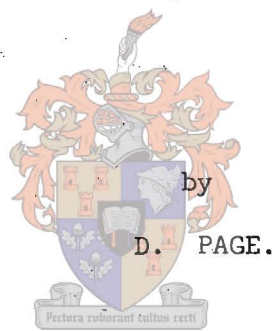


THE O.F.S. GOLDFIELDS

PLANNING FOR AN EMERGING METROPOLIS.



[Stcl. the author]

(Preface 1969)

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A DEVELOPMENT PLAN FOR THE O.F.S. GOLDFIELDS.INTRODUCTION.

The initial plan for the Orange Free State Goldfields grew from 1947 onwards out of consultations between various government authorities and organisations who had an interest in the location and development of the mining industry and associated land uses. As shown in the 1954 Report (19) the Natural Resources Development Council played a major role in the survey and planning whilst the individual gold mining companies undertook the actual development projects including a major portion of the housing and the infrastructure (20, p11).

As described fully in the 1954 Report (19) the new towns of Allanridge, Welkom, Riebeeckstad, Virginia and Blaauwdrift as well as the already existing town of Odendaalsrus were planned to contain the urban development which was expected to occur as a result of the establishment of the Goldfields. With the exception of Blaauwdrift, which was proclaimed but not developed, they grew at a tremendous pace. The total population of these towns stood at 47,589 Whites in September of 1960.

The Goldfields have now considerably extended their influence probably covering an area encompassing also the towns of Hoopstad, Bothaville, Bultfontein and Kroonstad as will be seen in figure 1 on which the growth rates of the towns between 1951 and 1960 are shown. The propensity for growth was undoubtedly strengthened by the improved maize yields in the larger area. The towns lying further out have, as is shown on the map, experienced a setback, probably due to the migration pattern inwards towards the focal point, set in motion by the new economy. It is also apparent from the plan that a typical interregional communication axis has developed across the Goldfields extending from Klerksdorp to Bloemfontein. As will be shown later, this structure agrees very closely with the core-periphery growth model described by some American regional planners.

It has been felt for some time by the Provincial authorities that sufficient growth of the settlement pattern has now occurred since the previous report (19) to determine the propensities of this growth and to prepare a new development plan which will set rational standards within the constraints of the national policy of decentralisation and planned developments.

A Steering Committee was duly appointed by the Administrator with Mr. Havemann, the then M.E.C. in the Provincial Council, as chairman and with representatives of the Universities of the Orange Free State and of Pretoria, the Chamber of Mines, the Natural Resources Development Council and the Provincial Administration. This occurred at a time when a class of the post-graduate course in Town and Regional Planning of the University of Pretoria were in their final year of study and were available for a programme of field work which would normally form a part of their training. Arrangements were accordingly made for members of the class to carry out the land-use and resources surveys. Simultaneously research projects were allocated to personnel of the University of the Orange Free State and a traffic count carried out by the Provincial Administration assisted by the N.R.D.C. and several hundred senior scholars.

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A list of reports which ensued from these investigations appears in Appendix A.

After the survey and planning series was started in 1962 it soon became apparent that there were primarily three fields of study which could be separately formulated and each of which merited a full investigation. These were, briefly:

- (a) A planning study of the Goldfields Region, containing all the towns which had become economically integrated with the mining towns;
- (b) A study of the peripheral towns - which had become arrested in their growth due to extensive emigration of the human resources to the Goldfields - with a view to pinpointing the causes of their decay and finding a means of rejuvenating them;
- (c) The establishment of a master plan for the emerging new metropolis comprising the city of Welkom and the adjoining gold mining towns of Allanridge, Odendaalsrus, Riebeeckstad and Virginia.

This report deals with the latter of the three problems.

At the last meeting of the Steering Committee held in June, 1966, it was decided that this final planning report of the series would be written by the present author after all the other reports were tabled. The last of these became available in 1967.

Due to pressure of work and numerous other commitments the report could not be completed till now. Although this is reputedly an attempt at establishing a master plan for the Goldfields it is a source of great disappointment to realise that a task of such proportions can only be handled by a team of planners who are constantly on the site to note the intimate details of month-to-month development and changes in the development pattern. Proposals are made later in this report for the establishment of a metropolitan planning body to work out a more detailed master plan.

A plan evolved by a single person on data which have been collected over a number of years will inevitably prove to be too rigid for practical application and this thesis must therefore be considered rather as a frame for a master plan, containing the rationale for, rather than the content of, a plan. It will be shown that, although the Goldfields have come close to the threshold for take-off, there is danger of its relapsing into a number of ghost towns if the gold mining should come to a premature end and the competition with the Southern Transvaal should prove too strong in this early stage of its growth.

It would seem logical therefore for the Government to adopt a development policy for the survival of the Goldfields and to this end to institute a programme of fostered growth under the powers established by the Physical Planning and Utilization of Resources Act No. 88 of 1967.

D.P.
Stellenbosch.
December, 1969.

The author wishes to give grateful acknowledgement to the National Council for Social Research and to the Provincial Administration of the Orange Free State for the financial assistance which made possible a visit to several European and American planning institutions.

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CHAPTER 1.

A PLANNING RATIONALE.

In order to find a planning rationale for the Goldfields Metropolis it has proved necessary to study the emerging metropolitan forms in the older Western countries in conjunction with the contemporary climate for urbanization in South Africa. The form emerging in South Africa seems to be running in close parallel with what has happened in some older countries and it should consequently prove possible to predict with some precision the form that would satisfy local conditions within the constraints of the national planning objectives.

1.1. METROPOLINIZATION IN THE UNITED STATES

From a study of overseas examples, and a recent study by Kemp (4) of the South African scene, the following may be considered to be the historical sequence in which urbanization is proceeding as a world-wide phenomenon in countries which were colonized by Europeans.

The early process of colonization would favour certain regions which are endowed with rich agricultural soil. In the process of occupation these tracts were equipped with an infrastructure and as roads and marketing facilities to facilitate the exploitation of the agricultural resources (10,p.63). If, in the process of industrial diversification one or more of these regions be endowed also with rich mineral resources the cumulative effect will give rise to accelerated urbanization, particularly if the initial settlement be centrally situated with reference to the transportation routes. The growing market created by this influx of an urban population adds the third element in the cumulative chain of events which gives rise to national metropolitan structures.

This, in brief, may be considered to have been the chain of events which led in the Southern Transvaal to the emergence of the Pretoria-Witwatersrand-Vereeniging metropolitan complex with the exception that the role of agriculture was subservient to the rather dominant influence of gold mining.

Friedmann (3,p.68) has extrapolated this process to the contemporary scene in Venezuela by suggesting that over-concentration in one city leads to over-saturation and a process of decentralization becomes inevitable. Caracas which at one time contained more than a third of the economic life of Venezuela began losing its attraction for the immigrant when Guayana emerged as a powerful new growth point.

To achieve a reversal of the flow of migrants to the existing overcrowded metropolitan centres new economic growth must focalize on a particular growth point where the new process of metropolization assumes a dispersed or multinuclear form. The process of multinuclear focalization has been formulated by Myrdal as the circular causation theory (7).

Lampard (6,p.321) ascribes this poli-nuclear form to the need for areal specialization. The rapidly increasing world population has created the need for the more efficient use of resources - accentuated by the higher standards of living and the more specialized needs of man.

Innovation, bred of necessity and keen competition, has brought about an ordering of the metropolitan components into a pattern of maximum efficiency in the integration of those functions that use a common infrastructure and a separation of those that have the least affinity. An improved technology of transportation and communication and a more advanced technology for providing municipal services have strengthened this trend toward a clustered metropolis.

Rising standards of living create the need for the non-physical resources. Environment for good living contains not only the tangible commodities of shelter, food and clothing but also the institutional, the latter becoming more specialized with time.

The threshold values of these institutional services require people to live together in greater numbers. In fact, the French view, as expressed in the policy of metropolises of equilibrium, is that a milieu of good living needs a population of at least 300,000 people.

Rodwin has further shown (12,p.223) that 50 to 70 percent of the investment in the manufacturing industry is taken up by the urban infrastructure. Towns of a certain size already contain this infrastructure, and have therefore arrived at the take-off stage and economically therefore form the targets of the process of focalization. Rodwin assumes the take-off stage of a town to be reached at a population size of 50,000 persons. This is a significant figure when dealing with the future of the O.F.S. Goldfields.

1.2. THE URBANIZATION OF SOUTH AFRICA.

Extrapolating the American rationalizations to the South African scene, a very similar process of evolution is apparent.

Table 1 shown a schematic classification of the larger towns listed in the 1960 census report (16) into the principal historical, economic and functional bases.

Very few, if any, of the larger South African town have experienced the full cycle of cumulative advantages of resource endowment as described by Perloff. Certainly no region has been so richly endowed with agricultural potential as to have given rise to a colonial economy with an agricultural export base.

1.2.1. The Port Cities.

Cape Town failed to foster a colonial economy because its agricultural hinterland, encompassing the vineyards within a radius of only about 50 miles, did not reach far enough into the interior to establish an infrastructure and a market mechanism essential to a sustained self-generating economy. It lacked the cumulative advantages of good agricultural potential backed by a mineral resource hinterland which made Boston the exporting capital of a colonial economy in the United States. An infrastructure comparable with the Erie canal and the latter roads and railways of the Eastern Seaboard never developed in the Cape.

The greater distance to foreign markets and a similar barrenness of hinterland initially also inhibited the emergence of Port Elizabeth and East London as exporting centres.

But an improved transportation technology is overcoming the handicap of distance as far as Durban is concerned. This harbour is endowed with both a rich agricultural hinterland and mineral resources stretching far into the interior. These cumulative advantages have created the infrastructure which affectively links the harbour with the Southern Transvaal. This growth axis has sparked off an incipient megalopolis which, if unchecked, will fill the Tugela Valley and its tributaries at an unprecedented rate of growth.

A comparison of the growth rates of the four harbour cities shows that Durban with its present growth rate of 2.74 per cent per year has outstripped the others. The national average is 1.7 per cent whilst that of the Town metropolis is only 1.46 per cent.

TABLE 1.

TOWNS AS REGIONAL CENTRES ACCORDING TO INITIAL OR CONTINUING
ECONOMIC OR FUNCTIONAL BASES.

Economic or functional base.	Growth rate 1921-60	White population size				Growth category	% growth rate 1951-60
		1921	1936	1951	1960		
<u>Harbour cities.</u>							
Cape Town	1.42	126791	183046	266715	305155	A	1.46%
Durban	3.02	61098	97583	152850	196398	A 1	2.74%
Port Elizabeth	3.4	25313	48694	79328	94931	A 1	1.94%
East London	2.19	21010	31311	43946	49295	A	1.24%
<u>Administrative centres.</u>							
Pretoria	3.93	45590	78028	151100	207202	A 1	2.44%
Bloemfontein	3.04	19426	30080	49074	63046	A	2.73%
Pietermaritzburg	2.06	17998	22521	32620	40065	A	2.24%
King Williams Town	0.32	5928	5840	6397	6731	B.D	0.55%
<u>Higher education.</u>							
Potchefstroom	2.38	8189	10774	16708	20615	A	2.28%
Stellenbosch	2.75	3695	5012	8252	10738	A	2.87%
Grahamstown	0.99	7237	8198	8680	10668	B	2.24%
Pietermaritzburg		17998	22521	32620	40065	A	
<u>Agricultural seats.</u>							
Paarl	2.18	6058	8823	12196	14128	A	1.59%
Kroonstad	2.87	4291	5333	10047	13068	A 1	2.87%
Pietersburg	3.86	2452	4240	7644	10858	A 1	3.85%
Queenstown	1.60	5231	6723	8759	9743	B	1.15%
Bethlehem	2.21	3383	5011	7030	7985	A	1.38%
Standerton	2.48	2562	2949	4707	6722	A	2.72%

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Economic or functional base	Growth rate 1921-60	White population size				Growth category	% growth rate 1951-60
		1921	1936	1951	1960		
<u>Gold mining</u>							
Witwatersrand towns	3.013	242089	421738	833780	729448	A	1.55%
Klerksdorp	6.213	3121	4561	9138	19390	A 1	8.43%
Orkney	-	-	-	1793	6596		15.03%
Carltonville	-	-	-	5507	16111		12.21%
<u>Other mining</u>							
Kimberley	0.74	18468	15914	20486	24739	B.D	2.05%
Witbank	3.67	2081	3556	7072	8590	A 1	2.11%
Newcastle	0.71	2447	2113	2815	3235	B.D	1.51%
Dundee	1.65	1586	1636	2455	3013	B	2.23%
Vryheid	2.25	2062	3127	4328	4942	A	1.44%
<u>Manufacturing</u>							
Germiston	3.41	23115	40146	67147	86314	A 1	2.74%
Vereeniging	6.81	1843	5487	17322	24564	A 1	3.83%
Vanderbylpark	-	-	-	11851	21916	A 1	6.83%
Sasolburg	-	-	-	-	6777		
Kempton Park	9.72	226	895	5475	10698	A 1	7.47%
<u>Rural district centres</u>							
Rustenburg	4.75	1734	3154	7263	10751	A 1	4.31%
Ermelo	1.48	2716	2579	4221	4849	B.D	1.50%
Graaff Reinet	0.28	4516	4448	4902	5047	B	0.31%
Lichtenburg	2.90	1867	3237	4374	5806	A 1	2.41%
Wellington	0.88	2666	2979	3512	3769	B	0.54%
Aliwal North		2444	2566	2767	2631	B.C	
Fort Beaufort	0.93	1039	1541	1475	1494	B.C	stat.
National average	1.82	1521343	200334	2641689	3088492		1.70%
<u>Growth category.</u> A. Continuous growth at above national average growth rate. B. Flagging towns growing at less than national average. C. Arrested towns in which growth started declining at a particular time. D. Rejuvenation after arrested growth. A 1. $1\frac{1}{2}$ times or more the national rate							

1.2.2. Urbanization of the Interior.

With the colonization of the Orange Free State and the Transvaal Republics the Administrative seats of government were established at points where the immigrants successfully clustered together for mustering and organizing their political and cultural needs. Examples of these are Winburg, Potchefstroom, Andries Ohrigstad, Lydenburg, Zoutpansberg and Rustenburg, none of which survived purely on account of their agricultural merit.

As the interior became colonized by farmers, agriculturally based towns arose as small administrative and functional centres for the farming communities. Very few of these towns were founded in particularly fertile areas. The availability of water and irrigable land and the centrality for the siting of churches, schools and shops were the main considerations.

Most of these towns became arrested and are in fact still flagging because they lack the secondary requirements for growth, namely the follow-on advantages of fertile soils, mineral wealth or central markets. Some of them later emerged as growing towns due to some of the cumulative advantages enumerated by Kemp.

Kemp has found (4,p.200) a correlation between sustained growth of towns and a high per capita gross national product. This in fact confirms the theory that the towns with the biggest cumulative advantages of all resources experience the faster growth rates.

From the statistics in Table 1 it is clear that the systematic urbanization of the interior of South Africa commenced with the discovery of diamonds at Kimberley and the gold fields of the Transvaal. Particularly the gold mining industry may be considered to have played the major role in the focalization of development in the Southern Transvaal.

Where the road and rail systems in North America resulted from the needs of agriculture they may be considered to have arisen in the interior of South Africa as the result of the needs of the gold mining industry. Evidently the usual first link in the chain of cumulative advantages, namely an incremental environment for intensive agriculture was missing and gold mining affectively filled this role.

Quite fortuitously the ingredients for a shift from gold mining to the steel-producing industry was present. Coal, initially mined at Boksburg and Springs and later at Witbank, dovetailed perfectly with the iron ores at Pretoria and later with that of Thabazimbi and Postmasburg. Thus the Witwatersrand as the main labour pool and principal market for consumer goods in South Africa experienced a successive cumulative advantage.

It is worth noticing that some of the isolated mining towns such as New Smitsdorp (near the present town of Pietersburg), Pilgrimsrest and Barberton never emerged as virile towns probably due to the small scale of the diggings and the fact that there were no "follow-on" advantages associated with their localities.

On the other hand the scale of operations on the Witwatersrand imparted a momentum to the growth which easily encompassed the whole of the Southern Transvaal when the focus shifted

from gold mining to the manufacturing industry. The tentacles of growth easily reached to such towns as Vereeniging, Witbank, Postmasburg and others and, as in the case of North America, a vertical shift is now occurring downwards to the petrochemical and the electrical industries.

1.2.3. The Present Urban Scale in South Africa.

The economic and functional bases of towns in South Africa include port facilities, administration, gold mining, other mining, manufacturing, agriculture, higher education and others. Monofunctional towns probably do not occur and all towns would include a mixture of at least two of these functions, denoting hinterland ties associated with what could be considered "cumulative advantages" in terms of the Perloff model. The fewer the ties the less virile the settlement is likely to be.

From a study of Table 1 it is apparent that gold mining towns are more virile than the others, particularly in the initial stages when the gold mines start producing and expanding their scale of operations. Unless diversification occurs and other functions are added, possibly in response to the markets that have been created, these towns are likely to stagnate and die when mining operations cease. An extreme example is the Dominion Reefs estate, a village of more than a hundred houses which was evacuated when the mine stopped producing. Other examples are Nigel, Brakpan and Randfontein which started flagging from about 1950 due to the decrease in their mining activities. Although the scale of operations in new mining towns imparts an immediate momentum to their growth, there is thus a clear need for diversification to prevent later stagnation. Gold mining towns which had acquired a strong manufacturing base, such as Germiston, Springs and Benoni, experienced no setback with the closing of their mines.

Rural district towns have a growth rate below the national average unless they are associated also with other functions or serve a particularly large or fertile hinterland. Examples of the latter are Pietersburg with a growth rate of 3.85 percent per annum and Kroonstad, with 2.87 percent respectively. Unless new functions are added even these are likely to falter as is evident in the case of Harrismith and Bethlehem (1.38 percent). Pietersburg is now experiencing its sustained growth due to the accretion of a strong industrial component.

Similarly a study of the towns within each of the other functional categories shows that those with a combination of functions have greater virility than the others in the same category. Thus in the administrative function Pretoria (2.44 percent) far outstrips the others due to its strong industrial complement and its other functions. Apart from being an administrative capital and having a strong industrial base, it has also been a university town and the centre of a large and active agricultural setting for a comparatively long time. In the higher education category Stellenbosch is the most virile (apart from Pretoria) probably due to its strong agricultural base and the presence of large wineries as secondary and tertiary functions.

Manufacturing towns experience a sustained growth at a rate which is roughly double the national average. Assuming that manufacturing towns acquire this function as a result of their

location in relation to physical resources, transportation routes, labour and markets it is clear that these towns have experienced the full cycle of cumulative advantages, particularly if they are also situated in a rich agricultural setting and lie within a gold mining complex.

1.2.4. Megalopolis.

The most significant phenomenon in urban growth is the urban complex of the Southern Transvaal containing the Witwatersrand towns, Pretoria, Witbank and the Vaal triangle containing Sasolburg, Vanderbylpark and Vereeniging. The growth of this settlement is shown in Table 2 from which it will be apparent that the rate of growth is nearly one and a half times the national average. Reduced to figures this means that the population of the PWV is increasing at the rate of 24000 persons per year - equivalent to a town of the size of Stellenbosch. In this process of growth it is drawing a migration stream of 7000 persons from elsewhere - mostly small rural towns which are thereby rendered even more sterile than before.

TABLE 2.

GROWTH OF THE P.W.V. COMPLEX.

	1921	1936	1951	1960	Growth rate 1951-1960
Witwatersrand Towns	242089	421738	633780	729448	1.52%
Pretoria	45590	78028	151100	207202	2.44
Vereeniging	1843	5487	17322	24564	3.83
Witbank	2081	3556	7072	8590	2.11
Sasolburg				6777	-
V.d. Bylpark			11851	21916	6.83
Kempton Park	226	895	5475	10698	7.47
	291829	509704	826600	1009195	2.15%

The problems created by overconcentration of population in a single urban complex and the withdrawal of human resources from already depressed areas have been described in the Barlow Report for the London of 1938, and lately also for most of the metropolises of the world.

In most countries this phenomenon has given rise to national policies for decentralization and focalization of growth in their depressed areas. It has been shown by Myrdal (7) and others that the most effective way in which to stem the tide of migration to the overgrown megalopolis is to create a new growth point sufficiently virile and economically viable, to act as a new magnet for investment of capital and human resources. It has also become clear that such a growth point should be at such a distance from the existing megalopolis that it will form a new independant economy, focalizing the resources from its own hinterland and neighbouring hinterlands into a new focal point. If daily commuting were possible between the old core and the new one the new settlement will merely form an extension of the existing one and aggravate the ills it is meant to cure.

1.3. THE AIMS OF THE STUDY.

A master plan for the emerging metropolis should indicate broadly a land-use pattern for the next twenty-five years. Enough information has been gathered by field observation which has been systematically rationalized in the reports listed in Annexure A to provide a total view of the existing development in the region.

The present report will concentrate on the inner core of the region and for the purpose of arriving at realistic proposals for its physical development will deal with the following aspects:

- (a) The gold mining potential only in so far as this has a bearing on the future growth of of the Goldfields;
- (b) The distribution of the manufacturing industry particularly with a view to determining the location quotients of the different types for the future allocation of industrial sites;
- (c) A brief demographic analysis and forecasts of the size of the future population;
- (d) A physical analysis of the available land for future development together with the existing services and other physical factors which have a bearing on the functional differentiation;
- (e) From these a land-use allocation map for all the urban functions for the next twenty-five years will be compiled.

For much of the information required for this tremendous task the author will rely heavily on the reports which have already appeared. Some of the simulation models which have been applied for normalizing the land requirements of the several functions have been adopted from other published work.

CHAPTER 2.THE ROLE OF THE GOLD MINING INDUSTRY.2.1. THE FUTURE OF GOLD MINING

According to Van Biljon and Botha (13,p.1) gold is mined generally in the Basal Reef of the Witwatersrand System but the Kimberley A and B and the Elsburg Reefs are also mined on the Loraine estate.

Prospecting has revealed that most of the adjoining country, although extensively mineralized does not hold much promise for profitable gold mining. The faulted and fractured nature of the gold bearing area, together with the abundance of underground water make mining a hazardous venture.

Figure 2 shows the situation of the producing gold mining areas and the proclaimed lease areas. Of these Merriespruit and Jeanette had already stopped producing by 1962 (the former due to inundation) and were to have been maintained on a caretaker basis. Freddie's North and Freddie's South had similarly come to a critical stage and are now run by Freddie's Consolidated. A new company, Free State Saaiplaas to the north of Virginia commenced operations later and started producing in 1961.

According to Van Biljon and Botha the mines can be divided into three groups, distinguished from each other by their location, their payability and their general life expectancy. (See also Table 3.)

- (a) The northern group containing the mines of Loraine and Freddie's Consolidated, lying between Allanridge and Odendaalsrus.
- (b) The central group which includes the Free State Geduld, Western Holdings, Welkom, St. Helena, President Brand and President Steyn, disposed around the city of Welkom.
- (c) The southern group containing Harmony, Free State Saaiplaas and Virginia.

The economic viability of some of these mines depends largely on their uranium production and a change in the uranium market will have a critical effect on gold mining generally. To date this byproduct seems to be a decreasing source of income.

The mines of the central group have much better prospects than the northern and the southern groups on account of a higher grade, larger reserves and less difficult mining conditions (13,p.2) a fact which is also borne out by the production figures to date as shown in Table 3. Welkom is likely to experience the beneficial impact of gold mining on its economy much longer than the other towns.

Table 3 shows the general trends in mining production from the producing mines for the period 1960 to 1967. The production of gold in fine ounces in relation to tonnages milled is also shown in the group in figure 3. A projection of these curves indicates that the mines have already reached their peak and that production will start decreasing from about 1970 unless a new factor is introduced in the gold mining industry.

As is shown in Table 4, it is significant that during this period the profits from both gold mining and uranium production have started decreasing and that the average production per ton milled has increased from 9.46 pennyweights to 10.95 pennyweights, probably in response to a fairly steep rise in the pay limit of the ore.

From these figures and the estimates of the ore reserves of the mines as provided by the Government Mining Engineer (which are of a confidential nature and cannot be supplied here) it is evident that the life of the mines is limited (13).

2.2. GOLD MINING AND THE INFRASTRUCTURE.

Perloff (10,p.38) explains how, in the United States of America, the primary industry organized itself financially and equipped itself with the infrastructure to improve production and the marketing of its product. Similarly in the Goldfields the several mining houses instituted heavy construction programmes in order to equip the mines with labour, material and engineering services to produce gold more systematically and on a payable scale.

The report of the Chamber of Mines (20,p.1-10) describes the role played by the gold mining industry in procuring the engineering services such as water, electricity, roads and railways through the appropriate undertakers. The report also describes how hospital services were initiated for both Bantu and Whites at the several mines and how the hospitals at Odendaalsrus, Welkom and Virginia were eventually built by the Chamber of Mines at a cost of R886,156.

Probably the most significant role played by the industry in the urbanization programmes was the provision of housing. The townships of Allanridge, Welkom, Riebeeckstad, Virginia and Blaauwdrift were established by the mining companies involved and as township owners as well as sole employers of practically the entire urban population the industry may be regarded as having sponsored the entire housing programme.

Table 5 shows the rate of township development. Unfortunately no figures are available for Odendaalsrus but it must be assumed that a large portion of the later development of this town is also attributable to the mining industry.

From the table it is immediately apparent that building development is closely associated with the growth of the mining industry: Welkom and Virginia were filled to 64 and 52 percent respectively of their potential by 1963. Allanridge, with a very poor mining component, had developed only 17 per cent of its potential by the end of 1963.

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TABLE 3.

PRODUCTION OF GOLD IN THE O.F.S. GOLDFIELDS.

Name of Mine	Associated town	Gold produced in fine ounces					Trend
		1960	1962	1964	1966	1967	
	Northern Group						
Freddies Consolidated	Odendaalsrus	159332	152874	301522	415614	404577	Apparently at its peak
Lorraine	Allanridge	204324	373583	433110	441295	438495	Apparently at its peak
Northern Group	TOTALS	363656	526457	734632	856909	843072	
	Central Group						
Free State Geduld	Welkom	979320	1265182	1830930	1942943	1917732	Apparently at its peak
President Brand	Welkom	1131672	1359341	1408563	1580382	1586265	In full production
President Steyn	Welkom	467810	653837	822544	865090	870449	In full production
St. Helena	Welkom	684966	934545	1076624	1065179	1068386	In full production
Welkom	Welkom	375163	493657	711449	783055	731629	In full production
Western Holdings	Welkom	1726878	1546010	1862260	1940604	1844806	In full production
Central Group	TOTALS	5365809	6252572	7712370	8177253	8019267	
	Southern Group						
Free State Saaiplaas	Virginia		253331	248933	500479	658083	Growing
Harmony	Virginia	775217	971757	969420	983526	946107	In full production
Virginia	Virginia	326729	443669	509409	494313	474007	In full production
Southern Group	TOTALS	1101946	1668757	1727762	1978318	2078197	
Goldfields	GRAND TOTAL	7195067	8447786	10174764	11012480	10940536	

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TABLE 4.

TONNAGES MILLED AND PROFITS FROM MINING.

	1962	1963	1964	1965	1966	1967
Tons milled	17,866,000	18,863,000	20,474,600	21,434,800	21,786,100	22,313,900
Dwts. per ton milled.	9.46	9.78	10.01	10.07	10.11	10.95
Profits from gold mining	R105.81m	R119.95m	R135.25m	R140.99m	R139.86m	R133.39m
Profits from uranium	R19m	R12.42	R12.39	R11.50	R5.06	R3.19

TABLE 5.

TOWNSHIP DEVELOPMENT BY MINING COMPANIES.

Township	Number of erven laid out	Erven developed and date	Percentage of available erven
Welkom	7918	5057 (31.12.1963)	64
Naudeville	328	240 (31.12.1963)	73
Virginia	4867	2556 (31.12.1962)	53
Riebeeckstad	865	155 (31.12.1962)	18
Allanridge	3423	571 (31.12.1963)	17
Total	17401	8579	

Source : Chamber of Mines Report (20).

A sign of the mining decay of the northern area is that construction of dwellings in Allanridge had practically come to a standstill by the end of 1963.

It has been shown by Rodwin (12,p.227) that 50 to 70 percent of the capital investment in a growth point is absorbed in providing the required urban infrastructure consisting of engineering services, housing and institutional establishments. The towns of the Goldfields may now be considered to be fully equipped and paid for from the proceeds of the primary industry. In a programme of planned industrial diversification cognizance must be taken of this situation and the fact that an urban infrastructure worth an amount well in excess of one billion Rand must either be preserved and used or allowed to fall into decay.

2.3. GOLD MINING AND REGIONAL INCOME.

In 1963 approximately 11000 White males were in mining employment. From this it may be de-

duced that practically the whole of the 8500 dwellings then in existence were occupied by mining families.

Table 6 shows the growth of the White employment figures in Gold mining from 1947 to 1962. Assuming an annual per capita earning of approximately R2500 it means that in the year 1962 approximately R26 million was paid out in salaries and wages to Whites only, thus establishing a firm market for consumer goods and services.

TABLE 6.
EMPLOYMENT OF WHITES ON THE MINES FROM 1947 TO 1962.

MINE	NUMBERS EMPLOYED			
	1947	1952	1957	1962
Freddies Consolidated	199	840	583	432
Free State Geduld	-	341	635	992
Free State Saaiplaas	-	-	177	501
Harmony	-	301	1089	1571
Jeanette	-	53	-	-
Lorraine	-	309	604	800
Merriespruit	-	64	-	-
President Brand	-	336	734	977
President Steyn	-	591	922	1190
St. Helena	171	524	762	1011
Virginia	-	275	1066	1049
Welkom	172	762	875	874
Western Holdings	-	558	833	1060
TOTALS	542	4954	8240	10457

Source : Chamber of Mines Report (20).

From the Report of the Chamber of Mines (20, Table 6) an amount of R66,209,719 was spent during 1962 by the industry on stores, of which an amount of R63,038,933 went to South African Manufacturers, indicative of the tremendous backward linkage of gold mining on the South African economy.

According to the same report (20, Table 5) the total profit of the mining industry in the period 1958 to 1962 (inclusive) amounted to R446,667,087 from a working revenue of R80,779,163. These figures indicate the rate of capitalization of the mineral resources of the area, which may also be regarded as the capital-generating propensity of the industry. The total taxation paid during the five year period ending 1962 amounted to R113,595,308 (20, Table 4), the industry thus contributing also very largely to the national coffers.

2.4. LINKAGE WITH OTHER INDUSTRIES.

According to the industrial survey carried out in 1963, which is described more fully in chapter 3, only about 30 per cent of the economically active White population was employed in manufacturing, the service industry and construction. Apart from a small employment component in the finance and commerce sector, the bulk of the employment was still connected with mining.

As will be shown in the analysis of the manufacturing industry, 21.4 per cent of all manufacturing, service industries and construction was directly dependent on the gold mining industry. The construction industry, which formed 37 per cent of the total industrial employment in 1962 was still intimately associated with gold mining.

The region is not well endowed with minerals that can replace gold mining as a basic industry. Massive limestone deposits of satisfactory quality are found in the vicinity of Hennenman to a depth of twelve feet with an overburden of four feet, covering an area of 5000 morgen. This deposit is being worked by the Whites Portland Cement Company and the Anglo Alpha Cement Company (8, p.4) Production and employment figures are given in the chapter dealing with the industrial survey.

Large quantities of water are pumped from the mines daily, containing from 3000 to 4000 parts per million of salt. It has been suggested that the salt be recovered by pumping the water into the numerous pans and allowing it to evaporate. The obvious weakness in this proposal is that the water is only being pumped as part of the mining operations and if these should cease the costs of pumping the water would not be commensurate with the recovery of salt.

The coal deposits of the Middle Ecca which occur at Welkom and Odendaalsrus at depth cannot compete successfully with deposits elsewhere due to their inferior quality, low thermal value and the inconsistency of the seams and the cost of recovery at that depth (8, p.4). Table 7 below gives the statistical qualities of the coal.

TABLE 7.

STATISTICAL DATA OF THE COAL SEAMS IN THE GOLDFIELDS.

Seam	Average depth	Width of seam	Washed coal			
			(Ash content)	Calorific value	Volatile Substances	Humidity
Upper	475 ft.	97 inches	21.3%	10.4	28.8%	4.2%
Lower	575 ft.	119 inches	24.6%	9.7	24.0%	4.7%

(Source 8, p.5)

It has been estimated that 75 million tons may be available and it is possible that the deposit may become economically important at a later stage for power generation and in the petrochemical industries.

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Uranium and pyrites are recovered economically at the present time as part of the gold mining process - the former at a decreasing rate of payability. These industries will cease, in any event, with the closing of the mines.

Other minerals which may become important in time are the heavy earths : ilmenite, zircon, rutile and monasite which occur ten miles north-northwest of Bothaville (13,p14). There is apparently no steady market for these minerals and the heavy production and transportation costs preclude their successful competition with other supplies elsewhere.

CHAPTER 3.

THE SECONDARY INDUSTRY.

Apart from published statistical material use was made of a comprehensive survey by questionnaire posted to all industrial undertakings within the wider region. Due to poor responses a number of establishments had to be visited by members of the research staff in order to obtain the required information. In the end the survey amounted to a sample of 50.6 per cent as measured against the sample tabulation of the 1960 census adjusted to the survey date. The information used in this analysis may therefore be considered to be an accurately representative survey for practical purposes.

For purposes of analysis, comparisons of the regional pattern were made with national averages and individual towns and industries with averages for the region. In all cases employment figures were used rather than output for purposes of comparison because these were found to be more reliable.

To distinguish clearly between manufacturing, service industries and construction all dry cleaning establishments, workshops and garages were classified as services. A similar adjustment was made to the national figures in order to establish a basis for comparison.

3.1. INDUSTRIAL DIVERSIFICATION.

Table 8 shows the industrial employment structure of the Goldfields in comparison with that of the Republic as a whole, the East Rand and the West Rand respectively.

From this Table it is clear that the stage of diversification of the Goldfields core towns in 1960 were still far behind that of the Republic and the other Goldfields areas. Gold mining is, at 51.1 per cent of the total economically active population, by far the biggest source of employment, being roughly ten times as high as the national average and almost double that of the West Rand. In manufacturing, on the other hand, the employment is only a third of the national average and still less than half that of the West Rand.

TABLE 8.

EMPLOYMENT STRUCTURE OF WHITES IN THE GOLDFIELDS IN 1960.
(ODENDAALSRUS, WELKOM, VIRGINIA).

INDUSTRY	O.F.S. Goldfields Percentage employment in each sector.				
	Employees	% of total	R.S.A.	East Rand	West Rand
Agriculture	335	2.0	10.3	0.7	3.7
Gold mining	8820	51.5	5.5	12.5	27.8
Manufacturing	1179	6.9	20.1	31.0	15.6
Construction	1419	8.3	6.3	6.5	5.6
Electricity	111	0.6	0.9	0.9	0.6
Commerce and Finance	1882	11.0	20.5	16.2	16.4
Transportation	432	2.5	10.7	12.3	10.9
Services	2589	15.1	22.1	16.0	16.1
Unemployed	345	2.0	3.6	3.9	3.3
Total	17112				
Percentage economically active of total population.		34.4	36.9	60.5	35.3

Source : Sample Tabulation no. 1. Population census 1960.

The employment in construction is proportionally much higher than both the national average and the Witwatersrand, indicating that this emerging metropolis is still in the stage of preparation of its infrastructure for more efficient production. Judging by employment figures the transportation system is still far short of the national average.

That the core towns are still virile and growing is indicated by the low unemployment rate of 2.0 per cent as compared with the national average of 3.6 per cent.

Table 9 shows the growth of manufacturing and construction in five-yearly periods from 1935 onwards. Establishments are related to average employment figures in each and the growth indicated in employment figures in order to obtain a more realistic representation. This can, at best, be only a rough indication of growth and is perhaps more satisfactorily shown on the graph in figure 4.

It is interesting to note that grain milling has been the most prominent industry since before 1935 in the towns peripheral to the area where the later gold fields were to be established. Cement factories already existed at Hennenman and Ventersburg and these easily gave rise to a fairly strong component of the construction sector.

Kroonstad is the only town to have acquired a fairly balanced industrial structure whilst grain milling remained the more important industry in the other peripheral towns, excepting Bothaville and Theunissen.

Industry in the core towns developed in harmony with gold mining providing either the construction or the mining equipment required in the mining field.

Figure 5 shows the main industrial specialization of each town, seen in historical perspective. The following emerging specialisms were apparent in 1962:-

- (a) Although industry in Kroonstad has been suppressed to some extent by the emerging new core towns the construction sector has increased (from 20.9 per cent to 26.1 per cent of the total employment in industry) and services as well as manufacturing have gained. Grain milling, the predominant industry has weakened (from 66.9 per cent in 1935 to 34 per cent of all industries in 1962);
- (b) In Hennenman - Ventersburg the cement factories and associated construction firms have maintained a stand of practically 100 per cent of the total employment in industries;
- (c) In Virginia mining construction and mining timbers still employed about 75 per cent of the total labour force in the secondary sector and services only 18 per cent;
- (d) In Bothaville the manufacture of farming implements which commenced in the period 1946 to 1950 formed more than 60 per cent of the total secondary industry sector. Grain milling and construction were weakly emerging industries at about 19 per cent and 2 per cent respectively;
- (e) In the other peripheral towns (Theunissen excluded) grain milling increased from 35 to 5 per cent and some diversification towards the services was still proceeding;
- (f) Since brickmaking on a large scale commenced at Odendaalsrus between 1936 and 1940 this undertaking has maintained a distinct lead in the industries. Manufacture of food and beverages and construction are also developing;

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SOURCE : INDUSTRIAL SURVEY OF 1963

TABLE 9.

CHRONOLOGICAL SEQUENCE OF INDUSTRIAL GROWTH IN THE GOLDFIELDS REGION.

TOWN	Main industrial types established, according to employment figures.							
	Before 1935	1936 - 1940	1941 - 1945	1946 - 1950	1951 - 1955	1956 - 1960	Total	Industry
Kroonstad	1. Grain mil- ling 2. Construc- tion	1.Construc- tion 2.Furniture	1.Grain mil- ling 2.Clothing	1. Dry Cleaning 2. Construction	1.Brick ma- king (Construction)	1.Construc- tion	1.Grain mil- ling 2.Construc- tion	Diversification pro- ceeding. Construc- tion and grain mil- ling weakening.
Hennenman Ventersburg	1. Cement	-	1.Construc- tion 2.Bakery	1. Construction 2. Service	-	1.Grain mil- ling	1.Cement 2.Grain 3.Construc- tion	Building construc- tion emerging; dy- namic.
Bothaville	-	1.Service	1.Service	1.Farm Imple- ments 2.Grain milling	-	1.Service	1.Farming Implements 2.Grain	Agriculture; Farm implements; dynamic.
Bultfontein Hoopstad Wesselsbron	1. Grain mil- ling	1.Service 2.Grain mil- ling	1.Grain mil- ling 2.Service	1.Construction 2.Service	1.Service 2.Grain mil- ling	1.Grain mil- ling	1.Grain mil- ling 2.Service	Grain milling and service industries.
Theunissen	-	1.Service	1.Construc- tion	1.Construction	-	-	1.Metal pro- ducts	Construction; indus- try weakly represen- ted.
Odendaals- rus	1.Grain mil- ling	1.Brick ma- king	1.Bakery	1.Food	1.Construc- tion 2.Drink	-	1.Bricks 2.Grain mil- ling	Construction mate- rials (bricks) In- dustry weakly repre- sented.
Virginia	-	-	1.Construc- tion	1.Non-met. min. 2.Construction	1.Service 2.Timber	-	1.Non-met. min. 2.Timber	Indeterminable; mi- ning construction still predominant
Welkom	-	-	1.Construc- tion 2.Grain mil- ling	1.Construction 2.Mining mach.	1.Construc- tion 2.Service	1.Services 2.Construc- tion	1.Construc- tion 2.Food	Mining construction still predominant. Deversification pro- ceeding.

- (g) Welkom started off with a strong construction component in the period 1941 to 1945 (82.1 per cent of the total secondary employment) but has since acquired a firm manufacturing and services base. Manufacture of cheese (1946 - 1950), grain milling, chemicals and machinery together formed about 21 per cent of the secondary employment.

From the graph on figure 4 it is apparent that Kroonstad started giving way to the industries in the emerging core towns from about 1947 onwards and that the other peripheral towns started expanding their industries from 1946 onward at a fairly rapid rate, overtaking Kroonstad in 1951. From that date onward these towns have also started lagging, probably in sympathy with the overall decrease in the growth rate.

3.2. THE PRESENT DISTRIBUTION OF INDUSTRIES.

Table 10 shows the industrial employment in the region, and the distribution of these industries is shown diagrammatically in figure 5.

A breakdown is made in Table 10 of the industrial labour into race groups and sexes and a comparison made with the national employment structure. Measured by the national averages the indices for construction, nonmetallic mineral products (mostly cement and bricks), food and beverages were 2.4636, 2.2174, 1.6879 and 1.4444 respectively, showing that the basic industry of gold mining was being implemented by a vigorous construction programme. The manufacture of machinery was also high at 1.4750, mainly in consequence of the manufacture of mining equipment but largely also on account of the large undertaking which manufactures agricultural equipment at Bothaville.

Lack of diversification is apparent from the low employment ratio in the manufacture of consumer goods. The absence or scarcity of undertakings in the manufacture of textiles, wearing apparel, furniture and metal products indicates that the region is still largely dependent on industrial centres outside the area.

The implication of the imbalance in the employment structure is that, apart from the workers who will become available from the eventual decline in gold mining, employment will have to be found for the surplus of nearly 4000 in the construction programme. A more diversified pattern of manufacture of consumer goods is clearly indicated.

Table 11 shows the distribution of industries within the region. Of the total employment of 17039, 58.1 per cent were attached to the core towns and of these 78 per cent were attached to Welkom. In the peripheral towns Kroonstad employed 50 per cent of the total and Hennenman - Ventersburg 31 per cent, leaving the other peripheral towns only weakly developed except for the manufacture of agricultural equipment at Bothaville and grain milling in the south-western sector.

From the table it is clear that there is a distinct orientation of industrial types to their respective resources. It has already been shown that this pattern has been evolving since 1945 when gold mining first imparted a focalizing effect to industries in the north-western Free State. The distribution is more clearly shown on figure 6, as follows:-

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TABLE 10.

Bultfontein?

INDUSTRIAL EMPLOYMENT IN THE GOLDFIELDS REGION (COMPRIZING THE CORE TOWNS, KROONSTAD, BOTHAVILLE, BETHLEHEM, HENNENMAN, HOOPSTAD, THEUNISSEN, VENTERSBURG AND WESSELSBRON) AS AT 1962.

Industrial Group	Employed figures						Total	% of Total	% in R.S.A.	Index	Surplus Employment
	Whites		Coloured		Bantu						
	Male	Female	Male	Female	Male	Female					
1. Food	372	144	28	-	2532	152	3228	18.9	11.4	1.6579	+ 1277
2. Beverages	75	16	-	-	285	67	443	2.6	1.8	1.4444	+ 134
3. Tobacco	-	-	-	-	-	-	-	-	0.5	-	- 85
4. Textiles	-	-	-	-	-	-	-	-	5.5	-	- 935
5. Wearing Apparel	14	38	47	101	32	235	467	2.7	9.9	0.2727	- 1221
6. Wood, Cork	22	6	-	-	486	-	514	3.0	4.0	0.7500	- 168
7. Furniture	28	6	-	-	40	-	74	0.4	2.2	0.1818	- 304
8. Paper products	-	-	-	-	-	-	-	-	2.5	-	- 423
9. Printing	55	63	6	-	30	-	154	0.9	2.5	0.3600	- 271
10. Leather products	-	-	-	-	-	-	-	-	0.6	-	- 103
11. Rubber products	28	6	-	-	81	-	115	0.7	1.5	0.4667	- 136
12. Chemicals	34	18	-	-	69	-	121	0.7	5.1	0.1373	- 747
13. Petrol and Gas	-	-	-	-	-	-	-	-	1.0	-	- 168
14. NonMetal Minerals	457	36	8	-	2107	-	2608	15.3	6.9	2.2174	+ 1433
15. Basic Metals	-	-	-	-	-	-	-	-	5.6	-	- 951
16. Metal products	184	32	-	-	573	-	789	4.6	9.0	0.5111	- 747
17. Machinery	435	24	-	-	549	-	1008	5.9	4.0	1.4750	+ 326
18. Electrical Mach.	4	2	-	-	10	2	18	0.1	2.9	0.0345	- 474
19. Transport Equipm.	-	-	-	-	-	-	-	-	3.3	-	- 557
20. Diverse	-	-	-	-	-	-	-	-	2.1	-	- 356
21. Services	239	97	18	-	713	99	1166	6.8	2.6	2.6154	+ 719
22. Construction	1206	99	28	-	4998	4	6331	37.2	15.1	2.4636	+ 3757
T O T A L S	3153	587	135	101	12505	559	17040				

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TABLE 11.

COMPARATIVE INDUSTRIAL EMPLOYMENT STRUCTURE IN THE TOWNS OF THE GOLDFIELDS.

INDUSTRY GROUP	Percentage of each group of the total employment in each town or group of towns.										
	Region	Bultfontein Hoopstad Wesselsbron	Theu- nissen	Hennenman Venters- burg	Botha- ville	Kroon- stad	Total peri- pheral towns	Oden- daals- rus	Vir- ginia	Welkom	Total core towns
1. Food	18.9	54.6	-	20.0	20.1	38.1	30.7	24.3	5.0	11.5	10.4
2. Beverage	2.6	-	-	-	-	1.5	0.8	6.7	-	3.5	3.9
3. Tobacco	-	-	-	-	-	-	-	-	-	-	-
4. Textiles	-	-	-	-	-	-	-	-	-	-	-
5. Wearing apparel	2.7	-	-	-	-	12.9	6.5	-	-	-	-
6. Timber	3.0	-	-	0.7	0.6	-	0.3	-	26.6	1.2	5.0
7. Furniture	0.4	-	-	-	-	1.5	0.7	-	-	0.3	0.2
8. Paper products	-	-	-	-	-	-	-	-	-	-	-
9. Printing	0.9	-	-	-	-	4.3	2.2	-	-	-	-
10. Leather prod.	-	-	-	-	-	-	-	-	-	-	-
11. Rubber goods	0.7	-	-	-	-	-	-	-	-	1.5	1.2
12. Chemicals	0.7	-	-	-	-	-	-	-	-	1.5	1.2
13. Petrol etc.	-	-	-	-	-	-	-	-	-	-	-
14. Non Metal	15.3	-	-	59.1	0.2	10.5	23.9	45.8	32.3	2.0	9.1
15. Bas. Met.	-	-	-	-	-	-	-	-	-	-	-
16. Metal	4.6	-	69.6	1.6	-	-	0.9	-	3.1	8.6	7.3
17. Machinery	5.9	-	-	-	57.2	5.5	10.2	-	-	3.6	2.9
18. Elec. Mach.	0.1	-	-	-	-	-	-	-	-	0.2	0.2
19. Transport	-	-	-	-	-	-	-	-	-	-	-
20. Diverse	-	-	-	-	-	-	-	-	-	-	-
21. Services	6.8	36.2	13.0	2.4	15.8	5.6	7.4	13.4	9.6	5.3	6.4
22. Construction	37.2	9.2	17.4	16.2	6.0	20.0	16.5	9.9	23.3	60.8	52.2
TOTAL EMPLOYMENT	17039	344	45	2239	923	3589	7139	561	1516	7821	9898
% of Total	100.0	2.0	0.3	13.1	5.4	21.1	41.9	3.3	8.9	45.9	58.1

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- (a) Grain milling in the south-western sector in the towns of Bultfontein, Hoopstad and Wesselsbron with a location quotient of 2.89, equivalent to a surplus labour of 123 above the average;
- (b) Cement factories in the eastern sector at Ventersburg and Hennenman with an emerging construction industry. The cement factories here have a location quotient of 3.86 giving a surplus labour of 980 employees;
- (c) Production of agricultural equipment at Bothaville, the nearest point to processed steel from the Southern Transvaal and centrally situated with respect to the wheat and maize fields. The location quotient for this industry is 9.69, equivalent to a surplus labour of 473;
- (d) Construction, mostly in support of gold mining at Welkom and Virginia, but also an emerging manufacturing component, obviously oriented to the large market. At Welkom the surplus employment in construction is about 1600 and with diversification this labour will shift to the manufacturing sector;
- (e) Kroonstad, as the oldest settlement of some size showed the most advanced stage of diversification, fairly representative also of the consumer goods. Food processing provided the highest location quotient with a surplus employment of 690 above the average for the region.

Welkom is the largest industrial centre in the region with a labour force of 7820 which is more than twice that of Kroonstad. It is clear that Kroonstad will lag behind even further in the future.

The respective orientations of the industries as described above will evidently persist for some time into the future and use should be made of this fact in the planning for future industrial growth.

3.3. THE CHARACTERISTICS OF THE INDUSTRIES.

3.3.1. Some labour characteristics.

Table 12 shows the female employment component as a percentage of the total for each town as well as the White - Bantu ratio and the Coloured component as a percentage of the total.

Female employment is particularly high in Kroonstad at 23.8 per cent for Whites and 15.4 per cent for Bantu. This is evidently due to the large female employment in the clothing factory. It is clear from the table that the female component of industrial labour rises with diversification.

Kroonstad also takes the lead in the Coloured employment at 5.1 per cent of the total. The average percentage in the core towns is only 0.3 per cent as against 1.4 per cent for the total region. This situation is likely to have changed considerably since the date of the survey as provision has now been made for Coloured housing at De Bron near Welkom.

The White - to - Bantu employment ratio at Kroonstad is highest in the region at 1:3.41 whilst at Hoopstad, the lowest in the region, it is only 1:0.72. It is likely that the ratio decreases with distance from the Bantu areas in the east and possibly also with the provision of Bantu housing on a regional scale. Influx control will continue to keep the ratio low in the newer towns and especially so in the service industries in the White residential areas. The

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present high ratio in the new towns is possibly due to the high representation of the construction industry.

TABLE 12.
SOME LABOUR CHARACTERISTICS

Town	Percentage female of total labour	White : Bantu ratio	Percentage of Coloureds in total labour
Bothaville	7.5%	1 : 1.94	0.4%
Bultfontein	6.0%	1 : 3.10	1.2%
Hennenman	4.2%	1 : 2.90	1.1%
Hoopstad	-	1 : 0.72	-
Kroonstad	19.2%	1 : 3.41	5.1%
Theunissen	-	1 : 1.55	-
Ventersburg	0.8%	1 : 3.05	0.4%
Wesselsbron	6.7%	1 : 2.75	-
Total peripheral towns	11.7%	1 : 2.92	2.9%
Odendaalsrus	2.5%	1 : 4.92	-
Virginia	3.1%	1 : 6.11	0.5%
Welkom	4.4%	1 : 3.72	0.2%
Total core towns	4.1%	1 : 4.04	0.3%
Total Region	7.3%	1 : 3.5	1.4%

Table 13 reflects the labour characteristics of individual industries. The highest White - Bantu ratio pertains to the timber industry at 1 to 17.71 whilst grain milling, brickmaking, the cement works and construction, i.e. the least diversified undertakings, are also heavy employers of Bantu labour. On the other hand the service industries such as cold drink manufacturers, dry cleaners and bakers are not only less Bantu labour intensive but could possibly reduce this ratio by administrative control as the labour in this class is semi-skilled rather than unskilled as in the basic industries. It is also possible that females could replace Bantu labour to a larger extent. The table shows that female labour is already well represented in the printing and dry cleaning industries.

Average sizes of establishments and the floor area per worker are also shown. These norms are applied later in this report for the planning for industrial expansion.

Not shown in the table but readily deducible from the data supplied is the average size of establishment in terms of labour. There is a large range in the size of establishments in grain milling, brickmaking, and construction and a simple average would be meaningless. A few undertakings are large but the majority are of the domestic type and some are run by the owner and an assistant.

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TABLE 13.

LABOUR CHARACTERISTICS IN INDIVIDUAL UNDERTAKINGS

	Percentage females	White:Bantu ratio	Average size of establishment	Floor space per worker	Average no of labourers
Roller mills	9.8%	1 : 4.85	16158 sq. ft.	345 sq. ft.	Wisselend
Wood & Cork pr.	0.7%	1 : 17.71	24700 sq. ft.	566 sq. ft.	44
Printing	24.4%	1 : 0.30	5500 sq. ft.	660 sq. ft.	8
Cold drinks	4.1%	1 : 3.1	7600 sq. ft.	247 sq. ft.	31
Cement and stone crushing	-	1 : 3.2	73000 sq. ft.	483 sq. ft.	151
Brick making	-	1 : 5.0	Mostly out of doors		Wisselend
Machinery	2.5%	1 : 1.2	25950 sq. ft.	204 sq. ft.	127
Dry Cleaners	30%	1 : 5.7	3490 sq. ft.	147 sq. ft.	24
Workshops	7.7%	1 : 1.36	2620 sq. ft.	480 sq. ft.	5½
Builders	1.5%	1 : 3.00	Mostly without fixed premises		Wisselend
Constr. Eng.	-	1 : 4.0	7260 sq. ft.	97 sq. ft.	(75)
Bakeries	7.5%	1 : 4.9	12100 sq. ft.	324 sq. ft.	37

3.3.2. Characteristics of the predominant industrial types.(a) Grain milling.

With the exception of a large mill at Welkom all undertakings were in the peripheral towns and all the larger establishments sell on the national markets. With the exception of the Welkom undertaking which was selling 35 per cent of its products to the mines, only small amounts were being sold direct to the mining industry.

The smaller mills in the rural areas act as service establishments to the farming communities and consumers supply their own transport from the farms to the mills and back.

The larger firms rely on the producers of grain to supply their own transport to the mill from where the meal is usually dispatched by rail. Bran is one byproduct which is exported in bulk.

The location factors, ranged in order of importance by the producers in the questionnaire were as follows:-

- (i) access to raw materials,
- (ii) access to markets,
- (iii) railway facilities,
- (iv) suitable sites and thereafter, in descending order, location on a main road, availability of unskilled labour and suitable buildings.

Practically all the undertakers complain that labour is not available in sufficient quantities and that the transportation services are inadequate. Most would like to have the embargo on private transportation beyond the 30 mile radius removed.

Grain milling has a direct strong backward linkage with agriculture and, within the region, a forward linkage with bakeries for local consumption only. This industry could, in the process of diversification, absorb a variety of processes including, apart from the preparation of cereals, also the canning of fruit and vegetables from the Sand-Vet irrigation scheme.

(b) Bakeries.

The raw materials are obtained within the region and all production is sold locally. Approximately 31 per cent of the product is sold direct to the gold mines.

The main location factors, ranged in order of importance according to the undertakers are

- (i) access to the market,
- (ii) availability of skilled labour,
- (iii) availability of raw materials in bulk.

(c) Cold drink factories.

Raw materials consist of sugar which is imported from Durban, fruit concentrates and chemicals-which are introduced from the Southern Transvaal - and gas in bottles from Germiston.

Some undertakers find skilled labour difficult to obtain and one complained that fuel costs are too high. The establishments are all situated within the core area and they cater for local consumption, including 16 per cent of the product which is sold direct to the mines.

Ranged in order of importance the main location factors are:

- (i) proximity to the markets,
- (ii) availability of skilled labour,
- (iii) availability of unskilled labour and
- (iv) availability of suitable sites away from sources of pollution.

(d) Clothing factories.

This industry is represented by one factory and a few small ladies' outfitting establishments, all at Kroonstad. Coloured labour forms about 31 per cent of the total and Bantu 58 per cent, the female component being 80 per cent of the total. According to the returns from the undertakers, difficulty is experienced in obtaining suitable labour.

(e) Timber.

The industry caters principally for the mines but building material is also produced as well as firewood. Mining timber comes mainly from Natal and the Northern and Eastern Transvaal, whilst the raw materials for firewood and building materials are obtained from local merchants and the Witwatersrand.

The main location factors, ranged in order of importance are:-

- (i) railway facilities,
- (ii) access to the markets (linkage with the mines),
- (iii) availability of unskilled labour. The ratio of unskilled to skilled labour is about 18 to 1 and it seems undesirable, therefore, to encourage this industry in the Goldfields.

(f) Furniture.

The industry produces for markets within the region and about 27 per cent of the product is sold direct to the mines. The undertakers find the availability of raw materials unsatisfactory but as this consists largely of imported timber the position is not unique to the Goldfields. Some timber is obtained from the Witwatersrand.

(g) Printing.

The printing industry is confined to Kroonstad and consists of a complement of skilled workers at a ratio of 1 White to 0.3 non-White of whom some are Coloureds.

The raw materials, consisting largely of paper, are introduced from outside and the product is largely exported to the national markets.

Arranged in order of importance, the following are the main location factors:-

- (i) the availability of skilled labour,
- (ii) access to the national markets via the railways and
- (iii) access to raw materials.

Because the industry is highly mobile, these location factors all appear to be tenuous and the establishment of most of the undertakings seems to be a historical association with persons rather than the result of a particularly favourable site.

(h) Rubber products.

This industry caters largely for the motor trade and although some work is done directly for the gold mines and is therefore exported indirectly, it must be considered to be a local service industry.

Raw rubber is introduced direct from Port Elizabeth or from the headquarters of some of the establishments which are in Johannesburg. According to the returns some difficulty is experienced in obtaining suitably trained labour.

(i) Chemicals.

This is a newly emerging industry associated closely with the mining industry which absorbs about 75 per cent of the product.

Raw materials are obtained from Sasolburg, Witbank and lately sulphuric acid is produced at the mines from the pyrites.

(j) Cement.

This is an important industry both from an employment point of view as well as for its forward lineage with construction. Its product is bulky and the construction industry would therefore be oriented toward the raw materials rather than the markets and this means that construction would show a tendency to locate in the eastern sector of the Goldfields complex.

Although the quality and quantity of limestone are satisfactory, the water supplies seem inadequate and engineering services for the maintenance of machinery are not satisfactory. According to the undertakers the raw materials are not easily assembled at their present location. Approximately 386,000 tons are handled annually.

The main location factors arranged in order of importance are:-

- (i) availability of raw materials,
- (ii) railway facilities,
- (iii) access to markets. According to these the present location of the factories seems satisfactory.

(k) Metal products.

Practically all the undertakers complain of the lack of skilled labour and the inadequacy of transportation facilities. Inconvenience is suffered from delays in obtaining raw materials where these are supplied from the Witwatersrand. Only in a few cases is steel bought from local merchants.

All undertakers supply to the mines direct in quantities varying from 10 per cent to 100 per cent of their output. Of the total product 78 per cent is supplied direct to the mines. Most of the undertakings are located in Welkom with a few at Virginia and one at Theunissen.

Arranged in order of importance the following are the main location factors:-

- (i) availability of skilled labour,
- (ii) access to markets (linkage with mines)
- (iii) unskilled labour,
- (iv) railway facilities and
- (v) access to raw materials.

(1) Machinery.

Apart from the agricultural implements produced at Bothaville, the main product appears to be mining equipment. The raw materials consist mainly of steel, introduced from Iscor and from firms on the Witwatersrand.

The industry has a high intake of labour, largely of a skilled nature, and the major portion of the product is marketed outside the region so that it is important from the point of view of basicness. Of the total labour force 58 per cent is Bantu.

Arranged in order of importance the following are the main location factors:-

- (i) availability of skilled labour,
- (ii) unskilled labour,
- (iii) railway facilities,
- (iv) access to raw materials and
- (v) access to markets.

Some difficulty is experienced in obtaining skilled labour and complaints have been recorded that the railway services are inadequate. One large undertaker stated that municipal services - water and electricity - are too expensive.

(m) Engineering construction.

There appears to be a strong force of attraction for engineering establishments along an axis extending along the railway line from Kroonstad to Welkom. The industry is the main source of employment in the secondary sector, the total employment having been about 1800 in 1962. About 52 per cent of the industry is linked with mining.

Arranged in order of importance the following are the main location factors:-

- (i) availability of skilled labour,
- (ii) availability of unskilled labour,
- (iii) access to markets (linkage with mines),
- (iv) railway facilities,
- (v) availability of raw materials and
- (vi) suitable sites.

All the establishments find the lack of labour and particularly skilled labour an obstacle to expansion. The majority also recorded their dissatisfaction with the adequacy of the transportation services. This factor, combined with the fact that the industry is highly mobile, has created a strong competition from firms on the Witwatersrand. Most of the materials are also obtained from Johannesburg and some firms merely assemble on the site the materials which are manufactured and supplied by firms on the Witwatersrand.

(n) The Service industry.

This industry consisted mainly of workshops and dry cleaners employing 6.8 per cent of the total industrial labour.

In the workshops category the location factors were ranked by the undertakers as follows:-

- (i) access to the markets via a location on the main road,
- (ii) proximity to clients,
- (iii) availability of skilled labour,
- (iv) suitable sites and proximity to railways.

In the dry cleaning category the location factors were ranked as

- (i) location in the shopping area (market)
- (ii) availability of skilled labour and
- (iii) availability of suitable buildings.

3.4. A BASIC - NONBASIC ANALYSIS

Table 14 is an attempt at a basic - nonbasic analysis to establish the regional flow of industrial goods in the secondary sector. In the survey very few production figures were provided and consequently recourse has had to be taken to calculating exports according to employment figures. The analysis at best therefore only shows proportional imports and exports rather than absolute volumes. These may assist in deriving linkage effects of specific industries which may be of value in designing a programme of industrial investment for growth and diversification.

In some cases local consumption has been calculated from average consumption per capita for the Republic, the surplus or deficit over local requirements thus being considered as direct exports or imports. No attempt has been made to determine exports or imports through other industries which would have provided a direct measure of linkage effects.

From an inspection of the results of the analysis it is clear that gold mining is still by far the main exporting sector (R124,810,000 annually as against a total deficit of R20,493,000 in the others combined) The next highest is the production of food (specifically grain milling) with an annual export of R181,000 per annum in 1962.

In the analysis the surplus of R311,000 in services and R6,005,000 in construction have not been considered as exports. In the case of construction the surplus must be taken as local investment in production capital which will decrease annually with time.

Apart from the fact that production of food, non-metallic minerals and machinery have already developed into basic industries, it is clear that textiles, metal products and building materials should be fostered to satisfy an emerging new market. These industries are mobile and could easily form backward or forward linkages with the existing clothing factories, agricultural implements factory and the cement factories.

The grain mills which are already responsible for an annual import of capital amounting to R181,000 should be encouraged to diversify into the production of a full range of cereals and

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TABLE 14.

BASIC - NONBASIC ANALYSIS OF INDUSTRY FOR 1962.

* Local services and local capital investment, no export.

SECTOR OR INDUSTRY GROUP	L A B O U R					
	Regional Employment	Calculated normal for pop. 100,000	Surplus or deficit	Normal nett output for pop. 100,000	Capital inflow or outflow	Sales to gold mines (indirect export)
Gold mining	90360				+ 124,810	
1. Food	3224	3108	+ 116	4,844	+ 181	173
2. Beverages	441	466	- 25	992	- 53	
3. Tobacco	-	179	- 179	529	- 529	
4. Textiles	-	1177	- 1177	1,722	- 1,722	
5. Wearing apparel	466	2504	- 2038	3,013	- 2,452	
6. Timber	518	1041	- 523	762	- 382	129
7. Furniture	73	571	- 498	834	- 727	15
8. Paper	-	630	- 630	1,378	- 1,378	
9. Printing	154	650	- 496	1,580	- 1,206	
10. Leather	-	150	- 150	205	- 205	
11. Rubber	115	370	- 255	992	- 684	27
12. Chemicals	121	1360	- 1239	3,098	- 2,822	91
13. Petrol & Gas	-	230	- 230	791	- 791	
14. Non met. Min.	2607	1881	+ 726	2,414	+ 932	223
15. Basic metals	-	1270	- 1270	3,444	- 3,444	
16. Metal Products	789	2220	- 1431	3,395	- 2,188	456
17. Machinery	1008	930	+ 78	1,766	+ 148	201
18. Elect. Mach.	18	870	- 852	1,665	- 1,631	
19. Transp. Equip.	-	899	- 899	1,772	- 1,772	
20. Diverse	-	430	- 430	768	- 768	
21. Services	1166	708	+ 458	480	* + 311	
22. Construction	6339	3371	+ 2968	6,820	* + 6,005	1870
Totals excluding mining	17039	25015	- 7976	43,264	+ 103,317 (including mining)	3186

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canned foods from raw materials to be supplied by the Sand-Vet irrigation scheme.

If grain milling were to be isolated as a single industry the excess of nett product over local consumption would amount to R30.5 million which means that this industry is subsidizing the total food producing group of industries by approximately R30 million.

Once the construction programme is complete the production of transportation equipment could be planned to absorb the labour and infrastructure.

Construction could in the intervening period be made less dependent on the Southern Transvaal by the introduction of light steel foundries for producing reinforcing material and metal beams.

3.5. A SUGGESTED PLANNING PROCEDURE.

- (a) Before any planning proposals can be made it will be necessary to arrive at a fairly accurate estimate of the population growth within the planning period of, say, 30 years. The growth rate will depend not only on the natural increase but on the migration pattern which will be set up by the available employment opportunities.
- (b) Planning for industrial expansion must aim at recouping the mining labour which will be lost in the planning period by the decline in gold mining and aim also at providing the additional employment opportunities required by the growing population.
- (c) In the selection of industry types cognizance will have to be taken of the population needs in consumer goods and particular emphasis placed on those that can form a backward lineage with the existing basic industries as disclosed by their location quotients and the favourable location factors. Sectoral shift from non metallic minerals and construction to building materials will probably penetrate from the east. Light machinery and metal products should be made to penetrate from the north whilst food processing should diversify from grain milling and penetrate from the west and southwest. The service industries and fine metal works will probably gravitate into the central city with its pool of highly skilled labour and high threshold values.
- (d) Much reliance cannot be placed on free enterprise for selection of sites or even types of industry so that a firm development plan or master plan will be required and means devised for implementing its provisions.

CHAPTER 4.DEMOGRAPHIC ANALYSIS.4.1. THE POPULATION DISTRIBUTION PATTERN.

Table 14 shows the distribution of the population in the Goldfields region at the time of the 1960 census. The pattern of distribution on Whites in the central area is shown graphically on figure 7. The form of the emerging new metropolis in relation to the mines, the railways, the main roads and the pre-existing urban pattern is clear from this diagram.

The thin spread of the rural population in the core area in comparison with the much older settlement at Kroonstad speaks well for the firm control over land subdivision and land use which was imposed by the Natural Resources Development Council, the body which up to 1967 controlled development in this area.

Table 15 further shows that the total urbanization in the core area stood at 90.4 per cent in 1960 whilst in the peripheral districts it was only 39.3 per cent for all races. The proportion of Whites to the total population in the core area had increased from 24.4 per cent in 1951 to 28.0 per cent in 1960 whilst in the peripheral areas it had increased from 31.5 per cent to 38.0 per cent, indicative of the immigration of Whites into the area and the suppression of Bantu immigration by influx control. The proportion of Whites would be considerably higher but for the large body of Bantu mine workers.

What is particularly significant is the fact that Coloureds had increased from 320 to 1953 in the intercensal period 1951 to 1960. According to the 1960 Census Report (17) the majority of the Coloured immigrants are drawn to the services sector (68 per cent of the total economically active). Agriculture has drawn none but, surprisingly, 12 per cent work on the mines. If housing should become available it is evident that many Coloureds will be drawn to the Goldfields, especially if industry should become more diversified and more semi-skilled employment opportunities become available.

It is understood that immigration of Coloureds is in future to be limited to a few "growth points". There is as yet no statutory control over the movement of Coloureds and presumably the only manner in which migration can be influenced would be by the provision of housing and other facilities. Coloured labour may thus play a significant role in the implementation of Government policy in the future.

Reitsma (14.p.39) has observed a trend toward Africanization of the rural hinterland and mention is made of the "black spots" which are being created by the emigration of Whites from the periphery to the core. Between 1951 and 1960 the Bantu-White ratio had increased from 1.654 to 2.175 for each White person in the urban areas (an increase of 31.5 per cent) and from 6.372 to 10.134 per 1 White in the rural areas - an increase of 59.0 per cent. The town of Bothaville experienced the highest influx with an increase in the ratio by 107.0 per cent. This is also the town which underwent the greatest industrial expansion in that period.

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TABLE 15.

POPULATION DISTRIBUTION IN THE O.F.S. GOLDFIELDS REGION IN 1960.

TOWN AND/OR DISTRICT	WHITES			COLOUREDS			BANTU			TOTAL ALL RACES		TOTAL ALL RACES URBAN AND RURAL	URBAN % OF TOTAL
	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural	Total	Urban	Rural		
Welkom	27096	824	27920	288	30	318	70230	4263	74493	97614	5117	102731	
Odendaalsrus) and Allanridge)	8559	550	9109	120	15	135	22472	6341 *(38012)	28768	31106	6906	38012	
Virginia	11934	782	12716	103	9	112	29020	5273	34293	41057	6064	47121	
Total	47589	2156	49745	511	54	565	121677	15877	137554	169777	18087	189864	90.4%
Bothaville	1861	2098	3959	34	36	70	3469	20818	24287	5364	22952	28316	
Bultfontein	1385	1264	2649	18	12	30	2094	11776	13870	3497	13052	16549	
Hennenman	2830	686	3516	36	32	68	5673	6100	11773	8539	6818	15357	
Hoopstad	805	1376	2181	9	184	193	1577	14744	16321	2391	16304	18695	
Kroonstad	13483	3768	17251	819	101	920	29149	31668	60817	43451	35537	78988	
Theunissen	1531	1657	3188	20	71	91	4721	14986	19707	6272	16714	22986	
Ventersburg	3915	687	4602	79	31	110	8094	6499	14593	12078	7217	19300	
Wesselsbron	1097	1023	2120	5	1	6	2705	12283	14988	3807	13307	17114	
Total	26907	12559	39466	1020	468	1488	57482	118874	176356	85399	131907	217305	39.3%
Grand Total	74496	14715	89211	1531	522	2053	179159	134751	313910	255176	149994	405169	63.0%

Source : Population Census 6th September 1960 Geographical Distribution of the Population.
Government Printer, Pretoria, 1963.

* Mine compound.

4.2. THE MIGRATION PATTERN.

No data is available of the Non-White migration pattern and consequently an account can be given only of the White migration.

Reitsma has shown (11,p.65) that the natural rate of increase for Whites in the core area is approximately 2.88 per cent which is particularly high and shows the youthfulness and vitality of the population. The actual rate of growth of the population in the area, however, varied from 24.20 per cent between 1944 and 1951 and 16.98 per cent in the period 1951 to 1960. This means that there was, actually, an average immigration of 21.32 per cent and 14.10 per cent respectively per annum in the two periods.

Calculating backward from 1960 the total natural increase was approximately 8300 persons between 1944 and 1960 in the core towns, which means that the immigration of Whites in that period was approximately 37,000 persons.

Table 16 compiled from the 1960 census as supplemented by the above calculation shows the total immigration pattern for the Goldfields. It seems that the largest number which came from the Transvaal - nearly three times as many as from the Cape and the O.F.S. - were evacuated from the mines which were closing down on the Witwatersrand, probably by direct transfer of personnel by the mining companies concerned.

The large proportion of children under the age of 15 years from the Transvaal emigrants substantiates the view that mostly younger families migrated. Emigrants from the Cape were evidently mostly single persons. The large body of migration from the Free State hinterland probably resulted from the focalizing effect of the new growth point and its variety of employment opportunities.

Table 17 shows how the immigrants were absorbed by the different industrial sectors. Measured against the existing average employment in each sector it means that gold mining and commerce benefited most by the influx of workers.

4.3. DEMOGRAPHIC ANALYSIS OF THE WHITE POPULATION.

4.3.1. Age and sex structure.

The rapid urbanization of the core area is apparent from the fact that in the region the rural population had decreased from 18,920 in 1951 to 14,420 in 1960 whilst the urban population had increased from 27,377 to 64,006, mostly by immigration.

The comparative age and sex structure of the core and the peripheral areas respectively are measured against the structure for the Republic in figure 8.

TABLE 16.

IMMIGRATION OF WHITES TO THE GOLDFIELDS TOWNS.

BIRTHPLACE	A G E G R O U P S					
	0 - 14	15 - 19	20 - 24	25 - 64	Over 65	Total
Cape	1324	414	729	4614	275	7356
Natal	354	79	104	590	16	1143
Transvaal	7757	2102	2087	7049	94	19089
S.W.A.	78	7	21	126	-	232
Rhodesia and Nyassaland	148	14	12	64	2	240
Rest of Africa	4	6	6	36	2	54
Europe	320	113	236	1224	24	1904
Other areas	11	3	11	63	3	91
O.F.S.						6891
TOTALS.	9996	2738	3206	13766	416	37000

TABLE 17.

ABSORPTION OF WHITE IMMIGRANTS IN THE DIFFERENT INDUSTRIAL SECTORS.

SECTOR	PERCENTAGE ABSORBED	PERCENTAGE OF TOTAL ECONOMICALLY ACTIVE ON GOLDFIELDS.
Gold mining	56.0	51.5
Commerce and Finance	15.6	11.0
Services	12.6	15.1
Construction	8.2	
Manufacturing	2.4	
Agriculture	0.3	2.0

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TABLE 18.

MAJOR OCCUPATIONS IN EACH INDUSTRY : ALL RACES, IN 1960.

INDUSTRY DIVISION	PROFESSIONAL, TECHNICAL.	ADMINISTRATIVE, EXECUTIVE, MANAGERIAL.	CLERICAL	SALES	CRAFTS- MEN	SERVICE WORKERS	OTHERS	TOTAL
Agriculture	3	1	1	-	19	1	3	177
Mining	475	31	1943	4	81,583	912	3	89,484
Manufacture	28	75	151	67	1969	45	3	2,431
Construction	31	90	111	3	5005	28	2	5,350
Electricity	7	-	5	-	299	10	-	324
Commerce and Finance	57	312	1020	1282	2543	133	-	5,917
Transport	5	45	143	2	342	20	-	929
Services	1283	116	615	55	925	8564	3	12,009
Unemployed	9	-	32	8	135	45	1368	1,624
TOTALS	1896	670	4021	1421	92,820	9758	1387	118,245

Source : Population Census 6th September, 1960.

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In the core area the 20 to 40 year group represents 36.1 per cent of the total population against the normal of 27.5 per cent for the Republic. This bulge correspond with the immigration into the region. The over 60 year group forms 2.3 per cent of the total as against the normal of 9.8 per cent. The under 10 group at the other extreme forms 32.2 per cent of the total as against the normal 22.2 per cent, indicative of the youthfulness of the settlement.

In the peripheral area the representation in the over 60 group is far above the average for the Republic, thus clearly representing the residuals of the inward migration. The pronounced inward concavity in the 20 to 40 year group represents the loss of workers to the new focus developing in the Goldfields.

4.3.2. Major occupational groups.

Table 18 shows the major occupational groups for all races in the Goldfields. Separate data for Whites is not available. The figures as given for all races may be misleading in the "craftsmen" and "service workers" classes and are possibly not of much use for purposes of comparison with other regions or national norms. However, a fair idea of the structure of the economy may be deduced from the table.

Broadly there are four categories of workers: skilled technical personnel, clerical personnel, semi-skilled workers and service workers. Table No. 19 has been compiled to indicate the range of skills now available in the various industry divisions. From this table it is clear that mining is the least diversified of all industry divisions and that the shift to skilled workers progressively increases in the order: mining, construction, manufacturing, services and commerce, respectively. This probably agrees with the national pattern. This is very nearly also the order in which the percentage of semi-skilled workers decreased in the various economic sectors and could therefore serve as a model of sectoral shift for a development programme of labour training and adaptation.

TABLE 19.

RANGE OF SKILLS IN THE MAIN INDUSTRY DIVISIONS.

Industry division	Skilled workers %	Clerical personnel %	Semi-skilled workers %	Service workers %
Mining	0.6	2.3	96.0	1.1
Manufacturing	4.2	9.0	81.0	2.0
Construction	2.3	2.1	93.6	0.6
Commerce	6.2	38.9	43.0	2.2
Services	11.6	5.6	7.7	71.3
Average for all industries	2.2	4.6	78.5	5.2

Table 20 shows the distribution of workers in the major occupational groups in all industries combined. Average incomes of male White workers in each category are also given. Figures for other race groups are not available.

The low ratio of female employment is also indicative of a lack of diversification but may have a different significance in the Bantu group where nearly all the mining labour consists of males who are introduced from outside on short-term contract.

For Whites the modal income which ranges from R2000 to R3000 per year corresponds closely with the income of miners and craftsmen. The income of the order of R6000 per year forms only a small portion of the total and contains mostly the professional and technical occupations.

4.3.3. Standard of Education.

Table 21 shows the standard of education reached by the economically active White males in the major occupational groups. Other particulars, not shown in the table, are the following:

- (i) In the professional group the modal level of education is matriculation with a diploma (29.6 per cent of the total);
- (ii) In the administrative and clerical groups the modal value is matriculation (35.0 per cent of the total);
- (iii) In the mining group the modal value is standard 6 and 7 (46.8 per cent of the total);
- (iv) In the craftsmen and services groups the education level is also standard 6 and 7 (41.3 per cent).

The unemployed group also falls mainly in the standard 6 and 7 category.

An important consideration is the training facilities which are available for the training of personnel for the various industrial employment categories. A shift from mining to manufacturing, commerce and services must necessarily be preceded by the raising of education levels.

In township development provision is automatically made for primary and secondary schools and according to Oosthuizen these facilities already exist in sufficient measure in all the residential areas (11). Facilities for technical training exist at Welkom, Odendaalsrus and Kroonstad and presumably provision will be made as the need arises elsewhere also.

A case can now be made out for a university within the urban complex at a central point. Consideration is given to this matter in a later chapter when a development policy is discussed and a master plan suggested for development for the next 25 years.

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TABLE 20.

MAJOR OCCUPATIONAL GROUPS AND AVERAGE INCOME.

OCCUPATION	NUMBER OF EMPLOYEES			MAIN DISTRIBUTION	AVERAGE PER CAPITA INCOME (MALE, WHITE).
	White	Coloured	Bantu		
Professional, technical	1642	-	251	1038 Services 468 Mining	R5987
Admin., execut. and managerial	633	-	37	293 Commerce 107 Services 75 Manuf.	R3583
Clerical worker	2894	5	1123	1033 Mining 965 Commerce 513 Services	R2008
Sales workers	1051	5	364	939 Commerce 58 Manuf.	R2533
Farmer, etc.	74	16	388	45 Agric. 24 Mining	R2409
Miner, quarryman, etc.	4400	2	1	4383 Mining	R2665
Transport and Commun.	441	8	943	278 Transp. 93 Mining	R1569
Craftsmen etc.	4721	88	88011	2585 Mining 1202 Constr. 449 Manuf.	R2095
Service, sport and recreation	513	236	9009	Domestic	R1900
Total economically active according to sexes.	13652 2958 16610	162 209 371	94819 6445 101264		MALE FEMALE TOTAL
Not economically active	11065 19843	63 73	7238 13167		MALE FEMALE
Grand Total	47518	507	211669		

4.4. HOUSING.

It has been shown in Chapter 2 how the mining companies took upon themselves the task of providing housing for their employees through subsidiary companies. The residential erven, although laid out by the mines, had been offered for sale to private developers. At the time of the survey a large reserve of lots was still available in all the towns.

It will be necessary to formulate a clear housing policy to prevent overcrowding in the central area and to encourage local decentralization to the townships of Allanridge and the - at present - completely undeveloped Blaauwdrift, by prescribing statutory green belts and an efficient mass transportation system. The intervening green belts will be required not only for definition and separation of the individual towns but also for intensive market gardening, recreation and for inter-municipal and institutional services.

The housing types prevailing in 1960 are shown in Table 22, derived from the 1960 census tabulations. A total of 90.9 per cent of the population is housed in single detached dwellings. This is a particularly high proportion according to national standards and particularly so when the recent migratory origin of the population is considered. Only 8.1 per cent of the population reside in flats or other multiple dwelling types and less than 1 per cent in hotels or boarding houses - a situation which must be regarded as particularly favourable in the modern milieu of housing shortage. Only 171 children between the ages of 15 and 19 lived in flats, from which it can be deduced that mostly young married couples occupy flats.

4.5. POPULATION PROJECTION.

The population growth for the next 25 years may follow one of three possible paths:-

- (a) The population may continue to grow as a result of sustained gold mining and a resulting industrial diversification which may closely follow that of a comparable gold fields urban complex such as the Witwatersrand which it closely resembles in form;
- (b) The gold mines will be worked out within the foreseeable future and before sufficient momentum has been gained for the towns to become selfsustaining, the settlements - with the possible exception of Welkom - will become ghost towns;
- (c) The extensive infrastructure which has been created for the gold mining industry, including housing and communications, will, by introducing a deliberate development policy and the necessary administrative control, be preserved and the necessary employment created to absorb the present population and the future natural increase.

It is hoped to indicate in this thesis the most likely path that must be followed and to help formulate a development policy to prevent the total collapse of the Goldfields economy.

4.5.1. The metropolitan Johannesburg model.

For the sake of convenience and in accordance with the policy of influx control on non-Whites, only predictions of the White population are made in this thesis.

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TABLE 21.

STANDARD OF EDUCATION OF ECONOMICALLY ACTIVE WHITE
MALES ON THE GOLDFIELDS.

LEVEL OF EDUCATION	SOME MAJOR GROUP				TOTAL
	Professional	Miner, etc.	Craftsmen	Unemployed	
None	-	5	8	3	23
Up to Std. 5	1	105	167	15	368
Standard 8	63	1025	1222	35	3143
Standard 10	154	530	271	1	1906
Bachelor's Degree	35	8	2	-	67
Master's Degree	6	1	2	-	12
Diploma with Std. 10	309	191	292	1	1023
Degree and Diploma	94	12	9	-	9
TOTALS	1041	4393	4648	137	13649

Source: Population Census 6th September 1960. Vol.2 No. 14. Report on the Gold Field Area of the Orange Free State.

TABLE 22.

TYPE OF DWELLING FOR WHITES BY AGE IN THE GOLD FIELDS.

TYPE OF DWELLING	AGE GROUPS					TOTAL
	0-14	15-19	20-24	25-64	over 65	
House	18601	3016	3328	17573	639	43157
Flat	790	171	557	1207	69	2794
Apartment	57	18	61	81	5	222
Licensed Hotel	8	3	10	88	4	113
Private Hotel	39	48	81	121	4	293
Institution	-	-	1	2	1	4
Collective Dwellings	43	189	295	300	8	835
Other & unspecified	4	6	17	35	8	70
Total Single	19542	3141	1738	1574	442	26437
Married	-	310	2612	17833	296	21051
Total	19542	3451	4350	19407	738	47488

Source : 1960 Census Tabulations.

The Gompertz exponential curve of the form $Y=K+Ab^x$, described in Appendix B, was adopted for determining a mathematical expression to fit the metropolitan Johannesburg census figures for 1921, 1936, and 1951. As a test for its accuracy and applicability the model was then used to predict the 1960 population of metropolitan Johannesburg. The model predicted 412,773 for September 1960 whereas the actual figure was 413,153. This error of 380 persons (0.092 per cent) was considered negligible and the calibration of the model accepted without question.

The model was then made to predict backward until it arrived at the figure for the year 1884 which was adopted as the date of the first gold rush to Johannesburg following on the rumour of the discovery of gold. The model gave a population for that year of about 4000 persons which, though obviously not correct, at least proved that the shape of the curve is realistic if only the middle portion is used.

The Orange Free State Goldfields population for 1960 was then fitted onto the curve and predictions made backward and forward according to the figures printed out for metropolitan Johannesburg. The results of this prediction are shown in Table 23.

4.5.2. The Cohort Survival model.

Table 24 shows the predictions based on the nett survival rate of the population according to its age and sex structure. In this model migration was completely ignored. The purpose of the calculation was merely to determine the natural increase of the population over the planning period in order to formulate a development policy that would prevent an outward migration of population in the event of the mines closing down.

The average natural reproduction and death rates were used in each of the age groups and predictions made in five yearly leaps.

A comparison of table 24 with table 23 shows that if no migration occurs the total population by 1985 would be less than half that which would result from a normal metropolitan explosion. A development programme would therefore need considerable adjustment in scale between the two extremes.

4.5.3. A rational diversification model.

It may be assumed that both the two foregoing models are in error. The Witwatersrand simulation model is in error in that metropolization is now occurring on a much wider front than in the Witwatersrand of 1912 when most of the South African urbanization was being focalised into a single growth point. On the other hand urbanization is occurring at a much more rapid rate than merely the natural increase of the population. The momentum already gained on the Goldfields should ensure that its growth will match that of any urban settlement that has reached the "take off" stage where the normal sectoral shift from the primary through the secondary to the tertiary sector is proceeding. Welkom, together with the surrounding cluster of towns, has reached the threshold for most of the central functions.

TABLE 23.

PREDICTIONS OF GOLDFIELDS WHITE POPULATION BY GOMPERTZ EXPONENTIAL
CURVE IN SIMULATION OF METROPOLITAN JOHANNESBURG.

INPUT: METROPOLITAN JOHANNESBURG WHITE POPULATION	Y E A R		POPULATION PREDICTED.
	Johannesburg	Goldfields	
1921 : 158, 936	1893/4	1951	18000 (actual 11071)
1936 : 269, 358			
1951 : 365, 663	1902/3	1960	47589(actual)
predicted :	1912/13	1970	100,000
1960 : 412, 773	1922/23	1980	170,000
actual 413, 153	1927/28	1985	207,000
error - 380	1932/33	1990	244,000
= 0.092 per cent	1937/38	1995	278,000
	1942/43	2000	314,000

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TABLE 24.

A COHORT SURVIVAL PROJECTION OF THE GOLDFIELDS POPULATION.

AGE GROUP	1970		1975 Total	1980 Total	1985 Total	1990 Total	1995	
	Male	Female					Male	Female
0 - 4	6559	6316	10981	11431	13138	15632	8830	5656
5 - 9	5297	5115	12131	10348	10773	12381	7382	7348
10 - 14	4028	3937	10381	12097	10319	10742	6187	6160
15 - 19	2865	2668	7945	10356	12067	10294	5367	5349
20 - 24	3519	3450	5503	7903	10302	12004	5120	5120
25 - 29	3732	3260	6910	5457	7837	10217	5978	5927
30 - 34	3496	3108	6932	6854	5412	7774	5102	5031
35 - 39	3063	2706	6534	6860	6784	5356	3835	3859
40 - 44	2455	1930	5685	6440	6761	6687	2686	2593
45 - 49	1892	1421	4286	5560	6299	6613	3231	3313
50 - 54	1239	927	3201	4144	5378	6093	3332	3064
55 - 59	623	502	2052	3035	3930	5105	2954	2831
60 - 64	327	372	1040	1897	2807	3637	2382	2349
65 - 69	198	319	620	919	1676	2481	1658	1560
70 and over	251	425	874	1090	1472	2341	1666	1895
			-	-	-	-	65717	65063
Totals			85092	94406	104970	117371	130780	

Source : C.O. du Preez : 'n Toepassing van enkele simulasiemodelle op Suid-Afrikaanse stede. Unpublished planning report, University of Stellenbosch 1969/70.

A model of inter-industry shift can be based on the shift which has been observed on the Witwatersrand in Johannesburg, the East Rand and the West Rand successively in reverse order as shown in Table 8.

If it is assumed that the combined rate of natural increase and immigration in the O.F.S. Goldfields in 1960 corresponded with the rate of change in the employment in gold mining and industry combined the growth rate is easily determined from the figures supplied in chapters 2 and 3 as 3.6 per cent per annum.

In the Gompertz curve of the Witwatersrand the growth rate in 1912, which was adopted as the 1960 starting point for the O.F.S. Goldfields was 6.4 per cent. The cohort survival starting rate of growth from Table 23 is found to be 2.0 per cent per year.

Adopting a standard growth rate of 3.6 per cent per year for the O.F.S. Goldfields appears to strike a realistic mean which may, at the worst, introduce only a calibration error in the development plan. Also, adopting a straight line exponential curve seems to offer the mean between the Witwatersrand descending Gompertz curve and the ascending growth curve displayed by virile growth points such as Pretoria, Durban and lately also Kimberley.

Table 25 shows the population growth of the Goldfields up to the year 1995 together with a sectoral distribution of the economically active population. Mining employment follows a flat curve descending from 1980 onwards whilst manufacturing should start rising fairly steeply from 1970 onwards to absorb the population increase. Employment in agriculture will start rising slowly from 1970 onwards due to an increase in market gardening and the tendency for plot holders to live in town. By the end of the planning period it is possible that intensive agriculture will be conducted under glass to provide vegetables and fruit to the increasing population.

Recent observation of growth figures has shown that the projections for 1970 are considerably overestimated, particularly for Virginia and Odendaalsrus. From a report by Dr. Kemp of the Provincial Administration to the Director of Education^x it seems that school attendance at Virginia and Odendaalsrus have declined by 1.3 and 2.4 per cent per annum respectively whilst it is increasing at Welkom by 3.1 per cent per annum.

The flattening of the growth curve at this particular point in the history of the Goldfields is not very surprising but may be offset by a positive programme of diversification away from gold mining.

In a later chapter the distribution of the population in the various towns of the Goldfields will be determined by a metropolitan simulation model and a prediction made of the space required for each of the urban functions.

^x Report dated 27th October, 1969 from the Director of Local Government to the Director of Education.

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TABLE 25.

ESTIMATE OF WHITE LABOUR NEEDS IN THE MAIN INDUSTRIAL DIVISIONS ON THE
GOLDFIELDS.

INDUSTRY	LABOUR REQUIREMENTS									
	1 9 6 0		1 9 7 0		1 9 8 0		1 9 9 0		1 9 9 5	
	%	no.	%	no.	%	no.	%	no.	%	no.
Mining	51.5	8820	41.3	10640	30.1	12083	17.9	11125	12.5	9640
Agriculture	2.0	335	1.5	386	1.8	723	2.0	1243	2.0	1543
Manufacturing	6.9	1179	14.1	3633	21.3	8551	29.5	18334	32.0	24681
Construction	8.3	1419	7.5	1932	6.7	2690	5.9	3667	5.8	4473
Transport	2.5	432	4.9	1262	7.3	2930	9.7	6029	11.0	8484
Finance and Comm.	11.0	1882	12.5	2330	14.0	5620	15.5	9633	16.3	12571
Services	15.1	2589	15.8	4071	16.4	6584	17.1	10628	17.5	13497
Unemployed	2.0	345	2.4	620	2.4	963	2.4	1491	2.9	2236
Total econ. active	34.4	17112	38.0	25764	41.6	40144	45.2	62150	47.0	77125
Total population		47589		67800		96500		137500		164100

CHAPTER 5.THE PHYSICAL FRAMEWORK FOR GROWTH.5.1. TOPOGRAPHICAL DETAIL.

Figure no. 9 shows the surface geology of the Goldfields region. From the profiles the structure in depth, particularly of the gold-bearing rocks, can be gauged. The extensive faulting which has proved a serious hazard to mining is also apparent from the profiles.

The sandstone and shale of the Karroo System have given rise, in this area, to a comparatively featureless plain at an elevation of about 4500 feet above sea level. The agricultural qualities of the soils associated with this area have been discussed in other reports (19).

The recent alluvial soils of the Sand river valley stretching from Virginia westwards and the Highveld prairie soils between Kroonstad and Hennenman are very fertile and should be protected from urban encroachment and preserved for intensive agriculture and market gardening.

The dolerite sills in the southern sector and the sandy soils in the western and northern areas provide suitable foundations for building but the shales of the Eccra and the Beaufort Series have elsewhere weathered into expansive clays which are unsuitable for foundations and should be avoided in order to save expensive methods of construction. Where the clays are covered by sand of a depth in excess of 15 to 20 feet, however, building construction is still safe.

The numerous pans in the environs of Odendaalsrus and Allanridge and also to the west of Welkom lie on the clayey shales of the Upper Eccra and may be regarded as unsuitable for building development especially from a microclimatological aspect.

Aerial photographs were used for identifying the areas covered by different soils and land-availability maps prepared for each of the Goldfields towns. Soil type, land-use and access to services were used as sieves, and maps 18(a) to 18(e) may serve as a framework for a development plan for the metropolitan Goldfields.

5.2. CLIMATE.

The temperature and rainfall statistics for Kroonstad are given in Table 26. These may be regarded as fairly representative of the climate of the Goldfields with the exception that there appears to be a slight decrease in the rainfall westwards.

The average annual rainfall measured at Odendaalsrus is 480 mm., varying from an absolute minimum of 208.5 to an absolute maximum of 958.1 millimeters per year.

The fairly uniform spread of the rainfall over the rainy season ensures suitable conditions for the growing of dryland wheat and maize. The first frost appears on an average on the 22nd April and the last on the 22nd October thus ensuring a fairly long growth season. About 80 per cent of the rain occurs in the growing season, with an average of three showers of more than 10 millimeters in each month.

The influence of the climate on human comfort is shown in figure 10 which shows that there is a considerable range: from bitingly raw in winter to very warm in summer. As shown on the diagram the climate never exceeds the human tolerability limits and may even be classified as mild in comparison with Belfast and Durban respectively.

TABLE 26.
CLIMATIC STATISTICS OF KROONSTAD.

MONTH	Daily Average Temp. °C.		Relative Humidity		Average Rainfall	Days with a minimum of 10 m.m. rainfall.
	Max.	Min.	8 a.m.	2 p.m.	m.m.	
January	30.0	14.9	70	39	93	3.1
February	29.0	14.6	77	41	81	3.1
March	27.3	12.6	85	47	85	2.7
April	24.3	7.8	87	43	43	1.6
May	21.0	2.6	89	38	22	0.9
June	18.2	1.5	84	37	8	0.2
July	18.4	1.6	86	31	9	0.4
August	22.0	1.2	73	29	13	0.3
September	25.1	5.6	62	32	20	0.5
October	27.8	10.3	60	29	55	1.6
November	28.4	12.2	63	32	82	2.8
December	29.7	13.9	65	36	95	3.0

Source: Weather Bureau Report W.B.20.

With respect to street drainage the intensity and duration of showers, coupled with the flat landscape, may create problems of a serious nature, unless adequate provision is made for run-off.

The large range in day and night temperatures, especially in the winter months, necessitates the provision of expansion joints in large buildings. Psychologically the range in temperature, and especially the occurrence of about 17 days with temperatures in excess of 30°C during January, may prove extremely irritating. On the other hand the human body may not easily adjust to the days of extreme cold of under 0°C of which here are, on an average, 22 in July.

Observations of the microclimates in relation to the landscape have shown that climatic advantage may be gained by a northerly orientation of buildings on sloping land. Catabolic flows of considerable depth were observed on level and on concave sites but on land with a slope of 2° or more it rarely exceeded 6 ft. Double storey dwellings may, therefore, offer an advantage on flat sites. In summer, also, relief is offered by the circulation of air which occurs

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on sloping and on elevated sites. During moderate winds no such microclimatic differences could be observed.

It is evident that low-lying terrain should be avoided for residential layouts, especially where these are below industrial layouts or on their windward side. A study conducted by Dr. Halliday of the C.S.I.R. (21,p.8 - 10) showed that there is a reversal of the adiabatic temperature lapse rate during winter nights extending to a depth of 250 feet. This means that the danger of atmospheric pollution by industrial smoke is extremely high as the smoke is not able to rise above this level and is therefore likely to spread along the surface over a large area. The prevailing surface movement of air occurs in a westerly and a northerly direction. This, in fact, means that no industries should be sited to the east or the south of towns unless chimney stacks of a height of 150 feet or more are used in factories which burn more than 500 pounds of coal in an hour. Halliday has shown that smoke emitted at a height of 150 feet is likely to rise another 100 feet and will then disperse without leaving a concentration of pollutants. This danger of atmospheric pollution exists at night time only.

5.3. LAND USE.

5.3.1. Virginia.

As shown on figure 11 Virginia is divided by the Sand River and the railway line into several residential components. The fragmentary form of the town has been accentuated by the penetration into the town of the four mines on its periphery: Harmony and Saaiplaas on the west, Virginia in the south and Merriespruit in the south-west.

Approximately 5000 residential stands were laid out, of which approximately 1750, i.e. 35 per cent were developed at the time of the survey. Only 7 per cent of these were in private ownership, the rest having been developed by the mining companies and let at a nominal rental of R60 a month to mining employees.

Ten blocks of flats and two hotels also provided high-density housing to mine workers.

The business centre has been laid out on 250 stands of which only 30 had been developed at the time of the survey. Provision has been made in the layout for the full range of government, municipal and office functions.

An industrial layout of 150 stands was established on Extension 3 at the southern extremity along the main railway line. Some of these stands are equipped with railway facilities. Provision is also made in the business centre for the service industries.

Bantu housing has been provided at Moloding across the railway line opposite the industrial area. At the time of the survey 6000 persons were being housed in the township and of these 2000 were living in the two hostels. The mine workers, totalling about 36,000 persons are housed in compounds at the several mines.

The new township for Coloureds at De Bron, which lies in a central position with respect to Welkom and Virginia, will now absorb the Coloured immigrants to the Goldfields. As explained before, the stream of Coloured immigrants is likely to increase.

Peripheral and peri-urban development includes a hospital, a race course, a golf course and extensive municipal open space. The agriculture consists of some intensive market-gardening, some dairies, a piggery and the Sand-Vet irrigation scheme to the south-west.

The highest land values in Virginia occur in the business centre and along the main streets. The price of industrial land is still fairly low, probably due to the present lack of demand and the wish of the Council to attract more industries.

The broken nature of the terrain and the fragmentary development has resulted in high development and service costs with a correspondingly high municipal rate of 5½c per Rand on land values.

5.3.2. Odendaalsrus.

Odendaalsrus was already an established town with a population of 300 Whites and 500 Bantu in an adjoining location when gold was first mined in 1946 three miles from the municipal boundary. The commonage, with the exception of 800 morgen which was kept for future expansion, was made available to the mines.

The land-use of Odendaalsrus is shown on figure 12. In the development plan the old village was zoned for business and other central uses and encircled by a road of 220 feet width. Provision was made in the business centre for municipal offices, government buildings, schools, churches and several parks.

At the time of the survey 870 of the 1450 residential stands had been developed and of the 40 industrial sites only 11 had been developed, mostly for warehousing and builders' and construction yards. A few service industries in the form of dry cleaners, welding and repair shops as well as a bakery, are located in the business centre, mixed with shops and other functions. The administrative function is well represented by a variety of government offices and the municipal offices. A large number of stands within the business centre are still vacant.

Peri-urban development consists of a hospital, sewerage works, a cemetery and a municipal market garden surrounded by the mining land. The close proximity of the mines to the town is evidence of the policy of the Natural Resources Development Council to provide housing for mine workers and staff within a maximum distance of three miles from the shaft head.

5.3.3. Allanridge.

Figure 13 shows the layout and the functional arrangement of stands at Allanridge. At the time of the survey only 36 per cent of the total of 1800 stands were developed but the dwellings were still owned by the mining company. Nine of the 45 sites for flats were developed as well as

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two of the 22 business stands. Only the post office had been developed in the administrative offices zone. The total population amounted to 2700 Whites and 8000 Bantu. No industrial sites had been laid out although 152 morgen of land is available for industries for later development.

A separate township of 754 residential stands and a small business centre has also been laid out for Bantu. This township however has not been used.

The growth of Allanridge has been considerably retarded by the closing of the Jeanette mine. Shaft No. 3 of the Loraine mine is nearer to Odendaalsrus so that some of the mine workers prefer to live out of town. In spite of the setbacks, however, the new town hall was completed in June 1961 at a cost of R40,000.

Allanridge is still very much a satellite of Odendaalsrus and most of the shopping by residents occurs in Welkom. There has been talk of cancelling the Extension 3 layout to relieve the land finance company of the costs of upkeep of the services and the rates which have had to be paid since the township was established. None of the stands in Extension 3 had been developed.

The municipal income is still too low for the development of the open spaces and the provision of all the services. The mines were consequently still held responsible for the engineering services. To relieve the situation to some extent the mines have to pay full rates on all stands, whether they are developed or not.

5.3.4. Welkom.

With Odendaalsrus and Allanridge at 9 and 17 miles respectively to the north, Virginia at 16 miles to the south-east and the proposed Blaauwdrift at 9 miles to the south, Welkom lies at the centre of gravity of the emerging metropolitan complex.

The metropolitan function of Welkom is apparent from the communication pattern. Primary roads link it directly with Odendaalsrus, Kroonstad, Virginia, Hennenman, Theunissen and on the regional scale it is also linked with Kimberley, the Western Transvaal, the Eastern Free State and Bloemfontein. The daily traffic in 1963 exceeded 2000 vehicles a day on the north-south axis and 3000 vehicles on the east-west axis. It now also has rail connections to the surrounding towns.

A fleet of 26 municipal buses was operating at the time. A daily air service to Johannesburg and to Bloemfontein as well as a week-end link with Durban were also available.

The broad land use pattern of Welkom is shown on figure 14 on which appears the various residential units including De Bron - the Coloured Township - and the Bantu residential area which are separated from Welkom by unoccupied buffer zones. The industrial zone lies to the south of the central business area. The main roads and the railways give direct access to these industries.

The areal interrelationship between the mines and their several dormitories is evident from the layout. Apart from the well-rationalized location of the business centre, the government and

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other institutions and the recreation areas, provision was also made for the outward growth of the several urban functions. Riebeeckstad may, for example, be seen as a very conveniently placed suburb of the city, also well disposed in relation to the mines and the industries of Virginia and Odendaalsrus.

5.3.5. Blaauwdrift.

Figure 15 shows the layout of Blaauwdrift which was planned to be established on the bank of the Sand river, nine miles south of Welkom on the main road to Theunissen.

Provision was made in the layout for approximately 850 residential stands and the usual functions associated with a business centre including a site for municipal offices, government offices, two theatres, hotels, some churches and garages.

The site is more broken and lends itself to a more interesting layout than any of the others in the complex. Located on a southern slope and in such close proximity to the river it is likely to have a severe winter climate. The soil is derived from dolerite and consequently no heaving clays are found in this area. The main road runs through the township and this may also prove to be a serious handicap to the convenience and safety of the residents.

5.4. THE METROPOLITAN INFRASTRUCTURE.

Figure 16 shows the regional infrastructure in broad outline. This includes the main communication systems, the water and electricity mains and recreation areas.

5.4.1. Water.

Water is pumped from Balkfontein near Bothaville on the Vaal river by pipeline with a capacity of 52 million gallons per day to Koppie Alleen from where it is distributed to the several towns.

Large quantities of water are pumped from the mines but this water contains salts in excess of 3000 parts per million and it is therefore not fit for human consumption. It is possible that the research staff of the Council for Scientific and Industrial Research, who have been doing research on desalination of water, may find a means of making the water fit for domestic or industrial use. This would also relieve the mines of the task of disposing of the water by evaporation to prevent it from percolating back into the ground-water supply from where it has to be pumped to the surface.

According to the industrial survey the price of water and electricity is considered by some industrial undertakers to be excessive and a deterrent to industrial development. Water shortage may yet prove an obstacle to industrial expansion unless alternative supplies are found. The water which has now become available from the Allemanskraal dam in the Sand river will undoubtedly improve the position but the greatest relief will probably come from the present government policy of covering the entire Republic with an integrated water scheme from the Orange

river and possibly later also from the Oxbow lake scheme and the Tugela.

5.4.2. Electricity.

Electricity is supplied from the thermal power stations at Vierfontein, Highveld and Taaibos. The network which is known as the Rand and the Orange Free State Undertaking will meet the demands on the Goldfields for a long time ahead. Should it eventually become necessary to generate more electricity it may be possible to use the coal, which is available on the Goldfields and which has been described elsewhere, for this purpose.

5.4.3. Communications.

Figure 17 shows the road and rail communications system of the Goldfields together with traffic volumes and desire lines.

From the traffic count which was conducted in the North-Western Free State in May 1963 (14) some useful information for planning purposes is available.

Table 27 below shows the volumes of the through and stopping traffic in the Goldfields towns as well as the desire lines.

TABLE 27.
VOLUMES AND DESIRE LINES AND STOPPING TRAFFIC IN THE GOLD-
FIELDS TOWNS MAY, 1963.

TOWN	ROUTE	DAILY VOLUME	STOPPING TRAFFIC AS % OF TOTAL	REMARKS
Allanridge	Bothaville - Odendaalsrus	300	25	Bypass exists
Hennenman	Virginia - Odendaalsrus	190	45	Tarred road
	Ventersdorp - Odendaalsrus	130	43	Tarred road
	Ventersdorp - Virginia	130	52	Tarred road
	Kroonstad - Virginia	30	60	Part gravel
Kroonstad	Vredefort - Odendaalsrus	300	58	Tarred road
Odendaalsrus	Allanridge - Welkom	400	30	Tarred road
	Allanridge - Hennenman	280	50	Tarred road
	Allanridge - Kroonstad	30	75	Tarred road
	Wesselsbron - Welkom	200	30	Bypass exists

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TOWN	ROUTE	DAILY VOLUME	STOPPING TRAFFIC AS % OF TOTAL	REMARKS
Odendaalsrus	Wesselsbron-Hennenman	120	45	Tarred road
	Wesselsbron-Kroonstad	60	68	Tarred road
	Hennenman-Welkom	150	96	Tarred road
	Kroonstad-Welkom	40	86	Tarred road
Virginia	Hennenman-Welkom	280	72	Throughway exists
	Theunissen-Welkom	80	75	Tarred road
	Theunissen-Hennenman	50	60	Tarred road
Welkom	Odendaalsrus-Western Holdings	60	90	Tarred road
	OdendaalsrusW-OdendaalsrusE	100	99	Tarred road
	OdendaalsrusW-Hennenman	100	90	Tarred road
	OdendaalsrusW-Virginia	140	85	Tarred road
	Theunissen-OdendaalsrusW	120	27	Bypass exists
	Odendaalsrus-Virginia	200	62	Tarred road
	Hennenman-Virginia	190	74	Tarred road
	Hennenman-Theunissen	80	75	Tarred road

Source : Traffic Survey of May 1963 (14)

From the traffic report (14) the traffic needs may be grouped into three categories:-

(a) Bypasses to provide for movement on the national routes. These include:

- (i) A north-south freeway to link Western Transvaal with Bloemfontein via Soutpan, skirting the Goldfields by a fair margin.
- (ii) An east-west freeway to link Wesselsbron, Bultfontein and other towns in the west with the north-south national road and with the towns in the Eastern Free State.

(b) A local metropolitan ring road of an elliptical shape with one limb skirting the western sides of the Goldfields towns and one limb running along the eastern side of the towns.

(c) Access roads from the ring road to the several towns.

This road system will require several interchanges as will be shown in a later chapter.

According to the Traffic Report Welkom already generates a great volume of regional traffic and this is likely to spread to the other Goldfields towns. The elongated elliptical ring road would thus cater for regional access to the complex as a whole and the interchanges together with the short radial roads will provide access to each town from various sides.

The railway network to the Goldfields takes off from the main Johannesburg-Bloemfontein line at Whites near Hennenman and follows a route that takes it through Welkom and Odendaalsrus to Allanridge. Virginia is served directly by a station on the main line. Each of the mines within the complex is linked with the station at its nearest town.

All trains to the Goldfields are made up at Hennenman which serves as the marshalling yard for the system. Welkom, on the other hand, serves as the local sorting centre for traffic to the various mines and other destinations. All mining stores are handled by the Inter-Mine-Supplies which serves as the central buying organization and which distributes the stores to the individual mines. In December 1962 29,865 tons of goods were handled at this station of which 23,974 was consigned to the mines and the various industrial layouts.

A typical goods consignment over a period of one month to a mine was found to consist of 96 trucks carrying 680 tons of coal, 195 tons of explosives, 38 tons of stores of pipes, timber, rope, conveyor belting, etc.

Three passenger trains were running daily between Whites and the Goldfields. On an average 3000 tickets were sold each month to passengers at Welkom.

Welkom also forms the focus of the road motor services of the Goldfields. The service includes a daily run of goods to each of the mines; a daily passenger service to Bloemfontein; a similar service to Johannesburg, Kroonstad and Wesselsbron. There are also regular services to Klerksdorp, Maseru and Ficksburg.

From the observations made at the time of the survey many of the crossings were at grade and were found to be fraught with danger apart from offering long delays especially where shunting occurs across main roads (8,p.21).

5.5. REGIONAL RECREATION.

The survey has shown that the individual towns are well provided with facilities for local recreation such as sportsfields and parks.

The municipal recreation area on the banks of the Sand River at Virginia and the Flamingo Club on the lake at Theronia are likely, however, to develop into recreation centres of metropolitan scale together with the race courses at Welkom and Virginia.

The Willem Pretorius Game Reserve at Allemanskraal, 22 miles east of Virginia and approximately 30 miles from Welkom is truly regional in scale, and, according to a report by the Chief Planner of the Administration (15,p.4 - 10), it is patronized by people from the North-Western Free State and the Western Transvaal.

The reserve is served by a good road off the national road. It is already provided with 40 rondavels, a restaurant, a camping site, tennis courts, bowling greens and a swimming pool. A hall provides opportunities for indoor recreation as well as for conventions in the off-season periods. At the time of the survey a caravan park had been surveyed and proposals for the provision of additional accommodation and sports facilities had been put forward. It was realized also that some landscaping would be necessary to improve the appearance of the resort.

In the twelve months immediately preceding the survey the sleeping accommodation had been used to almost full capacity on 80 nights, which may be regarded as the length of the holiday season. Each rondavel generates a revenue of R240 per year.

Visitors come principally from the Goldfields (45 per cent of the total) and the rest of the Free State (23 per cent). Although no systematic provision was made for caravans as many as 65 at a time were accommodated on the grounds.

Parys and some other centres on the Vaal river may also prove attractive as regional resorts for the Goldfields.

5.6. TOTAL OPPORTUNITIES FOR GROWTH.

Figures 11 to 15 show the total availability of land and the potential for growth in the towns of Allanridge, Odendaalsrus, Welkom, Virginia and Blaauwdrift. In the next chapter the future population distribution over the Goldfields will be calculated from the figures supplied in table 25 in chapter 4 by a simulation model and the spatial requirements for each of the functions will then be calculated for each of the towns in the Goldfields.

CHAPTER 6.

A FRAMEWORK FOR DEVELOPMENT IN THE O.F.S. GOLDFIELDS.6.1. A DEVELOPMENT POLICY.

In the light of the tendency described in Chapter 1 for metropolis to develop everywhere in the economically advanced countries where the cumulative advantages for growth are present, the Goldfields of the Orange Free State seem to be the natural choice for such a new growth point in South Africa. Its hinterland offers the rich and extensive wheat and maize fields comparable to the American corn belt; in the secondary phase of diversification the exploitation of gold provided the stimulus to focalization necessary for establishing a metropolitan market and, finally, the advantage accruing from an effective infrastructure for manufacturing and marketing may be considered to be in the process of developing.

Considered from a macro-economic point of view a very strong case has been established for decentralization from the existing over-concentrated metropolitan areas to new growth points at a distance sufficiently far for an independent economy to arise and for the possible establishment of new growth areas. In this regard also the Goldfields, at 150 miles from Johannesburg, may be regarded to be ideally situated. As shown in Figure 1 this new growth point has already set in motion the circular causation described by Myrdal and, moreover, the growth axes between the West Rand and the Goldfields and again between Bloemfontein and the Goldfields are clearly evident.

However, Bantu labour will not be readily available and care will be taken in the selection of industries to avoid those establishments that required large complements of unskilled labour. This growth point may yet prove to be the much-needed challenge to developers for the innovation that will satisfy the strong need existing in South Africa today for independent parallel development of the races.

A development plan, in contradistinction to a town planning scheme, represents an estimate of the future spatial, social and economic needs of a community and the synthesis of a physical plan that will provide for these needs in accordance with the national policy.

The objectives of a development policy for the Goldfields may now briefly be stated to encompass the following:-

- (a) To foster, by the appropriate means a steady but sustained growth of the settlements in order to prevent the costly infrastructure that has been established so far from falling into disuse;
- (b) It is generally accepted that the only means of ensuring such a sustained growth is by providing employment opportunities;
- (c) Such employment opportunities must be created in the basic industries with the highest location quotients and a programme of shift oriented to the manufacturing and service industries with the best linkages;

- (d) Over-concentration in any one single town of the new metropolitan complex must be avoided by the location of the industrial estates in such positions that they exercise a balanced pull from all the settlements;
- (e) Commuting to these employment centres must be by mass transit along routes which have been planned in advance in such a manner that they cannot become over-congested;
- (f) Green wedges between the cities must be preserved by statutory regulation to prevent sprawl, to give definition to each city and to provide room between towns for intensive agriculture, recreation and the metropolitan services, including freeways and railways for mass transit.

6.2. AN ESTIMATE OF THE FUTURE POPULATION DISTRIBUTION PATTERN.

A model for simulating population distribution has been evolved from a study of several metropolitan forms. The distribution pattern of the Witwatersrand was finally adopted as the closest approach to the form evolving in the O.F.S. Goldfields. The several factors of concentration and local dispersal can be isolated by a process of solution of simultaneous equations involving town size, distance to the core (Johannesburg C.B.D.) distance to the main employment centres and a saturation factor depending on the stage of infill expressed as a percentage of the number of developed stands out of the total available number of stands. Although initially based on the model described by Donnelly, Chapin and Weiss (1), new growth factors were added and some of those used in the Greensboro model discarded, such as proximity to primary school and availability of services. It was felt that the model is required to establish the growth pattern on available land which is already or can be serviced and that municipal services are usually provided where the need arises.

The ^{saturation} factor, introduced into this model, is very evident in South Africa. In a study carried out by a group of planning students at Pretoria (2) a saturation curve of an S form was derived and its elements determined from the growth rate of Bryanston in Northern Johannesburg. The curve agrees with the observed phenomenon of reluctance to move to a completely new layout, the ensuing strengthening urge of invasion and finally the diminishing flow which follows on saturation of the available space.

The model is entirely empirical and moulded by a process of trial and error to simulate the distribution of the Witwatersrand towns. A series of runs was necessary for its correct calibration to the Goldfields overall growth rate. A description of the model appears in annexure C.

Because the location of the main employment centres is an inherent part of the model it was necessary to first pinpoint the positions of the proposed industrial estates without determining their size at this stage.

From the study described in Chapters 3 and 4 in which the origin of the raw material for industries, the availability of suitable sites and the location of the infrastructure were evaluated, it became evident that the most desirable positions for industries are at the localities marked

on Figure 19, between Virginia and Welkom and between Odendaalsrus and Allanridge respectively. The size of these estates is not important at this juncture.

The probable distribution of the White population in the Goldfields, as derived by the model, is shown on Table 28.

TABLE 28.
THE DISTRIBUTION OF THE WHITE POPULATION IN THE GOLDFIELDS AS
PROJECTED BY A GROWTH SIMULATION MODEL.

TOWN	Population size.				
	1970	1980	1990	1995	2000
Welkom	32 38364 (Actual 31 381)	73 51975 (Actual 38 000)	67504	77290	82112
Odendaalsrus	57 8840 (6045)	48 13260 (6360)	21800	26858	30703
Virginia	65 17835 (11 506)	46 26794 (12 300)	39015	48565	56093
Allanridge	78 2761 (2166)	72 3379 (2420)	6481	8130	8749
Blaauwdrift	-	592 (-)	2700	3256	3645
	74 67800 (50 098)	61 96500 (59 090)	137500	164100	181300

Initially Welkom and Virginia serve as the main magnets on account of their centrality and their employment facilities but with saturation of these centres Odendaalsrus gains in importance and a demand also arises for space in Blaauwdrift.

Initially the growth of Allanridge is disappointingly slow but in time this town also develops into more than a mere dormitory, probably due also to its position on the growth axis to the north.

To avoid over-concentration in Welkom, which may shortly experience a shortage of land, it will be necessary to encourage growth in Allanridge and Blaauwdrift. The implication of this is that the whole urban complex must develop as a close-knit system with a common infrastructure and employment centres common to two or more of the towns.

Welkom will obviously retain its hegemony in regard to specialist services and financial institutions but there is no reason why each of the other towns should not grow to a size that would ensure autonomy as far as administration and services are concerned.

Figures 19(a) to 19(e) show the probable form that will evolve in this system if the growth of the emerging metropolis is properly integrated.

6.3. THE FUTURE LAND REQUIREMENTS.

Sufficient information is now available, inter alia from the forecasts of the population size and distribution, estimated industrial diversification, and the land-use standards, to calculate the space requirements for each of the urban functions in the planning period.

6.3.1. Residential land requirements.

As was shown in Chapter 5, less than 10 per cent of the population on the Goldfields were occupying flats in 1960. This ratio is likely to change rapidly to conform to the national urban pattern where up to 25 per cent of the population in some towns occupy flats. In a recent planning survey of Stellenbosch carried out by the author, 26 per cent of the population were found to be occupying flats.

Assuming family sizes of 3.8 for Whites in single residential units and 2.8 in flats or similar grouped housing, the residential land requirements will be approximately as shown in Table 29 below.

TABLE 29.
RESIDENTIAL LAND REQUIREMENTS FOR THE GOLDFIELDS.

	1970	1975	1980	1985	1990	1995
Total population	67800	80900	96500	115200	137500	164100
Single dwellings	16050	18520	21330	24500	28220	32400
Area required (morgen)	3210	3704	4266	4910	5644	6480
Other dwelling units	6800	10520	15440	4900	30250	41000
Area required (morgen)	38	58	85	121	167	227
Total area required (morgen)	3248	3762	4351	5031	5811	6707

To ensure that a reserve of residential stands is always available and thus to eliminate inflation of prices due to a seller's market, all quantities should be increased by, say, 30 per cent.

Breaking down these figures to the five towns constituting the Goldfields, the land requirements for the residential function would be as indicated in Table 30 below.

The land allocation for residential purposes is shown in Figure 19. Suitability of land, disposition in regard to employment centres and the micro-climates have been considered.

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TABLE 30.

RESIDENTIAL LAND REQUIREMENTS FOR EACH TOWN IN DIE GOLDFIELDS.

Town	Land needed in morgen			
	1970	1980	1990	1995
Welkom	2627	3347	4074	4513
Virginia	1220	1726	2356	2836
Odendaalsrus	604	886	1316	1567
Allanridge	189	217	391	474
Blaauwdrift	-	39	163	190
	4640	6215	8300	9580

6.3.2. Industrial land requirements.

The expected industrial employment at five-yearly intervals in the planning period has been shown in Table 24. Assuming that the factories will range mainly between food processing in the south, manufacture of construction materials in the east, machinery and food processing in the north and service industries at the core, a fair estimate of the land requirements for the industrial estates can be made.

According to the standards of the existing establishments derived in Chapter 3 an average of 300 square feet of nett space is required per worker in the food processing industry with an average size of establishment of 12000 square feet. In construction the figures vary from about 25000 to 73000 square feet per establishment with an average nett area of approximately 400 square feet per worker. In the manufacture of machinery the average size is approximately 30000 square feet with a nett area of about 200 square feet per person. In the service and workshop industries the sizes of establishments average about 5000 square feet with an average nett requirement of approximately 500 square feet per worker.

Assuming that for all industries the average nett floor area per worker comes to 350 square feet or roughly 920 square feet gross area where parks, streets and statutory coverage restrictions are taken into consideration and a White - non-White ratio of 1 to 3 persists, approximately 2700 square feet, gross, of industrial land is required for each White worker. Table 31 shows the land requirements for industries in the planning period. As before, an allowance of 30 per cent is made to ensure that a reserve of plots is available.

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TABLE 31.

LAND REQUIRED FOR MANUFACTURING ON THE GOLDFIELDS.

Year	White workers	Land required
1970	3633	151 morgen
1980	8551	357 morgen
1990	18334	767 morgen
1995	24681	1033 morgen

At the time of the survey there was already available 303 morgen of industrial land at Welkom and 165 morgen at Virginia with room for expansion.

In pursuance of the policy to provide industrial employment opportunities to the residents of all towns, two new industrial estates will have to be established, one between Odendaalsrus and Allanridge and one on the main railway line near Virginia. Both these localities are shown in Figure 19, easily accessible to the labour - both White and non-White - and convenient to the regional transportation route for the new materials.

The site of 150 morgen which is at present held in reserve for industries at Odendaalsrus should be abandoned in favour of a site further to the north to be more convenient in relation to Allanridge.

6.3.3 The communication system.

The proclaimed mining lease areas around Welkom and between the other towns should be used to advantage in the planning for the future of the urban complex to provide a green belt or wedges, not only to separate the several towns but to provide the future metropolitan services such as freeways, a suburban railway passenger service for commuters, a communal cemetery and metropolitan institutions including a university.

The transportation needs, as determined by a traffic count, were formulated in Chapter 5. Accordingly provision will have to be made for the following:

- (a) A bypass for a freeway linkage of the Western Transvaal towns with Bloemfontein via Soutpan;
- (b) A bypass for a freeway linkage of the North-western O.F.S. towns with the Eastern Free State and Natal;
- (c) A local metropolitan ring road within the above regional system forming a flat ellipse along the eastern and the western boundaries of the towns, encompassing all the new development proposed in this report.
- (d) Short access roads from the ring road to the various residential areas and working places.

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These roads should everywhere be separated at grade and linked by interchanges to facilitate the movement of traffic.

Because the Goldfields towns are all closely knit into an integrated system of residential areas and working places, there will be a growing volume of daily commuters in all directions. It will hence be of great importance to provide a suburban passenger service to link the interdependent parts of the system.

The above road and rail proposals are shown schematically in Figure 19.

The railway network to the mines - when these cease working - will have to be integrated into the transportation system of the industrial estates. The line to Harmony from Virginia, for instance, would have to be connected with the line from Welkom to the President Brand mine to link the two industrial areas.

The new railway link which has been established between the Goldfields and the Vierfontein-Bultfontein line will prove of inestimable value for the localization of grain milling and machine production on the Goldfields.

6.3.4. Commerce.

It is generally accepted in the practice of township layout today that low threshold services such as schools, churches and shops selling convenience goods should be provided on a community scale in decentralised positions. These functions are, therefore, of little concern to the metropolitan planner. Where the central business areas of five potentially large towns of varying size and within easy travelling distance of each other are concerned, however, some care is necessary to ensure that under- or overzoning does not occur.

There are two important considerations in the layout of regional business areas:

- (a) Comparative shopping goods and specialised services have a high threshold value and not every town has a population large enough to support a business area of this category. The consequence is that people may travel from other towns and over long distances to get to such a business district.

The support that a shopping centre is likely to receive is in direct proportion to the earning capacity of its clientele and its size, measured in nett floor space, and it is indirectly proportional to the distances that people have to travel to get to it. These three factors have to be evaluated in their total effect where several business centres are in competition with each other for the patronage of a number of communities with varying purchasing power.

- (b) For the efficient functioning of business centres, it is necessary that the size of the centre be correctly planned in relation to its likely customers. For adequate returns to the businessman on the one hand and satisfactory service to the patron on the other hand, a turnover of between R30 and about R60 per square foot of nett service area per year is required. A fully equipped regional business centre has a threshold value of about 100,000 persons.

A simulation model for computing the size of business centres in a metropolitan system, given the purchasing power and the location of the several communities, has been designed by Lakshmanan and Hansen (5). An amended version of this model as adapted for use on the Goldfields is given in Appendix D.

Applying this model to the Goldfields and adopting the population forecasts given in Table 28, the gross areas required for each of the central business areas have been computed by an iterative process. The space required includes parking, open space and streets in the ratio of 3 to 1 and the turnover per gross square foot of business area was therefore taken as R10. The average per capita income for Whites was computed from the 1960 Census tabulations as R972.35 and this figure has been adopted as the average purchasing potential for all commodities including banking, real estate and services. Of this 35 per cent is spent on convenience goods and services in local and neighbourhood centres serving up to 7500 persons within their service orbits.

It was established in a student project carried out in the eastern suburbs of Pretoria (2) that the resistance to travelling is greater in the case of convenience services than for specialist services. If the identity $S = \frac{C.F.}{D^a}$ represents sales (S) as a function of purchasing capacity (C), size of centre (F) and is indirectly proportioned to distance (D), the exponential a of the distance varies from 2.58 for convenience services and 1 for specialist services. This in fact means that people are very reluctant to travel far for convenience goods but in the case of specialist services the resistance to travelling is a direct or straight line function. Table 32 shows the estimated turnover in the central business areas of the Goldfields towns as derived from the model used.

TABLE 32.

TOTAL ANNUAL SALES IN EACH OF THE DISTRICT BUSINESS CENTRES OF THE GOLDFIELDS TOWNS.

Town	1970	1980	1990	1995
Welkom	R27,717,037	R37,250,075	R49,285,343	R55,998,040
Virginia	14,275,565	19,825,699	27,691,198	33,239,740
Odendaalsrus	7,467,536	9,957,541	15,015,788	17,793,640
Allanridge	3,601,367	3,851,448	5,121,783	5,763,040
Blaauwdrift	-	201,470	918,870	1,108,090
Total turnover	R53,061,505	R71,086,233	R98,032,982	R113,902,550

From a comparison of the sales in Welkom and its population it is clear that this city serves a much wider field than its own municipal area. It is clear also that Allanridge will buy most of its comparative goods in Odendaalsrus and in Welkom. The volume of sales in Virginia is more or less consistent with the buying power of its own residents, showing that there is likely to be less interdependence between Virginia and Welkom than among the other towns.

Table 33 shows the estimated gross areas of the district business centre of each town, where such business centre is ranked as a "district" centre, of slightly lower rank than the American C.B.D.

TABLE 33.

DISTRICT BUSINESS CENTRES OF THE GOLDFIELDS TOWNS.

Town	Gross Area in square feet.			
	1970	1980	1990	1995
Welkom	2,771,704	3,725,008	4,928,534	5,599,804
Virginia	1,427,557	1,982,570	2,769,120	3,323,974
Odendaalsrus	746,754	995,754	1,501,579	1,779,364
Allanridge	360,137	385,145	512,178	576,304
Blaauwdrift	-	37,416	170,649	205,790

Converted to acres it means that by 1995 the respective business areas of the towns should be 128.55 acres for Welkom, 76.3 acres for Virginia, 40.85 for Odendaalsrus, 13.23 for Allanridge and 4.72 for Blaauwdrift. Overzoning has already occurred in some of these towns.

6.3.5. Other functions.

Other metropolitan services which will need careful planning include a communal cemetery, a communal sewage disposal works and a large airport of national standards. It will clearly be the function of a metropolitan planning team to locate these functions and to plan at the required scale. Suggestions for such a planning directorate are given later in this chapter.

The need for a university on the Goldfields is already being felt (8,p.23). The alternative locations shown on Figure 19 may serve as a preliminary approach for further investigation.

From recent observations it seems that Welkom has maintained a steady growth whilst the other towns on the Goldfields have lagged behind and the land needs calculated in this chapter are rather optimistic. The fact that Welkom will be approaching a saturation point as far as the available land for expansion is concerned will soon make for faster growth in the adjoining towns. In the long run the planning suggestions shown on figures 19(a) to 19(e) may prove realistic as far as the distribution of functions and the scale are concerned.

6.4. ORGANIZATION FOR PLANNING.

Intermunicipal land-use was controlled for a time by the Minister of Economic Affairs at the instance of the Natural Resources Development Council. As Controlled Area number 1, proclaimed under the Natural Resources Development Act No. 51 of 1947, this area was planned and controlled on an ad hoc basis. The Department of Planning has now taken over the functions of the N.R.D.C. under the provisions of the Physical Planning and Utilization of Resources Act No. 88 of 1967.

The need for control has now shifted from the national, i.e. the physical resources level, to the municipal and metropolitan levels and a new form of control has become necessary.

From surveys conducted recently in the field of organisation for planning, it has become clear to the author that there is a great amount of confusion in regard to the different levels of planning.

Broadly, planning may be regarded as falling into two categories:

- (a) national planning which encompasses (i) the formulation of policies for development which may devolve on political, social and economic considerations and (ii) the application of the national policies for the development of the geographical scene. This phase of the planning procedure involves the evaluation of the physical and cultural resources, an estimation of the human needs and the setting up of development programmes which involve, usually, the provision of an infrastructure for growth. This physical level of the national planning and development programme is best carried out in regional context so that resources may be evaluated in their role of interdependent contributions to a fully integrated society possessing economic and social autonomy. This subdivision of the national scene into areal units also facilitates research, planning, and the implementation of development proposals.
- (b) Urban planning, on the other hand, deals with the systematic ordering of the human habitat in regard to the provision of dwellings for the non-agricultural population and the provision of the necessary engineering, institutional and recreational facilities. Here again two levels may be differentiated:
 - (i) the purely local community scene where single municipalities are involved and
 - (ii) the metropolitan or inter-municipal level where two or more local authority areas are in such close proximity to each other that their peripheral services are likely to interlock, or where employment opportunities, residential areas and peripheral services are likely to be mutually interdependent.

There are thus, in reality four planning levels, two of which are, or should be, handled by the national hierarchy of institutions and two of which should be handled by the municipal authorities under direction of the Provincial Administration as provided for in the South African statutory framework (9).

For the purpose of this thesis, consideration is given to the third, viz. the metropolitan or the inter-municipal level as this is vitally involved in the Goldfields of the future.

As suggested for the master plan of the Goldfields, employment opportunities should be created on an inter-municipal basis, which must necessarily involve the provision of an inter-municipal infrastructure, including roads and railways for commuters, water, gas and electricity to the industrial estates and housing for the workers. The undertakers for these services are the Provincial Roads Department, the Departments of Transportation, Railways and Harbours, Water Affairs, the Electricity Supply Commission and the Department of Community Development, respectively, whilst administrative control vests in the Department of Planning in regard to the location of industries.

The South African constitution already defines the functions of the municipalities and the Provincial Administration respectively, in the planning of the urban scene. In these planning tools the several undertakers and controlling authorities mentioned above are denied a voice with the result that there is lack of co-ordination and often a lack of sympathy.

What is obviously lacking in the newly-evolving urban scene is, therefore, an administrative organisation for co-ordinating the interests of the respective undertakers and controlling authorities with those of the municipalities concerned in the planning organisation of the Provincial Administration. The solution of this problem lies in the creation of a planning directorate as illustrated in Figure 18. The hierarchical arrangement of the planning authorities is clearly illustrated in the figure.

Planning decisions are taken by the directorate which is representative of all interested bodies. It may employ planning consultants to carry out the planning surveys and to formulate the preliminary proposals but it is guided in the final adoption of development plans by its own members who represent the municipalities involved as well as all interested government departments and statutory undertakers.

After adoption of the plan it is processed by the Director of Local Government and may be proclaimed. Because no land-use zoning occurs and the land is, in any event, purchased or expropriated by the undertaker involved, the procedure for adoption and proclamation of master plans may be considerably simplified. The democratic principle of adoption of zoning plans by an elected body and the personal adversary procedure inherent in this democratic planning process are not violated in the preparation of these project plans: the undertakers already have statutory powers of planning and of expropriation; what is gained by this arrangement is merely co-ordinated planning.

There is no need to establish a metropolitan authority of elected representatives with its own independent rating system as was done in Metropolitan Toronto and elsewhere overseas. The proposal formulated above is almost in agreement with the Councils of Government established in some metropolitan areas in the United States in consequence of Section 701 (9) of the Housing Act of 1956 (9,p.32).

6.5. IMPLEMENTATION OF THE MASTER PLAN.

The provision of an infrastructure on the scale proposed in the master plan may necessitate a sharing of costs and possibly a basis for this may be arrived at by agreement at the instance of the metropolitan planning directorate.

Statutory undertakers already exist for many of the intermunicipal services such as road and rail transportation, a regional waterworks and the supply of electricity. Municipalities can, themselves, handle local services. There is obviously the need to establish a public utility corporation to handle sewage disposal. The lead should be taken by parliament to establish an Act similar to the existing statutory provision for the Rand Water Board and the Electricity Supply Commission to establish the framework for a corporation that can handle sewage disposal wherever towns are clustered together in a typically metropolitan pattern.

Whilst the self-interest and empire-building aspirations of city Councils have proved a serious obstacle to equable planning in the past a limited climate of competition and pride of performance provide an essential element of progress. For this reason it may be necessary to extend

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the municipal areas of jurisdiction to contiguous boundaries. No part of the Goldfields will then be without administrative control.

The composition of the directorate for intermunicipal planning, as described in the previous section, will remove the danger of biased planning and the overconcentration of development in the central city.

As explained before, national policy should aim at the preservation of the Goldfields and development should be funneled, as far as this is possible by the Government, toward ensuring a sustained growth of the complex. The municipalities should honour this policy and empire-building or overreaching aspirations for rapid growth should be discouraged. An unduly rapid growth in the Goldfields can only occur at the cost of development elsewhere.

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17. Bureau of Statistics: Report on the Gold Field Area of the Orange Free State. Population Census 6th September, 1960. Government Printer, Pretoria. 1966.
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APPENDIX A.

Reports published in pursuance of the study of the Orange Free State Goldfields and surrounding areas.

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APPENDIX B.

Programme written for the I.B.M. 1130 computer for the Gompertz population growth curve fitted on the census figures 1921, 1936 and 1951 for the Johannesburg Metropolitan area:-

$$Y = K + Ab^x \quad \text{where}$$

$$Y = \log y; \quad K = \log k \text{ and } A = \log a \quad \text{and}$$

$$k = \frac{y_2 y_0 - y_1^2}{y_0 + y_2 - 2y_1}; \quad a = y_0 - k; \quad b = n \frac{y_1 - k}{y_0 - k}$$

and y_0 is population figure for 1921, y_1 that for 1936 and y_2 that for 1951 and $n = 15$.

```

READ (2, 3) YA, YB, YC, P
3 FORMAT (3F7.0, F2.0)
YA = ALOG (YA)
YB = ALOG (YB)
YC = ALOG (YC)
AK = (YC * YA - YB * YB)/(YA + YC - 2. * YB)
A = YA - AK
B = ((YB - AK)/(YA - AK)) ** (1./P)
AAK = EXP (AK)
AA = EXP (A)
WRITE = (3, 7) AK, A,B, AAK, AA
7 FORMAT (3E15.8)
12 READ (2, 4) MA, MB, MC
4 FORMAT (3I4)
WRITE (3, 5)
5 FORMAT (' JAARTAL BEVOLKING'/)
Do 10 I = MA, MB, MC
X = I - 1921
Y = AAK * AA ** B ** X
10 WRITE (3, 6) I, Y
6 FORMAT (4X, 14, 8XF7.0)
PAUSE 1111
IF (MA) 12, 11, 12
11 CALL EXIT
END "
```

Input Johannesburg Metropolitan white population 1921 = 158,936; 1936 = 269,358;
1951 = 365,663.

APPENDIX C.

MODEL FOR POPULATION DISTRIBUTION IN MULTI-NUCLEAR
SETTLEMENTS.

This model was evolved for use on a desk calculation from the distribution pattern of the Witwatersrand towns by simultaneous solution of a matrix representing town population size, distance to central city, distance to nearest employment centre and a saturation factor based on the attraction of a town for settlement according to its stage of fill.

Town	Population 1960	Distance to Johannesburg	Distance to work	Percentage Occupation s	Growth rate 1960 r
Johannesburg	368,987	0	2.0	95%	0.8416
Germiston	56,956	10	1.4	80%	2.1707
Boksburg	27,596	14	1.8	75%	1.2256
Benoni	33,386	19	3.0	65%	1.7757
Brakpan	29,291	23	1.6	60%	1
Springs	38,217	30	1.7	45%	1.6932
Roodepoort	40,908	13	1.8	60%	3.5425
Krugersdorp	30,515	21	1.3	50%	1.3563
Randfontein	13,647	25	1.2	35%	0.7711

Equation solved $r = (ap + bq + ct)s$

where r = annual growth rate

p = Present population

q = distance to core

t = distance to nearest large employment centre.

s = saturation factor

Certain assumptions were made beforehand based on generally observed phenomena, such as:

- (i) New towns initially grow at a faster rate than the older large towns and this effect is best simulated by an exponential curve (1)
- (ii) Distance to core is a linear function and an indifference co-efficient of 0 is reached where another large or larger town exerts a stronger pull. This distance was accepted as 50 miles.
- (iii) A similar indifference margin exists for distance to work. A distance of 10 miles was adopted, representing the mean distance between towns.
- (iv) A saturation factor, represented by a curve of the form $y = \frac{k}{1+10^a+6^x}$ was adopted from work done by students from the Planning School at the University of Pretoria. (2)

As none of the growth factors can be isolated it is not possible to draw a regression line for each separately and the best values in combination could only be determined by an empirical procedure of repeated solutions at different values for each factor. The model is therefore not "mathematical" in the sense that it was obtained by solution of equations.

The coefficients for each of the parameters shown below gave the best fit. For ease of calculation on a desk computer tables of coefficients rather than curve formulae were used:-

(i)

P	500	7500	15000	22500	30000	300000
a	.0657	.0482	.0306	.0130	.0046	0

(ii)

%	0	10	20	30	40	50	60	70	80	90	100
S	0.25	.50	0.60	1.00	1.00	1.00	0.90	0.75	0.65	0.25	0

Any proposed new town (such as the presently undeveloped Blaauwdrift) is started when the nearest adjacent town has reached 60 per cent of its potential growth or when policy requires the establishment of such a town.

The population distribution fore-cast is calculated in five-year intervals and adjustments made to the percentage of fill and the coefficients applicable for that particular set of circumstances read off the tables.

	Table of inputs.					Output.		
	1960 P	Building lots	% 1.	b	c	r_1	1970	% ₂ etc.
Welkom	27920	7918	75	50	8	1.03918	38364	
Odendaalsrus	6102	1750	50	41	7	1.04466	8840	
Virginia	12716	4867	35	34	8	1.04128	17835	
Allanridge	2457	3423	17	33	5	1.01847	2761	
Blaauwdrift	0	850	0	41	5	0	0	

67800

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POPULATION GROWTH OUTPUT OF MODEL.

Input : Johannesburg Metropolitan White Population	Y e a r		Population	
	Johannesburg Metrop.	O.F.S. Goldfields	(a) Output	(b) Adopted
1921 : 158,936	1893/4	1951	18,000	11,071(Actual)
1936 : 269,358	1902/3	1960	47,589	47,589(Actual)
	1912/3	1970	100,000	76,000
1951 : 365,663	1922/3	1980	170,000	114,400
	1927/8	1985	207,000	129,200
1960 : 412,773	1932/33	1990	244,000	
	1937/38	1995	278,000	
Actual 413,153	1942/43	2000	314,000	
Error - 380				
= 0.092%				

The output figures in column (a) are completely unrealistic when compared with the figures actually adopted for planning purposes, shown in column (b). The latter figures are based on the natural increase, adjusted for the expected immigration, changing later to emigration, consonant with the labour needs following on the diversification of the industries.

APPENDIX D.

Model for computing area of district business centres at an annual turnover of R10 per gross square foot and a per capita income of the White population on the Goldfields of R972.35 per year.

In the initial calculation convenience goods are excluded, i.e. only 65 per cent of the buying power is taken into account and 65 per cent of the gross business area computed. Standard goods are assumed to be sold in local and neighbourhood shopping centres to population groups of 7500 or less (255,244 gross square feet or less). After computing the comparative goods and specialist service needs the floor space for local needs is added to each district business centre.

Floor space allocations are made from the model (5).

$$S_p = \sum_{i=1}^n \frac{\frac{C_i F_p}{d_i^a}}{\sum_{P=1}^r \frac{F_p}{d_i^a}}$$

Where S_p are sales in centre P , C_i is buying power in community i , F_p is floor space of centre P , d_i^a is the air distance from community i to centre P and a is an empirical exponential.

For specialist services and comparative goods a is taken as 1 but for convenience goods the resistance to travelling is much stronger and the exponent was found to amount to as much as 2.58 (2).

TABLE 1.
Population estimates.

Town		1970	1980	1990	1995
Welkom	(i)	38364	51975	67504	77290
Virginia	(j)	17835	26794	39015	48565
Odendaalsrus	(k)	8840	13260	21800	26858
Allanridge	(l)	2761	3379	6481	8130
Blaauwdirft	(m)	-	592	2700	3256

TABLE 2.

Community buying power at 65 per cent of R972.357 per capita.

Town		1970	1980	1990	1995
Welkom	(P)	R24,249,000	R32,850,000	R42,665,000	R48,850,000
Virginia	(Q)	11,722,000	16,935,000	24,659,000	30,695,000
Odendaalsrus	(R)	5,587,000	8,381,000	13,778,000	16,975,000
Allanridge	(S)	1,745,000	2,136,000	4,096,000	5,138,000
Blaauwdrift	(T)	-	374,000	1,706,000	2,058,000
		42,852,000	60,991,000	86,904,000	103,716,000

Computations done on a desk calculator.

Initial floor space allocations directly in proportion to buying power of local community.

1970 (Example computation)

	i	j	k	l	m	
P	$\frac{24247}{1}$	$+ \frac{11272}{17}$	$+ \frac{5587}{9}$	$+ \frac{1745}{18}$	-	= 2562.8
Q	$\frac{24247}{17}$	$+ \frac{11272}{1}$	$+ \frac{5587}{25}$	$+ \frac{1745}{34}$	-	= 1297.3
R	$\frac{24247}{9}$	$+ \frac{11272}{25}$	$+ \frac{5587}{1}$	$+ \frac{1745}{9}$	-	= 892.6
S	$\frac{24247}{18}$	$+ \frac{11272}{34}$	$+ \frac{5587}{9}$	$+ \frac{1745}{1}$	-	= 404.4

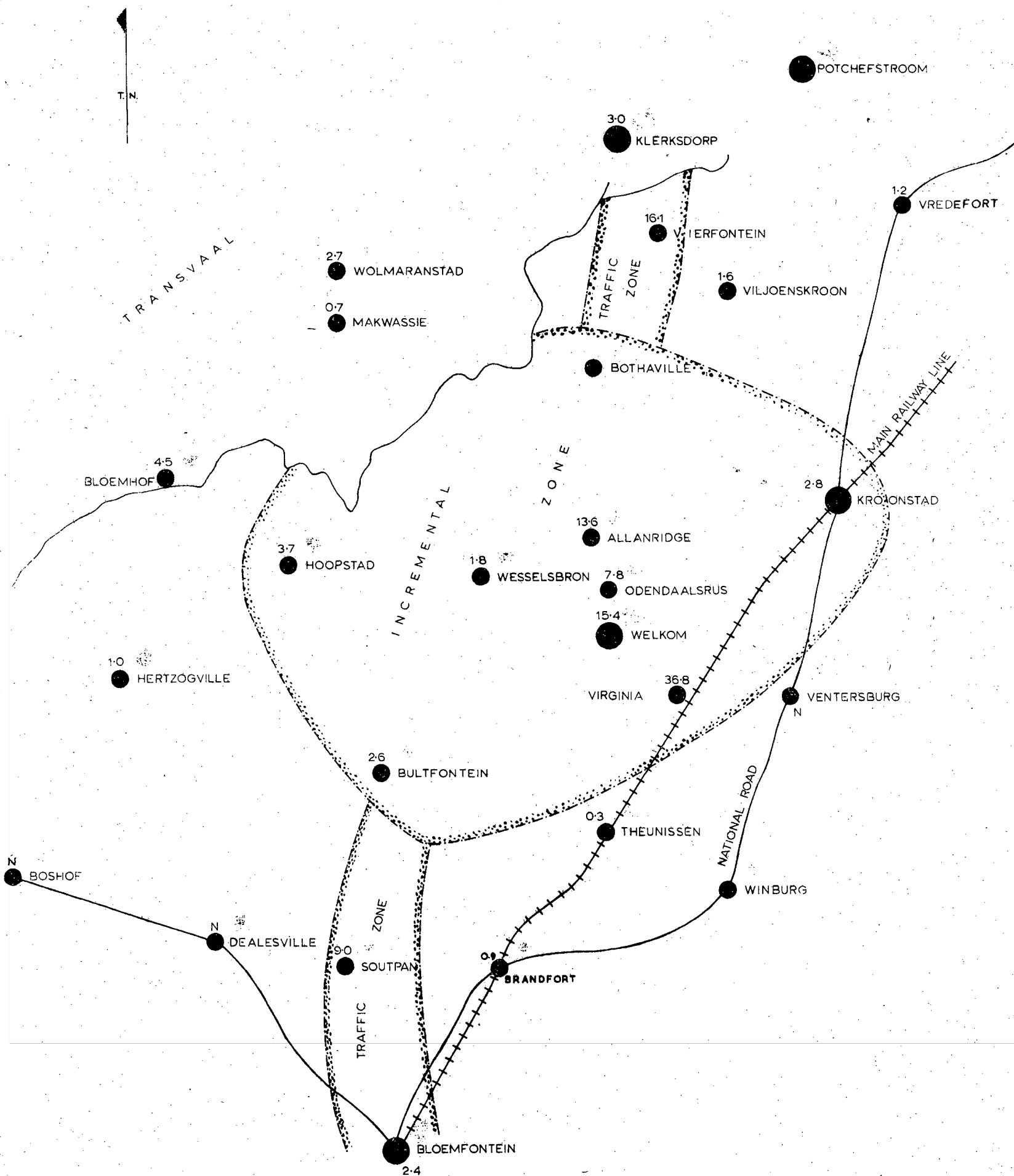
- 3 -

	P	Q	R	S	
i	$\frac{24247 \times 2424.7}{2562.8}$	$+ \frac{11272 \times 2424.7}{1297.3}$	$+ \frac{5587 \times 2424.7}{892.6}$	$+ \frac{1745 \times 2424.7}{404.4}$	= 229404
j	$\frac{24247 \times 1127.2}{17}$ 2562.8	$+ \frac{11272 \times 1127.2}{1}$ 1297.3	$+ \frac{5587 \times 1127.2}{25}$ 892.6	$+ \frac{1745 \times 1127.2}{34}$ 404.4	= 10846.6
k	$\frac{24247 \times 558.7}{9}$ 2562.8	$+ \frac{11272.3 \times 558.7}{25}$ 1297.3	$+ \frac{5587 \times 558.7}{1}$ 892.3	$+ \frac{1745 \times 558.7}{9}$ 404.4	= 4547.6
l	$\frac{24247 \times 174.5}{18}$ 2562.8	$+ \frac{11272.3 \times 174.5}{34}$ 12973.1	$+ \frac{5587 \times 174.5}{9}$ 892.6	$+ \frac{1745 \times 174.5}{1}$ 404.4	= 970.5

TABLE 3.

Final results of computations giving very nearly a sales potential of R10 per gross square foot of district business area, including convenience goods, financial services and other community transactions.

Town	Square feet of gross business area			
	1970	1980	1990	1995
Welkom	2,771,700	3,725,000	4,929,000	6,000,000
Virginia	1,428,000	1,983,000	2,769,000	3,324,000
Odendaalsrus	746,800	995,700	1,502,000	1,779,000
Allanridge	360,000	385,000	512,000	576,000
Blaauwdrift	-	37,000	170,600	206,000



CIRCULAR CAUSATION AND GROWTH AXES
THE OFS GOLDFIELDS
AN EMERGING METROPOLIS

The figures indicate the annual percentage of growth. 'N' indicates an absolute decline in population figures.

FIG. 1



Compiled in November 1969

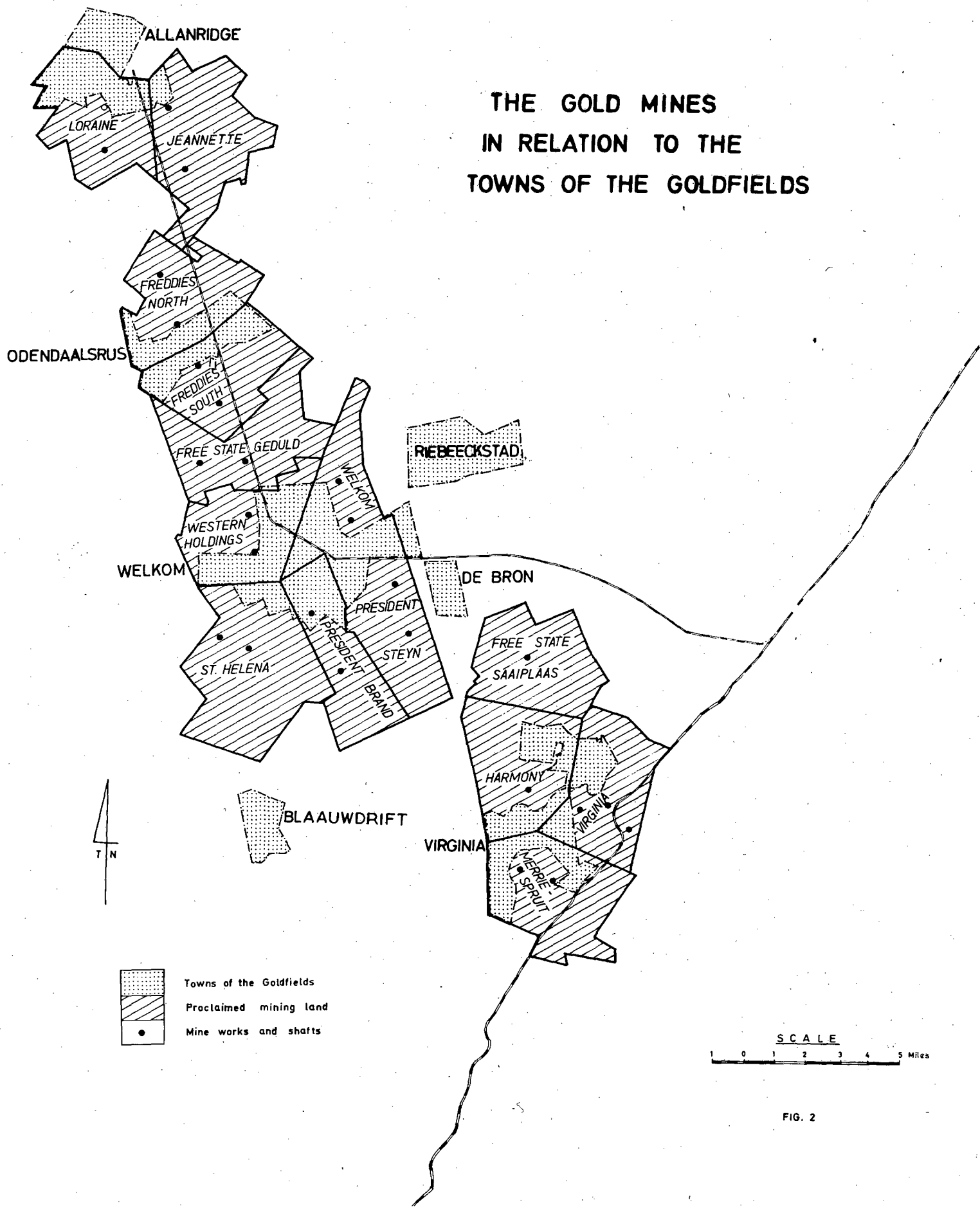
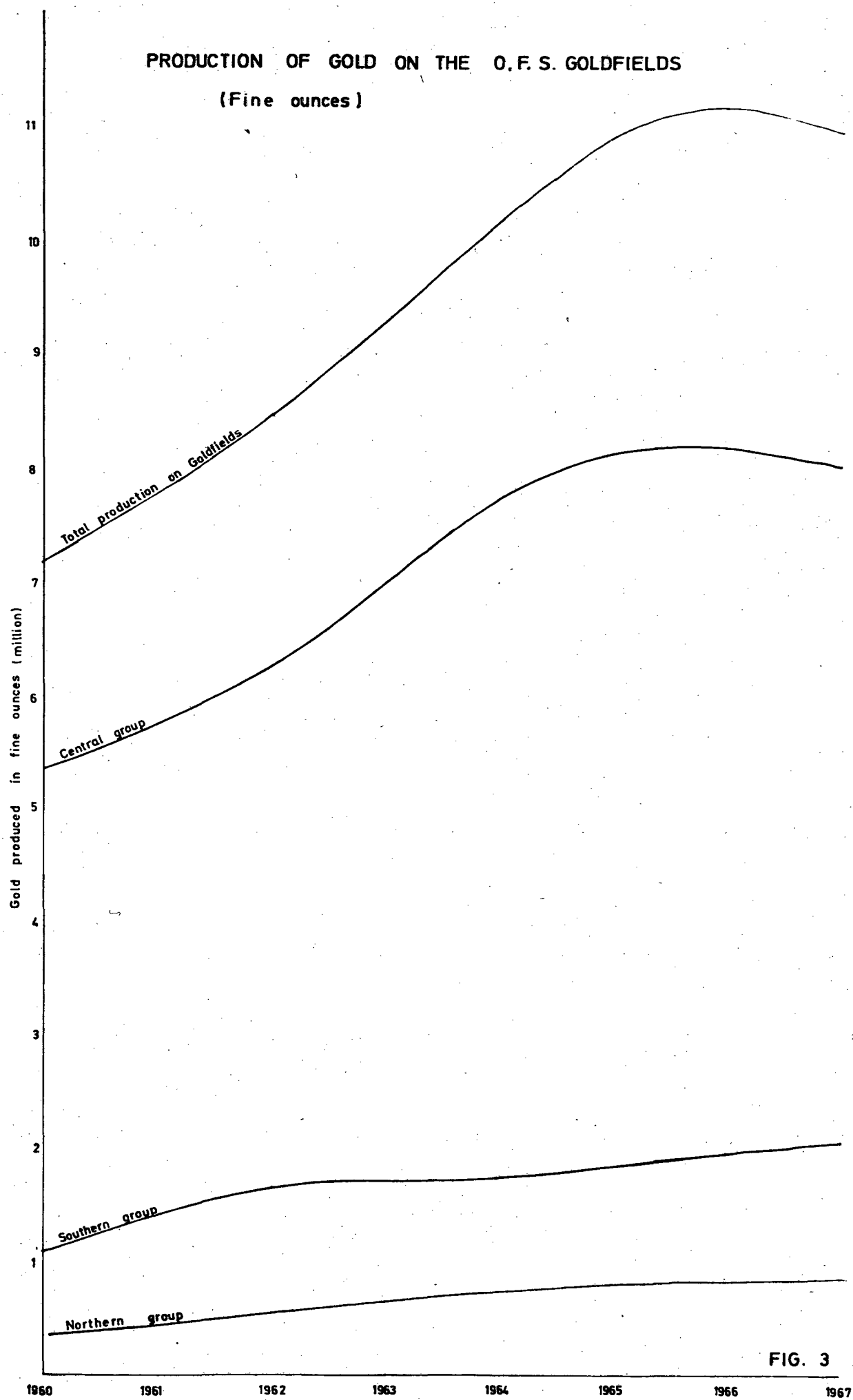


FIG. 2



COMPARATIVE GROWTH OF INDUSTRIES ON THE GOLDFIELDS.

(According to employment figures)

The Goldfield towns are Welkom, Virginia, Odendaalsrus and Allanridge

The region contains also Kroonstad, Henneman, Ventersburg, Bothaville, Bultfontein, Wesselsbron, Hoopstad and Theunissen.

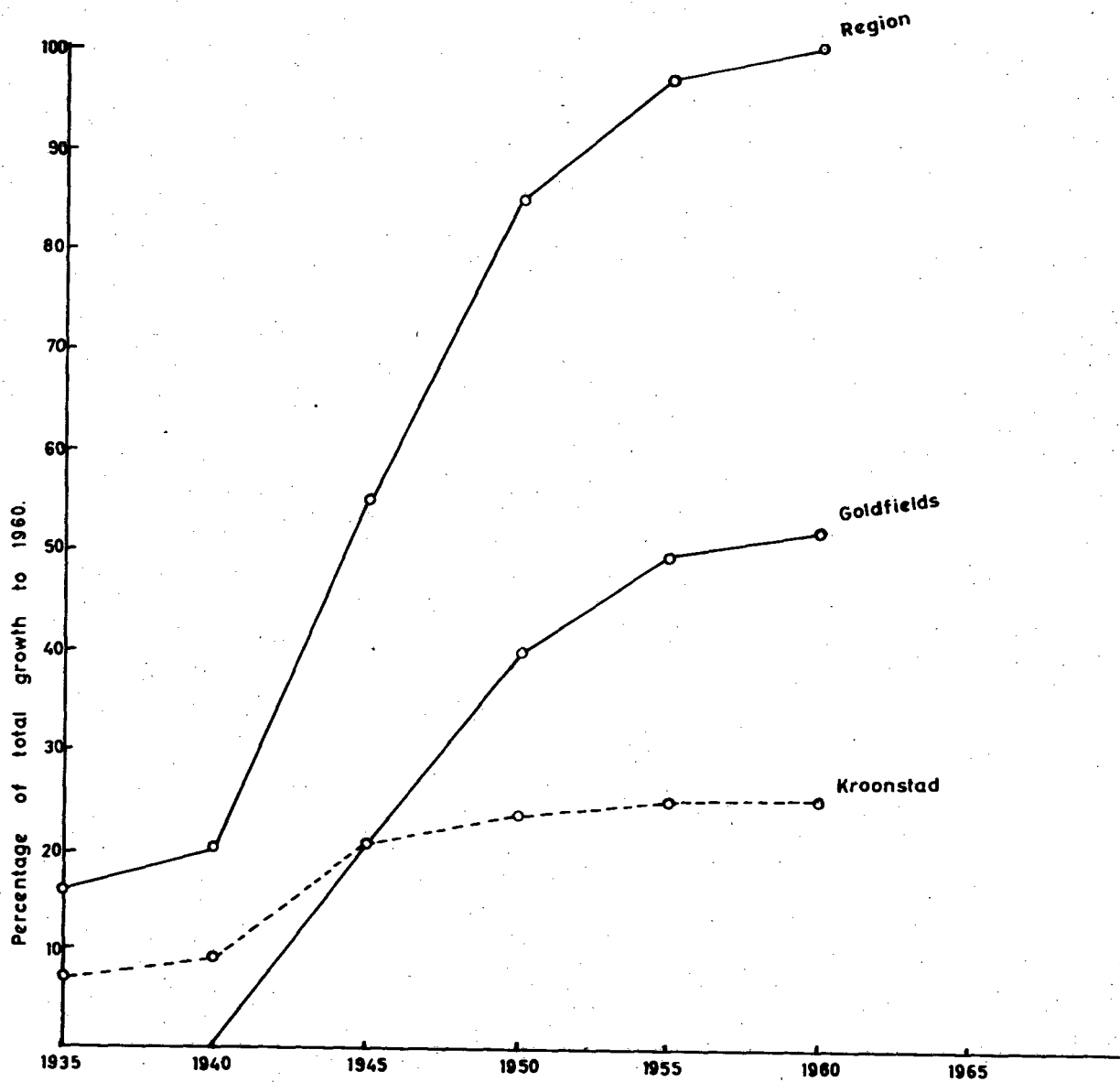


FIG. 4

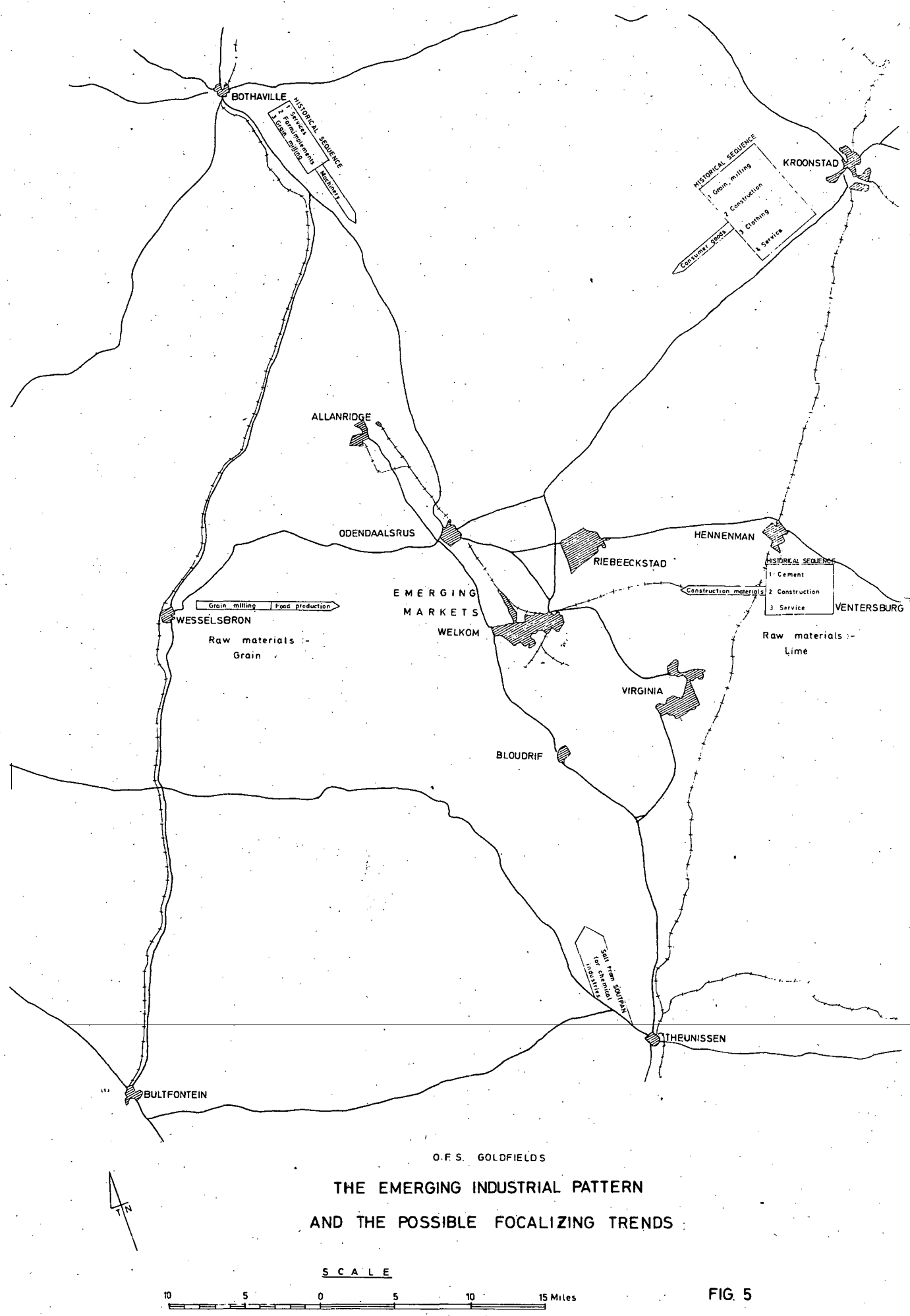
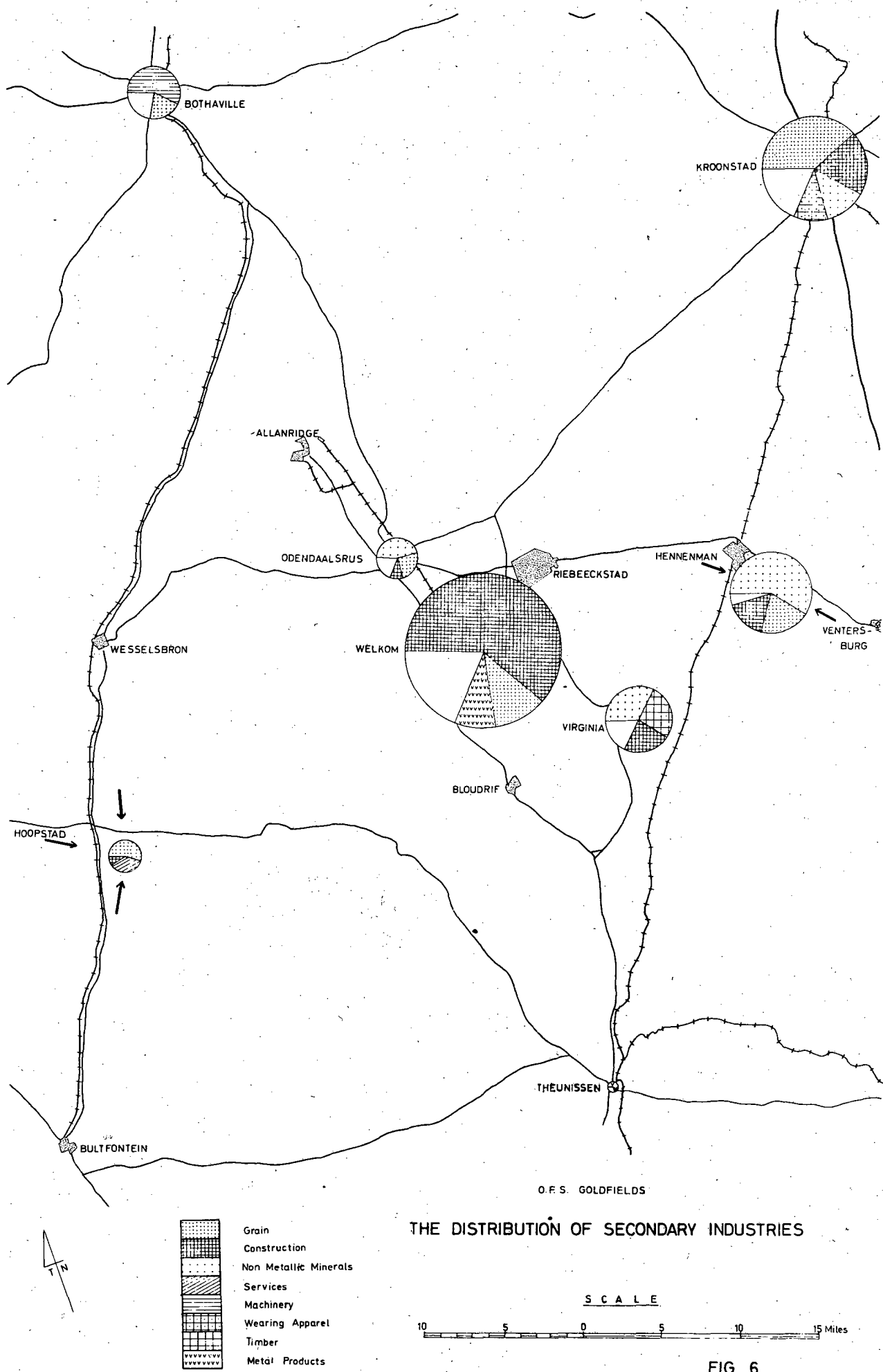


FIG. 5



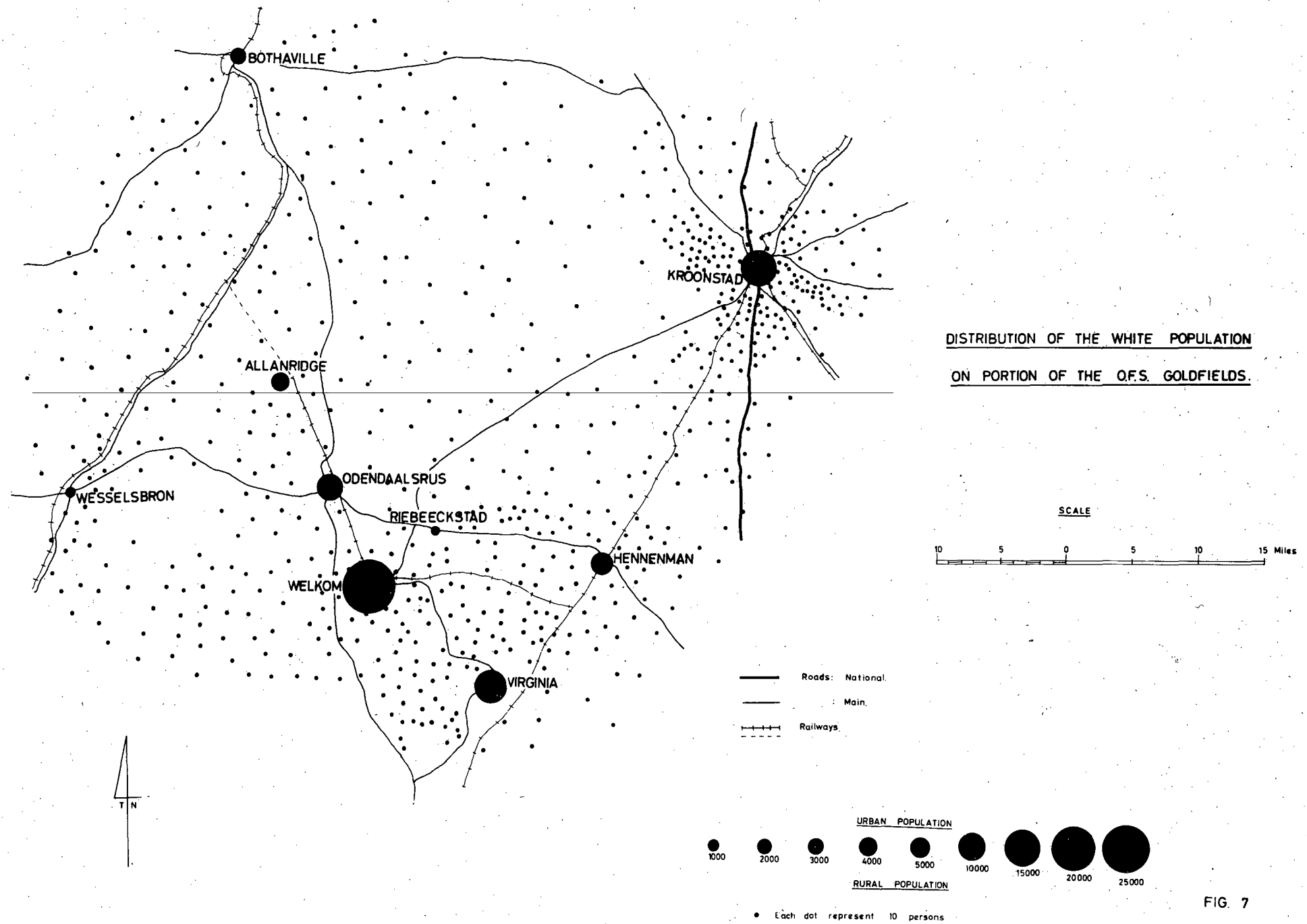


FIG. 7

THE COMPARATIVE AGE AND SEX STRUCTURE
OF THE WHITE POPULATION
ON THE GOLDFIELDS

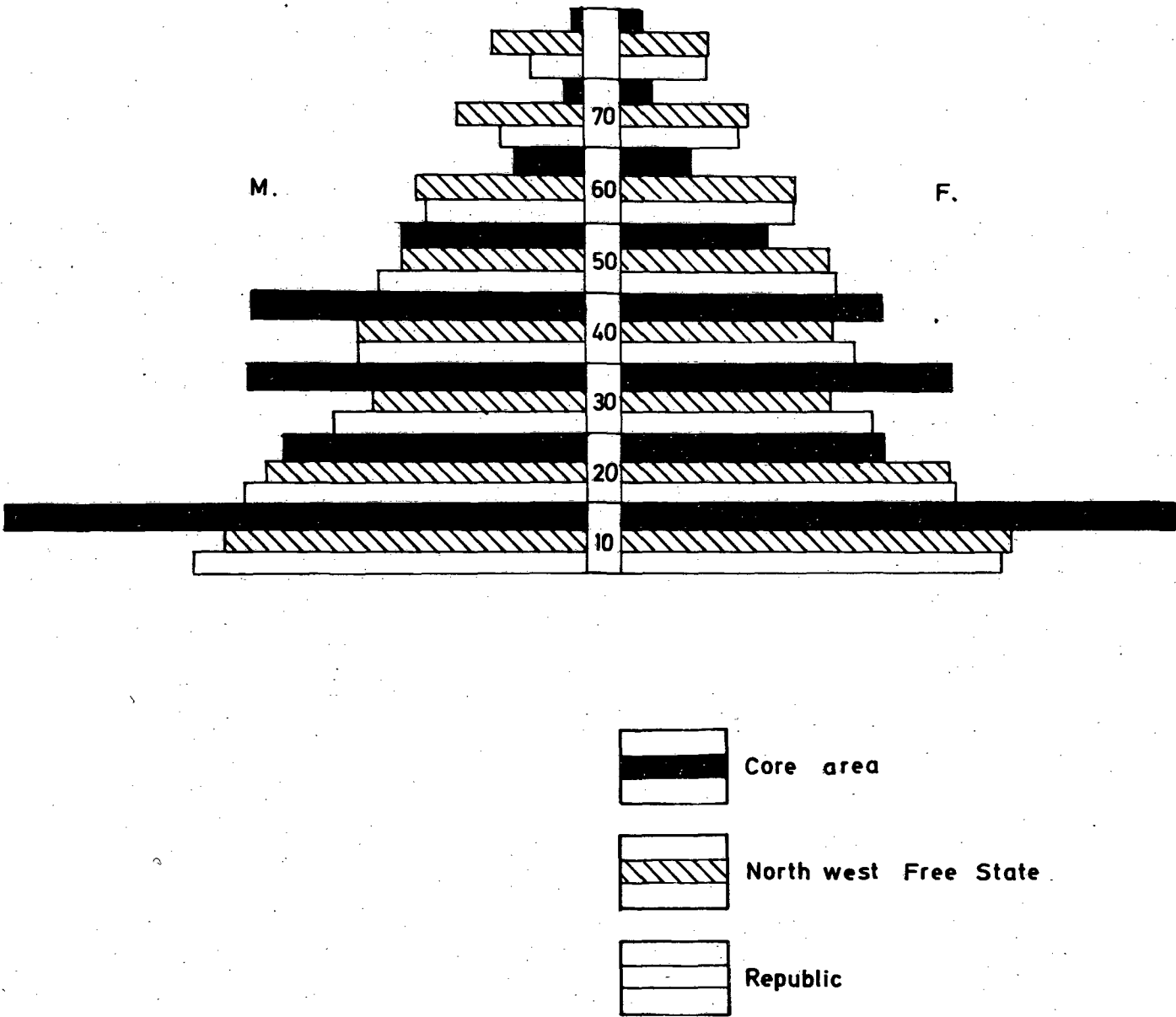
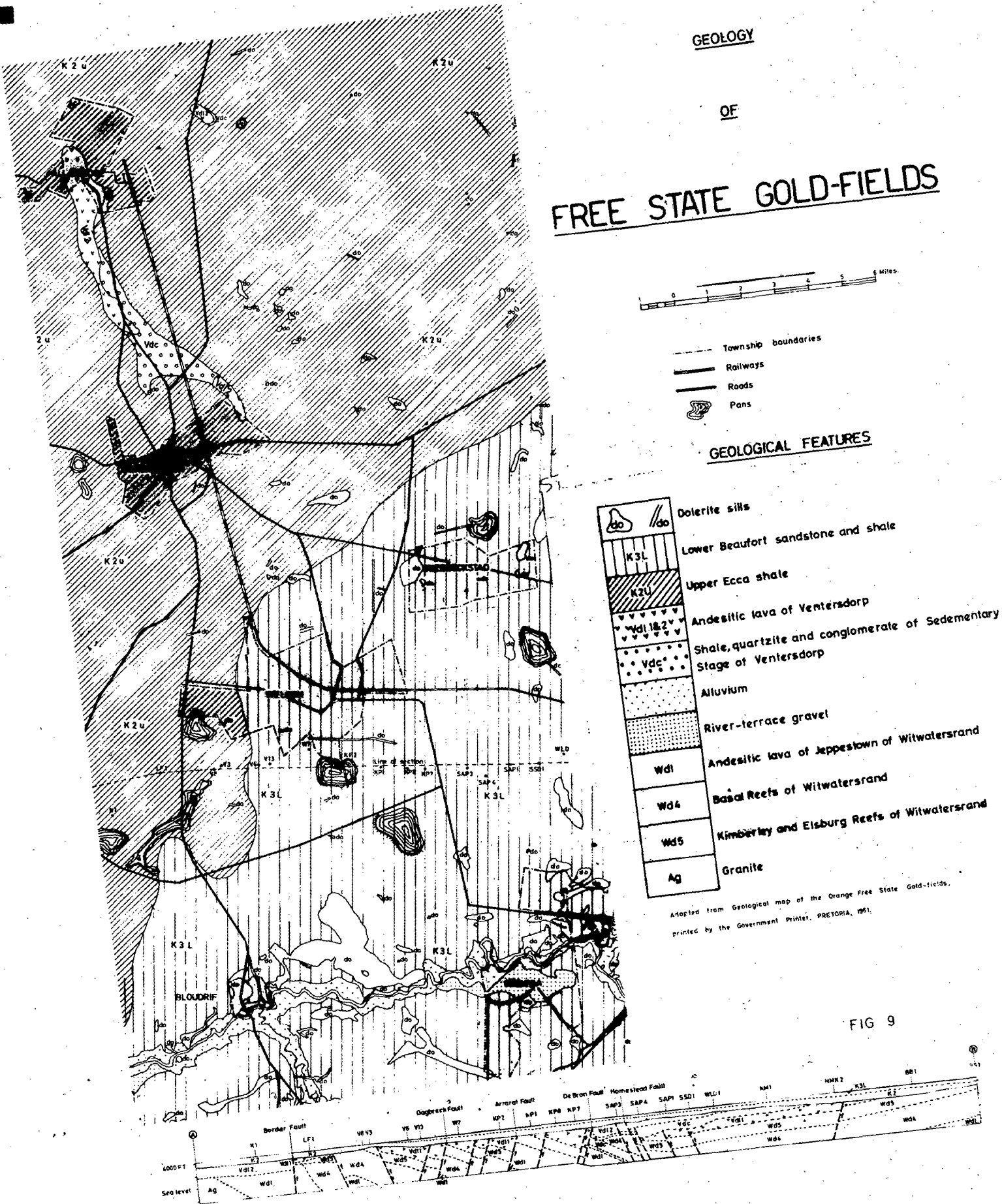


FIG. 8



CLIMATIC TOLERABILITY ZONES

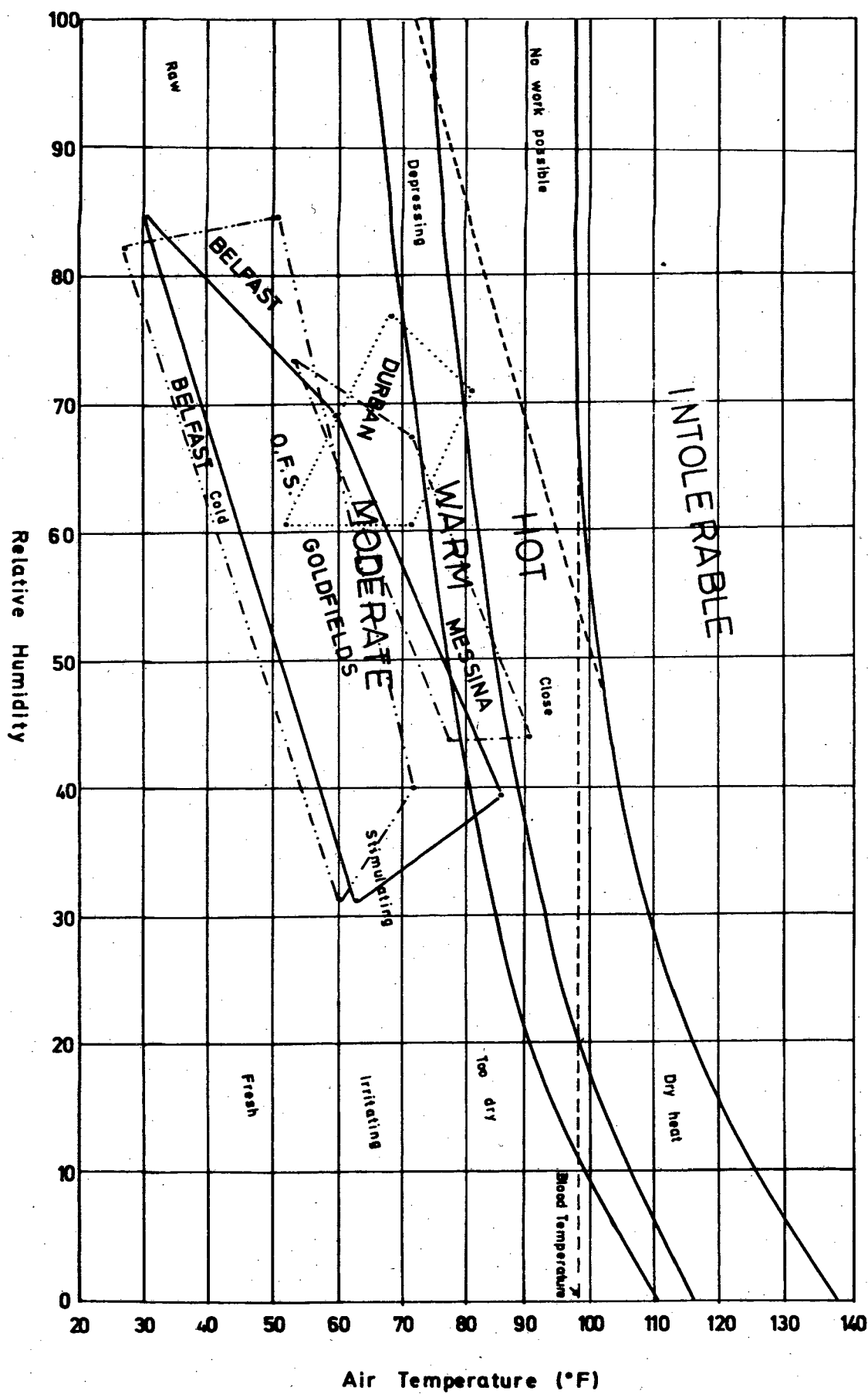


FIG. 10

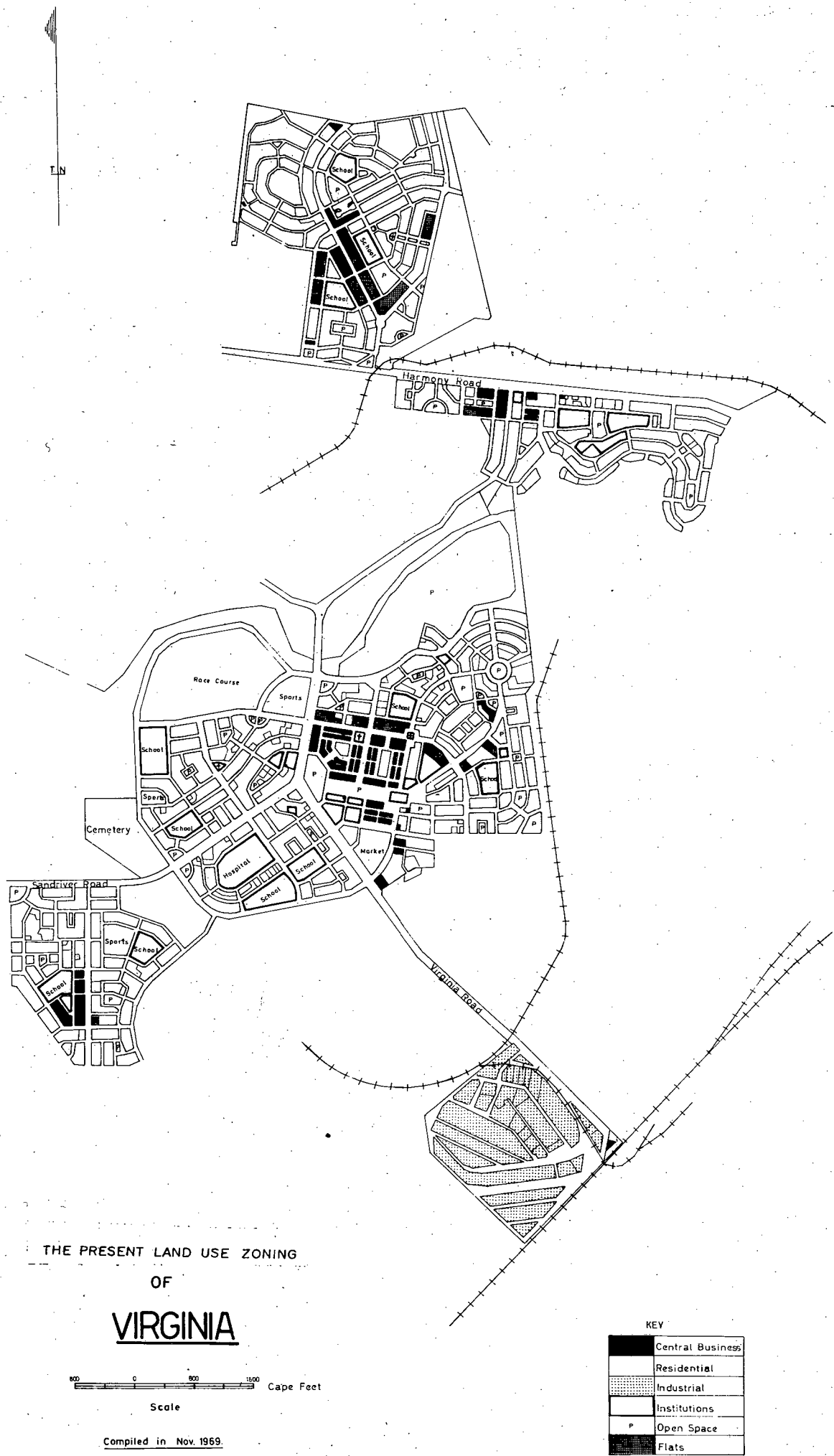
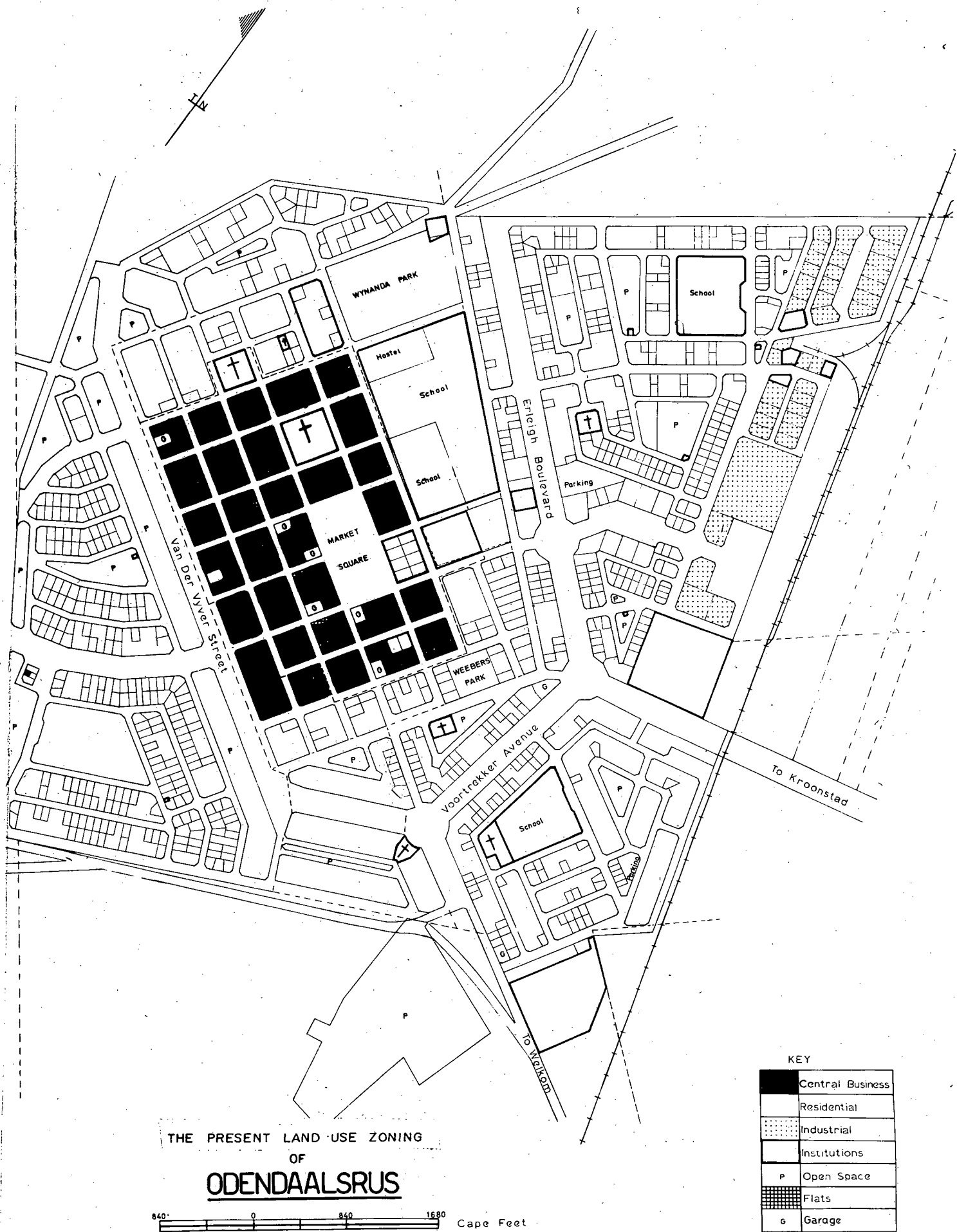


FIG. II



Compiled in Nov. 1969.

FIG. 12

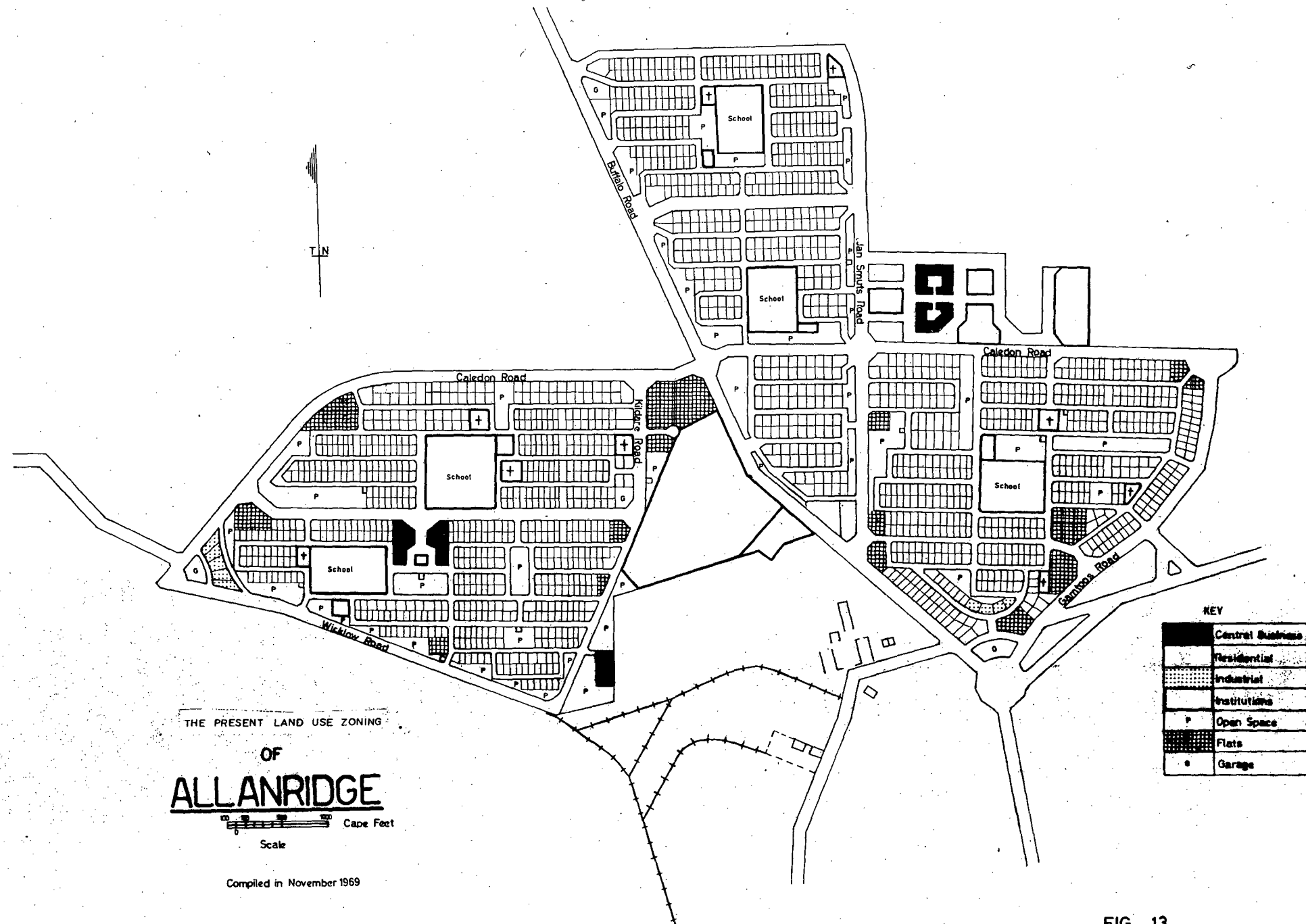


FIG. 13

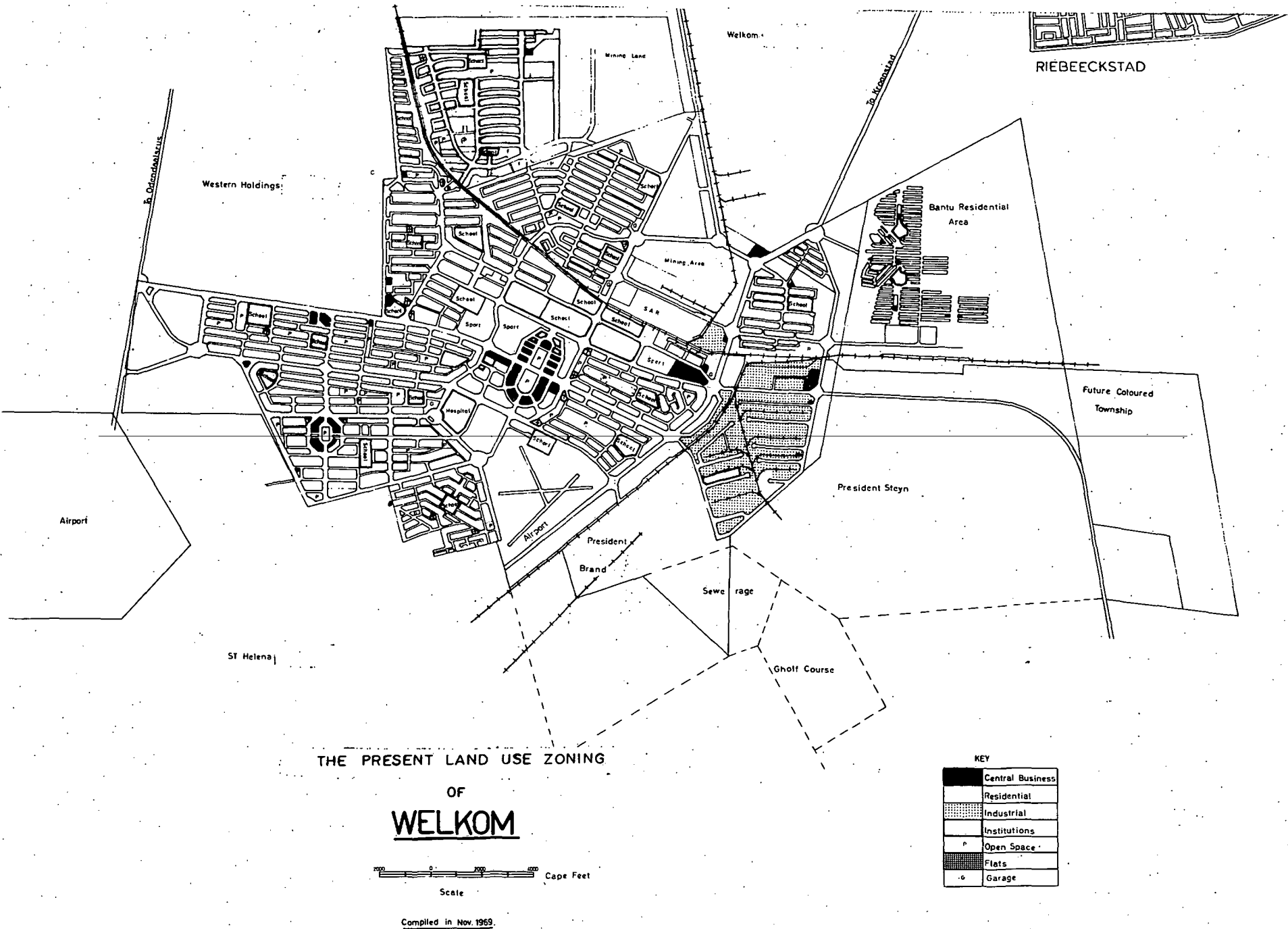


FIG. 14

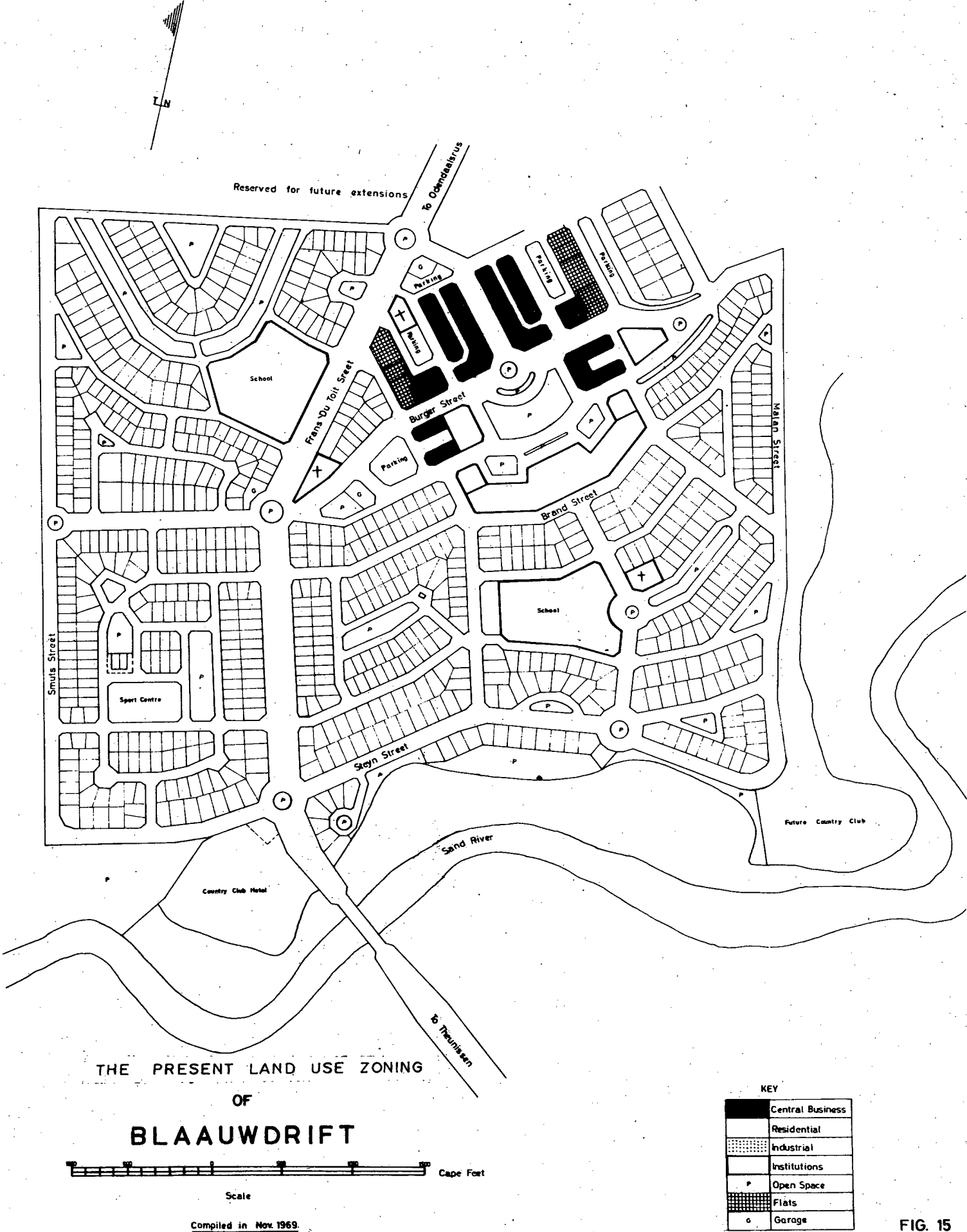


FIG. 15

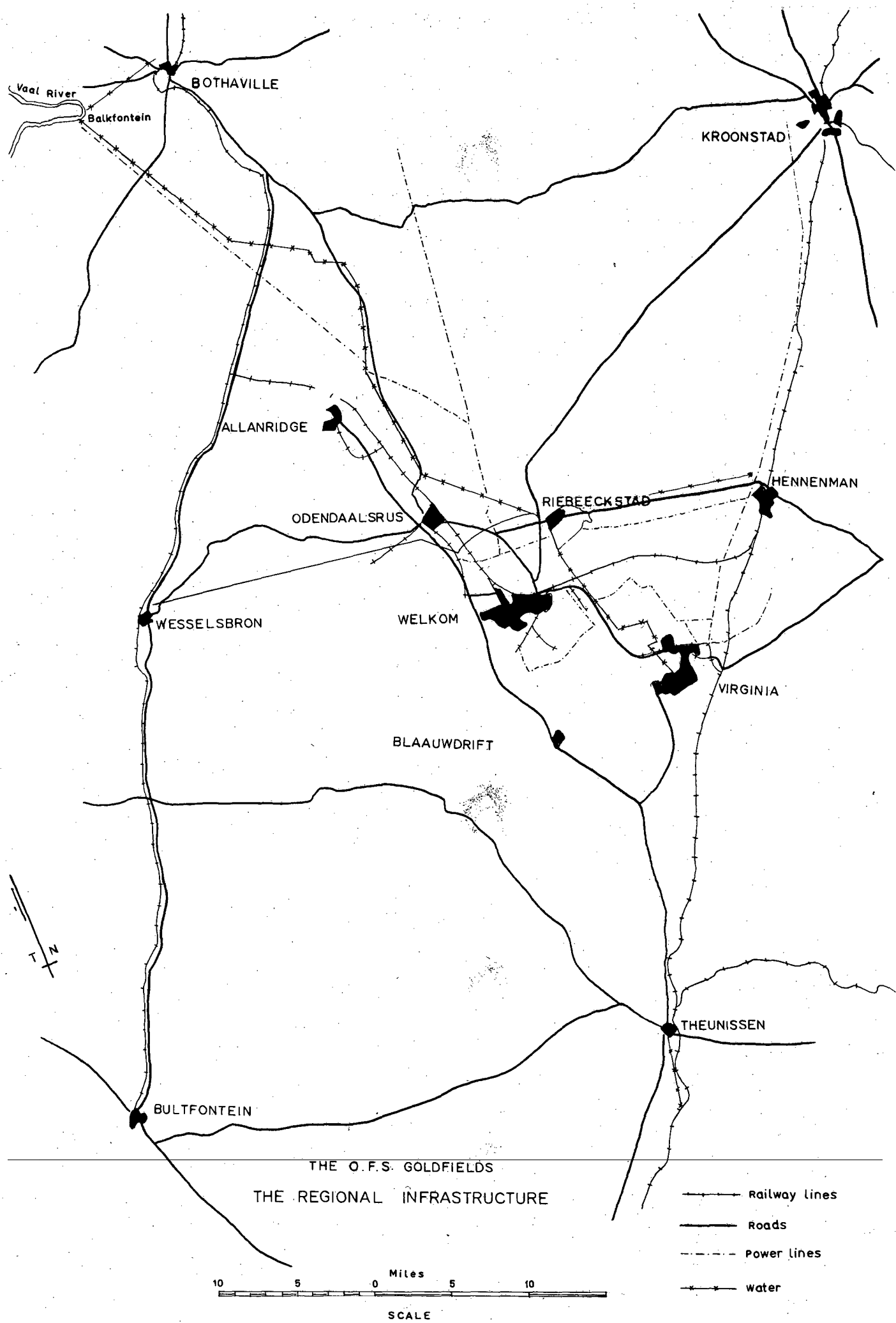


FIG. 16

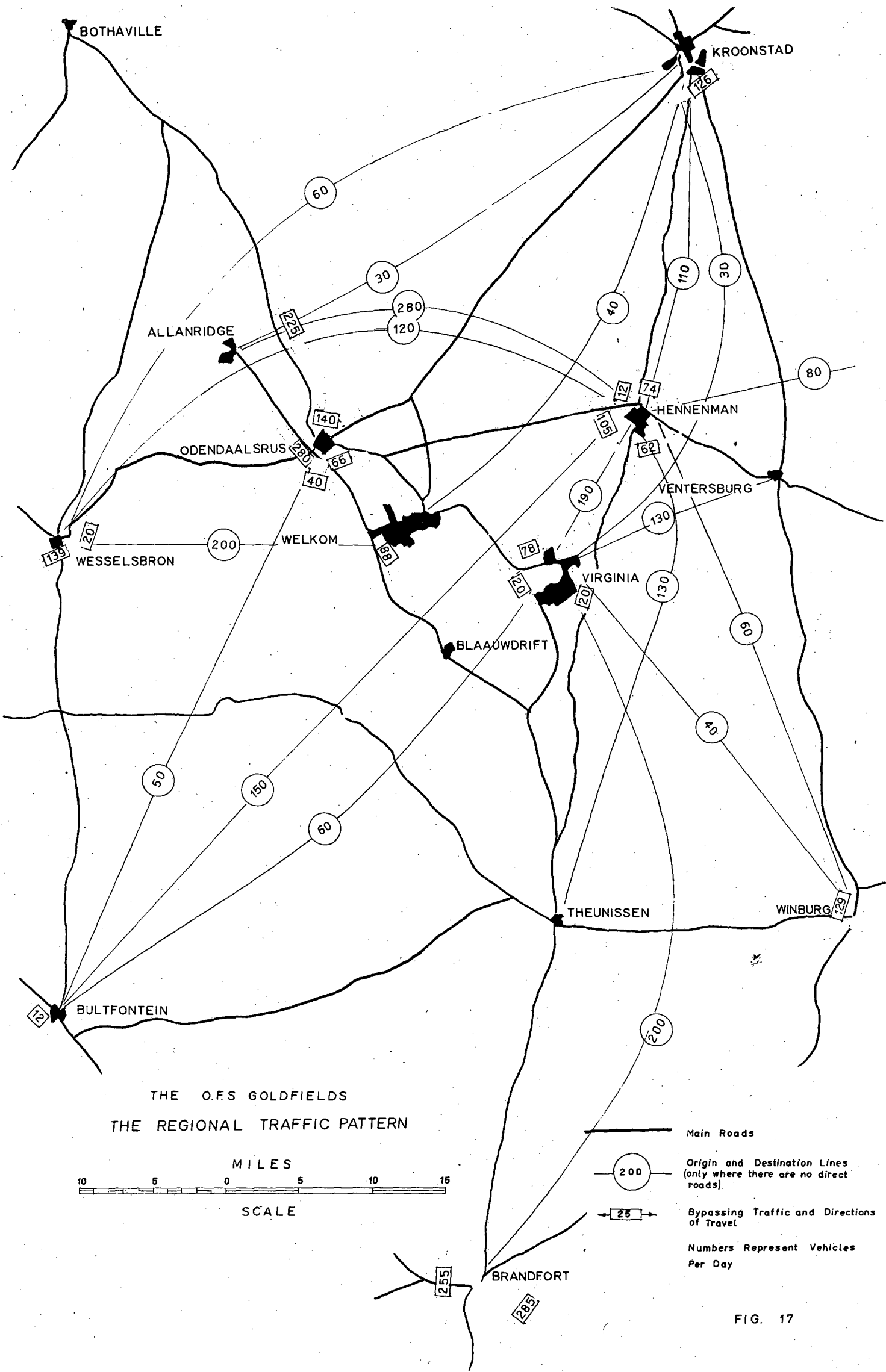
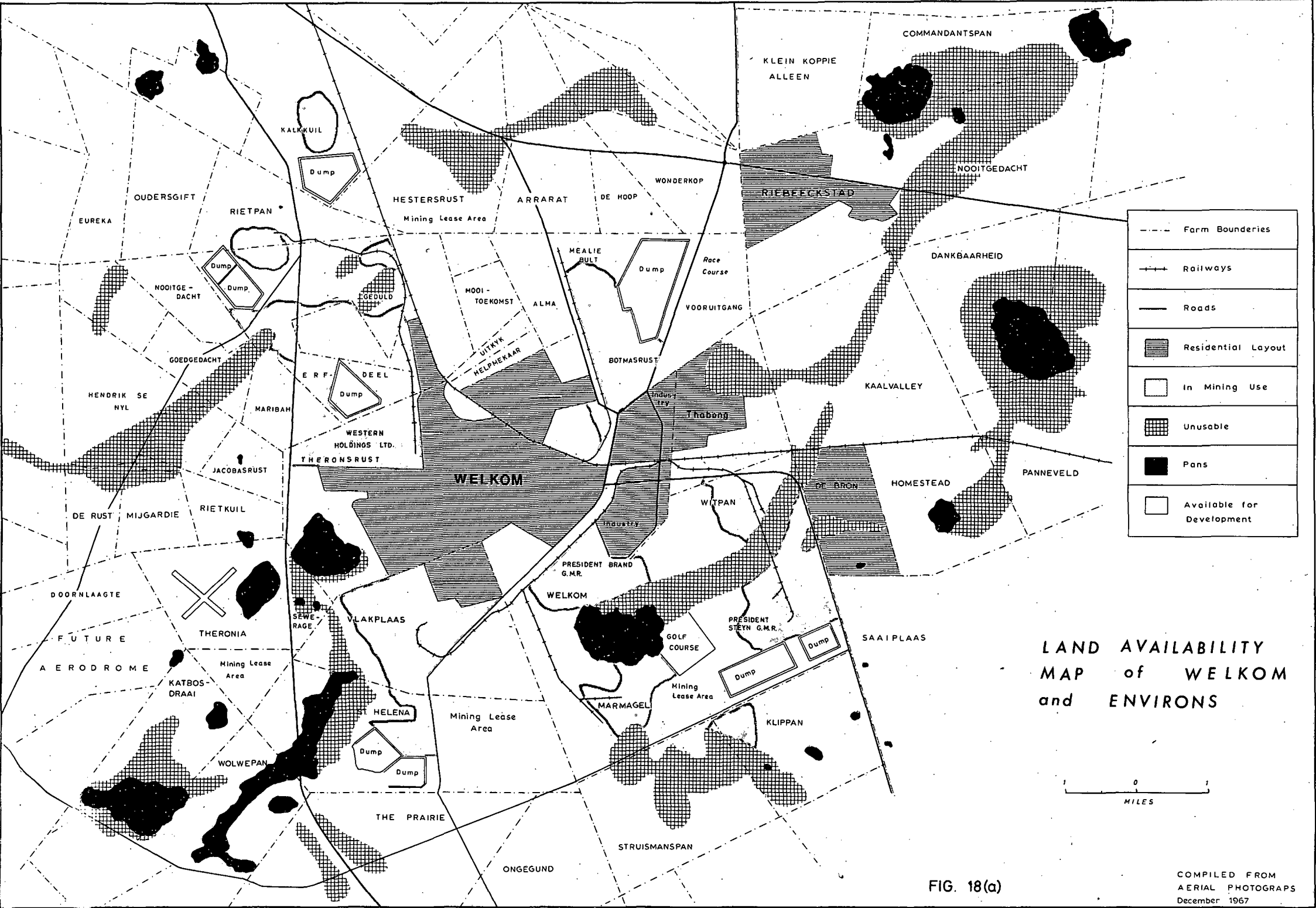


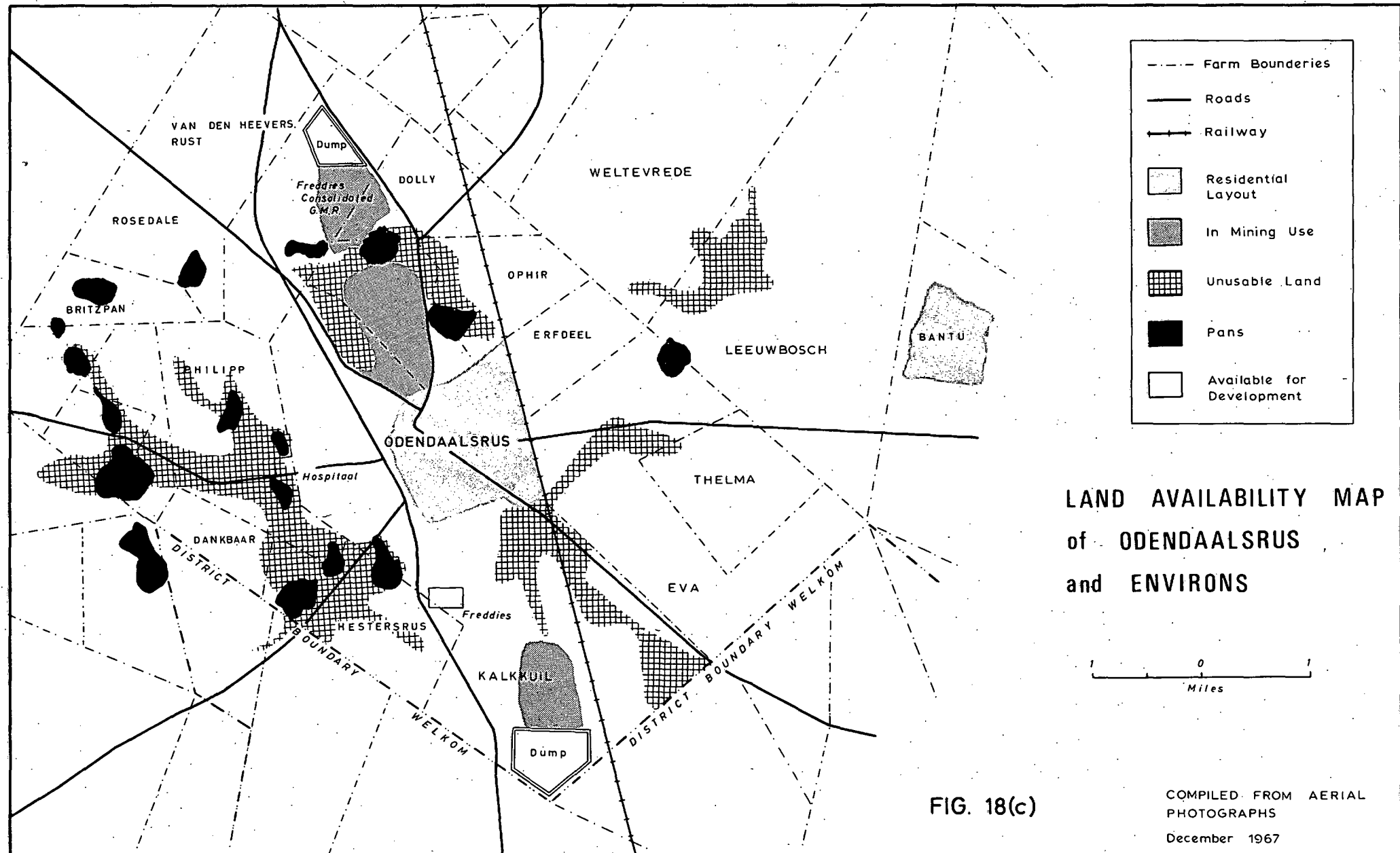
FIG. 17

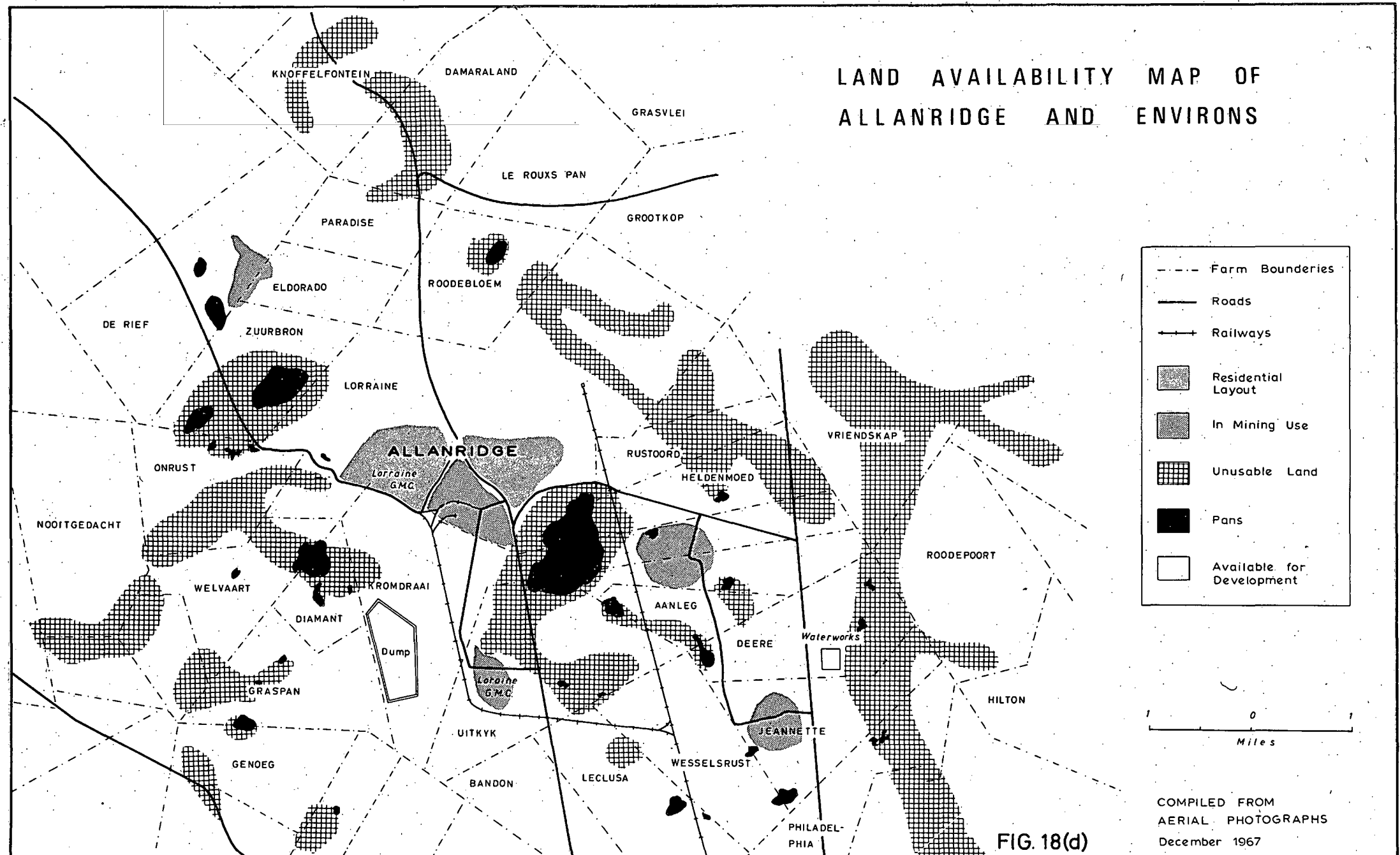


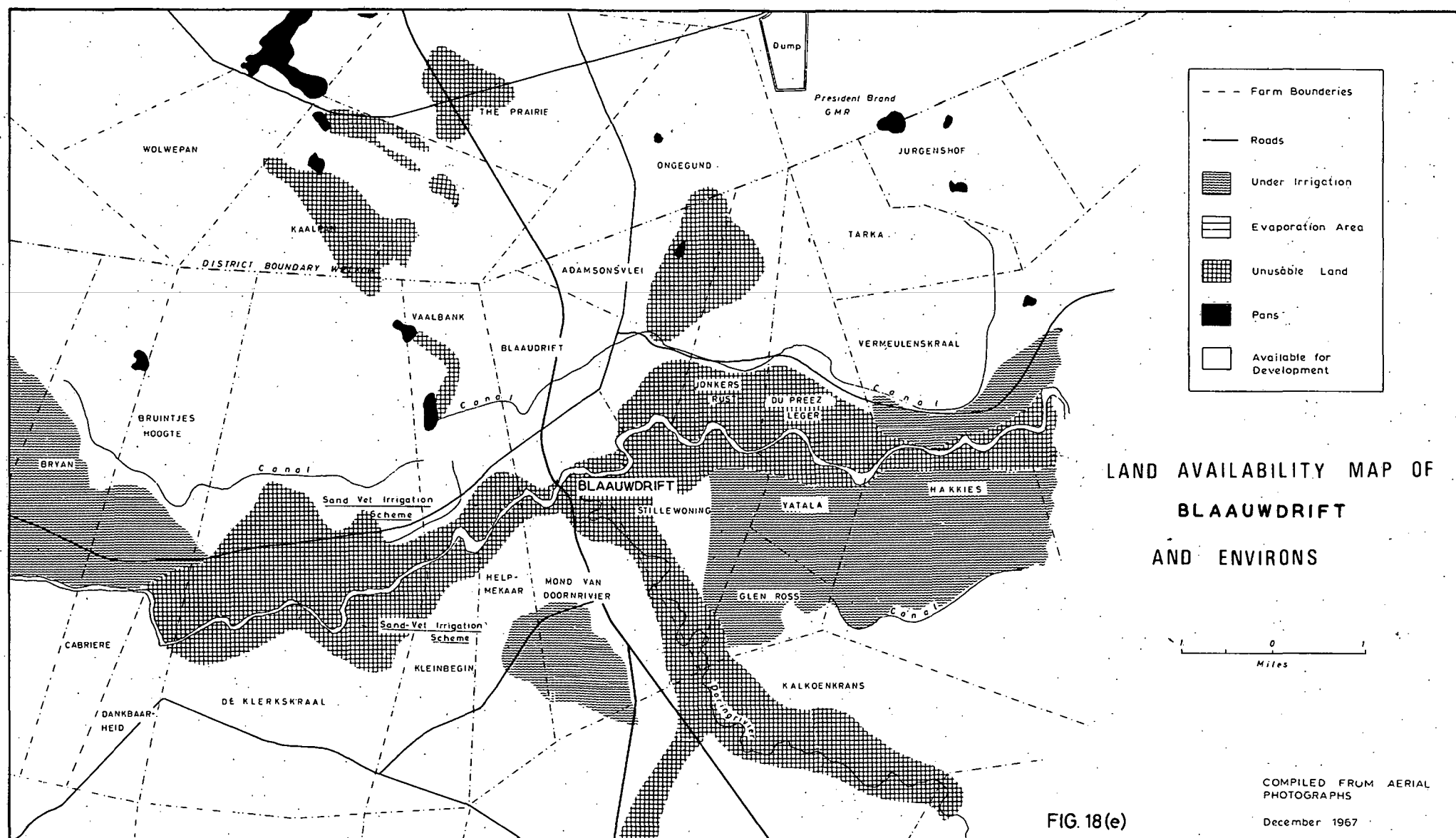
LAND AVAILABILITY MAP
of VIRGINIA
and ENVIRONS

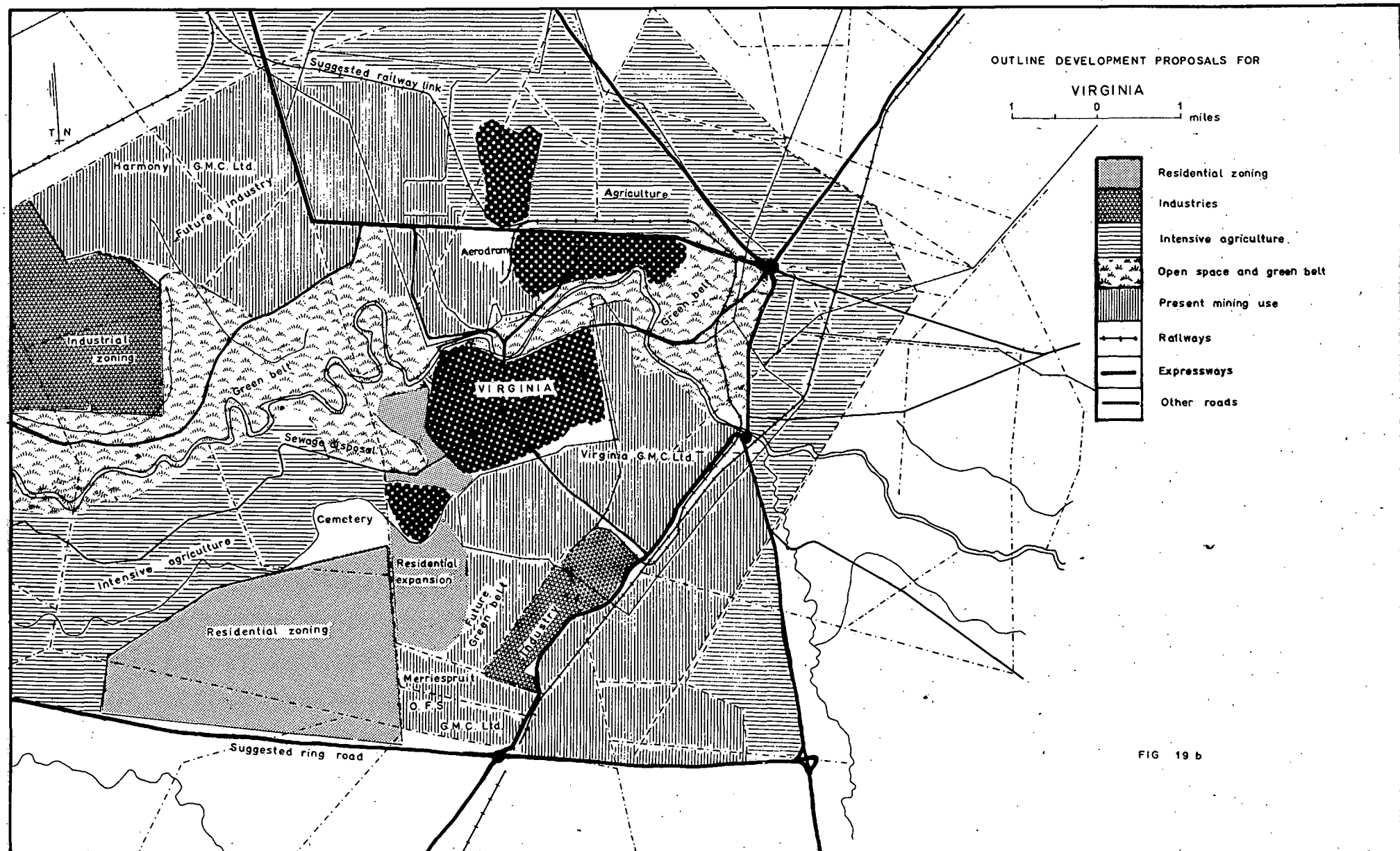
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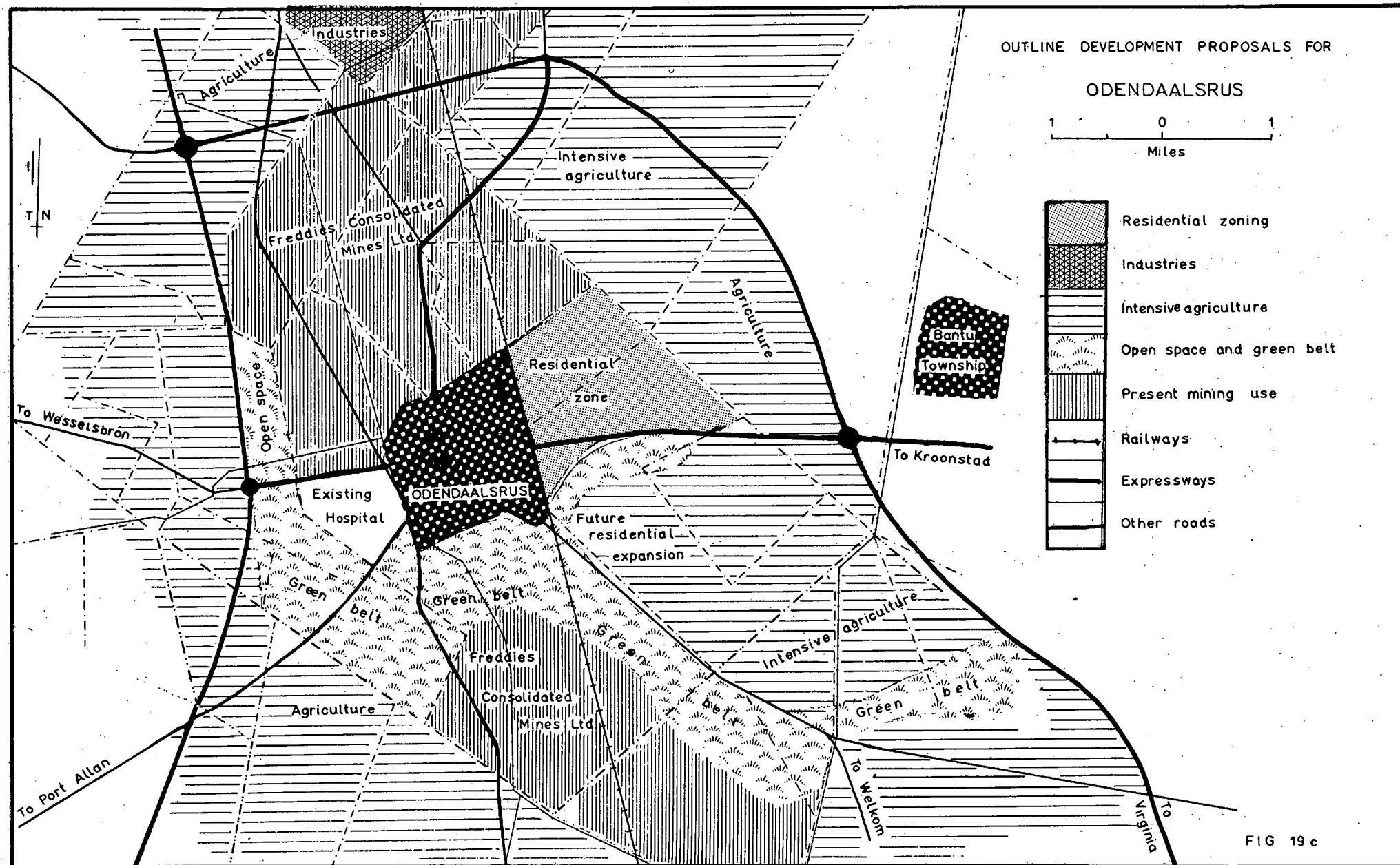
December 1967

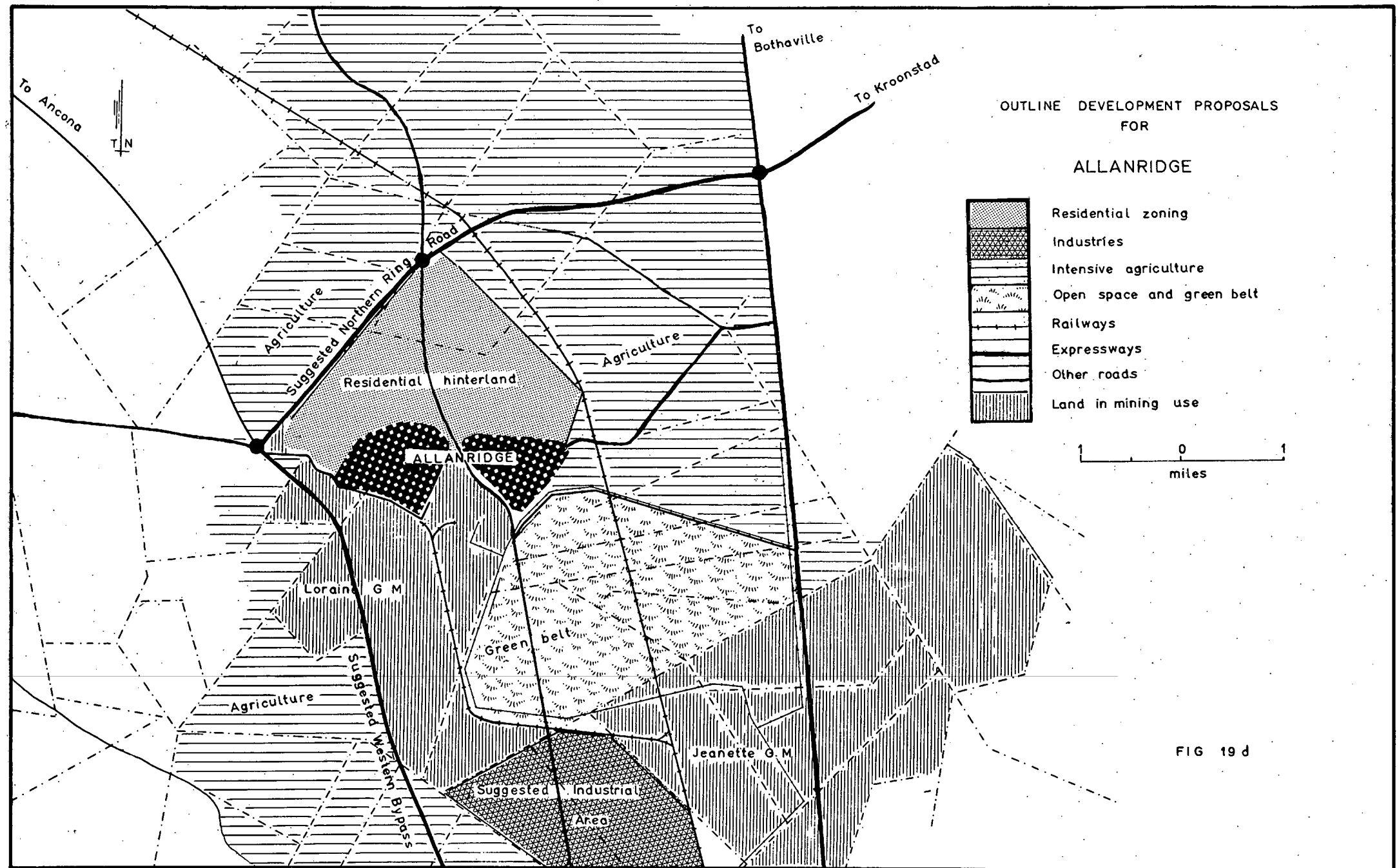












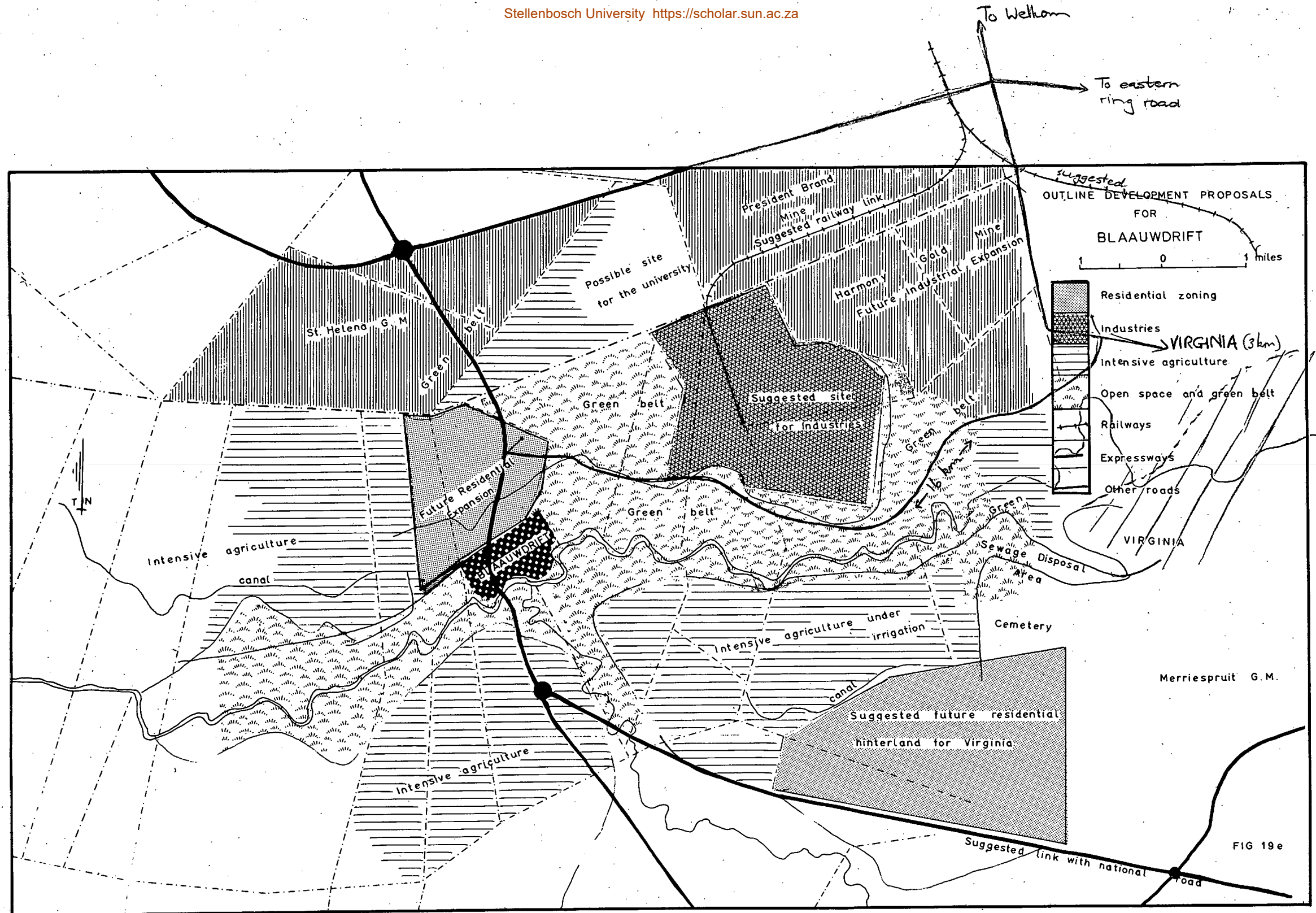
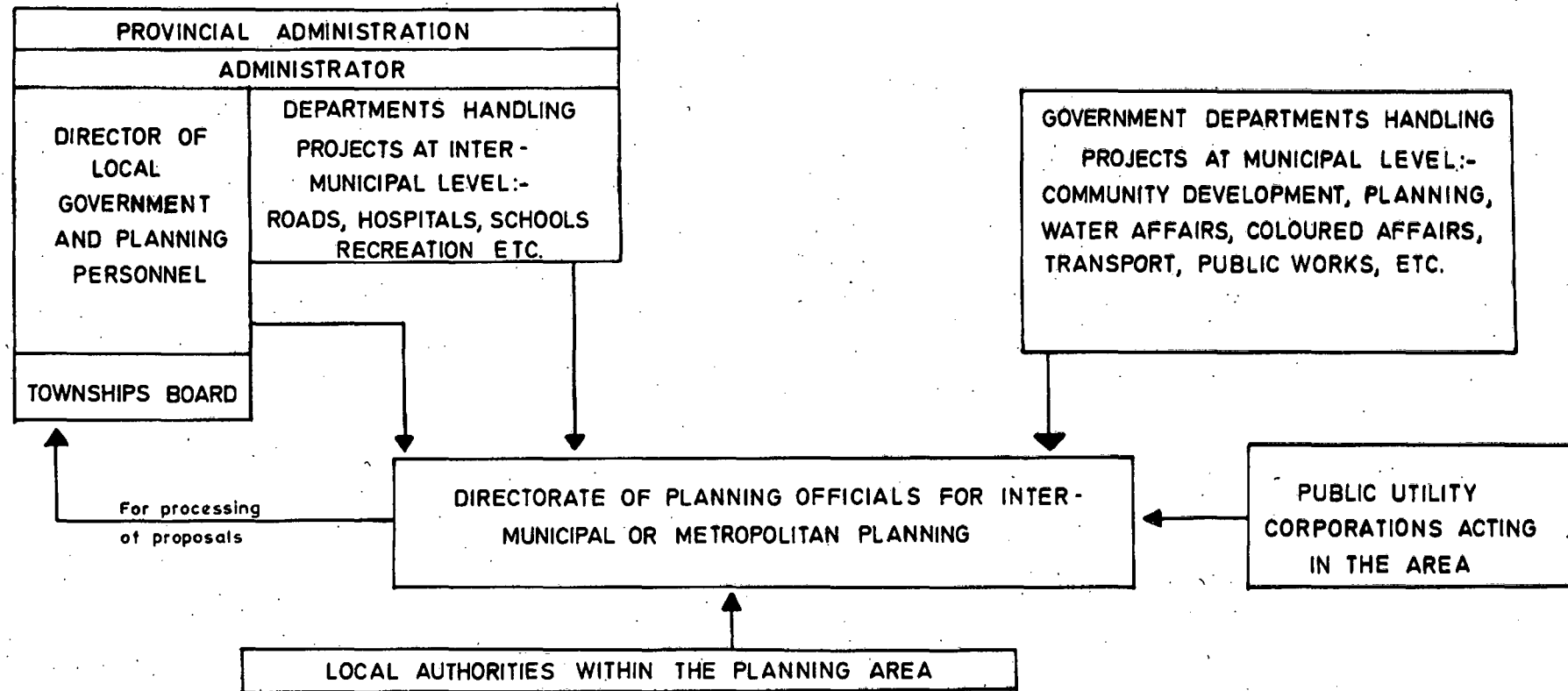


FIG 19e



ORGANIZATION FOR INTER-MUNICIPAL PLANNING.