deposits and power and water supplies, must have appeared as the most favourable site in the area.

4. THE ESTABLISHMENT AND DEVELOPMENT OF THE STUART PLANT

"In July 1948 the Queensland Cement and Lime Company completed a definite proposal for the erection of a cement works at Stuart, which proposal was strongly supported by the Queensland Government, and resulted in North Australian Cement Limited...going to allotment on 21st July, 1949."¹⁰

Three-fifths of the original capital was provided by four large companies¹¹ and the government of Queensland guaranteed

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¹¹Of the first issue of 500,000 20/- ordinary shares, 120,000 were taken by Queensland Cement and Lime Company Ltd., 120,000 by Adelaide Steamship Co. Ltd., 25,500 by Mt. Isa Mines Ltd. and 25,000 by Goliath Portland Cement Co. Ltd. (operating works in Tasmania). Investment Service, Research and Statistical Bureau, Sydney Stock Exchange, N54.
The site of the Stuart plant of North Australian Cement Ltd., showing road and rail transport facilities, the direction of movement of materials and product, and the utilization of the site by the company.
a loan of £200,000 arranged by the company with the National Bank of Australasia Limited.

The company which owned the limestone deposits at Calcium and which had treated and marketed crushed and burnt limestone of all types for many years was acquired by North Australian Cement Limited. Under the supervision of the Queensland Cement and Lime Company Limited construction at Stuart was commenced in 1949. The company then began the erection of a cement-brick making plant which was completed in September 1952 and which proved very useful in the company's building programme. The company was then able to trade in lime and cement bricks (made with cement from Darra) before it began the production of cement.

The extent of government co-operation is seen in the fact that the government guaranteed a loan of £30,000 from The National Bank to finance the brick plant scheme and in 1953 guaranteed an additional bank overdraft of £250,000. This extra capital was needed because the substantial rises in costs in Australia from 1949 onwards had greatly increased the cost of installation of the plant at Stuart above the original estimated £600,000. Even then in June 1954 the company needed further capital and offered for subscription a further 200,000 shares. The final cost of the project was in excess of £1,200,000 and consisted of a cement works and cement brick plant at Stuart and a limeworks and crushed metal plant at Calcium. The production of cement finally began in October 1954.

During the following years the company operated very successfully. Production rose from 58,524 tons in the first year of operations to 76,009 in 1957-58. This increase in production had been made possible by the installation of
The Stuart Plant of North Australian Cement Ltd.
a calcinator in the kiln. In this year the company was able to reduce the price of cement by 10/-.

By the end of the following year two more similar reductions in price had been made. The company ceased production of lime in 1959 and the production of cement bricks in 1961.

The extent of government assistance at the formation of the company has already been outlined. Indirect assistance in the form of large orders for governmental projects was also important to the company: the construction of the Tinaroo Falls Dam, for instance, took almost 65,000 tons of cement or the equivalent of a whole years production. Until June 1963 the company produced almost 620,000 tons and of this government financed purchases accounted for at least 180,000 tons or almost 30 per cent. (see Table 6)

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12 A calcinator consists of a grate enclosing steel bodies which dries the slurry entering the kiln and catches dust. It increases efficiency and output, the exhaust gases leaving the kiln with a temperature of 230°F instead of over 500°F. In other kilns, e.g. at Darra, festoons of chains in the kiln serve a similar purpose.

13 As indicated earlier it is almost impossible to obtain complete figures for government financed purchasing of cement. The figures stated here were released by North Australian Cement Limited to whom grateful acknowledgement is made; and apply to major government departments and to two private contractors (1) Ford Bacon and Davis engaged on the Mt. Isa Rail project and (2) Transfield Corp. engaged on the Barron Falls project dam on the Barron River. The figure of 20,000 tons for the bulk terminals is based on the fact that the Cairns terminal took 5,032 tons and the Mackay terminal 4,400 tons. No record is made of local Government purchases.
77.

**TABLE 6**

**GOVERNMENT PURCHASES OF CEMENT IN NORTH QUEENSLAND**

<table>
<thead>
<tr>
<th>Description</th>
<th>Tons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Sales by N.A.C. Ltd. 1954-55/1962-63</td>
<td>614,502</td>
</tr>
<tr>
<td>Purchases by: (Total to June 1963)</td>
<td></td>
</tr>
<tr>
<td>Irrigation and Water Supply (Tinaroo)</td>
<td>64,057</td>
</tr>
<tr>
<td>Main Roads</td>
<td>31,743</td>
</tr>
<tr>
<td>Co-ordinator General's Dept.</td>
<td>26,420</td>
</tr>
<tr>
<td>(Koombooloombah, Kuranda)</td>
<td></td>
</tr>
<tr>
<td>Railway Department</td>
<td>8,307</td>
</tr>
<tr>
<td>State Electricity Commission</td>
<td>2,991</td>
</tr>
<tr>
<td>Ford Bacon and Davis (Mt. Isa Railway)</td>
<td>17,305</td>
</tr>
<tr>
<td>Transfield Corp. (Barron Falls)</td>
<td>10,729</td>
</tr>
<tr>
<td>Bulk Sugar Terminals (estimated)</td>
<td>20,000</td>
</tr>
<tr>
<td><strong>TOTAL:</strong></td>
<td>181,552</td>
</tr>
</tbody>
</table>

The importance to the new company of such a large market should not be underestimated. At the same time however the contribution of the company to the development of Queensland must also be recognized. The largest private purchaser of cement by far was Mt. Isa Mines Limited whose developmental works at Mt. Isa and at the copper refinery at Stuart used over 40,000 tons in the period up to June 1963. During this same time sales to various concrete products firms (other than ready mixed concrete) totalled only 20,000 tons. Thus it can be seen that the structure of the North Queensland market is very different from that served by the Darra plant, the main differences being the increased size of the government sector and the decreased size of the concrete goods sector of the market.

It is interesting to note that the Queensland Government has been the only competitor to the companies mentioned here to manufacture a cement material in Queensland. This was in part due to the high rail freight component in
the delivered price of cement at the site of one of its major projects."At Koombooloomba a naturally occurring pozzolanic material has been successfully used as a partial replacement of cement in building the main dam, in the construction of which approximately 160,000 cubic yards of concrete were placed. This represents the first large scale use of a natural pozzolan in Australia, and the plant installed to process the raw material is understood to be the first pozzolan manufacturing plant in the Southern Hemisphere. Replacement of up to 30 per cent of the cement was found to be possible. The cost per ton of the processed pozzolan was about £10 per ton less than the cost per ton of cement at the site, so that in addition to the beneficial effects upon the resulting concrete, a substantial saving in cost was achieved.\[14\]

This production however was for a closed market. A more serious threat of competition came from imported Japanese cement in 1960. Three hundred tons were imported into Cairns and were offered for sale at a price substantially below that at which Stuart cement was available. A Tariff Board inquiry subsequently found that the cement had been "dumped" in Queensland as the freight rate for the cement was only one-quarter of that which would normally apply. A tariff was imposed to effectively counter the threat to the local industry.\[15\] The State Government took further action by reducing by one-third the straight through freight rate on cement from Townsville to Cairns, to Mt. Isa and to Mackay.\[16\]

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5. **ESTABLISHMENT OF THE PAKKHURST PLANT, ROCKHAMPTON**

In 1945-46 less than 4,000 tons of cement were sold in Rockhampton and its hinterland to the west, this quantity representing only 3.6% of the total sales in Queensland in that year. In 1961-62 the market in Rockhampton and Gladstone and their hinterlands was only 4% of the Queensland market, and this then represented a quantity of almost 15,000 tons. Even this amount would not be sufficient to warrant the establishment of a cement works in which the cost structure of operations would incorporate such economies of scale as to make the works efficient by modern standards. However a plant is being constructed at Rockhampton and to understand the reason for this it is necessary to examine the circumstances under which it was established and under which it may operate. Without an understanding of the social and political pressures which led to its establishment, and the conditions of collusion under which it will operate, the location of a plant in the area at all is not intelligible, as it is certainly not at this stage economically justifiable.

In this examination a knowledge of developments at Stuart can offer valuable aids to understanding, as there are many interesting parallels between the two cases.

In the late 1950's considerable interest was aroused in the prospects for development of the Fitzroy Basin and the Rockhampton and District Development Association was formed. This association actively engaged in publicising the resources and possibilities of the region, endeavouring to attract industry and seeking governmental aid for development. Much of the Association's information on the resources of the region was based on that compiled for a thesis by H. Juppenlatz, Department of Architecture, University of Queensland. In September 1957 the local press published three articles based on the Juppenlatz thesis which mentioned amongst many other things that "pure limestone, the basis of
the cement industry, is available in large quantities". It is not claimed that this statement prompted local agitation for a cement works but it is the earliest reference to the possibility of cement production in the area which has been located. More influential would have been a brochure compiled by Glenister Shiel, Resident Director and General Manager of Mt. Morgan Limited. In this brochure it is stated that "In the Capricornia area huge deposits of high quality limestone are known to exist. More than 100,000,000 tons are estimated to be in the Caves area while other large deposits occur at Marmor, Ambrose and Struck Oil." Mr. Shiel considered other development prospects and went on to propose the construction of dams and irrigation projects in the Fitzroy Basin. He states that "These structures would call for sufficient cement to give the cement manufacturing industry a start-up load, just like the cement works at Townsville got, and would ensure a continuing base load, just like the Mt. Isa railway project will ensure for Townsville." Promoted no doubt by the local interest in such a project, in late 1959 the two existing Queensland cement companies together formed a wholly owned subsidiary, Central Queensland Cement Pty. Ltd., to operate in the Rockhampton area. This company had an initial capital of £35,000, three-quarters of which was provided by Queensland Cement and Lime Company. The new company acquired some World War II Army buildings beside the railway line at Parkhurst, 8 miles north of Rockhampton, and began operations in December 1959. When

18 G. Shiel, Chemical Industries in the Rockhampton Area, Rockhampton and District Development Association, Rockhampton, p.4.
The Parkhurst plant of Central Queensland Cement Pty. Ltd.; the market it is intended to serve and the main transport routes; sources and movements of raw materials.
it was known in the area that the company was solely a marketing company and would merely sell cement from Barra from this depot, local agitation for a cement works began again. An attempt was made to form a local company but it was announced that Central Queensland Cement Pty. Ltd. would establish a clinker grinding and cement packaging plant to grind clinker from Barra to produce cement. The Report of the Director for Secondary Industries for the year ended 30th June, 1961 records: "Proposals for a similar industry have been submitted by a local company but it was not considered practical to financially support this second company to produce cement in Rockhampton when such a project was in process of establishment by an existing company". The proposed local company had no doubt realised the inadequacy of the local market and had sought government assistance such as was provided for North Australian Cement Limited.

On the 30th June, 1961 tenders were called for the foundations of the proposed cement plant at Parkhurst and a year later the Director of Secondary Industry stated that "Production was anticipated to have commenced by the end of June (1962) but delay in construction work will probably hold up operations until October of this year." It was April 1963 before the £200,000 plant began to operate.

From a consideration of these facts in the light of what happened at the Stuart plant it would seem:

(1) That the parent companies realized that the Central Queensland market was growing towards a stage where a

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20 Loc. cit., Department of Labour and Industry, Brisbane, 1961, p.7. This publication also contained the information that Central Queensland Cement Pty. Ltd. had sought and had been granted a guaranteed loan of £100,000 under the "Industries Assistance Acts". However the company did not require the loan and the offer lapsed.


22 Developments in Australian Manufacturing Industries, Dept. of Trade, Canberra, 1963-64.
cement works could be supported, and therefore that a competitor could establish in the area;

(2) That the parent companies realized it would be many years before such a plant could be an economic proposition, but that initial steps had to be made to forestall competition;

(3) That a satisfactory delaying tactic would be to begin the construction of a plant erecting the final processing stages first and, when demand conditions warranted it, erecting the primary stages;

(4) That, despite the hopes of persons in the Rockhampton area, the plant will not be fully operational until it can work to its planned capacity.

This last supposition is one that will be capable of verification at some time in the future. If this prediction is correct it will in turn verify the preceding assumptions on which it is based. In view of the existing surplus capacity at Darra and Stuart it seems that it may be several years before this verification occurs.

Three complicating factors must be considered; first, collusion between the parent companies, second, manipulation of freight rates by the Queensland Government and, third, commencement of development projects by the government.

A plant in Rockhampton having a factory price equal to that at Darra and given similar freight rates could usurp markets as far south as Bundaberg. But it is most unlikely that a small scale plant could do so. If the Darra price of cement were raised, or if the government offered a straight-through rate to Maryborough from Rockhampton, then an extension of the market area of the Parkhurst plant would be possible. If the government
The site of the Parkhurst plant of Central Queensland Cement Pty. Ltd., showing road and rail transport facilities, the direction of movement of materials and product and the utilization of the site by the company.
revoked the special Townsville-Mackay rate and introduced a special Rockhampton-Mackay rate, this also could extend the market area of the new plant. Such actions could more than double the demand it would be called on to satisfy and would allow it to begin full operations. Finally, if the government began some project[^23] which would ensure additional demand, the same purpose would be served.

However it does not seem that any event will occur which will contradict the first proposition of the thesis being argued here: a plant will be established in the area only when warranted by the growth of local demand. That the plant is market oriented is also easily seen for it is close to the focus of the third of the regional markets distinguished earlier in this study.

The limestone deposits which have been chosen by the company are at the Caves, 17 miles north of Rockhampton. Coal could be obtained from several fields but the most likely source is Baralaba which would involve a rail haulage of about 90 miles to Rockhampton. Because of the need to be close to Rockhampton for reasons of marketing and labour availability, and because of the locational pull of the limestone, a general situation was sought on the northern outskirts of Rockhampton close to the railway. Because the company was to begin as a marketing company for Darra cement, a site was chosen at Parkhurst where there were buildings available for use as a depot. For the site of the actual plant the company was able to buy a suitable area of ground about half a mile north of the depot and a spur line was built onto the site. The land acquired had the necessary clay deposits and lay between the main North Coast line and the Bruce Highway (the main northern road). The site is only 9 miles from The Caves where the limestone deposits are, and so is in easy access by either road or rail. Unless the

[^23]: Such as The Nathan Gorge Dam on the Dawson River.
The Parkhurst Plant of
Central Queensland Cement. Pty. Ltd.
State government makes special concessions on freight rates — either on the limestone, or on coal, or on cement — it seems likely that road transport will be used. The site has direct access to power supplies and the Rockhampton water supply. Water is not available at the site and even at present is a problem as purchase from the Rockhampton Council is expensive, though it may be cheaper when the water is available from the new weir at Splitters Creek from which it may even be available directly. The lack of water on this site and the absence of definite announced plans by the company gives rise to certain conjectures. First, there may be no concern about water at present as there is no plan to complete the works in the near future. Second the company may envisage the use of the "dry process". This process with its entailed heat economies, coupled with the fact that the Baralaba coal is a high grade "semi-anthracite", would reduce the amount of coal needed at the works and so reduce the costs associated with the long rail haulage.

At present the company is engaged in crushing clinker from Darra and by June 1964 had completed its first full year of operations.
CHAPTER V
SUMMARY AND CONCLUSIONS

1. THE PRESENT SITUATION: THE PRODUCERS AND THE MARKET THEY SERVE

Today there are three companies producing portland cement in Queensland. The oldest established and largest of these is the Queensland Cement and Lime Co. Ltd. with works at Darra that have a capacity of 500,000 tons and a production in 1963-64 of over 300,000 tons. This plant, due to a factor which was purely fortuitous in the original location decision, has an extremely favourable cost structure and this makes its factory price for cement the lowest in the state. It provides at present the three-quarters of the total Queensland supply of cement that is required by the south Queensland market.

The second of the companies is North Australian Cement Ltd., in which the previous company has a 20 per cent interest and representation on the board of directors. This company has a works at Stuart with an annual capacity of 120,000 tons and a production in 1963-64 of over 100,000 tons. The cost structure of this company is less favourable due to its smaller scale of production and the costly fuel which it continues to use in return for favourable government consideration in respect of tariff protection and freight rates for cement, and for the government-financed purchasing which has allowed it to operate at an economic level. This company serves a very extensive market area although three-quarters of its sales are made within fifty miles of the railway within three hundred miles north or south of the plant.

The third company, Central Queensland Cement Pty. Ltd. is a wholly owned subsidiary of the Queensland Cement and Lime Company and North Australian Cement Limited. As has been argued here its establishment seems to have been
prompted by the need to forestall competition in the vulnerable third regional market midway between the other two producers where their delivered price for cement is highest. But as this regional market is too small to support a full cement plant, it will not have one for some time unless there is an increase in the rate of growth of local demand. Such a change could result from the commencement of large developmental projects in Central Queensland. In the meantime the company is engaged in making cement using clinker from Darra.

The outstanding feature of the market served by these companies is the lack of competition. The areal extent of the market and the over-riding consideration of market orientation in the industry have forced a degree of geographical diversification on the industry. However the company structures have allowed, or encouraged, a degree of collusion between companies in supplying the market. The special freight rates introduced by the Queensland Government have furthered this rationalization of the distribution of sales areas.

In the Tariff Board Report referred to earlier it was stated: "The incidence of rail freights has the effect of dividing the Queensland market for cement geographically between the two producers.\(^1\) However in spite of Queensland Cement and Lime's financial interest it is stated that there is competition in the fringe areas."\(^2\)

From the evidence that has been studied it does not seem that this was ever the case and it certainly is not the case today. The method of marketing as described

\(^1\)This inquiry was held in mid 1961 at which time the Central Queensland Cement Pty. Ltd. was already marketing cement in the Central Queensland! Admittedly the cement was from Darra but the marketing company was owned jointly by the two "competitors" giving evidence before the Board of Inquiry.

\(^2\)Tariff Board Report, 10th November, 1961, Department of Trade, Canberra, p.4.
earlier does not allow any possibility of competition between the companies. The companies market their cement on the basis of fixed prices for the different classes of consumers, the consumer bearing the cost of transport. Competing wholesalers, or retailers, of the cement could presumably offer competitive prices for cement by altering the magnitude of their own margin of profit. Such adjustments in the final price of cement to the consumer could cause an adjustment to the boundaries of the areas supplied by the different companies. However such adjustments would be only minor variations on the boundaries agreed on by the companies and, in any case, this could hardly be construed as competition between the producing companies. But equally as important as the fact of collusion in explaining the absence of competition and the latitudinal division of the total market is the fact that was stressed in Chapter III that there are three largely separate regional markets which were largely predetermined by the patterns of population distribution and railway lines in the state. The combined effects of distance, transport costs and tariff barriers effectively shield the Queensland cement producers from overseas competition. The only imports of cement into Queensland since 1954-55 have been of special cements which, as was indicated at the outset, are outside the scope of this study. The overseas trade figures record only insignificant exports of cement from Queensland.

The situation with regard to interstate movements of cement is not as simple. The Queensland Cement and Lime Co. does supply cement in northern N.S.W. as far south as Armidale but the company is unwilling to release the amount involved in this trade. In view of the fact that this company can compete against the N.S.W. producers in the New England and Northern Rivers areas, it could seem reasonable to assume that the southern companies could not compete
farther north in Queensland. This is **not** the case as some southern cement is imported even to North Queensland. The amount involved in these interstate imports can not be calculated but it has been suggested that it is a considerable amount. Many graziers in Western Queensland have direct contact by road with Melbourne and Sydney. This is particularly true in the sheep rearing areas where wool is trucked to sales in these cities, and the freight rates on purchases from the south are very low or often non-existent. The difference between this trade and the normal method of supply of the Queensland market does not need to be elaborated.

On the whole it does not seem as if outside sales or outside imports are sufficiently large to invalidate the concept that has been used in this study of a virtually self-sufficient Queensland market. Really this market is seen to be tripartite - or more accurately, it is seen to be three regional markets - served by three plants of an inter-related group of companies.

2. FEATURES OF THE LOCATION DECISION IN QUEENSLAND

As has been shown the three Queensland plants each occupy a central position in a separate regional market. Each is conveniently placed to serve that market, particularly the single large city in which the main concentration of demand is located. In each case the location of the plant is such that, while maintaining proximity to the urban area as the prime consideration, it gives ease of access to the limestone supplies. In the case of each of the new plants, this means location on the rail line to the limestone deposits and on that side of the city. In the case of the older Darra plant, the site was chosen for this reason but a change has been made to a closer source of lime accessible by water though on the other side of the city. In each case accessibility to coal supplies has been judged less important than

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3 This point was raised by Mr. Besser, Sales Promotion Officer, North Queensland Cement Ltd.
accessibility to limestone, a fact easily explained by the relative weights involved.

In the case of each plant the selection of a near-urban site also guarantees the availability of labour and electric power, and both rail and road transport facilities are available at each site. There are also many other factors, usually grouped together as "urbanization economies", which are advantages that accrue from the choice of such a site.4

Quarrying operations at each site produce the necessary clay or sand materials. At the Darra plant water is drawn from the Brisbane River; at the Stuart plant water is obtained from two dams the company has built on Stuart Creek; at the Parkhurst site the only water available at present is potable water from the Rockhampton town supply.

The deductions in this study concerning location optimums have been made after an analysis of significant input and output factors. However it has been necessary also to consider historical conditions as well as those of the present, the circumstances of supply and demand at the time of establishment of the plant, competition with other producers and the influence of government policies and actions. To ignore these latter would have been to make unreal assumptions about the rationality and generality of the location decision. But once these are included the study belongs distinctively and peculiarly to Queensland and it is realized that, in the case of the Queensland cement

4 J. Reeves, "Transport Costs and the Location of Industry in Victoria", Economic Record, Vol. 27, 1951, p. 235, has an interesting comment here. "Finally, in addition to measureable comparative costs, there are those intangible advantages which make the large city so attractive to intending manufacturers, such as close proximity to an established business environment, and to the facilities provided by trade associations and other commercial enterprises, close proximity to the best clubs and hotels and those other aspects of the modern business man's life." This should remind us that the location decision, no matter how rational, is still a human decision and subject to the whims, fancies or prejudices of the entrepreneur.
industry, there are two aspects of its nature which prevent the findings of the study being applied widely in an unmodified form.

First, the industry has been established in this state for approximately fifty years which is only the second part of the century-long story of cement. Fortunately this has meant that the situation is not confused by relict features from a past age: there are no sites of plants long since abandoned and there are no plants occupying obviously poor locations but persisting in production. On the other hand the brevity of the history of the industry has limited the number of plants to be studied and so limited the significance of the study and the generality of its findings.

Second, the Queensland market exists as a set of largely independent regional markets each separated from the other and each of a size that can be served by one plant in that market area. This has lessened the incidence of competition to virtual non-existence. As a result viability in the face of competition can not be used as a measure of suitability of location. Further only in a study of the oldest established plant is a consideration of long term viability possible.

However within the context of time and place as outlined above, several factors have been found to be most important in the location decision. Further, these factors can be ranked in order of priority in the location decision.

1. The cement industry in Queensland has been found to be primarily market oriented. This is the result of the operation of a number of influences. Basically there is the need to try to minimize the transport costs of moving to the market a great weight of a low value product. This is reinforced by the fact that the standardized nature of the product means marketing on the basis of price alone.
and so distribution costs must be kept to a minimum. As the costs of marketing and distribution have risen over the years more than has the cost of raw materials it is observed that many industries exhibit increasingly a market orientation. The attraction of the main focus of the market to the majority of industries is a notable feature of the Australian scene in each state. In Queensland this takes a special form with the special spatial distribution that applies here.

In each regional market in Queensland the population is concentrated in one predominant city, Brisbane, Townsville or Rockhampton. In each case this city is the focus of the rail routes of the region so that location near this city is at once both close to the main concentration of demand and in a convenient location to serve the rest of the market. The influences operating to produce market orientation are general enough, but the expression of this market orientation by the near-urban location of a single large plant close to the main central point of each of the regional markets is a solution peculiar to Queensland.

2. This near-urban location has allowed certain relevant input factors to be regarded as ubiquities and so has efficiently removed them from the location decision. The chief among these factors being the availability of electric power and labour. Elsewhere than in Queensland these input factors could be truly ubiquitous and so a near-urban location would not be necessary. Also it is conceivable that in a less advanced society these factors would not be available even near a large city.

3. In choosing a general situation on the urban fringe of the main focus of the market the plants have been located to minimize transport inputs for coal and limestone and, due

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to the relative weights involved, the latter is more important.

4. Having found the general situation, the problem of the exact site was solved by the choice of an area of land where clay could be quarried and water obtained, and which had access to those relative ubiquities of a near-urban location - power, labour and transport facilities.

3. CONCLUSION

"...no one seems to know exactly what the conditions of cement production are, nor why the industry is located where it is." Even if we allow for the exaggeration in Lukeman's statement, it is still disquieting. Surely in the case of one simple industry composed of a relatively small number of fairly large scale plants, geographers should find it possible to reach some degree of certainty on these matters.

In the introductory chapter a research strategy proposed by McCarty was outlined. The prime need, suggested McCarty was for case studies as the result of which some small contribution could be made to the body of theory of economic geography. This research strategy provides perspective for the study undertaken here. In this study an attempt has been made to investigate the location of the three plants engaged in producing cement in Queensland. Each of the three case studies revealed the variety of combinations of factors involved in the establishment of a plant and the wide range of substitution possibilities that may be present even in the production of homogeneous product in a limited number of establishments in one area under roughly parallel economic conditions. The knowledge of this complexity compels the conclusion that no claim can be made for the broader applicability of the findings of this study.
The generalizations regarding location factors operative in the Queensland cement industry are offered as a hypothesis, highly restricted both topically and areally, to explain the existing patterns of the industry. The only way to move with certainty to the formulation of a broader and more generally applicable hypotheses would be by conducting other analyses similar to this one and by correlating the findings of each of these. In this way geographers can avoid the confusion that is made obvious in the conflicting statements which were quoted in the introductory chapter. As was pointed out, these conflicting statements were not wrong but only incomplete: they did not specify the time and place in which such generalizations would be correct.

This location analysis, as well as being an idiographic study complete in itself, is also the first section of a nomothetic procedure. Equal importance must therefore be attached to both the descriptive material and the results of analysis. The general theoretical statements which are the outcome of this study have been presented, not as the conclusions drawn from a deductive process of reasoning, but as a thesis to be argued through this study. It is now claimed that this thesis has been fully substantiated. Each proposition of the thesis has been demonstrated and, if this has been done satisfactorily, then it will be possible - for Queensland at least - "to know exactly what the conditions of cement production are" and "why the industry is located where it is."
A. METHODOLOGY

Ackerman, E.A. 
Geography as a Fundamental Research Discipline, University of Chicago, 1958.

Hartshorne, R. 

McCarty, H.H. 

B. INDUSTRIAL LOCATION - General and Theoretical

Alexander, J.W. 

Isard, W. 

Rawston, W. 

C. THE CEMENT INDUSTRY

(1) References in general economic geography texts:

Bengston, N.A. and Van Royen, W. 

Ekblaw, S.E. and Malkeme, D.J.D. 

Highsmith, R.M. and Jensen, J.G. 
Geography of Commodity Production, J.B. Lippencott, Chicago, 1958.

Miller, E. Willard 
Renner, G.T.,
Durand, L.,
Langdon, C. and
Gibson, W.B.

World Economic Geography, Crowell,
New York, 1957.

Smith, J.R.,
Phillips, M.O. and
Smith, T.R.

Industrial and Commercial Geography,

(ii) Other references:
Burn, D., editor,

The Structure of British Industry,
Cambridge, 1957.

Hildebrand, W.

"The Cement Industry", Development
of American Industries, editors
J.G. Glover and W.B. Cornell,

Lea, F.M. and Desch, J.

The Chemistry of Cement and Concrete,

Lukerman, P.

"The Geography of Cement?", The
Professional Geographer, Vol.XII,
No.4, July 1960.

D. CEMENT IN AUSTRALIA

Hogan, W.F.

"The Structure and Development of
the Australian Cement Industry, 1949-50
to 1959-60: A Preliminary View", Paper
read at Section G, A.N.Z.A.A.S.

Kindler, J.E.

"Engineering Structures in Queensland,
1951-60", Introducing Queensland,
Australian and New Zealand Association
for the Advancement of Science, Brisbane,
1961.

Reeves, J.

"Transport Costs and the Location of
Industry in Victoria", Economic Record,
Vol.27, 1951.
Robinson, A.J.

Shiel, G.
Chemical Industries in the Rockhampton Area, Rockhampton and District Development Association, Rockhampton.

---
Investment Service, Research and Statistical Bureau, Sydney Stock Exchange.

---

---
Annual Reports, Queensland Cement and Lime Co.

---
Annual Reports, North Australian Cement Ltd.

3. OFFICIAL PUBLICATIONS
(1) *Queensland*:

---
Queensland Government Gazette (various years)

---
Queensland Government Mining Journal (various years)

---
Queensland Parliamentary Debates (various years)

---
Queensland Parliamentary Papers (various years)

---
Queensland Year Book (various years)

---
Reports of the Director of Secondary Industries and Chairman of the Industries Assistance Board, years 1956 to 1963.
(iv)

---
Reports of the Under-Secretary for
Mines (various years)

---
Statistics of Queensland (various
years)

(ii) Commonwealth of Australia:

---
Developments in Australian Manu-
facturing Industry, Department of
Trade, years 1948-63.

---
Manufacturing Industries, No. 1,
Cement and Cement Goods, Bureau of
Census and Statistics (various years)

---
Overseas Trade, Bureau of Census and
Statistics, years 1908-61.

---
Tariff Board Report, 10th November,
1961, Department of Trade.

---
Secondary Industries Bulletins,
Bureau of Census and Statistics,
(various years)
APPENDIX 1

Brief extracts from articles and reports dated 1913 and 1914
by Mr. B. Dunstan, Queensland Government Geologist

Reference was made in Chapter II and on Map II to the activity of the Government Geologist in conducting survey work on the availability of cement materials in Queensland. Because Mr. Dunstan's speculations on the location of a cement plant were not directly relevant to the decision made for the Queensland Cement and Lime Co., no details were mentioned in Chapter II. However some reference should be made to them for their interest:

(a) as an example of a partial location analysis made in 1914, and
(b) for comparison with the decision to build a works at Darra.

Throughout this study the dominance of market orientation has been stressed. The alternative suggestions made here come from a man whose interest was in the raw materials and whose location considerations were raw material oriented.

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In "Portland Cement Manufacture in the Maryborough District", (Queensland Government Mining Journal, Vol. XV, July 1914, p.355), Mr. Dunstan says: "In the Maryborough District the ingredients for the manufacture of Portland Cement are to be found in a number of localities, close to railway lines at varying distances from Maryborough and from the deepwater port now being constructed at Urangan, the terminus of the Flalba railway line at Hervey Bay." He considers the availability of limestone at the deposits shown on the accompanying diagram.

He continues "Clay shale which usually furnishes most of the silica and alumina necessary in the Portland Cement mixture, is of common occurrence, and many places
in the Maryborough district can furnish the necessary supplies."

"Coal supplies, of which large quantities will be required in the manufacture of cement will have to be obtained from the mines at Howard, Torbanlea, Burrum River or Burgowan, or from Aldershot..."

"A good supply of water is an important adjunct to a portland cement works and the want of this is, perhaps, the weak spot in the Maryborough propositions. A large supply is not available near the city unless the city supply is to be utilized." Some of the possible locations were Aldershot, where there was a dam on Saltwater Creek, Dunthandu, Takura on Stockyard Creek on the Colton-Urangan line or Burrum River.

"Regarding sites for works, an ideal position would be where railway and waterway are both in the vicinity and these conditions would prevail in several places about Maryborough." He suggests the most favourable sites close to Maryborough to be Aldershot, Croydon Junction and Dunthandu. Takura could be satisfactory as coal could be found in the area and water was available. Burrum River would be favourable if the Marule limestone was used while either Graham's Creek or Hungar would be favourable if Biggenden or Curra limestone was used.

"In conclusion it can very confidently be stated that in no other locality in Queensland, with the possible exception of Gladstone, do the limestone coal and shale deposits exist so close together and convenient to a deep-water port as in this district, and every encouragement can therefore be given to the establishment of a portland cement industry."
In the annual report of the Mines department for 1913, and in the Mining Journal in August, the Government Geologist reported on other limestone deposits that had been assessed as well as those in the Maryborough district. Amongst these other deposits were three in the Rockhampton area - Raglan, Ambrose and Mt. Etna (The Caves) - and two in the Warwick district - Gore and Silverwood.
Tracing of a diagram illustrating "Portland Cement Manufacture in the Maryborough District"

Queensland Government Mining Journal
Vol.XV, July 1914, p.356
APPENDIX 2

Limestone deposits in South-east Queensland

The deposits of limestone in the "Maryborough district" referred to in Appendix 1 are part of a very extensive series of upper Palaeozoic sedimentaries which have been traced from Gympie to Gin Gin. Dunstan (1914) says the deposits "form a conspicuous horizon in the Middle Gympie Formation of the Permo-Carboniferous system" and traces their outcrops from Traveston to Rosedale. "The length of the belt is over 100 miles and along its outcrops there are enormous quantities of limestone of first class quality suitable for making lime and portland cement and for fertilizing lands on agricultural farms."

Analyses of the principal deposits investigated appear in the table below. It will be noted that the deposits closest to Brisbane (Gympie and Tamaroo) are of very low grade. The best deposits analysed were at Mundubbera and Biggenden.

The deposits of limestone in the Warwick district are older Silurian or Devonian deposits forming part of the Texas Block - the northern end of the great New England Palaeozoic Block. In his article on the Silurian rocks of the Border Rivers area K.G. Lucas says:

"Older Palaeozoic low grade metamorphic sedimentaries, some of which may be Silurian, outcrop fairly extensively between Warwick and Inglewood in an arc, fifty miles across, whose concave southern side swings around younger Palaeozoic sedimentaries. The whole outcrop is bounded from east to south-west by late Palaeozoic granitic bathyliths and to north and west by post-Palaeozoic deposits. Outcrops of these rocks west of the Silverwood area were called Bald Mountain Jaspers by Richards and Bryan (1926)"
Lucas suggests that the formation may be broadly subdivided. The oldest rocks are low grade metamorphics called Thames Creek Slate regarded as equivalent of Naranleigh-Fernvale rocks of the Brisbane area. The formation includes also lenticular deposits of pale limestone. "Jasper - limestone horizons occupy the upper part of the formation in the Cement Mills area where they may be 5,000 feet thick. The bottom of the formation is unknown but the exposed parts of the jasper may attain 15,000 feet."

"Indeterminate Rugose corals and algae? have been obtained from the limestone belts of the formation. Alveolites sp. (Silurian-Devonian) has been identified in limestone from "Cooinoo". Heliolites sp. (Ordovician-Devonian) is reported from the limestone at Cement Mills but the specimen is lost. If the limestone is Devonian (perforce Lower Devonian i.e. pre-Silverwood) then only the underlying uniform dark slate and sandstone may be regarded as wholly or partly Silurian."

The "Cement Mills" referred to is the quarry site near the Gore railway station and is the Gore limestone deposit referred to elsewhere in this study. "Cooinoo" is a nearby homestead.

To the east of these extensive beds of massive limestone are the deposits of the Silverwood area. As the following table shows they are of almost as high grade as the Gore deposits but they occur in smaller lenses.

The company statement regarding the selection of Gore as the quarry site was quoted on p.29. The statement that there was "no possible limestone in sufficient quantities nearer than Gore" points out the three main aspects to be considered - the quality of the limestone, the size of the deposit and the distance from Darra. It will be seen from the analysis figures given in the attached
table that the Gore limestone was of high quality and that the only equally good limestones were those at Silverwood, at Mundubbera or in the Rockhampton area. The first-mentioned were not in sufficient quantities and the others were not nearer than Gore. The deposits at Biggenden and Marule though of slightly lower grade could still have been used but they possessed no advantage in proximity. The Tamaroo deposit which was being worked was actually the best quality limestone near to Brisbane but it was a very small deposit and this presumably is why it was not selected.

Of the available limestone deposits Gore represented the closest of the high quality large-scale deposits, given that the cement plant would be close to Brisbane.
<table>
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<th>Locality</th>
<th>Moisture</th>
<th>Loss on Ignition</th>
<th>Silica</th>
<th>Iron Oxide</th>
<th>Alumina</th>
<th>Lime</th>
<th>Magnesium</th>
<th>TOTAL</th>
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<td>1.0</td>
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<td>0.7</td>
<td>55.1</td>
<td>0.1</td>
<td>100.1</td>
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<td>Biggenden (Warish's)</td>
<td>-</td>
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<td>2.8</td>
<td>0.9</td>
<td>1.1</td>
<td>53.0</td>
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<td>99.6</td>
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<td>1.5</td>
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<td>46.1</td>
<td>0.6</td>
<td>99.2</td>
</tr>
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<td>6.7</td>
<td>1.0</td>
<td>2.2</td>
<td>48.9</td>
<td>0.6</td>
<td>98.8</td>
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<td>5.1</td>
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<td>0.8</td>
<td>51.1</td>
<td>0.2</td>
<td>98.5</td>
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<td>Daylesford</td>
<td>1.5</td>
<td>43.5</td>
<td>5.1</td>
<td>3.4</td>
<td></td>
<td>46.9</td>
<td>Trace</td>
<td>100.25</td>
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<td>Gympie Cemetery (1)</td>
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<td>Malachi Creek (Rockhampton)</td>
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<td></td>
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<td>-</td>
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<td>Mt. Etna (Nearhotel)</td>
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<td></td>
<td>Trace</td>
<td>0.2</td>
<td>56.0</td>
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<td>99.7</td>
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<tr>
<td>&quot; (2)</td>
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<td>0.8</td>
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<td>0.6</td>
<td>54.2</td>
<td>0.2</td>
<td>98.8</td>
</tr>
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<td>0.3</td>
<td>0.8</td>
<td>53.3</td>
<td>0.4</td>
<td>99.5</td>
</tr>
<tr>
<td>&quot; (idle)</td>
<td>-</td>
<td>36.3</td>
<td>13.5</td>
<td>0.9</td>
<td>1.7</td>
<td>45.5</td>
<td>0.4</td>
<td>98.3</td>
</tr>
<tr>
<td>&quot; (blue rock)</td>
<td>0.2</td>
<td>32.2</td>
<td>21.8</td>
<td>1.3</td>
<td>2.6</td>
<td>40.5</td>
<td>0.5</td>
<td>99.1</td>
</tr>
<tr>
<td>&quot; (3 miles S.W.)</td>
<td>0.5</td>
<td>23.1</td>
<td>38.0</td>
<td>2.1</td>
<td>4.8</td>
<td>29.6</td>
<td>0.1</td>
<td>98.0</td>
</tr>
<tr>
<td>Marule (Willie Creek)</td>
<td>0.5</td>
<td>37.2</td>
<td>11.7</td>
<td>0.8</td>
<td>2.3</td>
<td>47.0</td>
<td>0.5</td>
<td>100.0</td>
</tr>
<tr>
<td>&quot; (Cliff Section)</td>
<td>-</td>
<td>37.0</td>
<td>12.1</td>
<td>1.7</td>
<td>1.8</td>
<td>47.2</td>
<td>0.9</td>
<td>100.7</td>
</tr>
<tr>
<td>&quot; (outcrop - Sandy Creek)</td>
<td>0.9</td>
<td>33.1</td>
<td>15.4</td>
<td>2.6</td>
<td>4.0</td>
<td>43.1</td>
<td>0.9</td>
<td>100.0</td>
</tr>
</tbody>
</table>
