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GREATER JOHANNESBURG AREA

TRANSPORTATION STUDY

VOLUME 2 : THE PLAN

CITY ENGINEER'S DEPARTMENT

JANUARY 1970

P R. B. LEWIS

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CITY ENGINEER'S FOREWORD

The first point I wish to make in introducing this report is that it is based on facts. It is the result of four years of intensive study of all aspects of the structure of the Study Area and the movements of its people and vehicles. The statistical date for relating the basic data was the 31st December 1965 and the projections relate to the end of 1985. The updating of the data since 31st December 1965 indicate that the projections are realistic and if anything, conservative. Unless there is a major crisis such as a World War or an economic recession of major proportions prior to 1985 the proposals recommended in this report must be implemented.

The proposals are disturbing in their magnitude - physically, what initially they will do to the structure of Johannesburg and financially in respect of the globular sums of money required to implement the projects. To the layman and particularly those whose properties will be affected, the proposals will be frightening and the query will be raised whether they are necessary. The facts reply firmly in the affirmative and society must face up to the fact that its tool, the motor vehicle, is responsible. If society wishes to make an increasing use of the motor vehicle in respect of its many activities then it must face up to the consequences of having to find the capital costs involved. If it does not wish to meet these costs then it must expect severe restrictions in the future on its use of the motor vehicle.

Grim as the picture is of the requirements for the end of 1985, it must be remembered that this date is only 16 years away and the compound increase of the problems after that date to the end of the century and later will make the alleviation of the chaotic conditions which will occur even more difficult and more costly.

Decentralisation of the central city activities must be encouraged - but in terms of an overall Metropolitan Plan. It is doubtful whether decentralisation will occur to any significant extent prior to 1985. Of the 16 million sq. ft increase in office space expected in the Central Area by 1985, over four million sq. ft has been erected already, several million sq. ft are in the course of construction, while numerous large projects are being planned. In all, over 10 million sq. ft of the required office space is committed in known projects.

We have to face a future filled with problems and potential frustrations. In the first instance we have to obtain the assistance of the Central Government and the Province. The assistance required is manifold but financial assistance and legislation to protect the corridor routes prior to the implementation of the projects are of priority. Regional and metropolitan planning must be placed on an effective footing and the question of the authority to run the mass transit system requires a decision.

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In a young developing country the availability of capital funds at all levels of government is minimal. The public will be required to face up to the fact that they will have to pay for the costs through the imposition of heavier taxes.

The public must be made aware of the problems, the action required to meet the problems and the implications to themselves. The success or otherwise of the implementation of the transportation plan rests in the hands of the public.

B. L. LOFFELL

CITY ENGINEER

January 1970

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Current World Thinking		
1.	Cities throughout the world are confronted with the problem of an ageing urban area with a road system designed for a past era.	1
2.	Invariably action is taken only when crisis proportions have been reached.	1
3.	The decision on what is to be done rests on the desires of the people who must be prepared to face up to the costs involved.	2
4.	Balanced transportation plans integrating public transport and motorway proposals are essential features of transportation plans throughout the world.	2
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6.	Motorway standards have been increasing with time.	3 & 4
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8.	The current approach to motorway systems in America is based on the "Corridor" concept which meets the demands of centralisation and decentralisation.	4
9.	Combined with the Urban Motorway system is the need to create an efficient arterial link system.	5
10.	Parking is an essential feature of a transportation plan but the extent of parking must be curbed in city centres.	5 & 6
11.	Most cities have adopted the duo rail for their rail rapid transit systems.	7
12.	To date, the monorail has been used only for single purpose and has not been adopted as a mass transit medium.	7
13.	Experience in other cities has revealed that the introduction of a rail rapid system requires an increase in the number of buses operating in order to provide an efficient feeder system to stations.	7
14.	It cannot be expected that any revolutionary form of mass transit media can be expected in the foreseeable future.	8

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15.	Even with trends throughout the world to decentralise, the central areas remain the largest single employment area.	9
16.	Maximum conflict between the pedestrian and motor vehicles exists in central areas and many cities have taken action to separate the two.	9
17.	Of the various means conc eived to avoid congestion created by motor vehicles in central areas the control of parking garages and their parking fee structures appear to be the most practical.	9
18.	A public transport system can serve efficiently only such areas where there are reasonable densities of population and large work areas.	9
19.	Transportation and land use planning must be completely integrated and ideally this should be on a metropolitan basis.	10
20.	Considerable financial aid is given by higher authorities elsewhere for the implementation of transportation plans.	10
21.	Buchanan in his report on Traffic in Towns has stressed that if society wishes to use its motor vehicle to an increasing extent then society must be prepared to pay for this choice.	11
	The Problems Confronting Johannesburg	
22.	Johannesburg, the centre of the richest region in the Republic and of a virile metropolitan area bursting with development, has the problem that all roads lead to it and particularly to its central area.	12
23.	Johannesburg has the problem of commuting movements from its twin city Soweto.	12
24.	Expenditure on development by the private sector is soaring while that of the Council is, and has been for several decades, severely restricted.	12
25.	The lack of appreciation of the city's transportation problems by higher authorities linked with a lack of finance are the greatest problems which confront Johannesburg.	12
26.	Johannesburg possesses acute deficiencies in respect of its present road system, its public transport system and its parking facilities. Man power shortage provides a real problem.	12

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27. The total population of the Study Area will increase from the 1965 figure of 1.27 million all races by 1.6 times to 2.046 million in 1985 but the vehicle growth will increase still more by a factor of 2.55 times for the Whites and 5.81 times for the non-Whites. 13

28. Vehicle trips made by Whites are expected to grow by a factor in excess of 2.5 and volumes entering the municipal area from the north has increased at an average annual growth rate of 11½%. See Table 1.2 14 & 15

29. Natural and man-made topographical features dictate the location of the corridor routes and many valuable properties will be affected. 16

30. The lowering of standards of the motorway in order to avoid properties which may be valuable now and not necessarily so in the future is unacceptable. 16.

31. The question is posed regarding Johannesburg's future whether it will be one of excessive centralisation or of planned decentralisation and the latter is accepted as the logical. 17

32. If and when decentralisation occurs the problems of movement of Bantu workers are outlined and the question is posed

(a) Where are the extra 400 000 Bantu expected by 1985 to be housed and

(b) Who will be responsible for their transportation? 18 & 19

33. Attention is drawn to the manner in which residential areas will be affected by transportation proposals and to the need for the Council to take action now for the families which will be displaced. 19 & 20

34. The metropolitan problems and the heavy burden the ratepayers of Johannesburg have to carry is a disturbing factor. 20

2. GOAL OBJECTIVE AND PRINCIPLES

35. These are of vital importance and they cannot be summarised without losing their basic quality and value. 22 - 26

3. TRANSPORTATION PLAN OPTIONS

36. Modal Split Options

There are four modal split options namely

(1) allow free modal choice or
(2) allow no modal choice or
(3) accept a modal choice between the above two or
(4) do nothing. 27

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37.	Free modal choice was virtually the situation in 1965. The continuation of this will require a vast system of motorways and arterials, huge complexes of garages and an increase of bus usage from 380 to 650 bus trips per hour.	27 & 28
38.	A rail rapid transit system could not be justified under this system.	28
39.	No modal choice would involve the restriction of the use of the motor vehicle as commuting medium to the Central Complex and only essential drivers would be permitted to enter.	28
40.	A rail rapid transit system would be justified. Without a rail rapid system the number of bus trips would have to be increased from 380 to 1 430 per hour.	29
41.	The essential driver traffic together with the commercial vehicle traffic would still be of such proportions that further motorways and improved arterial routes would have to be provided.	29
42.	This approach is too severe, will encounter opposition from the citizens and will be impossible to control.	30
43.	The restricted modal choice is a compromise between the first two modal choices, it will allow for certain optional use of the car for commuting and will just justify the introduction of a rail rapid transit system by 1985. This is the selected modal choice.	29 & 30
44.	It would be irresponsible to adopt a do nothing option as this would affect the economy of the city and the investments made to an extent that the citizens would force action.	30
45.	Highway Options There are four options available for developing the highway network of the future, all of these take into account the motorway system presently being developed.	31
46.	The option based on a major road or boulevard concept and no motorways will fragment the city to an unacceptable extent.	31 - 32
47.	The second option is a complicated extension of the present motorway system which will remain as the spine and consequently the chief traffic carrier and will be inadequate for this purpose.	32

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48. The third option involves the creation of a new motorway system with provision for public transport in its right of way to the latest standards and which will have connections to the present motorway at a limited few points. 32

49. The fourth option is that of adapting the third option to that of the corridor concept which is the selected option. See 3. 2. 1. 32

50. Public Transport Options

Public transport options are directly related to the modal split options. 32

51. In respect of rail rapid transit systems there is the choice of the options between monorail and duorail, type of track and type of wheel and location above or below ground. 33 - 34

52. Elevated structures create an environmental problem in heavily developed areas such as the centre of the city and in such areas the underground has many advantages. 33 - 34

53. Parking Options

In the parking policy options, consideration is given to the control to be exercised over the provision of parking in buildings and the parking to be provided by the Council for both long-period and short- and medium-period parking. 34 - 36

4. THE PROPOSED HIGHWAY PLAN

54. General

The restricted modal choice in respect of travel within the Central Complex has been selected as the desirable taking into account the economy of the city, possible decentralisation and flexibility beyond the design year of 1985. 37

55. The transportation plan has been designed on a peak hour estimated to be 65% of the 7 a.m. to 9 a.m. volumes. 37

56. The transportation system layout selected is to make the present motorway system a distribution system and to place transportation corridors around it. 37

57. The main elements of the plan for the design year 1985 are a system of motorways to be built in some of the corridors, a system of underground rail rapid transit lines and ancillary features such as the reconstruction of major roads, the provision of park & ride facilities, parking garages and express bus and feeder bus services. 37

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58. Natural and man-made features (Fig. 4.1) have dictated the corridor pattern (Figures 4.2 F and 4.3) but nevertheless a number of alternatives were investigated before the final system was selected and these are described (Fig. 4.2) 38

59. If nothing is done to provide relief, the capacities of the existing streets will be far below the 1985 volumes. 39

60. Even with the proposals recommended for improvement to the major road systems, capacities in certain areas will still be 5% and more below the 1985 volumes (Table 4.1). 39 & 40

61. Widths of corridors vary from 120 to 185m (400 to 600 ft) to accommodate a motorway with a wide central median for possible public transport routes or alternatively reversible lanes (Fig. 4.5). 41

Motorways

62. The standards applicable to the motorways take into account safety of movement, speed, protection of capacities and the future expansion of such capacities within the corridors. 41

63. System interchanges are 5 km (3 m) apart and interchanges to the local system 1.2 km ($\frac{3}{4}$ mile) apart. 41

64. The proposed motorways will form a box around the Central Complex. The box together with the existing motorways M1 and M2 will reduce the number of vehicles which use the surface streets in the Inner Cordon Area, Braamfontein and Hillbrow by 13000. 42

65. The motorway proposal involving an extension westwards of M2 and six new motorways M3, M4, M5, M6, M8 and M10 are described (Fig. 4.6 and Table A1 of Appendix). 42 - 45

66. The total length of the motorways is 56.8 km (35.3 miles) and the cost is estimated at R233.8 million at the prices and costs ruling in 1969. 46

Major Roads

67. Major roads are the backbone of the highway system and their capacities require to be protected by preventing large generators or attractors of traffic to abut on them. The number of cross roads need to be reduced to a minimum and service roads provided where possible. 46

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68. In Johannesburg the main arterial roads basically form a grid of about 1.5 km (1 mile) - the accepted standard for major roads. They should be designated as major roads and their rights of way increased in width to 38 m (120 C ft). (Figures 4.7, 4.8 and 4.9). 46

69. Proposals for 1985 are set out in Tables A2, A3 and A4 in the Appendix. 46

70. The estimated cost based on 1969 figures is R86.0m 46

71. There will also have to be a number of short local road improvements and these are also set out in Tables A2 - A4. 47

72. Some of the more ambitious of these are described. 47 - 53

5. PROPOSED PUBLIC TRANSPORT PLAN

73. Factors which must be taken into account in considering a rail rapid transit system are set out and the chief of these are the comfort and service to passengers. 54

The Proposed System

74. Of all the options possible that of the duo-rail with steel tyred wheels running on steel, underground in heavily developed areas has been selected. 55

75. The high density areas and the main work places inside the Central Complex are the main areas requiring service. The proposed system has taken into account the outlying areas now and in the future to be served and the outlying routes are fairly fixed. Several alternatives are possible within the Inner Cordon Area. 55

76. Two systems are to be discussed to illustrate the type of layout and the magnitude of costs but it is considered that a full feasibility study should be conducted at an early stage by experts in this field of transportation and consequently no firm recommendation is to be made. 55 & 56

77. The proposed rail rapid transit system with one possible layout in the Inner Cordon Area, is shown in Fig. 5.1 and is described in the text. 56

The 1985 System

78. The 1985 system is confined to the Central Complex with short extensions outside it. 56

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79. In the Central Complex the routes have been located as far as possible under roads and the stations are at about 900 metres (3 000 ft) centres. The tunnels are to be 3.75 metres (12.5 ft) in diameter. Stations will be at least 120 metres (400 ft) long and the marshalling yards will be at Robinson Deep. 56

80. Maximum grades of 3% upwards and 4% downwards have been adopted. Average train speeds will be nearly 4.2 km per hour (26 mph) when allowing for a 20 second stop at each station. 56

81. The system will be for the White race group only. 56

82. As mentioned there are two layouts which have been investigated for the Inner Cordon Area. The details of the first cannot be summarised and must be read in the text. Its total length is 23.6 km (14.7 miles) 57 - 61

83. Features of the proposals are the integration with park and ride garages and bus routes, the depth of the stations (due to topography) and the travel times viz. 7 minutes from Houghton Golf Course, $6\frac{1}{2}$ minutes from Parkview Golf Course, $5\frac{1}{2}$ minutes from the Rosettenville Corner, $3\frac{1}{2}$ minutes from Mayfair Station and the same time from Bertrams (Tables 5.1 & 5.2). 57 - 61

84. Passengers expected to alight in the morning peak two hours total 32 300 at the Commissioner/Harrison St station, 16 000 at the Jeppe/Von Wielligh St Station and 13 500 at Selby. 61

85. The scheme is estimated to cost R116 million at 1969 costs. 61

Alternative Layout in I.C.A.

86. The alternative is described and illustrated in Fig. 5.2. Its total length is 26.0 km (16.1 miles) and its estimated cost is R124 million. 61 - 63

Passenger Volumes

87. Basis for estimation is that 47% of the optional car drivers will be converted to public transport. 63

88. Details of the volumes are too difficult to summarise crisply and the text should be read. 63 - 64

Marshalling Yards and Inter Line Connections

89. 12 hectares (30 acres) of land will be required for this purpose at Robinson Deep. All lines will have to connect to the southern route in order to use the facility at Robinson Deep. 65

Page

Bus Feeder System

90. Fig. 5.3 shows the feeder areas draining towards the various stations. Certain buses will discharge passengers at the stations and turn around for the return trip, others will proceed to the Central Area. Outlying bus depots will require future consideration. 65

Comparison of 2 Systems

91. These are set out and require to be studied 65 - 66

Running Costs

92. No attempt has been made to estimate running costs. It is expected that fares will cover running costs but not interest and redemption of the capital costs. A guide to interest and redemption costs per passenger mile is provided in Table 5.4. If capital costs are to be redeemed from revenue it would cost approximately $16\frac{1}{2}$ cents and 13c to make the journey to the Central Area from Houghton Golf Course and Rosettenville Corner respectively. 67

Comparison With Other Cities

93. Comparisons of networks of the London Underground, the Bart scheme at San Francisco, Stockholm, Paris and Toronto are made and illustrated in Figures 5.4 and 5.5 and Table A5 in the Appendix. 67 & 68

94. The comparison reveals that stations in the centre of the city should be closer and that by 1985 the system proposed for Johannesburg is in terms of population, reasonable. 68

Interim Period 1970 - 1985

95. The factors requiring immediate action in the interim period include the problems of the existing service and certain of the termini. 68

Busways

96. Two schemes to assist bus movements on the north-western and the southern routes are described in detail and illustrated in Fig. 5.6 69

97. The north-western project envisages the use at peak hours of a lane reserved for buses only against the direction of the traffic in the one-way pairs of Melle and Biccard Sts and Sauer and Simmonds Sts. Details require to be studied in the text. 69 - 70

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98.	The southern project envisages the construction of an elevated bus route from Trojan into the Central Area terminating at the Vanderbijl terminus.	71
99.	The projects include improvements to the termini for the northern services and the southern service. For the former properties will have to be purchased in Pritchard Street (Fig. 5.8) and for the latter a deck erected over Vanderbijl Square.	71 - 73
100.	Termini for non-White services will require further study.	73 - 74

6. CAR PARKING FACILITIES

101.	Facilities in the centre of the city are required for long-period parking (all day), for medium-period parking (1 - 4 hrs) and short-period parking up to one hour for the quick purchase or business visit.	75
102.	Facilities for long-period parking need not be in the heart of the city. Medium-period and short-period facilities should be as they relate to shopping and business visits vital to the economy of the city.	75
103.	Outside the central area the provision of adequate parking is essential for all activities.	75
	Long-Period Parking Policy	
104.	Capacities of streets to handle traffic to and from parking facilities is of vital importance.	75
105.	The parking provisions of the Town Planning Scheme are not adequate in most cases and where sufficient parking is not provided in a building then a contribution of money to a parking fund should be required.	76
	Central Complex	
106.	Long-period parking is to be eventually prohibited on all streets and the Central Complex to be divided in three zones - A, B & C (Fig. 6.1).	75 & 76
107.	Basic standards adopted to be 0.7 spaces per 100 sq. metres (1 000 sq. ft) of gross office area and 0.5 spaces per 100 sq. metres of other non-residential floor area.	75
	Parking Zone A	
108.	Parking Zone A is the retail core in which the Council has already adopted the policy that there should be no further parking. Developers of new buildings should be required to pay the Council to provide this parking in terms of the standards.	76

Parking Zone B

109. Parking Zone B is the area surrounding Zone A and includes the office core. In this zone the parking spaces in a building on a site of or in excess of 1487 sq. metres (15000 sq. ft) should be equivalent to 0.5 spaces per 100 sq. metres of non-residential floor space. Where offices are included the excess of 0.2 car spaces per 100 sq. metres should be met by a cash donation to the Council to provide this space. 76 & 77

110. Where the sites are smaller than 1 487 sq. metres no parking may be provided in building and the cash contribution to the Council will apply. 77

111. Buildings with residential space must provide for 0.5 parking space per dwelling unit and for one space per two rooms for hotels. 77

Parking Zone C

112. Zone C is the outer zone of the Central Complex. Parking in buildings must be in terms of the standards for non-residential use provided the site is 1 487 sq. metres or more. Residential buildings will be required to provide parking space at the rate of one space per dwelling unit. 77

113. Where parking space is not provided to the required standard then the cash contribution factor applies. At present this works out at R1 000/parking space on the basis that the cost of land is excluded. 77 & 78

Outside The Central Complex

114. Further study is necessary but the following are some of the interim measures proposed:- For retail, 6 spaces/ 100 sq. metres (gross); offices and industries 2.0 spaces/ 100 sq. metres (gross). See Table 6.2 and 6.3. 78

Medium-period parking

115. There is a need for a clearcut short- and medium-period parking policy as the provision of these facilities are vital for the economy of the city. 79

116. Provision should be made per 100 sq. metres of floor space; 0.2 spaces for offices, 0.5 spaces for retail and 0.1 spaces for other non-residential uses. 79

117. Long-period garages are to be sited on the fringe of the I.C.A., medium-period at strategic positions within the I.C.A. and short-period at kerb side involving an extension of metered areas. Outlying park and ride garages are important features of the plan. 80

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118.	Parking spaces required, based on the standards outlined, together with the deficiencies are given in Tables 6.5 and 6.6 respectively for long-period and short-period parking.	80 - 82
119.	The parking garages are shown in Fig. 6.2 and summarised in Table A7 of the Appendix.	82
120.	The costs to erect garages in the Central Complex are estimated at R36 million and the land still to be purchased will cost R6m. Table 6.7.	83
121.	The garages are described.	84 - 88
122.	The park and ride garage facilities are estimated to cost R22.58 million.	88
123.	No recommendations are made regarding the provision of parking facilities outside the Central Complex. These will be handled in the continuing study.	89
124.	Truck loading should be on-site whenever possible and the metered areas for on-street parking should be extended.	89

7. TRAFFIC ENGINEERING, EDUCATION AND ENFORCEMENT

Traffic Control

125.	The objectives of the plan include not only alleviation of congestion and reduction of travel time but also road safety.	90

Traffic Control Devices

126.	The recommendation by the Chief Traffic Officer that investigation be made to improve the existing system of signals and the introduction of computer control is endorsed.	90
127.	Television surveillance at selected key intersections and greater use of vehicle actuated signals are recommended.	90 & 91

Regulations

128.	The design, siting and clear-message of all traffic signs is essential	91
129.	To obtain maximum use of existing facilities "No stopping" regulations must be extended both in coverage and time.	91 & 92

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130. Parking will have to be banned on most arterial roads in the Central Complex, more loading bays provided and all on-street parking in the Central Complex should be gradually converted to short-period parking and controlled by meters. 92

Enforcement

131. Ways and means must be found to overcome the manpower shortage and vigorous continuous campaigns initiated to enforce the regulations. 92

132. The need to promote a vigorous continuing campaign of educating the public in regard to their responsibilities as drivers is reiterated. 92

Traffic and Transportation Engineering

133. The transportation plan, colossal as it is, is not a static document but will be required to be expanded to meet the situation after 1985. Continuation of the studies is essential. 93

Operational Traffic Engineering Branch

134. Every possible means must be used to maintain efficient use of present and future road space. To achieve this a Traffic Engineering Branch must be established and details are provided of similar units overseas. 93

135. The Branch would be required to carry on with the collection and analysis of statistics and to initiate studies. 94

136. All plans and proposals which affect the road system initiated in the private and public sectors should be examined and approved by the Branch. 95

Public Transport Operational Traffic Engineering Section

137. The establishment of such a section in the Transport Department is recommended. 95

Continuing Transportation And Land Use Study

138. This is considered to be essential and to be handled by the Forward Planning Branch. Repeats of the original surveys on a smaller scale will have to be put in hand and analysed. 95

139. On the land use side, the eventual form of the city must be decided on, the Central Area requires particular study for the purpose of effecting improvements and eventually a Comprehensive Plan for the whole city prepared. 96.

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140. A great deal of time and money has been spent in compiling all the statistical background - this information must be continually updated. 96

8. PROGRAMME OF DEVELOPMENT

Priorities

141. It is accepted that the implementation of the plan cannot be financed from Council's resources. Negotiations for a financial formula will be protracted. Interim measures essential. 97

142. Priorities are protection of the corridors, exact definition of corridors where development pressures are greatest, a second opinion be obtained, improvement to public transport system and feasibility study of rail rapid transit, major roads and parking garages and early acquisition of land. 97

Estimates

143. Costs are based on present day prices, expected average annual increase of approximately 6% in costs and estimated costs will double in 12 years. 98 & 99

9. FINANCE

144. Summary Of Capital Requirements.

Facilities Not Financially Self-Supporting

Highways :	Motorways	233.8m	
	Major Roads	86.0m	
	Traffic Engineering	5.0m	R324.8m
Public Transport :	Rail Rapid	124.0m	
	Interim Measures	5.7m	R129.7m
Total Capital Cost (Not self-supporting)			R454.5m

Facilities Financially Self-Supporting

Parking Garages :	Central Complex	42.0m	
	Park & Ride	22.6m	R 64.6m
Total Capital Cost (Self-Supporting)			R 64.6m

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145.	The section dealing with present financial facilities still has to be completed.	103
	Recommendations Of Various Commissions	
146.	The Borckenhagen Committee recommended briefly that higher authorities would contribute 50% of the costs of highways, that the Transvaal Province would retain all licence fees and Johannesburg would keep vehicle registration fees and should consider rates on buildings. This of no real value to Johannesburg.	104
147.	The findings of the Schuman Committee have not yet been published.	104
148.	The Marais Commission recommended that the present contribution to the National Road Fund should be substantially increased and that large expenditures and bold thinking should be embarked on. Expenditure on road building should keep pace with growth of national economy and mass transit studies should be put in hand. Decisions from the Government are awaited.	104 & 105
	Financial Requirements	
149.	Highways: Require an annual expenditure of R21.32m on 1969 prices. Additional sources of revenue which will increase annually are necessary and should be derived from highway users.	105
150.	Public Transport: Is revenue producing but this is limited to covering running costs if fares are to be kept low. Requires an annual expenditure of R9m. Loan funds could be entertained provided interest and redemption can be obtained from additional sources of revenue. Interim measures require R0.63m per annum.	105 & 106
151.	Parking Garages : Are revenue producing and can be financed from this source. Consideration should be given to the establishment of a parking authority to overcome loan problems.	106
	Possible Sources of Revenue	
152.	An annual revenue of R21.95m will be necessary for period 1970 - 1975 and this will increase to R30.6m in 1985.	106
153.	Rates: An increase of 1c in the rand will bring in R5.8m per annum approximately. It is likely that an increase of up to 1.5c in the rand will be necessary by 1985 and the increases could be staged. This increase should be used to finance the rail rapid transit system.	106 & 107

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154. Parking Fees. The first call would be to finance the parking garages. An increase in fees is overdue but it is unlikely that revenue from this source can assist other projects. 107

155. Loans are a first class way of financing projects provided revenue is available to redeem such loans. 107

156. Subsidies are out in terms of present Government policy and even if the policy is reversed the Government would require to raise the money from road users. 108

157. Road Tolls seldom occur in urban areas except where expensive bridges and tunnels are erected and toll collection points planned and erected. They are not considered to be feasible. 108

158. Petrol Tax is at present 13c of which 6c is allocated to the National Road Fund. An increase in the tax would mean that the road user would pay for the facilities. It is estimated that a 2c increase if allocated to Johannesburg would bring in R2m. More could be obtained if a realistic formula was to be applied. 109

159. Vehicle Licences. It is estimated that Johannesburg will collect about R1. 3m of the R6. 1m paid for licences in 1969/70 financial year. Licences are increasing at 6% per annum. If licence fees were to be doubled and the additional money allocated to Johannesburg approximately R6m would accrue in this way. If a straight R40 was added to licence fees then R11m would accrue to the Council. 109

160. Vehicle Registration. The amount is negligible and this source is discarded. 110

161. Motor Vehicle Purchase Tax. An additional 5% tax on the purchase price of all vehicles would bring in about R3. 5m per year. 110

162. General Purchase Tax. This should not be considered. 110

163. Local Income Tax. An imposition of this tax would catch the people living outside the city who use the Council's facilities for getting to work. If an average of R10 per year per working person was to be levied some R2m would accrue of which R1m would be for highways. 110 & 111

164. Direct Road Pricing is still a conception and is unlikely to work. 111

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165. The proposed sources of revenue for meeting the annual costs of R31.7m per year are summarised on Page 112. 112

166. It is estimated that the White population under existing prices will spend about R3 200 m on their cars in the next 15 years. The proposed highway projects will require R320m in the same period or 10%. 113.

167. With the proposed licence fee and petrol tax increases the average motorist would pay about R118 per year in taxes. In Britain the average motorist pays about R190. 113

168. The above proposals are all dependent on Central Government or Provincial Government approval. 113.

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TRANSPORTATION PLAN

1. INTRODUCTION

1.1 Current World Thinking On Transportation Systems

1.1.1 The dilemma of cities

Cities are for people! A statement which at the beginning of the 20th Century could well be true. Citizens in that era could expect a full and satisfying life of participation in social, cultural and recreational activities in addition to those of normal living and working. Today, and in fact for the past three or four decades, philosophers, and others as well, are wondering whether cities are for motor vehicles or for people. Man has created a tool which may well become his master in most of his activities.

"Crisis planning" is a much used planning term. It is very apt, because a study of past planning action in most of the cities of the world reveals that in general this action has occurred only when circumstances have reached critical proportions and became intolerable to all sections of the people and to all levels of government.

Cities are faced with the dilemma of an ageing urban area with a road system designed for a past era. Around their boundaries are to be found mushrooming urban areas containing the homes of the upper income classes who are mainly multi car owners requiring the city to provide them with the means to travel by car from their areas of residence to their places of work and pleasure within the cities. These problems confronting cities have been appreciated by enlightened higher government levels overseas and a regional or metropolitan approach to the transportation problems is the rule rather than the exception.

The problem confronting Johannesburg today is whether to allow the crisis to develop or to take action to the cost of its ratepayers from which they will reap only partial benefit. The question can well be asked "can a satisfactory solution ever be achieved?". No city in the world has found a solution. Exploding populations and car ownership are far outstripping the efforts of public authorities no matter how resourcefully they are tackling the problems.

On the other hand no responsible authority in this modern age can contemplate sitting back and letting matters get so out of hand that even an alleviation of the mounting problems let alone a solution becomes eventually humanly and financially impossible.

The current thinking is to be discussed broadly and briefly under five main headings namely:-

The desires of the people
Road networks and parking
Public transport
Land use and related factors
Financial issues.

1.1.2 The desires of the people

Theoretically it is the people who should establish their objectives or goals for their city. It is their responsibility through their actions, their participation and their votes to ensure that action is taken to achieve these objectives. However, it is only in recent decades that Central and State Governments throughout the world have not been dominated by rural-elected representatives and the affairs of the cities have consequently suffered.

The citizens of the United States of America with a high standard of living have chosen a car-oriented way of life and have been prepared to pay for it. In Europe with lower standards of living the emphasis has been on efficient and convenient public transport systems.

In the Republic of South Africa an increasing proportion of the citizens through their actions are following the American pattern of requiring the motor car to be their principal mode of travel. Others, on the other hand, are clamouring for a more efficient public transport system.

Citizens, however, cannot be expected to appreciate the enormity of the problems they are creating through their desires and demands. It becomes the task of the planners through study, research and projections into the future to indicate the problems that will have to be confronted, the steps to be taken to meet these problems, the financial implications involved and the upheavals that will be caused to environments throughout the city by the implementation of the projects. It is at this stage that public participation is of such vital importance. In America where citizens are required to vote to permit the local authority to raise money for major projects, their desires can be freely ventilated.

For the majority of car owners, costs to a certain level and a degree of congestion are of secondary importance. They resist the possibility of changing to public transport and it is only when costs and congestion become intolerable that they are prepared to consider a change of mode. This state of affairs is now occurring in America, despite the inherent desire to use the automobile. Citizens are demanding more efficient public transport systems including mass transit media to which are integrated "Park 'n Ride", "Kiss 'n Ride", and "Bus 'n Ride" facilities. Transport authorities both in America and elsewhere are now ensuring that their projects cover a co-ordinated system of motorways, major streets, collector streets and efficient public transport systems.

It can be accepted that motorways do not obviate the need for public transit and conversely an efficient public transit system does not obviate the need for motorways. Both are necessary to serve all the functions of a growing city.

People today are demanding high standards for their travel. The motor car provides the ideal of comfort, convenience and virtually a door to door service. A public transport system must attempt to reach this standard as closely as possible if people are to change their mode of travel from the motor car.

Unacceptable restrictions on the use of the private car linked even with subsidization of fares cannot effect a change of mode unless there is efficiency and comfort in the journey by public transport.

People are largely fickle, self-centred and lazy and there can never be certainty that an attractive public transport service will receive the support it deserves. This is illustrated by a recent poll in Los Angeles, the most car oriented city in America, where there was an overwhelming vote in favour of the construction of an underground system. A subsequent probe of those who voted in favour revealed that they had done so in hope that the neighbours would use the underground in preference to their cars and thus give the voter a freer journey to his destination - by car.

It is apparent that the desires of the private car owners must be balanced against the desires of others and also considered in terms of what is feasible or desirable for the whole city. It is doubtful whether the desires of the people of the Greater Johannesburg Area are any different from those in comparable cities in other parts of the world.

1.1.3 The road network and parking

This section of the report will cover only matters affecting motorways, the main arterials and parking.

(a) Urban motorway system

The accepted purpose of an urban motorway system is to provide safe, rapid and orderly movement of traffic throughout the urban area. Traffic includes not only movements by private motor cars but also trips by commercial vehicles so vital for the economy of the area. In providing this service the system relieves the traffic on arterial and local roads which would otherwise become hopelessly congested. A motorway system by itself has not been accepted anywhere as providing the ultimate solution to traffic problems.

The misguided expectation that motorways would provide the complete solution is one of the reasons why they have become the subject of criticism. It is significant however, that in America, despite the admission of certain mistakes, most cities are pressing forward with vigorous programmes for the establishment of urban motorway networks.

Outside of America, most cities with a high standard of car ownership are, after detailed study, following the same course of action.

As yet, no alternative proposals, not even the "boulevard" concept expressed in the Republic, measure up to the efficiency of the motor-way system.

Motorway design standards have been increasing with time. In the early sixties, design speeds for urban motorways were 50 mph in the heart of the city, 60 mph a little further out as development became less intense and then finally 70 mph. This gradation permitted fairly compact interchanges in the heavily developed areas and gradually more spacious interchanges further out.

The present recommendations are that the design speed must be 70 mph throughout and consequently interchanges, even close in, must be designed with this overall speed in mind, thus resulting in large land requirements. Also to maintain smooth operation at high volumes, the desirable distances between interchanges have been increased. Ancillary lanes and collector-distributor roads of varying degrees of access control become necessary, resulting in greater difficulty in serving the ordinary street systems and requiring considerable widths of rights of way.

While it has been proved essential from the aspects of safety, smoothness of operation and the ability to carry extra high volume loads safely, that these higher design standards are necessary, motorways would appear to be getting outside the city scale and an intrusion on the environment.

However, if motorways are to be used in the transportation plan, and the alternatives are many more higher accident prone, ordinary major roads requiring more land because of their greater number than the motorways they replace, the motorways must be designed to the latest standards.

It should not be accepted, however, that transportation authorities, not only outside America, but also within, are following blindly the accepted American practice in regard to Motorways. Professor Kain of Harvard University, at the recent International Conference in Toronto, expressed the view that not enough use was being made of existing facilities both arterial and motorway, for all forms of transport. He considered that public transport (express buses and other transit facilities) should be permitted on the motorways. There is justification too, in other criticisms that standards are being raised to the extent that the urban motorways are becoming isolated and that there are too few links both onto and off the motorways into the arterial systems. Further criticisms are in regard to the effect the motorway systems have on the urban environment and there is now a strong move not only related to landscaping but in the use of space above and below selected lengths of motorways to achieve a continuity of the existing development on either side.

Current research in America has revealed that movement patterns in most cities bear a similar relationship. It is apparent that a grid of transportation corridors catering for motorways and mass transit facilities can accommodate a large proportion of the movements. The grid comprises corridors running east to west and north to south at three to four mile intervals with interchange facilities. The conception envisages the definition of these corridors even though they are not required to be developed immediately and makes provision for their protection. The corridors vary in width from 400 to 600 ft. The protection envisaged is tantamount to the freezing of high-cost development in such areas pending the eventual taking of the land for the construction of the motorway. Legislation to ensure this protection is an essential tool.

The Corridor concept is a great step forward in transportation planning as the pattern serves the movements which will develop should decentralisation occur in addition to serving movements to centralised work places. Complete details of the research are awaited with interest.

(b) Arterial routes

It is accepted practice in preparing a transportation plan that the network of arterial routes require to be studied in detail and to be co-ordinated with the motorway system and public transport facilities. With the growth of a city most arterials have formed a radial pattern with the centre of the city. The development of motorways creates additional lateral movements to points of access to the motorways. These lateral movements are further increased if movements are to be made to stations of an underground system.

It will be found that all transportation plans feature the development of an efficient arterial system in addition to the motorway project. It will also be appreciated that buses, in order to provide a service close to places of residence and work, require to use an efficient arterial and major street system.

Motorways and major roads must be planned for anticipated traffic volumes 20 years ahead but the transportation corridors must protect the right of way for facilities to come after this period. There is no evidence to show that these corridors or in fact the motorways or the major roads will become redundant through change in technology. A change in the technology of transportation will almost certainly come but it will not be overnight thus there is no fear that well designed motorways and major roads will not serve their full economic value. However, with wide safeguarded corridors, future transportation engineers will have flexibility to cater for the inevitable change of technology. If these corridors are not protected, the continual inevitable pressures for land development and urban expansion can prevent the finding, at reasonable cost and minimum disruption, rights of way for the future transportation facilities, whether there is a change of technology or not. By setting aside and protecting wide corridors now, it is possible to form the city in homogeneous areas and future facilities will not cause deterioration of the environment.

(c) Parking

In this section the trends regarding parking in central areas and of the provision of parking related to transit systems will be discussed.

It is common knowledge that central areas cannot contain the motor vehicles of all the people who desire to use them, neither can the street systems cope with the movements. Authorities throughout the world are being forced into taking strong action to curb the amount of parking facilities being made available to the public in both private and public garages.

The purpose for which private cars enter the central areas can be classified as follows:-

(i) for business purposes by a person operating from a business in the Central Area.
(ii) for business purposes by a person making a business call from his business outside the Central Area.
(iii) for shopping purposes.
(iv) for commuting purposes.

Up to the 1930's, railway services, on surface and underground, supplemented by tram and bus services, were the major means for transporting people. Larger populations living in an urban sprawl around the older cities and increases in car ownership were two factors instrumental in the decline of patronage. Universally public transport services have suffered in the same way and most have operated for a long time in the red.

Difficulties in movement in cities, however, have reached an impossible level and a large number of cities are now reviving or developing mass transportation facilities. Wherever possible, action has been taken to improve bus services by means of busways, either on special routes or in independent rights of way in the motorway systems, but the most significant move has been to implement underground transit systems. Since World War II underground railway projects have been constructed by Montreal and Toronto in Canada, Cleveland in the States, Stockholm, Leningrad, Lisbon and Oslo in Europe and Nagoya in Japan. A number of cities are presently constructing underground systems. The largest and most expensive being the Bart project in San Francisco. In Germany, underground projects are under way at Munich, Frankfurt and 9 other cities, in Holland at Rotterdam. A number of other cities in Europe are planning underground systems and a table giving details of existing underground systems is to be found in the Appendix of this report.

The introduction of an underground system does not alleviate the need for an efficient public bus service. In Toronto and Montreal the outlying bus services are rerouted to the nearest underground stations where the interchange between bus and railway takes place in efficient and modern combined railway and bus stations. Hamburg has a similar integrated system of bus and underground service. The Bart scheme in San Francisco is being planned similarly.

The linking of bus routes to underground systems overcomes the problems of low densities within the immediate vicinity of the underground system. The provision of "Park 'n Ride" facilities as well at these stations, assists further the problems of serving low density areas by an underground system.

To date, Japan is the only country to have installed two monorail routes. The word "routes" is used advisedly as they are single purpose and do not form part of a mass transit monorail system. While the possibilities of a monorail system cannot be entirely discarded, neither France nor Germany the principal manufacturers of the monorails, have accepted their product as providing an efficient mass transit medium.

Considerable research is being conducted throughout the world into alternative forms of mass transit media. In Pittsburg, U.S.A., the Westinghouse group is experimenting with a duo-rail project travelling on an elevated structure similar to that of a monorail. In France there is considerable activity with a project known as the Aerotrain. It has proved itself in the experimental stage as a possible fact inter-urban means of transport but its speed is a possible detriment to its use as an intra-urban means of transport. Other schemes such as moving platforms, mini-electrically driven and computer controlled cars, which can be formed into trains are still conceptions.

Provision of parking for the first three categories is the most important in the interests of economic viability of a city.

London has adopted a policy of restricting almost entirely the provision of parking facilities in private buildings in its core areas. Public garages are provided on the fringe and more generous provisions are permitted in private buildings outside the core.

Dallas in the United States with a population approximately that of Johannesburg in its recent plan for its Central Business District (CBD) proposes a circle of garages close to its core with an outer circle on the outskirts of the CBD which will be constructed afterwards. These latter garages tie into the freeway loop and link to the core by a proposed rail transit system.

Paris on the other hand is constructing massive garages under certain of its boulevards in the heart of the city.

Pricing of parking facilities in central area garages have been framed to cater for the purposes for which they have been designed. Those serving retail cores are priced to the advantage of the short-term parker (the shopper) and to the disdavantage of the all day parker. Garages in the immediate vicinity of office cores are similarly priced in order to have available facilities for the visiting businessman to the area. Facilities for all day parkers are provided in the fringe garages.

Many cities levy a very high charge for all-day parkers in order to discourage the use of the motor car for commuting purposes. Even without that as the main purpose it must be appreciated that garages in the central area occupy valuable land and are costly to erect. Parking fees throughout the world are very high compared with those charged in public garages in Johannesburg and a review of the parking fees here is long overdue.

The Toronto Metropolitan Authority and several cities in America have established or are considering establishing Special Parking Authorities with the power to control all parking in the central areas, both private and public, and to provide such additional public facilities as it deems necessary.

Frequent references have been made to the "Park 'n Ride" facilities provided in conjunction with mass transit facilities. These may take the form of open lots at railway or underground stations with capacities of up to 2 000 cars or alternatively of parking garages forming part of the station complex. Facilities have also been tried out in Britain at bus terminals but as yet have not been altogether successful. The trends, however, are already appearing in Johannesburg and with improved bus services may increase. Durban operates a small but efficient "Park 'n Ride" facility served by mini-buses some $1\frac{1}{2}$ miles from the city centre.

1.1.4 Public transport

During this century the public transport systems have enjoyed periods of booms and deep depression and now the trends appear to point to a degree of hope that they may come into their own but unfortunately due to rising costs, not as a viable proposition.

In general it cannot be expected in the foreseeable future to expect any revolutionary form of mass transit media. This statement was endorsed at the Toronto Conference in 1967.

1.1.5 Land use and related factors

The central areas of cities are the focus of the major land use and transportation problems. In nearly all the cities of the world with the possible exception of Los Angeles the central areas are the major single centres of employment, they remain the shopping hub of the cities and they provide facilities for social, cultural and entertainment activities; they contain government offices at all levels and historically they provide a meeting place for citizens from all walks of life. Despite a weakening due to urban sprawl and decentralisation, the centres maintain a strong vitality.

Central areas are fundamentally areas of concentrated pedestrian movement. In this modern age they have become areas of extreme conflict between pedestrian and vehicle movements. This conflict has reached such proportions in most cities that urgent remedial action has become necessary.

Montreal has probably led the field in this regard with its vast network of underground pedestrian ways lined with shops linking key areas and the underground stations. Toronto and Dallas are following suit, while in London the Barbican and Piccadilly schemes make provision for overhead pedestrian movements. Other schemes in Europe are the Bull Ring, Birmingham; the Lijnbaan, Rotterdam; the Hötorg, Stockholm, while other cities have closed main shopping streets to vehicular traffic.

Theoretically a transport plan should contain provisions denying vehicular movements across the central axes of the core. Practically, this proves virtually impossible to achieve. Nevertheless, the target should be to provide greater amenity to the pedestrian and less convenience to the motor vehicle.

Some 40 years ago the American cities experienced the same boom in central area development as Johannesburg is enjoying today. If anything, due to the very high floor space permitted, there was over-development. Then followed a period of congestion, stagnation and depression. Property values dropped, decentralisation either took place or was being contemplated to a considerable degree (Pittsburg). It was only at this stage that the private sector disturbed at the falling value of its investments decided to take an active part in the rehabilitation and redevelopment of the central area.

The redevelopment and revival of central areas was linked with the introduction of motorway projects. Considerable success was initially achieved but this was temporary and congested conditions again prevailed. The stage has been reached now where the authorities in America are turning to improved or new public transit systems in an attempt to alleviate the situation.

Johannesburg can learn from this - to accept the establishment of an efficient public transit system as its first priority and to maintain a balance by extending its motorway project.

In Sydney the traffic plan is alleged to have attracted more traffic into the central area. The improved traffic light system with T. V. control has resulted (it is stated) in the city "being turned over to wheeled traffic" and that city walking times have been doubled and pedestrians "hunted off the streets". If true, this is a state of affairs which must be avoided at all costs.

A considerable amount of thinking has been done overseas to ways and means of controlling congestion in and around the city centres by direct regulations or by pricing.

In the realms of direct regulation the proposal is to prevent all private cars from entering the city centre. These private cars that must enter it must get exemption permits. Stockholm, in particular was considering this approach but the difficulties appear to be insurmountable.

In the road pricing approach to congestion control, economic principles are applied in order to make a driver pay for the cost of the congestion he inflicts on other drivers. The theory being "that traffic flow will tend to stabilize at the level at which the costs of road use to those who find it just worthwhile to join the traffic equal the benefits obtained by them from their journeys". [1] In order to make this a practical proposition various ways of paying for the use of congested roads have been considered. One method suggested is the fitting of charged meters in cars and these meters are discharged by electronic impulses at a rate proportional to the state of congestion on the road. Thus the more congested the road, the quicker the meter discharges and the more frequently the driver must pay to have it recharged. As yet no such system has been introduced.

At present the only practical way of controlling congestion, and then only in a limited way, is by the control of parking garages and their price structures.

The larger cities of the world have accepted that planned decentralisation of central city activities is essential. Paris in its regional scheme is busy establishing such centres at points linked to its transit system. This is the general policy on the Continent while London is attempting to achieve the same ends by providing incentives.

In America, where control of land use has not been as efficient as its ability to plan and construct highway projects, industries, shopping centres and to a lesser extent offices, have decentralized to sites adjoining highway systems and particularly to areas close to places of entry and exit from such systems. This decentralization has in general occurred well outside the established urban areas and is virtually uncontrolled. The developments near the Boston By Pass and the route from Toronto to the Niagra Falls are classic examples. Decentralization of this nature means that service by public transport becomes impossible and workers and shoppers rely almost entirely on the motor car for their trips.

A public transport system can serve efficiently only such areas where there are reasonable densities of population and large work areas.

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1. "Paying for Roads" by G. Roth p. 34

It is an accepted principle that initially the existing land use pattern determines the framework of the transportation plan and thereafter the transportation plan and its extensions must determine the future land use plan. The comprehensive plan for Stockholm serves as a model in this regard. It is a practical implementation of the famous "Finger Plan" of Copenhagen. Growth point comprising shops and offices are related to the stations of the underground system with high density residential development within 800 metres of the station and lower densities further away. The highway system provides for lateral movements in addition to radial routes to the Central Area. Decentralized industrial work areas are strategically located relative to the residential areas and the underground.

A transportation plan for a city is affected by the land use patterns and particularly by changes in the pattern in the metropolitan region surrounding it. Ideally, the transportation plan and the land use control should be implemented on a metropolitan basis.

1.1.6 Financial issues

Representatives from 40 cities were represented at the Toronto Conference in 1967. The major cities on the American continent, in Europe on either side of the Iron Curtain, Asia and Africa (Ibadan and Johannesburg) were represented. Common ground was found by all in regard to the paucity of funds available to the lowest forms of government - local and metropolitan.

With their taxing and trading revenues very much circumscribed by higher authorities, none could face up to the globular sums for dynamic action to solve urgent problems.

A number of Central Governments, realising the position, had taken active steps to provide finance in the form of grants and subsidies to assist the cities in their transportation problems.

It is not possible to detail the full extent of such assistance, but the following are known details:

Mass transit (Underground railways & tramways) *

Federal Republic Germany	:	Federal Republic 50%
	:	States 25%
	:	Local Authorities 20 - 25%
Belgium	:	Up to 100%
Britain	:	Up to 75%
Sweden	:	Up to 90%
Spain	:	Up to 100%
France	:	Up to 50% the District of Paris Region (a supreme regional authority) the remaining 50%
Netherlands	:	An annual amount equivalent to R12 million
United States	:	A globular amount each year.

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* Mr B.C. Floor, Transport Research Centre, Stellenbosch.

1.1.7 Motorways and arterial systems

United States	:	All major motorway schemes and the main arterials passing through the cities which connect to the State net work are financed wholly by the Federal Government and/or the State and local authorities carry no costs. Subsidies and grants in respect of other roads.
Britain	:	The government finances 75% of the costs of approved motorway projects.
The Continent	:	It does not appear that a fixed policy exists in the continental countries. The Central Governments, however, allocate varying proportion of taxes of fuel and on vehicles for urban motorways. Government and State loans are also available.

There is a growing opinion throughout the world, and this was expressed at the Toronto Conference, that the vehicle owner, if he wishes to make free use of his vehicle, must be prepared to pay for the facilities which provide him with this freedom.

In America users of vehicles contribute to the costs of certain projects by paying tolls. In general this applies mainly to certain State highways, to costly bridges and tunnels but seldom to the urban motorways.

Buchanan in his report on Traffic in Towns, has the following in his General Conclusions:

> " A Question of investment.
>
> 444. The broad message of our report is that there are absolute limits to the amount of traffic that can be accepted in towns, depending upon their size and density, but up to those limits, provided a civilised environment is to be retained or created, the level of vehicular accessibility a town can have depends on its readiness to accept and pay for the physical changes required. The choice is society's. But it will not be sensible, nor indeed for long be possible, for society to go on investing apparently unlimited sums in the purchase and running of motor vehicles without investing equivalent sums in the proper accommodation of the traffic that results. It is true that there are many other claims on material resources, but it is a weak argument to say the needs of traffic cannot be met, seeing that it is a problem we are continuously creating by our extreme readiness to invest in motor vehicles. There seems to be an issue here which society must face, for at present the two investments are getting further and further apart. All the indications are that to deal adequately with traffic in towns will require works and expenditure on a scale not yet contemplated."

He indicates that in 1952 business and private consumers invested £280 million in motor vehicles while public authorities invested only R10 million in roads. In 1961 the capital investments were £900 million, while the investment in public roads was only £100 million. His point is well made.

1.2 The Problems Confronting Johannesburg

1.2.1 General

Johannesburg, the centre of the richest region in the Republic and of a virile metropolitan area bursting with development has the problem that all roads lead to it - not so much to its general area but specifically to its central area. As things are now, Johannesburg stands on its own in meeting these problems.

It also has the problem that it is a twin city - Johannesburg proper, dominantly White and containing the major work centres and Soweto, a Bantu dormitory, numerically larger in population but relatively poor. With their respective centres some 12 miles apart the commuting problems between the cities are becoming increasingly acute.

While the private sector is spending globular sums of money on the development of huge projects throughout the city, the Council is being restricted in its expenditure on essential services by edicts from the Central Treasury and a shortage of revenue. The provision of these services is falling further behind the requirements set by the tempo of development. This phenomenal development has resulted in an escalation of land and property values, a factor which will seriously prejudice the opportunity to implement a comprehensive transportation plan. The flat refusal of the Central Government to provide any further financial aid for motorways in cities does not offer much encouragement for the implementation of future projects.

The lack of appreciation of the city's transportation problems by higher authorities linked with a lack of finance are the greatest problems which confront Johannesburg.

Johannesburg possesses acute deficiencies in respect of its present road system, its public transport system and its parking facilities. It has to meet the problem of an exploding population and a still greater rate of growth in car ownership. It has the problems of natural and man-made topographical features and it faces the dilemma of whether its future is to be one of centralised business and commercial activities or whether a decentralisation will seriously affect its vitality, structure and economy. The possibility of decentralisation on a large scale requires its Transportation Plan to be tailored to take care of this eventuality.

It has its problems in regard to its surrounding metropolitan area and it has to consider the effect that any new facilities designed to meet the transportation problems will have on the environment of residential areas and the pattern of shopping centres.

In grappling with these problems the Johannesburg City Council faces the problem of a man power shortage. This applies throughout its service. In the transportation field however, much can be achieved if there is an adequate staff to ensure that there is strict enforcement of traffic regulations and if there is a full running staff to run its fleet of buses and sufficient artisans to repair and maintain them. Unless legislation is amended to permit the employment of non-whites in these fields, the immediate future holds little hope of any chance of success in coping with the problems.

1.2.2 Transportation deficiencies

In the first volume of this report the growth of traffic on the existing road system was analysed and the 1985 journeys and car ownership predicted from population and employment estimates. Some of these results are highlighted in Tables 1.1 and 1.2

TABLE 1;1 : - 1965 - 1985 GROWTH IN SUMMARY

	1965	1985	Growth Factor
Population[1.]			
Whites	450 000	724 000	1.61
Bantu	726 000	1 137 000	1.57
Coloureds	69 000	133 000	1.93
Asiatics	32 000	52 000	1.63
Total	1 277 000	2 046 000	1.60
Employment[2.]			
Whites : Central Complex	150 000	262 300	1.75
Study Area	220 000	359 200	1.63
Non-Whites:			
Central Complex	120 200	176 100	1.46
Study Area	192 400	301 700	1.57
Person Trips[3.]			
Whites	466 400	1 181 400	2.53
Cars[4.]			
Whites	130 900	333 500	2.55
Non-Whites	13 000	75 500	5.81

1. Table 6.1 Volume 1
2. Tables 6.5, 6.6, 6.7 Volume 1
3. Table 7.11 Volume 1
4. Table 7.5 Volume 1

TABLE 1.2 : PAST VEHICLE VOLUME GROWTH

	Average Annual Growth Rate
Inner Cordon Area[1]	
Volume entering 7 - 9 a.m.	5%
Volume leaving 7 - 9 a.m.	8½%
Municipal Area[2]	
Volume entering on north 7 - 9 a.m.	11½%
At Key Counting Stations[3]	
7 - 9 a.m. city-bound volume on:	
Jan Smuts Ave	6%
Louis Botha Ave	3½%
Jules Street	6%
Eloff St Ext.	4½%
North screenline	
South bound volume 7 - 9 a.m.	6%

1. Table 4.1 Volume 1
2. Section 4.2.3 Volume 1
3. Table 4.3 Volume 1

It will be noted that the study area population and employment will grow by about 60% but that the White employment in the Central Complex will grow by 75%. Car ownership among the Whites is expected to grow by a factor of about 2.6 while for non-Whites the factor is expected to be 5.8. This rapid growth in car ownership will make the number of person trips grow faster than the growth of population or employment. Trips made by White persons are expected to grow by a factor of about 2.5. The growth of car travel is expected to exceed this factor.

This large growth in person trips cannot be handled by the existing transportation facilities which, in and around the Central Complex, are already heavily overloaded by present day volumes.

The deficiencies in highway capacities in and around the Central Complex are obvious to all road users by the traffic congestion and resulting delays. In volume one of this report it was shown that traffic volumes on the various cordons and screenlines have been increasing between 3½% and 11½% per year. The traffic facts summarised above show that vehicular traffic must increase appreciably. The increase of 11½% per annum from Randburg and

Sandton, the highest of all, is indicative of the burden which the city is forced to bear.

The period of severe congestion has been increasing gradually over the years and while it is still short compared with some overseas cities if nothing is done the congestion will become intolerable. The present motorway system, when complete, will relieve the Central Complex of a considerable volume of through traffic and will assist by providing a better distribution of traffic. However, with the growth rates predicted this extra capacity will soon be fully used.

In volume one of this report it was shown that the accident rate in Johannesburg was extremely high compared with other countries. With the growth of traffic predicted by the studies numerous high quality facilities will have to be constructed to reduce this alarming accident rate.

In the control of congestion, the safe movement of traffic and the reduction of accidents, an adequate traffic inspectorate is essential. The Traffic Department is having great difficulty of getting sufficient manpower for present day needs, so with the predicted growths the position must be viewed with great concern.

Deficiencies in parking space have become severe in recent years. The municipal parking facilities catering for the long period parker are now full shortly after 8 a.m. while even the garages designed for the short period parker are full by 8.30 a.m. This lack of parking capacity particularly for short period parking has a harmful effect on the daily functioning of the central area. Valuable time and money is wasted by businessmen and shoppers circulating around in their cars searching for a parking space. Not only is there this wastage but it also adds to the congestion in the streets. Unless action is taken in this regard the lack of parking capacity can cause a weakening of the central area.

The public transport system is suffering from acute manpower shortages and is thus not able to provide a full service. This in turn forces additional people to use their cars causing greater congestion which again delays the buses thus requiring more buses and crews to provide the necessary trips.

To handle the transportation growth predicted, public transport must carry a very considerably increased number of passengers so here again the inability to recruit and maintain an adequate running staff is most alarming. The only solution would appear to be the employment of non-white personnel.

A further undesirable feature of the public transport scene is the on-street terminals. These terminals make use of Johannesburg's notoriously narrow sidewalks consequently there is excessive pedestrian congestion almost every afternoon.

Another disturbing feature of the public transport system is the extreme overloading of trains carrying non-Whites to and from the Soweto area. This extreme discomfort and long travelling time results in a decrease in efficiency of the worker and will also result in

an increase in car usage by non-Whites for the journey to work. This again will have a detrimental effect on the road system and on the parking facilities.

To overcome the above deficiencies the construction of a large number of transportation facilities will be required. These facilities are going to cost a great deal of money and require large tracts of land. Unfortunately the natural physical characteristics of Johannesburg are such that they dictate to a large degree the location of transportation routes. Thus, although due regard is paid to existing and known proposed development, many valuable properties, privately and publicly owned, will be affected. The temptations to relocate major transportation routes by reducing standards in order to avoid buildings or properties that are important today but may be redeveloped in the future, must be resisted. This relocation can result in a facility that is permanently difficult and unsafe in operation and will cost the community more in the long term.

1.2.3 Topographical

The Central Complex, the main work centre of the city, comprises the central area with its shopping and office cores and the surrounding industrial work centres. Immediately to the north of the Central Complex is the double series of steep ridges of the Witwatersrand running from east to west. There are only a limited number of poorts through this range and these are already occupied by main arterial roads. This factor makes the provision of further motorways and arterial routes a most difficult task.

The steep grades of the ridge will also require an underground system to be at considerable depth in its general area.

Immediately to the south of the central area is the reef outcrop running from east to west across the whole study area with the wide belt of mining land immediately to the south of that again. The immediate vicinity of the outcrop provides problems in regard to the shallow undermining but these problems reduce but do not disappear further away.

The large belt of mining land contains man-made slimes dams and sand dumps, together with the Rand Mineral Railway line. These features bedevil the planning of communications both north-south and east-west.

Communications to the east and west of the central area are limited to the valleys running between the steep ridges and are further restricted by the railway line and the mining land. The main railway line which runs in a general east-west direction through the central area, has been lowered below ground level in its central section and this adds to the complexities of planning an underground route.

All these features have dictated the arterial pattern of communications in the past and restrict the freedom of planning for the future. This freedom is further reduced by the fact that the Central Complex and its surrounding area is almost 100% developed with costly buildings.

1.2.4 Centralisation vs Decentralisation : General

Johannesburg is presently undergoing an intensive redevelopment of its central area. As stated previously, this is a process which most of the American cities experienced before World War II. Other than New York, these cities experienced a decline in central city activities and a certain amount of decentralisation in the post-war period sparked off mainly by problems of congestion in the central area. In many cities massive redevelopment programmes linked with development of efficient transportation facilities have been undertaken to meet the demands of the business and commercial sectors for a revitalisation of the central areas.

Which way will Johannesburg go? Will it follow the pattern of New York with only minor declines of sections of its central area, or will it suffer a major decline?

The trends all point to the fact that Johannesburg, like all the large financial and commercial cities in the world, will continue to redevelop its central area despite the problems of congestion and difficulty of movement. Certainly within the period to 1985 the projections for the increase in floor space in the central area are likely to be realized.

Projects under construction or being planned at present will add at least 10 million sq ft of office space of the 16 million sq. ft increase expected by 1985. Projects under construction include the Carlton Centre and the Standard and Trust Bank buildings. Large projects being planned are the Messina development, south of Hollard Street, the schemes to the west of the Magistrates courts, the Sorec development near the power station, the brewery site in Braamfontein, the Sorec Civic Hills development near the Civic Centre and that of Rapp & Maister in the same vicinity and finally the large development immediately to the east of the Law Courts.

This huge investment in the central area is more likely to lead to demands by the private sector for action to alleviate congestion than to spark off a massive decentralisation of offices.

This does not mean that there will not be fairly extensive decentralisation of offices. The movement is already afoot and projects are being planned in the Braamfontein Werf area, in Bruma, at Sandton and Randburg and is receiving consideration in the Crown Mines development.

Congestion is likely to accelerate the decentralisation movement of offices which have no real tie with the central area.

Nevertheless the Central Complex will remain to well beyond the end of the century as the largest single employment area in the Metropolitan Region. By 1985 employment is expected to increase by 60%.

It can be stated that whether decentralisation occurs to a greater extent than that visualised or not, a plan facilitating movements to or from and in the central area, is essential. The plan would also be required to take into account the possibility of decentralisation occurring and should be tailored to fit both eventualities.

Congestion, however, is likely to cause many industrial and warehouse activities in the Central Complex to decentralise. If congestion is kept down to a reasonable level then these may remain and increase. Congestion involving delays int the receipt and delivery of goods has a greater impact on the business and commercial sector than delays in commuter travel. With increased development taking place throughout the region it can be expected that industrial and warehouse activities are likely to look for relocation in places accessible to the regional framework of freeways.

1.2.5 Centralisation vs Decentralisation : The Bantu Population

The merits of centralisation vis-a-vis decentralisation must not be viewed purely from the viewpoint of the aspirations of the White race group. The Bantu population has become a very strong percentage of the labour force for all activities in the centre of the city (see Table 1.1). Their availability will have a very strong influence on decisions on decentralisation in the future. Restricted as they are to a defined area for residence, with travel times and discomfort of travel already great, there may develop considerable opposition to working in places where the travel time is increased still further.

At present, the commuting service feeds the central area very strongly, it also serves the work places (mainly industrial) which are located close to the stations of the railway service. This service is not meeting adequately the requirements of a Bantu population which each year is becoming more sophisticated and due to a rising economy is looking for better things in life. Motor car ownership is always high on the list of the poorer sections. Attention has already been drawn to the high car ownership growth factor (5.8) and this could well be a gross underestimate particularly as this growth factor was calculated before the recent strong upswing in Bantu wages had created a new pattern for their future.

If the railway service from Soweto could be improved to a high standard and this would involve the construction of further routes aided by express bus services, the continued centralisation of activities in the central area has considerable merit from a planning point of view.

If the commuting service from Soweto is not improved then the city will have to face up to a stream of private motor cars entering the city from the Soweto area. The existing access routes will prove to be insufficient and the terminal facilities inadequate.

Provisions are to be made in the plan in an attempt to meet the problems of highway movement. These will undoubtedly prove inadequate unless the public transport system is improved. The attention of the railway authorities has been drawn to the problems and urgent action called for but without any apparent success to date.

Should decentralisation occur to any marked extent, and particularly should this occur to the north of the city as the existing trends indicate, then the travel pattern of the Bantu will change radically. No matter to what extent the train service is improved, the Bantu will prefer to use their car to get to the dispersed places of work. Direct bus serviees to the major growth centres will become necessary and the need for an efficient motorway system to take care of these movements becomes more and more apparent. The irony

of this situation is that Johannesburg and to a lesser extent the controllers of Tembisa will have to face huge costs to enable Randburg and Sandton to prosper as growth centres.

Decentralisation is occurring haphazardly; essential decentralisation should be planned. The logical direction in which the major decentralisation should take place is towards Soweto for businesses which rely now or will rely in the future on a substantial Bantu labour force in respect of their activities.

Johannesburg has little say over the changes of zoning it its own area, still less in its metropolitan sector. Rezoning for new employment areas initiated in the private sector are bull-dozed through with a minimum of motivation. The private sector at the same time is clamouring increasingly loudly for a relaxation of job reservation to enable it to employ more non-Whites. The transportation complications for the future are self evident.

The movements between Soweto and Johannesburg requires a subsequent detailed study. Before such study can be put in hand, two important questions need a decision from the Central Government, namely:-

(a) Where are the extra 400 000 Bantu expected by 1985, to be housed and,
(b) Who will be responsible for their transportation.

1.2.6 Impact of transportation projects on residential areas

Transportation projects bring in their wake the hardships of the demolition of homes and dwelling units, the despoliation of residential environments not only physically by their presence, but also by the introduction of concentrated noise and fumes and thirdly the severance of residential communities.

As long as citizens of a community accept that their motor vehicles and their travel trips in them are the supreme factor in their lives, so long will residential communities have to suffer. No planner can look on the requirements of a motorised age with anything other than in horror. Evolution requires the imposition of a system which was never visualised when urban development took place.

The problem must be made clear to all citizens, namely that the constant and increasing use of motor vehicles must lead to the implementation of a transportation plan and such implementation must lead to acute hardships for a large section of the community.

The rehousing of the middle and lower income groups displaced by the implementation of the transportation proposals, is a factor which the Council must take steps to solve as part of its plan. Following the approval of the Transportation Plan, a comprehensive study of all the residential areas will follow with the purpose of welding the cells created into homogeneous residential environments.

1.2.7 Impact of transportation projects on suburban shopping centres

Historically suburban shopping areas have followed a ribbon pattern along the main arterials leading from the centre of the city. These arterials originally contained the principal tram routes followed by the bus routes. From a civic and a traffic point of view this form of development has been most unfortunate. The arterials have become congested with local traffic and the string of shops do not provide the service or the quality which the modern shopper expects. Many sectors of the ribbon become depressed and industrial and other uses have intruded to create still greater depression.

The effect of transportation facilities will be to create growth centres at strategic positions related either to stations of the mass transit systems or to points of access to the motorways. The siting of these growth centres must form part of a comprehensive land use plan integrating the urban requirements with movement. The repercussions will be felt in the older shopping areas where even larger sections will feel the pinch. The need to renew older shopping areas will become a vital planning issue in the future.

1.2.8 Metropolitan problems

The theoretical policy of the National Transport Commission is that the National freeway encircling Johannesburg will solve all its transportation problems not only in respect of movements from the surrounding metropolitan area but also those which are generated within the freeway ring. It has also adopted the policy that urban freeways are expensive luxuries and solve none of the problems. The facts reveal that this is unrealistic and enlightenment may be obtained only when the stage is reached for "Crisis planning" to which reference is made in the second paragraph of sub section 1.1.1.

The freeway system around Johannesburg will undoubtedly assist movements from outside. Motorists will have the choice after getting on to the system of choosing their route of entry to the city. At present this will be on to the M1 or M2 motorways of the city or on to the arterial road system. All of these routes within and close to the Central Complex will be heavily overloaded and unable to cope with the traffic long before 1980 let alone 1985.

But what about the authorities which lie within the freeway ring? The major portions of Randburg and Sandton lie within the ring and also a portion of Roodepoort. All three are heavy generators of traffic with a destination inside Johannesburg. To what extent should they be required to contribute to the problems they are creating? The transportation plan has been designed for Johannesburg bearing in mind this metropolitan setting, the plan has thus been integrated with the proposed National Transport Commission's freeway ring. For effective operation the plan requires that Roodepoort, Randburg and Sandton carry on the plan through their area. One must accept that the municipalities themselves are unable to do so and it is doubtful whether they could even face up to costs of extending the motorway and rail rapid transit systems into their areas. The question could well be asked by the citizens of Johannesburg whether the motorists from these areas should not be taxed in some form or the other to help pay for the facilities which have become necessary and this is a factor which must receive consideration. Johannesburg has been

unsuccessful in preventing the Province from making bad planning decisions - what hope have the smaller authorities!

There is no doubt that Johannesburg's transportation problems are metropolitan in context and the sooner they are put on this plane, the better.

2. GOAL, OBJECTIVE AND PRINCIPLES

2.1 Goal

The transportation system for Johannesburg has been designed to satisfy the following goal:

> "To develop an integrated transportation system that will effectively serve the existing land use pattern in Johannesburg and to promote a healthy future pattern bearing in mind the expected development of the metropolitan area. This transportation system is required to (1) meet the anticipated travel demand generated by the existing and proposed land uses, (2) be efficient and economic to use, (3) to have a minimal disruption effect on the environment".

2.2 Objectives

In order to achieve the above goal the following objectives were set:

1. A balanced transportation system using each transportation mode for the purpose for which it is best suited bearing in mind the desires of the people.

2. The designation of transportation corridors to facilitate the construction of transportation facilities not only in the immediate design period but well into the future.

3. The alleviation of traffic congestion and reduction of travel time between component parts of the city.

4. The increase of road safety.

5. A transportation system which is both economical and efficient meeting all objectives at the lowest possible cost without sacrificing standards.

6. The maximum use of the existing transportation facilities.

7. The minimisation of disruption of desirable existing neighbourhood and community development.

8. A safe, fast, comfortable and reliable public transport system.

9. The encouragement of the use of public transport.

10. The improvement to pedestrian movements within the city.

2.3 Principles of Transportation Plan

In preparing the transportation plan it has been accepted that a co-ordinated system of motorways, arterial and collector roads and public transport facilities must be provided. The co-ordinated plan has been developed having due regard to the undermentioned general principles.

2.3.1 General principles

1. Studies have shown that it is not practically nor economically possible to provide a road system in the heart of the city that

will permit the apparently desired free use of the private car. Studies have shown that the workers of the Central Complex are the workers most likely to be encouraged to use good public transport. These facts have weighed heavily in the design of the system resulting in the recommendation of a rail rapid transit system and the acceptance that within the Inner Central Area no additional roads can be justified on an economic or environmental basis.

2. In attempting to secure an acceptable Inner Central Area environment the highway system has been designed so that theoretically wherever possible, arterial traffic should not have to cross the central east-west and north-south axis of the heart of the city. Linked with this is the principle of facilitating freer pedestrian movement throughout the Inner Central Area which will form part of a subsequent report on the Central Area.

3. A further general principle accepted is that the large growth in non-residential floor space already committed in the Central Area and the additional space predicted by the studies will continue to keep the Central Complex as the main work centre certainly up to 1985. While decentralised work areas are becoming more important it will be only after 1985 that they will become really significant. The transportation system must be able to cater for this change in orientation.

4. No transportation plan for a great city can be designed without an adequate number of

   (a) public transport operators, (bus drivers, bus conductors, rail rapid transit drivers, despatchers, inspectors etc., and

   (b) traffic enforcement officers.

The transportation plan envisages the use of all the latest mechanical and electronic devices such as automatic train control, automatic ticket issuing and cancelling machines, automatic ticket barriers, etc., but nevertheless, the availability of an adequate number of personnel for public transport and traffic control is essential and assumed to be forthcoming.

2.3.2 Highway principles

In designing the highway system of the transportation plan, the following principles have been used as a basis:

1. A system of wide transportation corridors would be protected to provide for the city's transport needs well beyond the design year, 1985, in a manner that would cater for both centralised and decentralised development.

2. The highway system to be built to suit the traffic demand has been based on desired free use of the car up to and bypassing the Central Complex. Within the Central Complex the highway system will cater only for a restricted modal choice by 1985. Thus a certain amount of change of mode i.e. park & ride operation is expected on the fringe of the Central Complex. To cater for this, the highway system must lead conveniently to park & ride interchange facilities.

3. The motorways to be built when required in the wide transportation corridors must have wide medians to accommodate future rail rapid transit, busways or reversible carriageway depending on long term demand.

4. The motorways must be built to the high design standards currently being advocated overseas but because of the natural physical features of Johannesburg, it is accepted that in certain areas gradients will have to be steeper than would normally be acceptable.

5. In calculating the highway requirements, the facilities are accepted to be running at capacity thus, although the highway plan may appear generous, the level of service provided will by no means be high but down to congestion level at peak periods.

2.3.3 Public transport principles

The principles used as a basis for the design of the public transport system are as follows:

1. Speeding up of the bus service and the use of buses in certain areas for park & ride operation in the period before the rail rapid system is in operation.

2. A revised bus service feeding rail rapid stations so that the distributory features of the bus can be combined with the linear feature of the rail rapid to give good pick up coverage in low density residential areas and rapid access free of traffic congestion to the high density central area.

3. The bus- or car- to rail interchange facilities must be of high standard to give fast, convenient, weather protected transfer from one mode to the other.

4. The rail rapid system stations to be so placed to permit a fast service outside the central area and to give good distribution of passengers to work places and shopping areas within the central area.

5. The above principles apply to the transportation system for the White race group. The principles applicable to the transportation system for the Bantu resident in Soweto include the necessity for efficient bus and rail services but as the latter is dependent on government policies, they fall outside the scope of this report.

2.3.4 Parking principles

The principles used in the provision of car parking facilities in the central complex are as follows:

1. Private enterprize to be permitted to build garages in conjunction with its non-residential development but the amount must be dependent on the position in the Central Complex and on the capacity of the local, collector and arterial road system.

2. The City Council to provide additional parking garages to cater for cars, based on a restricted modal choice (see 2.3.2 item 2 above) entering the Central Complex on the basis of large daily rated garages on the fringe of the high density areas for long term parkers and smaller garages, hourly rated, within the high density areas specifically to cater for the short term business appointment or shopping expedition.

3. The provision of parking must be adequate for the support of the city's economy but not necessarily for the non-essential car driver.

2.4 Standards for transportation facilities

It is not proposed to give detailed standards for transportation facilities because once certain basic standards are accepted the more detailed ones follow automatically and are well known to transportation engineers.

2.4.1 Highways

The proposed highway facilities should be designed to the following basic standards:

(a) Motorways:
- Design Speed : 110 km per hour (70 mph)
- Horizontal curvature : 600 m (2000') desirable; 450 m (1500') minimum
- Gradient : 3% desirable; 5% maximum (certain sections 6%)
- Lane width : 3.6 m (12 ft)
- Shoulder width : 3.0 m (10 ft) left; 2.4 m (8 ft) right
- Median : 18.3 m (60 ft) clear of shoulders

(b) Major Roads :
- Design Speed : 80 km per hour (50 mph) desirable; 65 km per hour (40 mph) minimum
- Horizontal curvature : 230 m (700') desirable; 125 m (400') minimum
- Gradient: 8% on new major roads - existing grade on improved major roads
- Lane width : 3.6 m (12 ft) desirable; 3.3 m (11 ft) minimum
- Median : 4.3 m (14 ft) including right turn lane

2.4.2 Parking garages

The proposed parking garages should be designed and located to the following standards:

Type : Long-period - clearway ramp type
Medium-period - ramp, split-level or sloping floor type

No. of Floors : maximum of 6 desirable unless entrances are at different levels or garage is partially below ground when more can be considered

Ramp Gradient : 10% Maximum

Dimensions :
- Parking bay 5.5 x 2.5 m (18' x 8')
- Aisle width 7.3 m (24')
- Ramp width 3.6 m (12')

Walking Distance : Long-period : 600 m (2000 ft) desirable
900 m (3000 ft) maximum

Medium-period 300 m (1000 ft) desirable
450 m (1500 ft) maximum

2.4.3 Public transport

The design and running of the public transport system should satisfy the following standards:

(a) Bus Service:

Load Factor : Multi-stop service : legal load standard
Express service : 1.0 No standing passengers

Stops : Multi-stop service : 0.4 km ($\frac{1}{4}$ mile)
Express service : only at major pick-up and set-down points.

(b) Rail Rapid:

Standards to be recommended by a consultant.

3. TRANSPORTATION PLAN OPTIONS

3.1 Modal Split Options

In the design of a transportation plan for a city, the City Council must decide on the policy to be adopted. As pointed out earlier, the natural desire of a population with a high standard of living, is to use the car whenever possible. The percentage of trips made by the different modes of travel, i.e. the modal split, will vary with the size of the city and its density of development. Generally the larger the city and the greater its density of development, the greater is the use of public transport.

In a fast growing city with an increasing standard of living and highly centralised work areas, the provision of a highway system permitting the unrestricted natural desire to use the car to the central area will cost a great deal of money and probably be economically unobtainable. The City Council must then decide on what degree of choice it will give its citizens in the use of their cars. There are basically four options open to the Council viz :

(1) allow free modal choice
(2) allow no modal choice, that is design to the essential driver only
(3) accept some degree of restriction between free and no modal choice and finally
(4) do nothing.

3.1.1 Free modal choice

The model used to determine the mode of travel that would be used for a particular trip was based on the following variables:

trip purpose, car ownership, availability of public transport, relationship of origin and destination to bus routes.

The results of the model, using the 1985 values of the variables, were applied on a trip purpose basis, to the various person-trip tables to obtain origin-destination tables for car trips, car passenger trips and public transport passenger trips. The modal split model took account of the use of South African Railways trains by White commuters but these figures have not been analysed in this report.

The origin destination results obtained after the application of the modal split model were tested for reasonableness on the north and south screenlines. The model predicted that in 1985, 72 400 vehicle trips would cross the north screenline between 7 & 9 a.m. This would be equivalent to a growth of just over 5% per annum, whereas this screenline has been growing at a steady 6% p.a. since 1954 and if this growth continued the 1985 volume would be 86 000.

The model predicted for the south screenline that the 7 - 9 a.m. volume will be 40 000 equivalent to an annual growth of just under 7%. There is no long term past growth figure for this screenline but from 1965 to 1967 the 12 hour volume grew at 9% p.a.

On the basis of these figures it is considered that the vehicle volumes predicted by the modal split model are reasonable and may tend to be conservative.

The public transport passenger trips obtained from the modal split model were also tested for reasonableness on the north and south screenlines. The passenger volumes crossing the north screenline were predicted to grow at about $3\frac{1}{2}\%$ p. a. while those crossing the south screenline were predicted to grow at about $1\frac{3}{4}\%$ p. a.

The model was derived from the Home Interview Survey and the Journey to Work Survey. At the time of these surveys it was assumed that people were choosing their mode of travel freely and thus would use the car if this is their preferred mode of travel. The results given by the modal split model using the 1985 values of the independent variables were thus considered to be the preferred mode of travel or "free modal choice" of the trip makers.

The free modal choice being based on the surveys is thus heavily reliant on public transport, particularly for trips to the Central Complex. The increased standard of living and consequent higher car ownership expected in 1985 will mean that a greater percentage of trips will be made by car. In comparison the percentage of trips made by public transport will decrease but the number of passengers carried by public transport will nevertheless be far greater in 1985 than in 1965. This will be particularly so in the case of those going to or from work.

A transportation plan based on free modal choice will require the reconstruction of many arterial roads outside the Central Complex. It would also require the construction of many new motorways leading into and bypassing the Central Complex. The highway requirements are shown diagrammatically in Figure 3.1 A. A large number of giant parking garages would be required within the heart of the Central Complex on the fringe of the Inner Central Area.

The public transport system would have to carry a greatly increased number of passengers in the peak period but the volumes would not be sufficient to justify a rail rapid system. This increased volume would require greatly extended terminals and the buses would be subjected to greater traffic delays unless expensive elevated busways penetrated the Inner Central Area. In 1985 about 650 buses would enter the Inner Cordon Area in the peak hour; this is about 1.7 times the 380 buses that entered in the peak hour in 1965.

Elevated busways would badly affect the environment and amenities of the central area because of the narrow street and visual intrusion. They would also require elevated bus termini for which considerable property would have to be purchased.

Studies have revealed that the use of elevated busways on an extended basis is not a feasible proposition.

3.1.2 No modal choice

The Home Interview Survey probed the necessity of using a car for the work trips. If a person needed a car to carry out business he was considered as an essential driver. If on the other hand, he did not need a car to earn his living but preferred to go to work by car he was considered as a non-essential driver.

In the 1985 analysis only study area residents with work trips to the Central Complex were analysed on an essential or non-essential basis. The reason for this was because the wide spread distribution of work trips outside

the Central Complex made it impossible to provide an attractive public transport system to convert non-essential drivers. On the other hand, the heavy demand from all over to the Central Complex might make it possible to provide an attractive rail rapid transit system to convert non-essential drivers.

Car drivers from outside the study area were not subject to an essential/non-essential analysis because their public transport system would be outside the control of Johannesburg.

All truck traffic is, of course, considered to be essential.

It was assumed that in 1985 the percentage of essential drivers would be the same in each sector as they were in 1965. These percentages were applied to the origin destination tables obtained from the modal split model. The non-essential drivers were thus considered to be bus passengers and were thus permitted "no modal choice".

A transportation plan based on the no modal choice option will still require some motorways and considerable improvement to major roads.

The highway requirements are shown diagrammatically in Figure 3.1 B.

Obviously the public transport system would have to carry very greatly increased volumes which would certainly be in the range of rail rapid transit. For these volumes to be carried by buses about 1 430 buses would have to enter the Inner Cordon Area in the peak hour in 1985. This is about 3.8 times the 1965 peak hour volume.

This number of buses could not be handled on the present street system, because even with no modal choice, vehicle volumes are estimated to be about 46% greater than the 1965 volumes. Also the central terminals would have to be greatly extended and probably dispersed.

This plan would thus require a rail rapid transit system with an extensive bus feeder system using busways in several areas.

A transportation plan based on no modal choice is considered to be completely impractical because the restriction on the use of the car, the citizen's and voter's preferred mode of travel, is too severe, provides no flexibility in the future and is definitely a shortsighted policy.

3.1.3 Restricted modal choice

A restricted modal choice transportation plan is one that does not provide sufficient highways to cater for all the trips of the citizens using their preferred mode of travel but still provides more highways than would be needed had the citizens been permitted no modal choice.

Obviously a restricted modal choice can vary from just above no modal choice to just below free modal choice. In this analysis the restricted modal choice on 1985 volumes was arbitrarily set at about halfway between the two extremes. This will permit a more gradual application of the restriction from the free modal choice in 1965 and will still provide some flexibility beyond 1985.

A transportation plan based on the above definition of restricted modal choice could just justify the introduction of a rail rapid transit system and the highway system will depend on what policy is adopted to handle the non-essential driver and car passenger trips that must use public transport. These

non-essential drivers could be permitted to use their cars to convenient public transport stops where the cars could be parked and the remainder of the trip completed via public transport. This policy would require a larger highway system in the suburbs than if these non-essential drivers were expected to walk to the nearest bus stop.

An attractive system would be to permit the non-essential drivers who are expected to us public transport, to drive to the nearest rail rapid transit station and then complete the trip by rail. This system would certainly require more highways but the highway system could be designed to provide good access throughout the suburbs and thus provide a good basis when work trips become more decentralised.

A transportation plan based on this basis would require major road reconstruction as well as several new motorways forming a bypass box around the Central Complex. The requirements - highway and rail rapid, are shown diagrammatically in Figure 3.1 C.

3.1.4 Do nothing option

This is not strictly a modal choice option but is likely to have a great effect on the choice of mode and in fact is likely to have a far reaching detrimental effect on the economy of the city.

This is considered to be a very unrealistic option. It would slow down and eventually stop the growth of the central area. This would lead to faster decentralisation to the suburbs and surrounding towns. But the existing road network is not designed for this and pressures will again be brought for a highway system to serve decentralisation. Public transport will be even less of a proposition because of the wide-spread work areas.

Big property developers have invested globular sums of money in central-city properties. Large projects are presently being constructed and still larger projects are being planned. Considerable opposition to a "do nothing" policy will develop from these property owners who may see the value of their investments declining if massive decentralisation is generated. Pressure will then be brought to bear on the Council to take action and such action will be the same as that required for the restricted modal choice mentioned earlier, which could have saved the Central Area as well as catering for decentralisation.

The do nothing option is essentially a case of delaying the inevitable and future councillors and officials will regret the lack of foresight of such a decision.

A study of the new cars registered in Johannesburg shows that the citizens of the Johannesburg registration district spent about 65 million rand [1.] on new cars in 1968. This figure has been rising each year in the past and is certain to continue rising in the future. The population of Johannesburg is rising each year, the amount of non-residential floor space continues to increase, the gross national product continues to increase thus all services must grow to serve this increase and since transportation facilities are a service, in fact an essential service, they too must continue to grow.

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1. Average car cost calculated from data in the A.A.'s "The Motorist" New car registration from Bureau of Statistics bulletins.

In the light of these facts the do nothing option is a policy which dare not be considered seriously for the dynamic city of Johannesburg.

3.2 Transportation System Layout Options

In designing a new transportation system for 1985 full cognizance must be taken of the highway system already committed. The most striking feature of the presently committed highway system is of course the R63m motorway system now partially opened and well under way construction-wise. This system must exert the most important influences on the design of any future transportation system.

The present motorway system was designed to standards that existed in the late 1950's and the early 1960's. These standards are below those that are advocated at the present time. Using these earlier standards, the present 6 - lane motorway system was designed to give very good service to the area through which it passed. Its interchanges are at a minimum spacing and it will be very difficult to connect it up with a more extensive motorway system without destroying its ability to give very good service to the particular part of the city through which it passes,

The present motorways were also designed to disrupt to a minimum, the area through which they pass and consequently their rights of way are the minimum required with no room for expansion. Due to the fact that there is no room for expansion, the danger exists that if they are developed as 6 - lane facilities right to the municipal boundaries, their capacity will be fully pre-empted by non-Johannesburg drivers and they will thus not be able to serve the citizens who have had to pay by far the greater proportion of their cost.

In developing a highway system for the city of the future, there are 4 approaches that can be taken, namely :

1. To fit in major roads schemes around the present motorway system.

2. To fit in other motorways with the present motorway development to form an overall motorway system. This will have to be augmented by additional major road schemes.

3. Make the present motorway development a distribution system and to place a new motorway system around it. This will have to be augmented by additional major road schemes.

4. To make the present motorway system a distribution system and to place transportation corridors around it, and develop motorways in these corridors to take the traffic as it develops. Again an extensive major road system will also have to be developed.

Considering the first option namely that of developing major roads to cater for the future growth will require the redevelopment of all existing major arterials to the maximum possible, together with three 6-lane major roads for every motorway that would otherwise be required. The problem here is that these roads would not have built-in protection of their capacity and will have no flexibility for the future when decentralisation of work places becomes more important. Also as the traffic builds up beyond the design year, new major road facilities will continuously be required. This will result in an excessive fragmentation of the structure of the city.

The second option, that of fitting in additional motorways to form a complete motorway system with the existing motorway development, would require

system interchanges between the existing motorways and the new motorways. This will mean eliminating several existing and proposed service interchanges resulting in loss of service of the existing motorways to the area through which they pass, together with possible serious congestion of the present motorways due to their premier position near the central area. The spacing of the system interchanges will leave very little space in between for service interchanges to the normal road system. This will result in an expensive motorway system which, because of the lack of service interchanges, will not give good access to that part of Johannesburg it should be serving viz. the Central Complex and its environs.

The third option is to keep the present motorway system to provide good service to the area through which it passes and to superimpose upon it another motorway system built to the latest standards which will give fair access to areas through which it passes but will provide excellent service to its citizens in the future when decentralisation of work places becomes more important. It can also be designed to give direct access to park 'n ride terminals connected with the underground rail rapid system thus assisting in the development of a truly balanced transportation plan.

The fourth option, an extension of the third mentioned above, is that transportation corridors are set aside forming a system over and above the present motorway system. Motorways will be built in the corridors as required for the future traffic. They will safeguard the future routes by making sure no expensive developments prohibit future construction.

3.2.1 The corridor system

The principle of the corridor system is to designate a system of transportation corridors about 120 to 185 metres (400 to 600 feet) wide throughout the study area. These corridors, for a city of the density of Johannesburg, should form a grid of about $5\frac{1}{2}$ km ($3\frac{1}{2}$ mile) centres. The corridors should form the basis of the ultimate transportation system for the city and some corridors would not have to be purchased for many decades. The important point is to designate the corridors at an early stage and to ensure that they will be protected from high intensity development.

This approach is the most logical to accept as it makes provision for most of the foreseeable eventualities. It safeguards the future expansion and extension of the system to cope with movements by private vehicles and by public transport after 1985 and will also cope with cross-town movements which will be generated should decentralisation occur to a marked extent. It is the recommended system.

3.3 Public Transport Options

The public transport plan is closely associated with the policy that is adopted in regard to the modal split. The effects of each modal split option on public transport has been discussed in Section 3.1 and these may be summarised as follows:

(a) Free modal choice will require an increased bus service but a high capacity system of the rail rapid type cannot be justified.

(b) No modal choice will require a greatly increased public transport service which cannot be handled by buses alone and a high capacity system of the rail rapid type becomes essential.

(c) Restricted modal choice also requires an increased public transport service which would be difficult to handle with buses alone and would just justify a high capacity system of the rail rapid type.

The public transport system then depends on the capacity demanded by the modal split policy. If the modal split policy requires a high capacity system then a system having large capacity vehicles running at very close headways with no interference from other traffic must be provided. The only system that fulfills these requirements is a train of vehicles on its own right of way, that is the fixed route rail rapid system.

Once a rail rapid system is required then the options reduce to (1) the type of track, namely duorail or monorail and (2) the vertical location, namely above or below ground.

3.3.1 Track type

The duorail with steel rails and steel tyred flanged wheels is extensively used throughout the world. It has proved to be very reliable with the minimum of design problems and modern techniques have made it comfortable and quiet.

The duorail with wood or concrete rails and rubber tyred wheels has been used on part of the Paris system and in Montreal. It is comparatively new and positive guidance and switching from one route to another complicates the design.

Both duorail types are well suited to underground, surface and elevated rights of way.

The monorail has been used on a few single routes but never in a full-scale public transport system. There are basically two types; in the one the coaches are suspended below the track while in the other they are supported above the track. Both types use rubber tyred wheels.

The suspended type is well suited to elevated locations because the track has to be supported above the coaches. It can also be placed underground but the overhead track requires a rather large housing and this, together with the pendulum nature of the coach, would require a larger excavation than for the duorail.

The rail of the supported type can quite easily be founded at ground level in its own right of way as well as spanning between columns. It can also be conveniently placed underground although again a larger tunnel will be required than for a duorail.

The rubber tyred wheels can negotiate steeper grades than steel tyred but the steeper the grade, the higher the power consumption and even on equivalent grades the rubber tyres consume more power because of their greater rolling resistance.

3.3.2 Vertical location

The least expensive place to locate the duorail or the supported monorail is at ground level if the right of way is available. This location is of course impossible in heavily developed areas where the surface is used for all modes of movement. It is, however, suitable for suburban areas where the surface or an open cutting can be used.

The next place to locate any of the rail types is on structure above ground. This could be inexpensive in direct capital cost if right of way does not have to be purchased e.g. if it were located over a road, but it is almost certain that property will have to be purchased to accommodate changes in direction. However, the elevated structure is also not suitable in heavily developed areas with narrow road reserves as in the Central Complex of

Johannesburg. Firstly the supporting columns and foundations of the elevated structures are fairly large. The columns would severely restrict the width of sidewalks or carriageways in the narrow streets and the foundations would necessitate considerable alterations to services. Secondly to provide an adequate system the elevated structures would have to run through the heart of the city having a very depressing effect on the environment. Thirdly several elevated stations would be required in the heart of the city. The stations would have to be at least 400 ft long and would nearly cover the whole street from building line to building line for nearly two blocks. This will have a further detrimental effect on the environment. Where two or more routes cross or come together and it is necessary to permit passengers to change routes quickly and conveniently, the resultant elevated stations will detrimentally affect the amenity of the area and the incidence of light to the abutting buildings. With the narrow pavements access escalators, equivalent to serving the second floor of a building, would have to be located in abutting private property.

In terms of direct construction costs, the most expensive place to locate any of the rail types is underground. There might, however, be a saving on property costs as even, when the route passes under development, compensation, if any, will not approach the cost of purchase which would be necessary if the route was on surface or elevated.

The crossing of routes underground creates no problems and where passengers have to change routes the resultant stations are purely a technical problem having no adverse effect on the amenity of the surface development.

Another intangible saving is the minimum impingement on the environment and the weather protection it offers to passengers.

Because of the high cost of the underground location it is only used in the highly developed areas where the environmental needs justify the extra cost and where the grades of the surface demand it. Outside these places the routes are either on surface or elevated.

3.4 Parking Policy Options

As with the highway system there are several parking policies that could be implemented. The main parking problems are in the Central Complex and can be divided into two parts; (1) problems concerning long-period parking, and (2) problems concerning medium-and short-period parking. These problems relate to non-residential buildings.

3.4.1 Long-period parking options

The modal split option adopted will not only decide the highway requirements but will also decide what long-period parking must be provided within the area subject to the modal split option, i.e. the Central Complex. Thus having decided on the modal split policy the long-period parking can be calculated and the policy options then revolve around how the required parking within the Central Complex is to be provided.

The following parking policy options are available:

1. Compel the developer of a non-residential property to provide off-street parking space to cater for the full long-period parking demand of his building. This, of course, is subject to the sites being large enough to permit an off-street garage. The Council to provide for any short-fall in terms of the calculated demand based on the modal split policy.

This, besides making it more difficult to calculate what the Council will have to provide, will mean that all new buildings on sufficiently large sites will encourage full modal choice while the majority of the occupants of buildings without garages will have to rely on public transport. This gives an unfair advantage to the larger buildings but it would reduce the Council's involvement in long-period garages.

2. Compel the developer of a site, sufficiently large to permit an off-street garage, to provide sufficient parking space to cater for the long-period parking demand of his non-residential building based on the modal split policy. The Council to provide the parking space necessary for those buildings without garages, again based on the modal split policy.

   While this option means that the larger building still has an advantage over the smaller building, it does not directly encourage full modal choice. This option could still mean that in the Inner Cordon area these could still develop too much long-period parking space.

   This option could, of course, increase the Council's involvement in long-period parking compared with the first option.

3. Compel the developer of a site sufficiently large to permit an off-street garage to provide parking at some determined rate per unit of non-residential floor area irrespective of the use of the floor area. The parking space provided in this case being less, particularly for office buildings, than the demand based on the modal split policy. The Council to provide the parking space necessary for those buildings without garages based on the modal split policy together with the shortfall of parking space of those buildings with garages.

   This option will, of course, increase further the Council's involvement in long-period parking but it will reduce the amount of long-period parking space in the area concerned resulting in better control of the modal split policy.

Coupled with all these options the size of site can be specified, below which no garage will be permitted and above which a garage is compulsory. This limiting size can be used to control the number of garages and thus vehicle entrances and exits in a block. It is particularly useful in the Central Area to prevent an objectionable number of small garages with the consequent disruption on the traffic flow.

3.4.2 Short-period parking options

Medium- and short-period parking facilities are essential for the economy of the city since they are for the convenience of the shoppers and the businessmen. These facilities, being for short-period use, must be convenient to the parkers destination and will prove to be the most difficult and expensive to provide.

In providing these facilities, the following options are open :

1. Certain existing garages in private buildings, that provide parking to the public as a whole not merely to the occupants of the building housing the garage, could have their prices controlled by the Council so that they favour the short- and medium-period parker. The

Council can then provide for the shortfall of medium - and short-period parking.

This option would make some ideally placed garages more readily available to the short- and medium-period parker and would reduce the Council's involvement in this type of parking.

2. The Council provides all the parking space required for the medium- and short-period parker. This will require the purchase of more highly priced property in the Inner Cordon Area but would give better control over this type of parking and in fact over the modal split policy.

   This, however, should not preclude existing private garages or future private garages from voluntarily offering to assist with this parking. However, if extra parking rights are granted, adequate controls must be available to prevent the Council's modal split policy being defeated.

4. THE PROPOSED HIGHWAY PLAN

4.1 Introduction

4.1.1 Modal choice

The options open in formulating the policy for the degree of car orientation to be used in the design of the highway system has been fully discussed in 3.1 Modal Split Options.

With due regard to the economy of the city, the probable increase in decentralised work areas, the need to retain flexibility beyond the design year and at the same time to justify a good public transport system, it is considered that the highway system should be based on a restricted modal choice. As mentioned previously, a restricted modal choice will permit into the Central Complex car volumes about midway between free and no modal choice.

As mentioned in Volume 1 of this report, 1985 traffic volumes were predicted for the morning peak (7 to 9 a.m.), the valley period (9 a.m. to 4 p.m.) and the afternoon peak (4 to 6 p.m.). From a study of these data, the transportation plan has been designed on a peak hour estimated to be 65% of the 7 to 9 a.m. volumes. At present the peak hour varies on different roads from 58% to 65% of the 7 to 9 a.m. volume but as congestion increases the figure will gradually decrease. The figure could also be decreased if an effective staggered working hours policy is implemented. The reduction in peak hour volume could be about 10% but certainly less than 15%.

4.1.2 Transportation system layout

The various options open for formulating the system layout were discussed previously. It is considered that the most flexible option to adopt, the one that is best able to cater for the growth of the city well into the future, is the last option mentioned previously in 3.2 Transportation System Layout Options. This is to make the present motorway system a distribution system and to place transportation corridors around it.

4.1.3 Elements of the plan

The main long term feature of the plan is the designation of transportation corridors to be used by all modes of travel. The two main features of the plan for the design year 1985 are a system of motorways to be built in some of the corridors and a system of underground rail rapid transit lines mainly within the Central Complex. Ancillary features include reconstruction of major roads, park & ride facilities, parking garages, express buses and feeder buses.

4.2 Transportation Corridors

The principles of the transportation corridors have been discussed previously. The designated corridors must form a well integrated system giving good access to the whole city area. They must permit fast travel between various areas of the city including reasonable access to the city centre while also permitting the bypass of this heavily developed area.

Johannesburg has numerous natural and man-made barriers that make the layout of a free flowing corridor network extremely difficult.

Figure 4.1 shows diagrammatically the several natural barriers that stretch across the city in an east-west direction severely restricting the location of north-south routes. This figure also shows that the present arterial road system has already made use of the gaps in the barriers. Added to the natural barriers the figure also shows the location of the gold mining outcrop which can be extremely expensive to cross because of the precautions that must be taken to prevent subsidences and to cater for more gradual differential earth movements. Further man-made obstructions are the gold mining sand dumps and slimes dams. These obstructions are not always insurmountable although there are a few very large high sands dumps which should be avoided and some slimes dams can be very treacherous.

Many corridor layouts have been considered but because of these barriers all have some disadvantages. Some of the layouts studied are shown in Figure 4.2.

The finally selected corridor system is shown in Figure 4.2F and to a larger scale in Figure 4.3. The system consists essentially of two north-south corridors and three east-west. This layout will provide direct continuous north-south through routes (across the 1969 municipal area) bypassing the heavily developed Central Complex on the east and west. It will also provide a direct continuous east-west route across the municipal area south of the Central Complex and an east-west route north of the Central Complex although, because of natural obstructions, not a direct route. The layout will also provide a northern direct east-west route across the municipal area through the Rosebank area.

The western north-south corridor runs southwards from Craighall over the western part of Parkhurst, down the Parkview Golf Course, through Richmond into Vrededorp, along the eastern part of Mayfair and then through mining land to the south-west near Baragwanath.

The eastern north-south corridor runs southwards from Bramley, Highlands North, Orange Grove, Houghton Estate then due south through Observatory over the very severe natural barrier to the Judiths Paarl-Lorentzville area to Troyeville, Jeppestown over the New Kazerne goods yards, over mining land and through La Rochelle, Kenilworth, swinging west along the escarpment and then southwards along the valley of the Klip River Road in the newly incorporated areas of Johannesburg.

The east-west corridor, south of the city centre runs due west from the National Transport Commission's interchange of the Eastern Bypass, Southern Bypass and freeway to the east, along the Rand Airport Road, past the new market parallel and south of the Rand Mineral Line, through Ophirton, over mining land to the Western Bypass near Riverlea.

The east-west corridor, north of the city centre, starts at the freeway from the Jan Smuts Airport at Bruma, runs east along the valley to meet the eastern north-south corridor at the Judiths Paarl/Lorentzville area. The north-south corridor then has to be used northwards to Houghton.

The east-west corridor north of the city centre then runs westwards from this north-south corridor parallel with Louis Botha Avenue, then through Parktown to Richmond and then on through Auckland Park, Westdene, Triomf, Newlands to meet the Western Bypass in Roodepoort.

The unfortunate break in the line of this east-west corridor is caused by the natural barriers and the need to provide a route towards the central area.

The more northernly east-west corridor runs from the Eastern Bypass on the Modderfontein Road westwards through Lyndhurst, Waverley, Houghton, Parkwood/Rosebank, Parktown North to the western north-south corridor mentioned previously. It then continues through Greenside, Linden and into Randburg to eventually meet the Western Bypass on the Muldersdrift Road.

4.3 Capacity Required in 1985

The highway requirements in various parts of the city have been analysed in great detail. To give an indication of the present capacities, the predicted 1985 volume and the capacity proposed, three of the numerous assignment screenlines that have been analysed on a sector basis are tabulated in Table 4.1. The assignment screenlines are shown in Figure 4.4.

It will be noted from Table 4.1 that if nothing is done the available capacity, taking into account the present motorway system, will be well below the 1985 predicted volume in nearly every section. For screenline 4, on the city's pre-1969 boundary, the available capacity is below the predicted 1985 volume on the northern, southern and western sections, the capacity of these sections varying from 20% to 80% of the predicted 1985 volume.

For screenline 6, surrounding the Central Complex and its environs, the available capacity on important sections will range from 20% to 100% of the predicted 1985 volume. The average for the whole screenline 6 being 56%.

Screenline 1 cannot be analysed in this way because the predicted 1985 volumes shown crossing this screenline take into account a rail rapid transit system and a motorway system bypassing the Central Complex.

In arriving at the major road requirement for 1985 traffic volume, it was assumed that the whole street width would be available for peak hour travel, i.e. that no-stopping regulations would be strictly enforced and that all at-grade intersections with other major roads would have adequate right hand turn lanes. On this basis the capacity of the major roads has been calculated on the assumption that they will be subjected to congestion. Thus although the highway recommendations may appear to be over-generous this is not the case but on the contrary are the bare minimum required.

It will be noted that on the pre-1969 municipal boundary screenline 4, even with the proposed improvements, the north-west sector will have a shortage of road space in 1985 equivalent to a 44 ft carriageway. The western bypass is expected to help the position to a certain extent but this will cause extra loading on the western sector. In the other sectors the proposed capacity is very close to the expected demand being at the most 5% below the required capacity.

On screenline 6 surrounding the Central Complex and its heavily developed eastern environs, the proposed capacity with one exception is slightly greater than the anticipated 1985 free modal choice demand. The exception is the south-west where the capacity is about 5% below the anticipated demand.

On screenline 1 surrounding the Inner Cordon Area, Braamfontein and Hillbrow, the proposed capacity generally matches the anticipated volume on a restricted modal choice basis except on the east and west. However, on the screenline as a whole the proposed capacity is about 6% above the anticipated restricted volume.

TABLE 4.1 : STREET CAPACITY & CITY-BOUND VOLUMES CROSSING SCREENLINES

Section		Existing Capacity[1]	Proposed 1985 Capacity	Predicted 1985 Volume
	Screenline 4			Free[3]
1	Northwestern	800	2 400	3 800
2	Northern (west part)	4 000	10 100	9 600
3	Northern (east part)	6 600	8 000	8 200
4	Northeastern	2 800	4 000	1 200
5	Eastern	9 400	12 200	8 100
6	Southeastern	3 600	3 600	3 400
7	Southern	6 600	13 400	12 000
8	Western	4 900	11 700	12 100
	Total	38 700	65 400	58 400
	Screenline 6			Free[3]
1	Northwestern	1 400	6 900	6 700
2	Northern (west part)	5 800	11 800	12 900
3	Northern (east part)	9 700	15 400	14 200
4	Northeastern	1 900	2 700	1 700
5	Eastern	11 700	13 100	12 000
6	Southeastern	1 800	5 400	4 000
7	Southern (east part)	2 700	6 600	6 200[2]
8	Southern (west part)	6 700	14 500	15 200
9	Western	5 900	11 800	11 700
	Total	47 600	88 200	84 600
	Screenline 1			Restricted[3]
1	Northwestern	2 200	3 400	3 300
2	Northern	10 000	15 600	12 500
3	Northeastern	1 900	1 900	2 600
4	Eastern (north part)	1 500	1 500	1 600
5	Eastern (central)	1 700	2 900	2 900
6	Eastern (south part)	6 200	6 200	8 300
7	Southern	7 200	11 500	10 700
8	Western	6 500	8 900	10 100
	Total	37 200	51 900	52 000

1. Includes approved motorway system
2. Assumes park & ride from Rosettenville corner
3. Free = Free modal choice. Restricted = Restricted modal choice

4.4 Motorways

A motorway is a high capacity dual carriageway road having no direct access to property and with grade-separated intersections throughout. Only certain classes of traffic are permitted on a motorway and pedestrians, pedal cycles, motor cycles and motor scooters are prohibited. The fact that a motorway is completely access controlled and restricted to certain classes of traffic, means that its capacity is safeguarded and cannot be reduced by adjacent development as can quite easily happen with a normal major road.

Properly designed motorways have also proved to be very much safer than ordinary major roads with their stop and go operation and mixture of traffic. However, for safe, smooth operation under high traffic volumes, motorways must have adequate lane widths and emergency shoulders. They must also have properly designed on- and off-ramps and adequate weaving distance between subsequent on- and off-ramps. All motorway rights-of-way must allow for the ultimate development of two four-lane carriageways even if only two, two-lane carriageways may be sufficient when first built.

As mentioned previously the transportation corridors must be 120 to 185m (400 to 600 ft) wide to accommodate a motorway with a wide central reservation for some future facility be it busway, rail rapid or even a reversible carriageway. Figure 4.5 shows the cross-section of the proposed motorways together with different stages of its development.

Two motorways intersect through a grade separated system interchange. These interchanges must be of high standard generally having only direct or semi-direct turns. The indirect loop turn of the clover leaf is seldom used for a system interchange.

Connection between the motorway system and the major road system, that is the connection that permits access to or from the motorway system, is through a grade separated service interchange. These interchanges take many forms with the diamond, split diamond, ramps on to collector-distributor roads and the partial clover leaf being the most common.

In order to maintain adequate operating conditions, interchanges must not be too close together and 1.2 km ($\frac{3}{4}$ mile) centres is the minimum. With system interchanges about 5 km (3 miles) apart it is possible to fit two service interchanges in between to give reasonable service to the major road system. Because of this limitation it is not possible to obtain full system interchanges between the present motorways, i.e. the M1 & M2, without seriously interfering with the service of both the present system and the proposed system to the major road system. Hence direct connection between the two systems has not been provided except in certain places for limited movements.

Ultimately the proposed motorway system can be developed as an eight-lane facility in all transportation corridors but this is not necessary for the anticipated 1985 traffic volume.

4.4.1 1985 Motorway requirements

The 1985 motorway requirements are shown in Figure 4.6 and summarised in Table A1 in the Appendix. While considerable investigation has been done into the feasibility of the schemes, further study to finalise the exact route location will be necessary. This study should start as soon as the plan has been accepted in principle.

The present motorway system, now well under construction and partly open to traffic, must be completed as originally planned with dual three-lane carriageways throughout except north of the Glenhove interchange on M1. North of this interchange the motorway should be developed with dual two-lane carriageways to prevent its full capacity being pre-empted by non-Johannesburg drivers north of the city.

The southern section of the M1, i.e. in the Kimberley Road area, presently developed as a four-lane facility must have an extra lane added to each carriageway in due course.

The proposed motorway system will form a "box" around the Central Complex and its heavily developed eastern environs. This box, together with the present motorways M1 & M2, will reduce the traffic that would otherwise have to use the surface streets of the Inner Cordon Area, Braamfontein & Hillbrow by about 13 000 vehicles in the peak hour, that is from 63 900 to 50 900 or 20%.

The proposed motorway system will consist of the following facilities, the estimated costs of which are based on small scale preliminary sketch plans and 1969 construction costs.

1. Motorway M2

Motorway M2 is the east-west motorway on the existing motorway programme. It runs from the eastern municipal boundary at Cleveland westwards across the city to the Main Reef Road near Treu Road. It was originally intended that it should be extended fruther westwards to meet the Western Bypass.

With the proposed corridor system it will not be necessary to connect the M2 to the Western Bypass. It will, however, have to be extended about $1\frac{1}{2}$ km (1 mile) westwards before the proposed new motorway system is built in the Mayfair area. This extension is estimated to cost about R1.5m including land.

Although it will not be necessary for the M2 to be extended westwards to the Western Bypass, it should eventually be extended through the right of way originally allowed for it in Riverlea to meet the Main Reef Road near Commando Road. This would take place beyond the present planning period ending in 1985.

2. Motorway M3

A north-south motorway, M3, starting at the Nicol Highway near Parkmore, running south down the valley as a 4-lane facility west of Craighall to the north boundary of Delta from where it continues as a 6-lane facility skirting Parkhurst to the intersection with the most northern east/west corridor near Gleneagles Road. From here it continues south down the Parkview Golf Course as an eight-lane facility through Richmond, Vrededorp and Mayfair to the southern east-west corridor.

From this corridor the motorway continues southwards as a six-lane facility to the Old Potchefstroom Road at Baragwanath.

The section from the Nicol Highway to Craighall is outside the Johannesburg municipal area and will have to be financed by other agencies.

The M3 will have system interchanges with future motorways in the east-west corridors -

(a) running past Rosebank
(b) north of and
(c) south of the Central Complex

It will have service interchanges with the extension of Jan Smuts Avenue (Old Pretoria Road), a new road through Delta from Randburg, Rustenburg Road and Green Way/Wicklow Avenue. It will also have service interchanges with 8th Street and 17th Street, Vrededorp, an improved May Street, Main Reef Road and a new spur to Carr Street, all via collector distributor roads.

The length of the motorway within the municipal area will be 16.9 km (10.5 miles) and construction is estimated to cost R34.4m, with land costing R24.9m.

The purpose of this motorway is to provide access to park & ride stations, directly at Parkview or via M6 at Parktown, to provide a western bypass of the Central Complex and to provide access to east/west roads feeding the Central Complex.

The motorway will require a realignment of Barry Hertzog Avenue and this has been included in the major road proposals.

3. Motorway M4

An east-west Motorway, M4, starting at the intersection of the Heidelberg Road and Rand Airport Road running westwards as a six-lane facility, through mining land south of the new market, through a system interchange with the M5 Motorway and continuing south of the Rand Mineral Line, as an eight-lane facility, through Trojan, Booysens, Ophirton continuing through mining land south of the Rand Mineral Line to an interchange with M3 and then continuing as a six-lane to connect to the Western Bypass at Riverlea.

This motorway will have system interchanges with the M5 Motorway, the M3 Motorway and the Western Bypass. A system interchange will also be required with the Eastern Bypass when the M4 is eventually extended eastwards.

Service interchanges will be provided with the Rand Airport Road/ Heidelberg Road, Outspan Road and via collector distributor roads with Rosettenville Road, a new southern expressway and Booysens Road.

The length of the motorway will be 11.7 km (7.3 miles) and construction is estimated to cost R19.7m, with land estimated at R10.1m.

The purpose of the motorway is to provide direct access to the park & ride station at Trojan, to provide access to north/south roads feeding the Central Complex and to provide a southern bypass of the Central Complex.

4. Motorway M5

A north-south Motorway, M5, starting at the northern east-west corridor, near the Highlands North shopping centre, running south as a four-lane facility through Cheltondale to Orange Grove where it expands into a six-lane facility and continues to the north-east corner of Bellevue. It then runs south down the western boundary of Observatory as an eight-lane facility going through deep excavations at times. From Observatory it proceeds across the valley in the Judiths Paarl/Lorentzville area on a very high structure before going into cutting through the Troyeville/Jeppestown area. It crosses over the main East Rand suburban railway line, crosses over the East-West Motorway, M2, and runs over mining ground to the southern east-west corridor. It then continues as a six-lane facility through La Rochelle, west of Rosettenville Corner through Kenilworth and westward along the escarpment to swing south down the valley past Glenvista.

The motorway will have system interchanges with the new motorways to be built in the east-west corridors

(a) past Rosebank
(b) north of the Central Complex going west
(c) east of the Central Complex and
(d) south of the Central Complex

A partial system interchange will permit restricted movements to the M2 Motorway. The motorway will have service interchanges via C-D roads with Zuid Street Extension, Louis Road, 9th Street Orange Grove, Observatory Avenue, Kitchener Avenue, Jules Street and via collector distributor roads to Rifle Range Road.

The purpose of this motorway is to provide access to park & ride stations, directly at Houghton Golf Course or via M6 at Parktown from the north and directly to Rosettenville Corner from the south and to provide an eastern bypass of the Central Complex and its heavily developed eastern environs.

The construction of the section north of Cheltondale and the section south of the southern east-west corridor can be delayed until after 1985 but the collector distributor roads associated with it in Kenilworth must be constructed earlier.

This motorway will be 9.8 km (6.1 miles) long and construction will cost an estimated R27.7m for the 1985 requirements, including the collector-distributor roads in Kenilworth. Land costs will be R12.2m.

5. Motorway M6

An east-west Motorway, M6, running westwards from a system interchange with the M5 Motorway near the Houghton/Observatory Area as an eight-lane facility parallel with Louis Botha Avenue through Parktown to cross over the M1 Motorway near Jan Smuts Avenue. It then continues westwards through a system interchange with the M3 Motorway near Richmond to continue westwards through Auckland Park to near Westdene as a six-lane facility.

This motorway will use Louis Botha Avenue as one of its collector distributor roads for serving the local area. It will provide service interchanges through collector distributor roads to Elm St, Harrow Rd, Claim St, Clarendon Place, Queens Road, a new spur to Simmonds St, the St David's Place-Melle Street scheme and Jan Smuts Avenue. At its western extremity it will have a service interchange with Plantation Road.

Its length will be 7.1 km (4.4 miles) and construction is estimated to cost R20.6m. Land costs will be about R31.0m.

The purpose of this motorway is to give access to the park & ride station at Parktown, to provide access to the link roads feeding the Central Complex from the north and to provide a high capacity northern bypass of the Central Complex.

6. Motorway M8

An east-west Motorway, M8, running from the eastern north-south corridor, Motorway M5, near the Highlands North shopping centre, westwards as a 4-lane facility to a restricted system interchange with the M1 Motorway near Cydna and then past the Rosebank shopping centre to a system interchange with the M3 Motorway in the western north-south corridor. It will have service interchanges with Oxford Road and Jan Smuts Avenue.

The purpose of this motorway is to provide good connections between motorways, to provide a much needed good east-west route and to provide good access to the Rosebank Shopping area.

The scheme will facilitate access to the north-south motorways permitting them to be fully used, thus alleviating the load on the major road system.

The eastern half mile of this motorway can be delayed until after 1985 and built when the motorway M5 is extended northwards.

The motorway required by 1985 will be 5.0 km (3.1 miles) long and construction is estimated to cost R10.0m. with land costing R15.0m.

7. Motorway M10

An east-west Motorway, M10, running as a four-lane facility from the National Transport Commission's freeway through Bedfordview through Bruma along the valley of Bezuidenhout Valley to meet the north-south M5 Motorway in a system interchange in the Lorentzville-Judiths Paarl area.

This motorway will have service interchanges via collector-distributor roads with Allum Road and Queen Street and with 5th Street, Bezuidenhout Valley.

The length of this motorway is 4.8 km (3.0 miles) and construction is estimated to cost R7.8m with land estimated at R2.0m.

8. All Motorways

The total estimated construction cost of the proposed 1985 motorway system is R121.5m for a total length of 56.8 km (35.3 miles). The total 1985 land requirements are estimated to cost R112.3m. Total cost R233.8m.

All motorways can be enlarged to 8-lanes in the future and can be extended along the reserved corridors.

In many instances the corridors can be used for additional purposes once the motorways have been constructed. In San Francisco "linear parks" have been developed under and alongside the elevated rail rapid transit system. This might be appropriate in some places in Johannesburg and in several places private enterprize could develop under and alongside elevated roadways, particularly in the Judiths Paarl/Lorentzville and Richmond areas. Private development could also be considered over depressed sections of motorway. At several park & ride stations the parking garages could be developed under or over the motorways.

This dual use of transportation corridors must be exploited wherever possible.

4.5 Major Roads

The term major roads refers to high quality arterial roads. These roads form the backbone of the highway system and should form a grid of about $1\frac{1}{2}$ km (1 mile) centres. The intersections are generally signal controlled but some heavily loaded ones may be grade-separated. All new or widened major roads shoudl be six-lane dual carriageways with an island wide enough to accommodate a right turn lane at all at-grade intersections.

The cross sections of various major roads are shown in Figure 4.7.

The capacity of the major road system should be protected as much as possible by preventing large generators or attractors to abut on them. The number of cross roads should be reduced to the minimum. Service roads with properly designed junctions at cross roads which intersect the major road should be provided wherever possible.

In Johannesburg the main arterial roads basically forming a grid of about $1\frac{1}{2}$ km (1 mile) centres should be designated major roads and where these rights of way are less than 38 m (120 C ft) new development should be controlled so that this width, or wider if service roads can be contemplated, can eventually be obtained.

The recommended designated major road system is shown in Figure 4.8.

The major roads improvements that will be required by 1985 are given in Tables A2, A3 and A4 in the Appendix. They are shown diagrammatically in Figure 4.9. While considerable investigation has been done into the feasibility of the schemes, further study to finalise the exact route location will be necessary where new rights of way are required.

The estimated construction cost of the major road requirements for 1985 is R59.6m. The estimates are based on very preliminary sketch plans using 1969 construction costs. Land requirements are estimated at R26.4m giving a total of R86.0m.

Some of these major road schemes will be just widenings within existing rights of way, other will necessitate the expropriation of additional rights of way but some are quite extensive schemes involving expensive structures. These will be described in a little more detail below.

The present Ten Year Major Road Programme (the outstanding schemes are marked with an 'E' in Tables A2 to A4 in the Appendix presently about halfway through construction, must still be vigorously pursued. The new recommendations do not supersede this programme although they may require larger facilities than originally planned.

4.5.1 Local improvement

In addition to the construction and reconstruction of major roads of considerable length, numerous local improvements are necessary. Some of these local improvements, while not of any great length, will be very costly, some involving grade-separation structures.

The local improvements that can be identified at this stage are also given in Tables A2 to A4 in the Appendix. However, as mentioned in Chapter 7 on Traffic Engineering, Education and Enforcement, congestion and danger points must be studied and the more important ones corrected each year. This will require an emergency fund allocation each year for these remedial measures.

Some of the more ambitious local improvements are described below.

4.5.2 Some proposed schemes

North of Central Area

1. St David's Place - Melle Street

This is a scheme proposed about 10 years ago and on the present Ten Year Major Road Programme. It now becomes a vital scheme in the proposed motorway system and in the interim public transport plans discussed in Chapter 5. It consists essentially of a four-lane link road from Oxford Road via St David's Place, connecting with the collector-distributor (C-D) roads of the east-west M6 Motorway then continuing southwards on a structure over Empire Road to cut through the hill in a short cutting in Melle Street to connect to the one-way street pair of Melle and Biccard Streets.

2. M6 - Simmonds Street Link

This is a new proposal to provide an extra feeder into Braamfontein and the Inner Central Area. It consists of a four-lane road running from the C-D roads of the east-west Motorway M6 southwards, bridging Empire Road passing over Helpmekaar Girls' High, then between the Fever Hospital and Johannesburg College of Education to link up with Simmonds Street. It will provide access to a fringe parking garage north of and under Hoofd Street.

3. Victoria Avenue - Joubert Street Extension

This is a scheme proposed over 10 years ago for which property has already been expropriated. It is on the present Ten Year Major Road Programme and will form an essential part of the proposed highway plan. Because of the proppsed east-west transportation corridor for Motorway M6 and the subsequent redevelopment of Parktown, its original alignment may have to be slightly altered.

4. Jan Smuts Avenue - West Street Flyover

This is an adaption and amalgamation of schemes first considered about fifteen years ago. The purpose of the scheme is to permit the entry of heavy traffic volumes from the north into the office area of the Inner Central Area without congesting the entrances to Braamfontein once the M1 Motorway reaches capacity.

It consists of a very long four-lane viaduct starting just north of the Loch Avenue intersection running south, flying over the proposed east-west M6 Motorway, the present north-south M1 Motorway, Empire Road and then over the Ameshoff-Jan Smuts Avenue intersection. It then continues down the middle of Bertha Street and across the Braamfontein marshalling yards to Newtown flying over Bree and Jeppe Streets and coming down to ground in West Street. A ramp system will permit connection to Bree & Jeppe Streets.

The scheme will provide access to a large parking garage in West Street as well as facilitating access to a new garage at Kazerne and at the old abattoir.

The scheme should be designed so that it can be constructed in two parts. The first, connecting Bertha Street to West Street and then, at a later date, extending the flyover northwards.

5. Solomon Street Bridge

This is a modified version of the scheme originally proposed in the 1947 Joint Technical Report on improved access to the north; a combined South African Railways & City Council report at the time of the reconstruction of Johannesburg Station.

The scheme consists of a 4-lane dual carriageway bridge starting just south of Showground Road in Solomon Street, passing over Smit Street, Braamfontein station and marshalling yards and Burghersdorp Street, then separating into two separate structures to come down to ground level either in Crown & Mint Roads respectively or Central & Lilian Roads respectively at Bree Street. Crown & Mint or Central & Lilian will have to be one-way to provide the necessary capacity.

The link to Crown & Mint Roads will be the most direct but the alternative link to Central & Lilian Roads would be more convenient as these roads could link through to the Main Reef Road.

However, this alternative would involve a slightly skew crossing of the Braamfontein railway yards and the purchase of the Johannesburg Indian Teachers Institute. More investigation will be necessary to select the final location.

The scheme will provide access to a long-period garage north of May Street.

6. Oxford Road Realignment and Widening

This scheme proposed a year or two ago is essential for the proper development of the Rosebank shopping centre. It envisages moving Oxford Road to the east between Jellicoe Avenue and Glenhove Road and the widening of Oxford Road/Central Avenue, Illovo, to six-lanes from the municipal boundary to Federation Road.

Adequate intersections will have to be provided near Jellicoe Avenue and at the crossing of the proposed M8 Motorway near Glenhove Road to cater for traffic movements into the Rosebank Shopping centre. The former may have to be grade separated while the latter, of course, must be grade separated but may have to have three levels.

7. Jan Smuts Avenue Widening

The widening of Jan Smuts Avenue is on the current Ten Year Major Road Programme. The widening of the whole road to six lanes is essential to the proposed highway system. However, to feed the proposed M3 north-south Motorway on the west and to relieve Jan Smuts Avenue in the south and to allow for the proper development of Rosebank, adequate intersections must be developed with the proposed east-west M8 Motorway and with Jellicoe or Tyrwhitt Avenue. The former intersection, of course, will be grade separated and may be three level while the latter may also have to be grade separated.

8. Harrow Road - Abel Road Grade Separation

This is the local improvement scheme to increase the capacity of Harrow Road at Abel Road. It consists of Abel Road flying over Harrow Road into Hendon Street and turning movements taking place by means of ramps. The presently troublesome south to east movement from Harrow Road to Hendon Street will be handled by an indirect turn via a loop ramp.

9. Houghton Drive - Motorway M1 Ramps Grade Separation

A ramp system from the M1 Motorway in Killarney leads directly to the portion of Houghton Drive running through The Wilds. The original intention was to have a signal controlled at-grade intersection between this route and the portion of Houghton Drive north of The Wilds. This intersection would also provide access to Killarney.

The proposed scheme is to make this intersection a grade-separated one so that traffic to and from the Motorway will not suffer congestion.

10. Oxford Road-Victoria Avenue improvement

This is a local improvement to increase the capacity of the Oxford Road-Victoria Avenue intersection so that the required volume can be handled through this bottle neck.

The proposal is a straightforward widening to provide a two-lane slip road into Victoria Avenue as well as a two-lane approach for traffic continuing south along Oxford Road to St David's Place.

11. Queen Elizabeth Drive-Melle Street Link

With the construction of a bridge across the Braamfontein Yard between Bertha & West Streets, it will be possible to alter the Queen Elizabeth Drive to give direct access to Melle Street.

This will permit a northbound one-way street route from Sauer Street via the Queen Elizabeth Drive to Melle Street and a southbound one-way street route from Biccard Street to Simmonds Street. This will considerably improve the effectiveness of the Melle Street/Biccard Street one-way pair and relieve the congested Wolmarans St between these two streets.

12. Klein Street-King George Street Flyover

This scheme was first proposed about fifteen years ago and will form an essential part of the highway plan to meet the proposed increased parking capacity at Union Grounds. The property for the flyover in Klein Street has already been expropriated.

The scheme consists of a 4-lane flyover from Pietersen Street running down Klein Street over Smit Street and following an 'S' shaped curve over Wolmarans Street and coming down on the wide sidewalk on the west of Joubert Park. The flyover will go over the nursery section of the park at the north-west corner

13. Cheltondale-Oaklands Link

This scheme is a westward extension of the Durham-Zuid Streets project and will run from Louis Botha Avenue across the proposed M5 motorway through Cheltondale around the north side of the proposed Valley Park development to connect to Haswell Street in Oaklands. It will also connect to the proposed extension of Atholl-Oaklands Road southwards between Abbotsford and Highlands North Extension.

The purpose of this link is to provide service connections to the motorways M5 & M8 for the existing and proposed development in the area.

14. Tana Road - Jellicoe Avenue Link

This link will run from Tana Road near Victory Park connecting with Rustenburg Road and the proposed M3 Motorway then passing through Parkhurst and Parktown North on a widened right of way to meet Jan Smuts Avenue at Jellicoe Avenue.

The purpose of this link is to provide good east-west connections to the proposed motorway M3 and to the Rosebank Shopping Area. By giving a through route along Jellicoe Avenue to Oxford Road the importance of the arterial, Tyrwhitt Avenue, which cannot be widened, will be reduced.

This, together with the other proposals, will provide the highway framework which will permit the development of a well designed master plan for Rosebank.

West of Central Area

1. Western Spur

This is a high capacity viaduct leading from the C-D roads of the proposed north-south M3 Motorway to large parking garages on the western perimeter of the Inner Cordon Area. The spur will run from just north of Mayfair along Carr Street to the vicinity of West Street.

The route of this scheme still has to be fully investigated.

2. Main Reef Road - May Street Rearrangement

In order to overcome the bottleneck caused by most of the Market-Commissioner and all of the Marshall-Anderson one-way traffic feeding into the Main Reef Road, the following schemes are proposed:

(a) A widened Main Reef Road to be connected directly with the Marshall/Anderson one-way pair.

(b) May Street to be widened to double its reserve and lead directly from the C-D roads of the proposed M3 Motorway into the Commissioner-Market one-way pair via part of the present Main Reef Road in Westgate which will be severed from the western part of the Main Reef Road by scheme (a) above. It will also give access to a long-period parking garage north of May Street.

3. Brixton Expressway

This is a six-lane facility bypassing the congested ribbon development in High Street, Brixton. The road will run from Queens Road, Mayfair, north of the Brixton shopping to link up with the recently reconstructed Perth Road/Main Road route in Westdene and Newlands.

4. Jeppe Street-Avenue Road Link

This is a local improvement scheme linking Jeppe Street to Avenue Road as directly as possible so as to permit the westward extension of the Jeppe-Bree Streets one-way pair into Mayfair. The westbound route will be brought back into Queens Road across the M3 right of way west of the railway. This will improve arterial traffic through Burghersdorp and materially improve access to the proposed Oriental Bazaar.

5. Baragwanath-Auckland Park Link

With the development of the Rand Afrikaans University and the proposed development in the Ormonde area near Baragwanath there will be a need for an improved alignment of the north-south major road J5; that is the Baragwanath Road - Ripley Road route. This has been designated a major road on Figure 9 but has not been included in the programme ending in 1985.

South of Central Area

1. West Turffontein Expressway

Considerable traffic is expected from the rapid development of southern areas recently incorporated. The proposed north-south M5 Motorway will carry a good deal of this but an additional major road will be necessary for the remainder and of course for the traffic growth in the West Turffontein area. A six-lane at-grade expressway is therefore proposed from the south passing up the West Turffontein Valley to meet the C-D roads of the proposed east-west M4 Motorway in the Robinson Deep area between Booysens Road and Turffontein Road. This will give direct access to a large park & ride garage at Trojan station on the rail rapid system.

2. Loveday Street Spur

This consists of a link between the C-D roads of the proposed east-west M4 Motorway and parking garages north of Park Central and at the Wemmer Parking area. It will be an elevated structure for most of its length and the northern part of it will be constructed first to be used as a busway to facilitate southern suburb bus services.

The spur will flyover the Rand Mineral Line at Booysens Station, give access to Loveday Street, run alongside the old slimes dam of the lower part of Park Central to flyover the present elevated M2 east-west Motorway into the Wemmer parking area.

3. Mooi Street Spur

This scheme provides a link from the C-D roads of the proposed east-west M4 Motorway in the vicinity of Wemmerpan through mining land to Mooi Street South at its interchange with the present M2 east-west motorway. The scheme will also link with an improved Sprinz Street and extended through the east of the Bantu Sports Ground to eventually link via a widened Polly Street with Troye Street.

This latter link will give direct access to a proposed parking garage in the Bantu Sports Ground. The spur will also give access to a parking garage near Hulbert Street east of Rosettenville Road.

4. Earp Street Scheme

This scheme was originally proposed in the 1948 Traffic Plan and the tunnel under the Rand Mineral Line embankment was built about two decades ago. The right of way through mining land was also proclaimed. This scheme forms an essential part of the proposed highway system particularly to serve Bantu traffic from the Bantu road (Project 6) now under construction.

5. South Rand Road-Rifle Range Road Link

This scheme was originally proposed many decades ago, part of it was implemented at a low standard in the fifties and part of it was deproclaimed as a provincial road about a decade ago.

The scheme runs in the original South Rand Road reserve from the Heidelberg Road intersection westwards through Tulisa Park, south of South Hills Extension and through Linmeyer, then continues westwards on a new reserve through Rosettenville Extension to join the Rifle Range Road which will have to be widened.

This scheme will link with the collector-distributor roads of M5 and provide access to the Rosettenville corner park & ride station before M5 is constructed.

East of Central Area

1. Voorhout-Pritchard Streets Scheme

This scheme is designed to give an extra link into the Inner Cordon Area from the east. It will run from the proposed eastern Motorway M10 westwards along Voorhout Street, Troyeville, over the main suburban railway line at Ellis Park, through Doornfontein under the elevated Sivewright Avenue and Siemert Road Motorway link to Pritchard Street.

This will provide good access to the proposed parking garages on the eastern side of the Inner Cordon Area and New Doornfontein.

2. Queens Road - Lower Germiston Road Link

This scheme envisages the widening of Queens Road, Kensington, from Bruma southwards and the improvement of the alignment through Malvern to the Cleveland Road interchange on the present M2 east-west Motorway. The road is then extended southwards over mining ground across the Rand Mineral Line to the Lower Germiston Road and then on to cross the east-west corridor south of the central area in the Rand Airport Road area. The highway will then veer west over mining ground to meet the deproclaimed South Rand Road in Tulisa Park at the Heidelberg Road intersection.

5. PROPOSED PUBLIC TRANSPORT PLAN

5.1 Introduction

In section 1.1.4 attention was drawn to the extent to which cities throughout the world were turning to the rail rapid mass transit system as their main public transport medium. It was also indicated that other than the monorail routes established in and near Tokyo, no city had adopted the monorail on a comprehensive basis. Buses, unless they are separated from the street traffic, cannot cope with the ever-increasing passenger loads being generated. Even if they are separated from the street traffic on to special elevated busways, the number of buses required, the personnel necessary to operate them, the physical impingement on the city, the terminal requirements, and the high costs involved, detract from this medium becoming an acceptable proposition.

In view of these factors it is logical that Johannesburg should consider the rail rapid form of mass transit as the most feasible to alleviate its public transport problems. However, the disadvantages of such a system is the extreme inflexibility of the line and the resulting linear service provided. The system therefore depends heavily on buses and cars for passenger distribution at the outlying stations.

In planning a rail rapid transit system there are certain basic factors which must be considered, namely :-

1. The system must serve the areas where passenger volumes warrant it.

2. The system must be planned to ensure that it can be extended to meet future demands.

3. The stations must be sited to give adequate coverage to residential areas and to places of work in the Inner Central Area and facilities must be provided at selected stations to enable an interchange of passengers from one route to another.

4. The system must be integrated with a comprehensive bus service feeding inter alia the outlying stations and suitable parking facilities must be provided at these stations to enable car users to change to the system.

5. All routes must be linked to marshalling yards and workshops.

6. The system must be attractive to encourage considerable numbers of motorists to use it. It must therefore offer:

   (a) overall average speeds considerably faster than those of the private cars.

   (b) comfort

   (c) reliability

7. Overall average speeds are dependent on stations spacing and a nice balance must be struck between high average speeds with poor distributions associated with large station spacing and the low average speeds with good distribution of close station spacing.

8. The system should be fully automated in respect of operations of trains, passenger movement in stations and fare collection.

The first part of the proposed scheme is expected to be operating in 1985 but passenger volumes and private car volumes will continue to increase and in the interim period various schemes for handling this increase will have to be undertaken. This section of the report will recommend measures to improve the bus service in this interim period.

5.2 The Proposed System

The options available, once it is decided that a rail rapid transit system is necessary, were fully discussed in Section 3.3 Public Transport Options. Taking into account all the factors and also the conclusions reached from studies in this field conducted for other cities in Europe and America, the option proposed is that of the duo-rail with steel tyred wheels and steel rails running underground in the heavily developed inner areas and on the surface or elevated in the outer areas.

The studies show that a rail rapid transit system for Johannesburg must pass through the following areas:

1. The Inner Central Area; the main work area
2. The high density residential areas of Bellevue, Yeoville, Berea and Hillbrow in the north-east.
3. Braamfontein, an important work area.
4. Parktown to intercept car and bus passengers from the north and north-west.
5. The southern suburbs an important residential area.
6. Mayfair an important residential area and western gateway to the central area.
7. Jeppestown and Bezuidenhout Valley to serve the eastern gateway to the central area.
8. In the more distant future
   (a) In the north-east : Orange Grove, Highlands North
   (b) In the north-west : Rosebank, Parkhurst and Randburg
   (c) In the west : Crosby, Triomf
   (d) In the south : the new development at Ormonde and the southern areas.
   (e) In the east : the new development at Bruma.

These criteria can be met by several system configurations but the main problem is to locate the stations within the Inner Cordon Area (I.C.A.) to provide the best passenger distribution. This location of stations within the I.C.A. requires further study and this can affect the configuration of the systems without appreciably affecting the layout outside this critical area.

No final route location for the rail rapid system has thus been recommended but a likely system, with an alteration in the I.C.A. is discussed to show the type of layout required and the magnitude of the cost. However, a full feasibility study must now be undertaken by recognised experts in this field to finalise the route of the system and advise on all the highly technical

equipment such as type of wheels (steel or rubber tyred), permanent way, signalling, automation etc.

The proposed rail rapid transit system, with one possible layout in the Inner Cordon Area, is shown in Figure 5.1. The various routes of the system will run underground within the Central Complex but outside this area they will run in the open wherever possible. In the north-east the route will run in the centre of the transportation corridor to Highlands North and beyond and in the north-west it will run in the centre of the corridor located in the Parkview Golf Course to the Randburg border and beyond. In the west the line will meet up eventually with the transportation corridor at Triomf. In the south the line will continue underground outside the Central Complex to Rosettenville Corner where it will continue in the centre of the southern transportation corridor to serve the newly incorporated southern areas. It is possible that a line to the south-west may prove a proposition and this could continue underground through Ophirton and Booysens to the proposed development in Ormonde.

5.3 The 1985 System

The immediate proposal is for the construction of the system within the Central Complex with short extensions outside on the north-east, north-west and south. This system is required to be operating by 1985.

In general the routes have been located as far as possible under roads to as to avoid interference with and damage to private properties.

Stations are at about 900 metres (3 000 ft) centres, which enables good speeds to be obtained, but the coverage is restricted. The tunnels are to be 3.75 metres (12.5 ft) in diameter in line with the London tube system. At stations the diameter is increased to about 7.8 metres (26 ft) to allow for the platforms, which will be at least 120 metres (400 ft) long. The marshalling and workshop yards for both schemes will be at Robinson Deep.

In working out the details of the system a maximum grade of 3% upwards and 4% downwards has been accepted. These grades are suitable for a steel on steel system and while steeper grades of 5% and more are claimed for rubber wheeled systems, power requirements increase enormously with increased grades. In addition, in order to assist the speedy starting and stopping of trains at stations, the lines run at a grade of 1:60 upwards when approaching a station and 1:30 downwards when leaving a station. The limitation of the grades referred to above determines the elevation of stations.

It is anticipated that the rail rapid trains will reach maximum speeds of approximately 95 km per hour (60 mph). Their maximum acceleration and deceleration is anticipated to be approximately 5 km per hour per second (3 mph per second) in each case.

It is expected that average running speeds of approximately 57 kilometres per hour (36 mph) will be obtained between stations on these systems. Average travel speeds will be nearly 42 kilometres per hour (26 mph) when allowing for a 20 second stop at each station.

An objective of the system is to enable passengers using the S.A.R. system to transfer to the rail rapid system at Jeppe and Mayfair stations.

Finally it must be stated that the system is designed for the movement of passengers of the White race group only. The present laws of the land make it impossible to contemplate catering for the different race groups as well. The movements of non-Whites will have to be catered for by surface buses and the S.A.R.

As mentioned before the location of stations in the Inner Cordon Area needs further study. A number of alternative routes have been investigated and in the description of the 1985 system two possible alternative layouts for this area will be discussed. These two alternative layouts have been based on two different principles. In the first, the lines are arranged to bring the 1985 passenger volumes directly to the main office area resulting in one station being heavily loaded and giving somewhat poorer coverage to the rest of the Inner Central Area. In the second, the line is arranged to provide better coverage of the Inner Central Area but the southern line does not serve the main office complex as quickly as in the first alternative.

The system proposed for 1985 is shown by the solid block lines in Figure 5.1. It comprises three separate routes, a northern U-loop to be termed the northern route, a southern route extending through the central area and then to the west, and an eastern route terminating in the central area. Should the residential development at Crown Mines warrant it, this last route could be extended in a south-westerly direction to serve this area.

This particular configuration has been accepted because of the balance of passenger volumes on each leg of the northern route and on each leg of the southern route.

The sections of the route required by 1985 have collectively a length of 23.6 km (14.7 miles). The northern route is the longest with a length of 12.7 km (7.9 miles), the southern route is 7.6 km (4.7 miles) and the eastern route 3.4 km (2.1 miles).

Description of the routes is as follows:-

The northern route: Commencing at a terminus near the southern boundary of the Houghton Golf Course and proceeding in a southerly and south westerly direction through Yeoville, Berea, Hillbrow into the central area via Joubert Park & Klein Street and then west via Commissioner Street, then north via West Street and Melle Street in Braamfontein to St David's Place in Parktown and then in a westerly direction to terminate at the southern end of the Parkview Golf Course.

The southern route: The southern terminus is at the Rosettenville corner. The route proceeds from there in a northerly and then north-westerly direction along the western boundary of Trojan where the connections to the marshalling yards and workshops will be made, then through Selby and into the city via Harrison Street, then westwards under Bree Street to terminate at its western terminus at Mayfair railway station.

The eastern route: Its eastern terminus is in the vicinity of Bertram Road and Voorhout Street, Bertrams and the route proceeds westwards past the Jeppe railway station and enters the city via Commissioner Street and then terminates at the corner of Harrison and Commissioner Streets where it is possible to change to the southern and northern routes.

It is necessary for all these routes to be inter-connected by rail in order that trains can reach the marshalling yards and workshops. The connection between the southern and northern routes is in the Kazerne area and that between the eastern and southern routes near the Harrison-Commissioner Street Station. The presence of the marshalling yards on the southern route places it in the priority bracket when construction is contemplated.

Table 5.1 reflects for stations outside the I.C.A. the type on each of the routes together with their depth below ground level and the number of passengers expected to alight or board the trains during the morning peak two hours. Similar data for stations inside the I.C.A. are given in Table 5.2

TABLE 5.1 : RAIL RAPID STATIONS : OUTSIDE INNER CORDON AREA

Station	Station Type[1]	Approximate Depth		Passenger Volumes Peak 2 Hours A.M.	
		Metres	Feet	Alighting	Boarding
Northern Line					
Houghton Golf Course	MC	9	30	1500	8100
Yeoville	MC	44	145	800	7200
Berea	I	24	80	500	5100
Hillbrow	I	29	95	3200	10100
Braamfontein	I	18	60	9300	3000
St David's Place	MC	38	125	1900	8700
San Souci	MC	15	50	2700	2500
Parkview	MC	0	0	2100	12300
Southern Line					
Rosettenville Corner	MC	17	55	1100	7300
Trojan	MC	8	25	1700	12300
Selby	I	9	30	13500	1000
Newtown	I	7	25	5100	900
Mayfair	MC	9	30	1400	14200
Eastern Line					
Bertrams	MC	0	0	700	3800
Jeppe	MC	18	60	3700	5900

1. MC = mode change station
   I = Intermediate station

TABLE 5.2 : RAIL RAPID STATIONS : INSIDE INNER CORDON AREA

Station	Station Type [1]	Approximate Depth [2] Metres	Feet	Passenger Volumes Peak 2 Hours A.M. Alighting	Boarding
Original Proposal					
Jeppe/Von Wielligh Sts	I	12	40	16 000	6 100
Harrison/Commissioner Streets	PI	15	50	32 300	2 800
Bree/West Sts	PI	9	30	9 100	1 900
Goud/Commissioner Sts	I	12	40	7 400	1 000
Alternative					
Noord/Claim Sts	I	17	55	7 100	4 300
Main/Troye Sts	PI	9	30	13 900	1 800
Vanderbijl Square	PI	23	75	20 200	1 400
Commissioner/Becker Sts	PI	13	45	16 800	1 400
Bree/Joubert Sts	I	18	60	16 500	2 800

1. I = Intermediate station
   P = Passenger interchange between different rail routes
2. Approximate depth of highest platforms below ground level

There are three types of stations. The one type, which combines an extensive parking garage and a bus station with the rail station, caters for the park & ride motorist and the feeder bus passenger. These change of travel mode stations will, for convenience, be referred to as "Mode Change" stations or M.C. stations. The second type - " the passenger-interchange station" - is located at the intersection of two or more transit lines and can comprise a series of platforms at different levels serving the different routes. The third type termed the intermediate station, is a normal suburban station, without any special features, serving its surrounding area.

Including the termini there are 11 stations on the northern line and five of these are M.C. stations. The private cars and buses provide a passenger distribution and feeder service to areas remote from the station and are essential for maximising the convenience and use made of the rail rapid service. The bus feeder system has worked excellently in Montreal and Toronto. The essential feature of the M.C. station is that the movements to and from parked cars and the station platform should be as quick and as convenient as possible

and that a sophisticated system of issuing tickets should be introduced to obviate delays to passengers using the bus or parking facilities. It is not proposed to discuss these systems here - they should form part of the feasibility study. The stations at Yeoville, Berea and Hillbrow provide a good service to the high density areas there. The station at Jeppe/Von Wielligh Streets is well placed relative to the Retail Core and the Medical Centre. The Office Core is served by the single station at the corner of Harrison and Commissioner Streets and this will create problems of pedestrian movement particularly as this station serves the other two lines as well. The interchange station between the northern and the southern routes at the corner of Bree and West Streets will serve the eastern section of Newtown and the western section of Johannesburg, while the Braamfontein station will serve that busy area.

The garage capacities for parked cars visualised for the M.C. stations are :- Houghton Golf Course 2 000, Yeoville 700, St David's Place 2 500, San Souci 1 500, Parkview Golf Course 3 000.

The demand for parking at these garages will depend on the development of the motorway and major road system. It is therefore possible that more garage capacity than shown above will be required in one area than in another; this is particularly so in the case of the San Souci and Mayfair garages (see eastern route). A larger garage may be required at Mayfair with the consequent reduction in the size of the San Souci garage. Final capacities will have to be determined nearer the construction time when more certainty exists regarding the construction of the various highways.

In all cases the design of and the land available for the garages should be such that the garages can be conveniently increased in capacity should the demand develop.

Expected travel times, that is the actual time the train takes, to the station at the corner of Harrison and Commissioner Streets are:-

From Houghton Golf Course	7 minutes
From Hillbrow	$2\frac{1}{2}$ minutes
From Parkview Golf Course	$6\frac{1}{2}$ minutes

On the southern route there are seven stations including the termini - three are M.C., two intermediate, and the two passenger interchange stations at the corner of Harrison and Commissioner Streets and the corner of Bree and West Streets to which reference has already been made.

The garage capacities for the parked cars visualised at the M.C. stations are : Rosettenville Corner 3 000, Trojan 4 500, Mayfair Station 1 500.

Expected travel times to the station at the corner of Harrison and Commissioner Streets are:-

From Rosettenville Corner	$5\frac{1}{2}$ minutes
From Trojan	3 minutes
From Mayfair Railway Station	$3\frac{1}{2}$ minutes

The eastern route has four stations including its termini. Two have M.C. facilities and the lone intermediate station at the corner of Commissioner and Goud Streets will serve the eastern section of the central area. The route

terminates at Commissioner and Harrison Streets. The capacity of the parking garage in Bertrams is expected to be 1 500 cars and that at Jeppe Station somewhat smaller with 1 000 cars.

The expected travel times to the station at the corner of Harrison and Commissioner Streets are:

From Bertrams	$3\frac{1}{2}$ minutes
From Jeppe	$2\frac{1}{2}$ minutes

It will be observed that the travel time to the centre of the city on all three routess is low. Time will be lost when changing from one mode to another, e. g. from car at a park and ride station to the train or similarly from a bus. It is essential that there must be a good frequency of the train service so that the time lost is a minimum. In order to encourage the use of park and ride facilities these good frequencies would have to be maintained throughout the day to enable prospective rail rapid passengers to reach their cars quickly at any time of the day.

One of the principles of the design of the routes is that the stations should be as near the surface as possible. With its topographical problems, and the limitations of the grades of the lines, this is difficult to achieve for Johannesburg. From Table 5. 1 it will be seen that the depths vary from about 7 metres (25 ft) to 44 metres (145 ft) at Yeoville. There are six stations at a depth of over 18 metres (60 ft).

These depths are disturbing particularly when considering costs and the time taken to reach platforms from the surface. It is estimated that a single escalator serving a depth of 27 metres (90 ft) would cost about R250 000 and this excludes any excavation of tunnel. In South Africa escalators are not permitted to move at a speed exceeding 37 metres per minute (125 ft per minute).

Improvements could be effected in regard to the depth of certain stations. If the Hillbrow station were to be moved further north, the depth could be decreased appreciably, but the station would not be conveniently sited relative to the Kotze Street shopping centre. The levels of the medians of the motorways have a considerable bearing on the levels of the nearest stations such as Yeoville and St David's Place. The integration of the engineering study of the motorway and the rail rapid transit systems becomes important.

Passenger volumes need to be discussed in a subsection on their own. In passing however, it would be well to note the number of passengers expected to alight in the morning peak two hours at the Commissioner/Harrison Street station (32 300), at the Jeppe/Von Wielligh Street station (16 000) and at Selby (13 500).

This scheme is estimated to cost R116m including an allowance for land.

5. 3. 1 Alternative layout in I. C. A.

As mentioned before alternative layouts in the I. C. A. can change the configuration of the network without appreciably affecting the layout outside the I. C. A. The possible I. C. A. alternative to be discussed now will change the system configuration.

This alternative gives rise to a northern U-loop similar to that of the original proposal and an overlapping southern U-loop. The eastern route becomes an east-west link traversing the full width of the central area. Details are shown in Fig. 5. 2

The collective lengths of the routes in this system are 26.0 km (16.1 miles). The northern route is 12.5 km (7.8 miles), the southern route 7.1 km (4.4 miles) and the east-west route 6.3 km (3.9 miles).

The northern route: The termini are the same as in the original proposal and from the station at Houghton Golf Course the route proceeds similarly through Yeoville, Berea, Hillbrow but enters the central area via Claim Street to Main Street where it turns to the west under Main Street and from there to a station at the corner of West and Commissioner Streets where it turns northwards through Braamfontein and follows the same route as the original proposal to the Parkview Golf Course.

The southern route: The first section from the Rosettenville Corner to Trojan is the same as for the original proposal, and from Trojan the route proceeds in a north easterly direction and enters the central area under Troye Street and bends to the west under Bree Street to turn southwards via West Street to the station at the intersection of West and Commissioner Streets. It is designed to be extended via Ophirton to the Crown Mines area.

The east-west route: Starting from Bertrams the route is the same as the original proposal to the vicinity of Jeppe Station but proceeds westwards from there via Main Street to West Street, then northwards and westwards through Newtown to terminate at the Mayfair Station.

The rail connection between the routes are in the vicinity of the Main/Troye Street station as shown in Fig. 5.2. This alternative will deepen some of the stations outside the I.C.A. but it will not appreciably affect the passenger volumes at these stations as shown in Table 5.1. The details of stations within the I.C.A. are given in Table 5.2 together with those of the original proposal for comparison purposes.

There are 12 stations on the northern route and the five with M.C. facilities are the same as for the original proposal. Of the four intermediate stations, three (Berea, Hillbrow and Braamfontein) are also in the same position as the original proposal, but the fourth is located in Claim Street, virtually underneath the S.A.R. tracks. The station at the corner of Main and Troye Streets serves all three routes and is thus a triple interchange station and that at Vanderbijl Square serves two routes and is thus a double interchange.

On the southern route there are six stations of which Rosettenville Corner and Trojan (as for the first alternative) are M.C. stations. Selby and the station at the corner of Bree and Joubert Streets are intermediate. This latter station will serve the Retail Core. The two remaining stations are the triple interchange stations at the corner of Main and Troye Streets and at the corner of Commissioner and Becker Streets.

On the east-west route there are seven stations of which three are M.C. namely, Bertrams, Jeppe Railway Station and Mayfair Railway Station. Newtown is the only intermediate station while once again the stations at the corner of Main and Troye Streets and at the corner of Commissioner and Becker Streets are triple interchange with the other two routes. Vanderbijl Square Station is a double interchange with the northern route.

The parking capacities for the M.C. stations are the same for both systems. No attempt has been made to calculate travel times on this

system. These will be somewhat longer than the original proposal although not appreciably so.

This alternative is estimated to cost R124m including an allowance for land.

5.3.2 Passenger volumes

Tha analysis of the Home Interview Survey revealed that approximately 33% of car drivers with a destination in the Central Complex require their cars for business purposes and the remaining 67% are optional car drivers. On the basis of the proposed restricted modal choice to be applied to this Transportation Plan, approximately 47% of the optional car drivers and their passengers will be converted to public transport. These " converted" volumes were computed and added to the increased transit patronage caused by the increased population predicted for 1985. The results were then applied to the various routes for the inbound passenger volumes in the morning peak two hours in 1985.

On the eastern leg of the northern route approximately 8 000 passengers would travel from the Houghton Golf Course station. This number would increase to approximately 15 000 after Yeoville and to 28 500 after Hillbrow. On the western leg it is anticipated that approximately 12 300 passengers will commence their journey from the Parkview Golf Course. This number will have increased to about 22 000 after Parktown.

This route would require 6-coach trains operating at about 2 minute headways in the peak period.

On the southern route it is expected that 7 300 passengers will commence their inbound journey in the morning peak two hours at Rosettenville Corner. At Trojan their numbers will increase to 19 000. These volumes can be obtained only if the whole of the southern suburbs, including Robertsham and Ridgeway have easy access by car and by bus to these two stations.

On the western leg in the two hour morning peak about 14 200 passengers are expected to leave Mayfair. This route would require 6-coach trains operating at about 3 minute headways.

On the eastern route it is anticipated that about 3 800 passengers will commence their inbound journey in the morning peak two hours at Bertrams and at Jeppe this number will increase to about 9 300. This route would require 6-coach trains operating at about 6 minute headways.

It is essential to note that these passenger volumes can only be obtained if the motorway plan is implemented. It is essential that the highway system should give fast and easy access to the M.C. stations and that the feeder bus service should have similar freedom of access.

It should also be noted that the volumes quoted above could vary considerably if the road system is altered or the priority of construction of different sections changed.

Overseas experience has been that the capacities of a rail rapid transit line are of the order of between 30 000 and 40 000 per hour depending on station length. The volumes quoted above for Johannesburg apply to the two hour peak period. Studies reveal that in the one-hour peak

approximately 67% of the total passengers of the two hour peak are carried. These figures are summarised in Table 5.3 . The figure for the one hour peak at Hillbrow would consequently be nearly 19 000 or around 60% of the maximum which could be carried on this line. The other routes, however, have considerable capacity available.

The volumes for the eastern route do not justify the early construction of this route. Due to the fact, however, that it has proved to be impossible to work out effective means for improving the bus service in this sector of the city, it has been upgraded in priority and included as part of the comprehensive plan.

The peak hour volumes could be reduced if an effective staggered working hours policy could be implemented. The reduction in peak hour volume will depend on the success of the policy and could be about 10% but certainly less than 15%. While this will not reduce the total number of passengers carried, it will permit better use to be made of a reduced rolling stock.

TABLE 5.3 : ANTICIPATED 1985 LINE VOLUMES

Inbound Section After :	Passenger Volumes. Peak : 2 Hours	1 Hour
Northern Line		
N. E. Leg		
Houghton Golf Course	8 100	5 400
Yeoville	15 000	10 000
Hillbrow	28 500	19 000
N. W. Leg		
Parkview	12 300	8 200
San Souci	14 100	9 400
St David's Place	21 700	14 500
Southern Line		
S. Leg		
Rosettenville Corner	7 300	4 900
Trojan	19 200	13 100
W. Leg		
Mayfair	14 200	9 500
Eastern Line		
Bertrams	3 800	2 500
Jeppe	9 300	6 200

5.3.3 Marshalling yards and line interconnections

It is proposed to locate the marshalling yard in the area immediately west of Turffontein Road and immediately south of the township Stafford in the Robinson Deep land. The proposed size of this marshalling yard is expected to be of the order of 12 hectares (30 acres). Detailed investigation would have to be undertaken to determine the quantity and type of equipment which will have to be provided in this marshalling yard. The type of equipment includes workshop and maintenance depots, servicing yards, storage yards, etc. Ready access will also have to be provided to enable trains to be brought into the southern line with a minimum of inconvenience to the operation of the line itself.

It is not envisaged that all rolling stock will be housed in the marshalling yard during night time and staging should be provided at the terminal ends of the lines, as well as along the lines at stations or at sidings near stations, in the Central Area. Very minor maintenance and cleaning can also take place at these siding areas on the lines during night time as well as in off peak periods during the day. During the day only some of the trains will be taken out of service but at night time after midnight, the whole service will close down.

This marshalling yard as proposed in the Southern Areas will only be large enough to take care of the volumes anticipated in 1985. When the extensions are constructed to make up the ultimate system, additional marshalling yards will have to be provided elsewhere. Likewise, detailed study will have to be undertaken to determine the greater requirements for this larger system and also the possible location of these yards.

5.3.4 Bus feeder system

Figure 5.3 shows the feeder areas draining towards the various stations. From these areas passengers will be collected or distributed by means of buses. These buses will converge to their stations, passengers will be transferred to the trains and the buses will be turned around to proceed back to the areas. In the afternoon the reverse will occur. These buses will have to be housed in depots and in these instances it might be advantageous to locate some depots in the outside areas rather than all near the Central Area. Detailed planning would have to be undertaken to choose the best location of these depots but it seems, from the operational point of view, that the location of these depots should not be too far from the Central Area. Some of these buses will not discharge all their passengers and turn around, but will proceed onwards through the Central Area so as to maintain coverage in the areas closer to the centre.

5.3.5 Comparison of the two systems

Statistical details are:-	Original Proposal	Alternative Layout
Total length	23.5 km (14.7 miles)	26.0 km (16.1 miles)
Number of stations	22	25
Deep stations over 18 metres (60 ft)	6	9
No. of double interchange stations	1	1
No. of triple interchange stations	1	2
Estimated capital cost including land	R116m	R124m

The longer length of the routes, the extra stations and the greater depth of a large number of stations ensure that the alternative will be the more expensive to construct.

However, it is necessary to look at the coverage provided by the two systems. As far as the residential areas are concerned, they are the same. In regard to the work places there is considerable difference. Attention has already been drawn to the figures of alighting passengers for the original proposal contained in Table 5.2. In the peak two hours over 16 000 passengers will alight at the Jeppe/Von Wielligh Streets station and over 32 000 at the Harrison/Commissioner Streets station. These are the only two stations which will serve the Retail and Office core areas and the eastern fringe area. Pedestrian movements on the surface will become impossible. Pedestrians could be distributed underground on moving pavements, already a feature in Sydney and to be a major feature at Expo 70 in Japan. The costs are likely to be high, but if such an underground pedestrian system could be extended, the results city-wide may be worth the costs.

In the alternative there will be four stations well sited to distribute passengers to the Core Area and the eastern and southern fringe areas. These stations are at the corner of Main and Troye Streets, Vanderbijl Square, the corner of West and Commissioner Streets and at the corner of Bree and Joubert Streets. Approximately 20 000 passengers will be discharged at Vanderbijl Square, 16 000 each at the West/Commissioner Streets and the Bree/Joubert Streets stations and 14 000 at the Main/Troye Streets station.

There are drawbacks however. The southern route of the alternative does not serve the Office Core well in that the stations are at the extremities of the core and a worker in the western section of the core would be required either to travel right round the loop in the central area, or transfer to the east-west route at the Main/Troye Streets station.

There are consequently the merits and demerits in both systems and as has been indicated before, the selection of the most feasible routes is the task for the experts in this field of transportation.

5.3.6 Running costs

No attempt has been made to estimate the running costs of the proposed system; this will be one of the duties of the consultant. It is expected that the fare revenue should cover the running costs but not the interest and redemption of the capital cost.

A guide to the interest and redemption costs in relation to the estimated 1985 passenger volumes is given in Table 5.4. The capital cost of the alternative has been used for this analysis i.e. R124m.

TABLE 5.4 : INTEREST & REDEMPTION OF CAPITAL COST PER PASSENGER-MILE

Section	Cost per passenger mile [1]
North-eastern leg	3.9c
North-western leg	3.0c
Southern leg	5.0c
Eastern leg	7.3c
Western leg	7.4c
Average for 1985 system	4.3c

1. Based on 6% interest over 30 years

If the capital costs had to be redeemed from revenue then, for a journey from Houghton Golf Course to the city centre, a fare of $16\frac{1}{2}$c would be necessary purely to recover the interest and redemption charges on the basis of the average figure in Table 5.4. For a journey from Rosettenville Corner to the city, the corresponding fare would be 13c.

5.3.7 Comparison with other cities

In order to indicate how the proposed Johannesburg rail rapid transit system compares with those of certain well known cities, the rail rapid networks of these cities have been superimposed, to the same scale, on a map of Johannesburg. These results are shown in Figures 5.4 and 5.5.

Figure 5.4 shows the London Underground, the San Francisco Bart Scheme, presently being constructed, and the Stockholm Underground, together with the long term Johannesburg proposal, in the Johannesburg metropolitan setting. These drawings do not show the railway commuter systems which in the case of London are very extensive.

It will be noted that London, with a population of over 8.2 million, has a very extensive system of 393 route kilometres (244 miles) giving a very good area coverage. The majority of the terminals of routes are within 16 km (10 miles) of the centre, but the extensive commuter services of British Rail serve areas well outside this radius.

The proposed BART system in San Francisco (population 2.9 million) is essentially a linear system brought about by the configuration of the areas it has to serve. The system has very long routes giving a total of 119 kilometres (74 miles).

The system in Stockholm (1.2 million people) is essentially a cross with branches on some of the outer lines. This system also has a very long route, particularly in relation to its population. The total route length being 58 kilometres (36 miles).

Figure 5.5 shows the centre of the London, Paris and Toronto systems superimposed on the central part of Johannesburg, together with the 1985 proposal for Johannesburg.

Paris (7.4 million people) has a very extensive system of 204 route kilometres (127 miles), the Toronto (Population 2.0m) system consists essentially of a cross with a narrow loop in the central area. The system consists of 24 route kilometres (15 miles) and extends no further than 8 km (5 miles) from the central area. The interesting point about the London (8.2m) and Paris (7.4m) systems is the large number of stations that occur in the central area. In some instances the stations are less than 0.4 kilometres ($\frac{1}{4}$ mile) apart. In Stockholm (1.2m) and Toronto (2.0m) there are also a large number of stations in the central area and again some of these stations are less than 0.4 kilometres ($\frac{1}{4}$ mile) apart. It is only San Francisco (2.9m), in these examples, that has a larger minimum station spacing, viz. about 1 kilometre ($\frac{5}{8}$ths of a mile).

From these examples it would appear that a closer station spacing should be considered for Johannesburg's Inner Cordon Area.

From the data given in Table A5 in the Appendix, the number of route miles of rail rapid system per million population has been calculated. It will be noted that these rates vary between 1 and 35 miles per million population, with 36% between 6 and 10 while London, Berlin, Hamburg, San Francisco and Stockholm are between 25 and 30 miles per million population. The proposal for Johannesburg, with anticipated 0.724 million Whites in 1985, is about 14.7 miles or 20.2 miles per million White population which is less than that of the five cities mentioned above but in the range of New York (21.0 miles/m) and Paris (17.2 miles/m).

5.4 Interim Period 1970 - 1985

The underground system is planned for operation in 1985. It is doubtful whether a system of this magnitude can be designed, the financial arrangements made and the system constructed in less than 15 years. Active steps consequently must be taken to improve the bus service in the meantime.

Factors which have to be taken into account are:-

1. The problems which the bus service is facing in its clash with private automobiles on the city streets.

2. The impossible position which has been reached in respect of the termini in the central area.

3. That expensive and extensive projects for busways cannot be undertaken if these are to become redundant once the underground becomes operational.

4. That nevertheless, such projects must be undertaken if they can be used later for another purpose such as spurs from the motorways to peripheral parking garages.

5. The topography, narrow streets and the virtual 100% development of all sites fronting such streets.

Within the limits of these circumscribing factors the street framework and the bus service system has been critically examined. It should be recorded that the planning team has already initiated the development of a busway project to assist the service to the north-eastern suburbs - the most heavily loaded of all the services and this is operating with reasonable success. Even greater

success could be obtained if staff was available for traffic enforcement. The services requiring relief consequently are those from the north and north-west, the west, the south and the east. It has not been possible, however, to come forward with any reasonable proposals which can provide relief to the services from the east and the west. A proposal to provide relief to the services from the north and the north-west and a further project from the south are considered to be feasible. Details of these will now be provided and the projects are illustrated in Figure 5.6.

Beyond these all that can be recommended are vigorous operational traffic engineering studies along all bus routes to investigate what measures can be applied to alleviate the lot of the buses. Any traffic engineering measures involving regulations, as has been shown on the north-eastern bus-way scheme, will require constant enforcement thus requiring a greatly increased traffic office establishment.

A further factor which could materially assist the bus service, and should not be overlooked, is the staggering of working hours. The General Manager of Transport has done some work in this direction and this should be pursued. It should be mentioned that the Commissions of Inquiry into the Co-ordination of Transport in South Africa, (the Marais Commission), recommended that local committees should be set up in the main cities to occupy themselves exclusively with the question of the staggering of working hours.

5.4.1 North-west bus project

This project makes use of the St David's Place/Melle Street link contained in the Major Road proposals in the previous chapter. It also requires the park and ride and bus interchange garage at St David's Place to be constructed as this forms an integral part of the scheme. St David's Place is one of the mode change stations of the underground proposals. The purpose of this project is to inaugurate an express bus service from St David's Place to the termini in town in the morning and a similar service out in the afternoon and evening. The one form of the express bus service will be a shuttle service between the parking garage at St David's Place and the city during peak hours. The other will be that certain express buses from the outlying suburbs such as Rosebank and Parktown North will diverted to St David's Place and make only one stop thereafter, namely in Braamfontein. The first service is based on the lines of a smaller project which is proving to be so successful in Durban and it will establish the advantages of this form of park and ride travel prior to the operation of the underground. Other suburban buses which have to make use of the multi-stops will be required to remain on their present routes.

The proposed route inbound for the morning period is as follows: From St David's Place it follows the Melle Street link which will also be used by private vehicles. At the intersection of Ameshof and Melle Streets, during the morning peak two hour period, the buses will run in a lane specially reserved for them on the eastern side of Melle Street and will travel in this lane in a southerly direction against the one-way traffic travelling from south to north. In the morning peak the opposing traffic will be fairly light on Melle Street and the loss of a lane for the buses will not upset the position but a no-stopping regulation for private vehicles must be enforced on both sides. From Melle Street the buses will turn left into Smit Street and then right into Biccard Street and proceed

southwards across Wolmarans Street. South of Wolmarans Street a central reversible bus lane (permanently reserved for buses) will carry the buses along the Queen Elizabeth Bridge (eastern section) to the point where the Sauer Street/Simmonds Street one-way pair intersect. The buses, during the morning peak will then proceed southwards through a specially designed channelisation scheme to the east lane of Sauer Street against the opposing traffic and further south turn off to their respective termini. The express shuttle service will terminate in Pritchard Street between Simmonds and Sauer Streets.

In the morning peak all of these buses, having reached their terminus, will then make their return journey on the normal routes and will receive no assistance. The outgoing volumes of traffic are light at this period and assistance is not warranted.

It should be noted that the reservation of the bus lanes in Melle Street and Sauer Street is for the peak period only, as the buses in the off-peak period will encounter no problems in using Biccard Street and Simmonds Street, the normal south bound one-way streets.

In the evening peak the express buses will proceed from their termini to Simmonds Street where a bus lane will be reserved for them on the western side and they will proceed northwards against the light on-coming traffic. They will then use the central reversible bus lane over Queen Elizabeth Bridge and then run along a reserved lane on the west side of Biccard Street, turn left into Hoofd Street and right again on to the Melle Street link. A no-stopping regulation for private vehicles on Biccard Street will have to be enforced. The return journey during the evening peak will be on the normal system. Once again attention is drawn to the fact that the bus lanes in Simmonds Street and Biccard Street will be reserved for the evening peak two hours only.

On the basis that the parking garage at St David's Place and the Melle Street link are required in the overall plan, the only construction work necessary besides the channelisation mentioned above, is that the eastern sidewalk of the Queen Elizabeth Bridge will have to be cantilevered over the railway tracks as the existing sidewalk will be required to compensate for the lane taken up by the central reversible bus lane.

Crisply the capital expenditure requirements of this project are:-

a. The construction of the St David's Place parking garage required in any case for the overall transportation plan.

b. The construction of the Melle Street link, required in terms of the Major Roads proposals.

c. The cantilevering of the eastern sidewalk of Queen Elizabeth Bridge and the alterations to the surface of the bridge.

d. The channelisation scheme south of the Queen Elizabeth Bridge.

The costs in connection with the alterations to Queen Elizabeth Bridge and the channelisation necessary a little further south are estimated to be R200 000.

Little of this capital expenditure will be wasted when the underground comes into operation as the whole system will revert back to use by private vehicles without any peak hour restrictions.

5.4.2 The southern busway

This project involves the construction of an elevated roadway from the Trojan area to a terminus erected on a deck over the present terminus at Vanderbijl Square which was designed for another deck.

The purpose of the scheme, like that in the north, is to inaugurate an express bus service from the southern suburbs and to encourage a park and ride system from Trojan in anticipation of the operation of the underground and the MC station there.

Commencing from the park and ride garage at Trojan the route will bridge over the S.A. Railway Mineral Line and proceed northwards to the western side of Loveday Street making use of the toe of the slimes dam of Park Central. It will proceed northwards over the intervening streets and the M2 motorway then past the Wemmer parking ground. Up to the Wemmer parking ground the structure will be of a permanent nature. When the need for an express service falls away due to the operation of the underground, this route can be used as a roadway spur to give easy access to and from the parking garage at Wemmer and another proposed garage along its route.

From the Wemmer parking area the route will still remain elevated over Rissik Street and will turn east into Main Street and terminate on an elevated deck over the present terminus at Vanderbijl Square. This latter section of the busway will be of a temporary nature.

The whole length of this elevated way in the interim period would be for the express buses moving in both directions and there would be no intermediate stops. Areas such as Selby would have to be served from the existing system as at present.

This project will prove to be most costly and will require further detailed investigation. Its merits, however, cannot be ignored and particularly as it will have considerable value when available for use by private vehicles

The estimated cost of the project is of the order of R1.50m excluding the cost of the permanent section which will be ultimately used by private traffic.

5.4.3 Bus termini

The present position in regard to the bus termini north of the City Hall is critical. The termini are all on-street with passenger queues congesting the sidewalks. The buses have difficulty in reaching their loading positions and there is considerable traffic congestion in the streets. In the period prior to 1985 there will be a marked increase in the number of buses required to handle the expected higher passenger volumes.

In the course of studying the problem, consideration was once again given to providing through services. There are several factors which have to be taken into account in this connection. In the first instance it is necessary for passenger volumes on each of the legs of the through service to be approximately equal, otherwise certain of the buses will be virtually empty on the journey on the leg with the lesser volume. There are no routes of the Johannesburg service with volumes which permit an efficient through service to be inaugurated. The bus service is running at a considerable financial loss and has a depleted running staff.

Any uneconomical trips will add further to the financial loss and will be a waste of manpower.

Alternatively, consideration was given to a certain number of buses making the through trip (the number of buses required to handle the lesser volume of passengers) and the balance of the buses on the higher volume leg would operate only on that leg. There are a number of disadvantages in this. Scheduling of buses becomes complicated and passengers become confused.

In both cases, accidents or hold ups for other reasons on any one of the legs will hold up the service on the other leg with the consequent discomfort to the bus patrons. As the systems now operate, the hold ups affect only the service on the particular route.

Consideration has also been given to siting the termini further to the south to provide greater coverage in the Central Area. This would mean that the buses would have a greater length of congested central city streets through which to battle with the resulting loss in running efficiency.

It is considered, consequently, that improvements must be effected to the termini situation north of the City Hall. The ideal would be to establish an off-street terminus comparable to that at Vanderbijl Square. The very high costs involved in the acquisition of an extensive site could not be justified. To alleviate the position, however, a compromise with the ideal is essential. It is recommended that a small off-street terminus be provided in Pritchard Street between Harrison and Loveday Streets by acquiring the half-blocks on either side of Pritchard Street. Before finalising on this location, several other sites were investigated, inter alia, Atwell Gardens, on a deck over the railway, Marshall Square and Oribi House. None of the alternative sites served the public as well as the site chosen.

This terminus will provide six off-street loading platforms approximately 160 ft in length. The two existing on-street termini in Pritchard Street will remain. Details of the layout are shown in Figure 5.7. If the terminus is established then it will be desirable to abandon all the Council on-street termini on the western side of Loveday Street in order to facilitate the bus movements from the terminus in a northerly direction along Loveday Street. The Greyhound and Roodepoort termini will remain on the western side of Loveday Street but some of these will be moved northwards once the widening of Loveday Street between Bree and Plein Streets has been effected.

It will also be necessary to have additional on-street termini in Kerk, Pritchard and President Streets between Rissik and Joubert Streets.

When the underground system is in operation, the need for the greater length of loading space will fall away. Part of the off-street terminus in Pritchard Street would then be converted to a short-period parking garage to serve the Retail Core. The garage would straddle the street as has been planned for the garages in Market and Mooi Streets and a sketch in this connection is shown in Fig. 5.8. The on-street termini for the north-eastern routes will also be reduced with the reorganisation caused by the rail rapid system.

If the off-street terminus is not provided then on-street termini will have to be provided in President, Pritchard and Kerk Streets west of Harrison Street which would mean a further extension of congestion on sidewalks and on the streets.

Statistical details are as follows:-

Existing on-street loading	624 metres (2080 ft)
Length required prior to 1985	918 metres (3060 ft)
Difference	294 metres (980 ft)
Length of loading platforms in proposed off-street terminus	387 metres (1290 ft)
Loss due to terminus	162 metres (540 ft)
Gain from terminus	225 metres (750 ft)
Length gained from extending termini to Joubert Street	180 metres (600 ft)
Total gain	405 metres (1380 ft)
Length lost in Loveday Street	93 metres (310 ft)
Nett gain	312 metres (1040 ft)

The cost of the off-street terminus is estimated at R4.0m including land cost.

The terminus at Vanderbijl Square will be adequate in the interim period provided the upper deck is added for the buses from the proposed southern busway. If the upper deck comes into operation within the next few years, there will be a temporary surplus of terminus space at ground level and a route, with an existing on-street terminus, could have its terminus transferred to Vanderbijl Square. This, however, because of the temporary nature, is not recommended.

The existing kerbside termini of the south-western routes in Loveday street will not be sufficient in the interim period and will have to be extended further south down Loveday Street about $\frac{3}{4}$ block to Main Street.

The existing terminus of the western route in Loveday Street, between Market and Commissioner Streets, will not be sufficient in the interim period and will have to extend into Commissioner Street between Loveday and Harrison Streets.

With the advent of the rail rapid system, the above two on-street termini could be abolished and all termini of the reorganised bus routes from these areas consolidated at Vanderbijl Square.

As far as the White bus service is concerned, the termini for the northern routes are the highest priority.

5.5 Non-White Services

It is not proposed to deal with non-White services in this report.

The Bantu are transported mostly by the South African Railways and to a lesser extent by private bus companies and the Johannesburg municipal buses. Travel facilities for the Bantu are by no means adequate and a detailed study is necessary to ascertain what will be required for the future. The Railway Administration are investigating ways and means of increasing the capacity of the rail service and it is uderstood that a proposal is now under consideration.

The Bantu bus termini will also require further study but a project has already been prepared for the Putco terminus at Noord Street. This is a partially underground terminus to be built in conjunction with the proposed extension of Joubert Park southwards into the Union Grounds. The implementation of this scheme is, however, dependent on the release of part of Union Grounds by the Defence Authorities.

The Coloureds are transported largely by private bus companies although many make use of the South African Railway trains as well as the Johannesburg municipal buses. The existing bus termini are barely adequate and will require further study.

The termini or expansion of termini for the non-White bus services in other parts of the city depends largely on Government transportation policy and steps will be taken to improve the position as and when the need arises. They will of necessity receive consideration when the study of the Central Area is taken a stage further.

6. CAR PARKING FACILITIES

There are several types of car parking that have to be catered for in various parts of the city.

In the central area of the city there is the long-period parking of the commuter; the medium-period, say 1 to 4 hours, parking of the shopper or businessman visiting clients, and the short-period parking, up to 1 hour, for the quick purchase or business visit.

In the case of the long-period parking, the car is invariably parked for eight or more hours without being used. The owner does not need the car to earn his living; he is the optional driver and the person most likely to be lured to public transport. This type of parking need not be in the heart of the central area and the judicious control of its provision could be a factor in encouraging a move to public transport.

The medium-period and short-period parking are the most essential for the economy of the city and these should be available at many points within the central area. A person needing this type of parking should be able to find it quickly and conveniently placed relative to his destination.

Outside the central area there are again the three types of parking requirements. In the case of shopping centres, provision must be made for the long-period requirements of the staff but the most important are the medium- and short-period requirements of the shoppers. This latter parking must be attractive and conveniently placed to the shops. Should the shopping centre have a considerable office development the provision of long-period parking space will of course, become important. The maximum demand for long-period parking is on weekdays when the shopping parking demand is not at its highest, but separate provision must be made otherwise the attractiveness of the shopping centre will be affected by office workers usurping medium- and short-period parking space.

In industrial areas outside the central area, parking is becoming a problem. Here the main demand is for long-period parking but sufficient medium- and short-period parking must be available for the essential business visitors.

Another type of parking that has not been used much up to now but must be encouraged, is the park ' ride variety. This is generally long-period parking at present near a good bus service where a worker leaves his car to complete the journey to work by bus. If this type of parking occurs at shopping centres, provision for this parking must be made so that the shoppers' parking is not interfered with.

In order that the required parking and control is provided it is necessary that the Council lay down a clear parking policy.

6.1 Long Period Parking Policy

The parking standards that the Council must require private developers to work to, will vary in various parts of the city. In the Central Complex where the traffic generated by the free modal choice cannot be handled on the road system, parking for non-residential development must be restricted. However, where the road system can handle a free modal choice the parking standards

must cater for the full parking demand.

Present requirements for parking are laid down in the Town Planning Scheme. Briefly the requirement is that, in Height zones 1 and 2 making proportional allowance for privileged uses, buildings on sites of 10 000 C ft^2 or more must provide parking almost equivalent to the area of the site. This compulsory requirement, with all the exemptions does not provide anywhere near sufficient parking space even for the restricted mode. It is essential that developers of new buildings be responsible for the supply of sufficient parking for their building in terms of the modal choice for the area in which the building is situated. Where a building in the Central Complex is prevented by the parking policy from providing sufficient parking for its requirements in terms of the restricted modal choice, then the owners of the building should contribute to the Council sufficient money for the Council to provide the additional parking spaces required.

All residential buildings no matter where situated, must cater for the full parking demand of the occupants.

6.1.1 Central Complex

Note: All references to floor area are in respect of the gross floor area. 100 sq. metres (approx.) equals 1000 ft^2.

It has already been shown that by 1985 the road system within the motorway box will not be able to handle the traffic generated by a free modal choice. It is therefore recommended that long-period parking be eventually prohibited on streets and that a combination of the second and third options discussed previously in "3.3.1 Long-Period Parking Options" be adopted. The basic parking standard proposed is 0.7 spaces per 1 000 ft^2 of office floor area and 0.5 spaces per 1 000 ft^2 of other non-residential floor area. It is proposed that the Central Complex be divided into three zones called Parking Zone A, B & C. Private developers of non-residential buildings over a certain size in each of these zones will be required to provide off-street parking on their property at different standards as detailed below.

Parking Zone A

The Council has already adopted a policy where further parking garages in buildings situated between Rissik and Von Brandis Street and Market and De Villiers Streets (the retail core) are not permitted. There are some garages in this area built before the above policy was adopted.

This area has been marked Zone A in Figure 6.1. It is recommended that the owners of any new buildings, or of buildings being substantially extended, be required to pay to the Council a sum of money proportional to the floor area of the building or extension. This money would then permit the Council to provide, in a fringe parking garage, the number of car spaces in terms of the basic parking standard. That is, office space parking must be provided at the rate of 0.7 spaces per 1 000 ft^2 and for all other non-residential space at the rate of 0.5 spaces per 1 000 ft^2 of floor area.

Parking Zone B

This zone is in the heart of the Inner Central Area surrounding Zone A and covering the main office areas of the city. See Figure 6.1.

In this zone any building on a site of, or in excess of 15 000 ft^2 must provide a parking garage within the building for the use of its tenants. The number of parking spaces must be proportional to the non-residential floor space of the building in the ratio of 0.5 parking space per 1 000 ft^2 of floor area.

Should this development contain office space then, since the restricted long-period parking demand is 0.7 spaces per 1 000 ft^2, the owners must pay the Council a sum of money sufficient for the Council to provide the extra spaces (i.e. 0.2 spaces per 1 000 ft^2) in a fringe parking garage. For development on sites smaller than 15 000 ft^2 the owner must pay the Council a sum of money sufficient for the Council to provide the number of spaces required in terms of the basic parking standard in a fringe garage. Buildings with residential space must provide for 0.5 parking space per dwelling unit and for hotels 1.0 space per 2 rooms.

Parking garages must be of a workable design with adequate sized aisles and parking spaces, such parking spaces must be easily accessible and of reasonable dimensions for average size cars. They should be close to the 18' x 8' bays used in municipal garages.

Parking Zone C

This zone is on the fringe of the Inner Cordon Area and runs up into Braamfontein surrounding the previously mentioned zones A and B. It extends outwards to the boundary of the Central Complex. See Figure 6.1.

In this zone any new building on a site of, or in excess of, 15 000 ft^2 must provide a parking garage for the use of its tenants. The number of parking spaces must be proportional to the non-residential floor space of the building.

For office space parking must be provided at the rate of 0.7 spaces per 1 000 ft^2 and for all other non-residential space at the rate of 0.5 spaces per 1 000 ft^2.

This parking requirement will take care of the buildings parking attraction based on a restricted modal choice, thus the owners will not be required to contribute to Council parking garages.

Buildings with residential space must provide for one parking space per dwelling unit.

A new non-residential building on a site less than 15 000 ft^2 in zones B and C will not be permitted to have a parking garage but since the building will demand parking in proportion to its floor area the owner must be responsible for paying for the provision of the parking. The owner should thus pay the Council a sufficient sum of money to enable it to provide the necessary parking at the basic parking rate required for non-residential buildings.

In all zones the developer should contribute to the cost of the garage structure only, not to the cost of the land nor the extra cost of an underground garage. The contribution should be at a fixed cost per parking

space, reviewed as necessary. The current contribution would be about R1000/parking space. These requirements are summarised in Table 6.1.

TABLE 6.1 : BASIC LONG-PERIOD PARKING REQUIREMENTS : CENTRAL COMPLEX

	Parking spaces per 1000 ft^2 Non-Residential Floor Area (gross)			
		To be provided on site by Private Developer in Zone:[1]		
Land Use	Total	A	B	C
Office	0.7	-	0.5	0.7
Other Non-Residential	0.5	-	0.5	0.5

1. To be provided on sites equal to or larger than 15 000 ft^2

6.1.2 Outside Central Complex

Outside the Central Complex the proposed highway system will cater for a free modal choice and garaging should be provided accordingly.

The developer must be responsible for providing sufficient parking space to cater for the demands of his building. In some instances, for example shopping centres, it may be more advantageous for the Council to provide a consolidated parking scheme and in this case the owners of new buildings should pay the Council in lieu of providing their own parking.

The amount of parking required varies in terms of use, size, situation of the development and the income group and class of person being served. Research both in this country and overseas has revealed that a formula of standards cannot be applied with any degree of certainty. Certainly more research is required insofar as Johannesburg is concerned, but the suggested standards contained in Tables 6.2 and 6.3 should be applied as an interim measure.

TABLE 6.2 : PARKING INDICES OUTSIDE CENTRAL COMPLEX

Land Use	Parking Index per 1000 ft^2 floor area (gross)
Retail	6.0
Offices	2.0
Warehouses : Wholesale	1.5
Industry	2.0
Cinemas	1 space/10 seats
Hospitals & Nursing Homes	1 space/1.5 bed

All residential buildings must provide sufficient off-street parking space for the parking they generate and in general residential areas provision must be made for visitors parking.

Car ownership in general residential areas varies with the income group, size of dwelling unit and distance from city centre, thus garaging requirements should be based on these factors. The owners of all new buildings must be responsible for providing this parking within the layout of the development. The recommended number of spaces per dwelling unit are given in Table 6.3 .

TABLE 6.3: PARKING INDICES FOR GENERAL RESIDENTIAL AREAS OUTSIDE CENTRAL COMPLEX

Income Group	Parking space per dwelling unit			
	Dwelling Unit Size			
Flats	1 room	2 rooms	3 rooms	4 rooms or more
High	1.0	1.3	1.6	2.0
Upper Middle	1.0	1.3	1.6	2.0
Lower Middle	1.0	1.0	1.3	1.7
Low	0.8	0.8	1.0	1.2
Hotels	0.5 spaces per room			

6.2 Medium-Period Parking Policy

The most critical area in need of a clearcut short- and medium-period parking policy is the Central Complex. This area is developed to such a density that on-street parking, the normal provider for this parking, is insufficient and it becomes essential to provide off-street facilities.

As mentioned before, medium and short-period parking space is vitally necessary to the good of the economy of the city. It is therefore recommended that where on-street parking is insufficient, the second option discussed under "3.3.2 Short-Period Planning Options" be adopted. In this option the Council will provide the necessary medium- and short-period parking space with possibly some voluntary help from private developers.

From the studies that have been made the standards given in Table 6.4 are recommended for medium- and short-period parking provisions.

TABLE 6.4 : MEDIUM- AND SHORT-PERIOD PARKING REQUIREMENTS : CENTRAL COMPLEX

Land Use	Parking Spaces per 1000 ft^2 floor area (gross)
Office	0.2
Retail	0.5
Other non-residential	0.1

6.3 Parking Facility Requirements

6.3.1 Central Complex

As mentioned before the owners of larger developments in the Central Complex should be responsible for providing parking for the occupants of their building either wholly or partially directly and/or paying

the Council to provide for the necessary shortfall. The parking actually provided by owners of the larger development should cater for the essential car parking in most areas and possibly some of the optional car parking in a few areas. The Council will have to build garages for the shortfall of medium-period parking and the shortfall of long-period parking up to the limit of the mode restriction adopted.

The principle of the Council has been, and should continue to be, to build larger garages for long-period parking on the fringe of the Inner Central Area. Smaller garages for medium-period parking should be built within the Inner Central Area conveniently placed to shopping and business premises. The short-period parking should be accommodated at the kerb side under parking meter control and also in the medium-period garage. Parking at the long-period garages should be sold at a realistic fixed price for the whole day. This realistic price must not be too low or it will encourage excessive use of the car for work and thus defeat the policy of restricted modal choice to the Central Complex.

Parking at the medium-period parking garages should be charged at a varying rate depending on the length of parking. Short periods should be realistically inexpensive and as the period lengthens the cost should increase very rapidly so that to park for a whole working day is too expensive. This form of pricing is essential to ensure that the garage is available for the shopper and the businessman's visits.

The pricing policy should be such that the garages as a whole are self-supporting; the stronger ones subsidising the weaker ones. However, the pricing policy must also be used to encourage the modal choice option accepted for the transportation plan.

The medium-period parking garages are considered absolutely essential to the economy of the city and it is the Council's duty to provide these in sufficient numbers, well located and to ensure that they are used for the purpose for which they were provided.

The proposed highway plan discussed earlier envisages a restricted modal choice for trips bound to the Central Complex. This policy depends very heavily on the success of a park and ride system thus the main feature of the parking plan is a number of very large parking garages on the motorway box directly connected to stations on the proposed rail rapid transit system.

Even with a restricted modal choice the Inner Central Area will not be able to handle all the traffic destined to it so the second feature of the parking plan is a number of large parking garages on the fringe of the Inner Central Area. In arriving at the number and the size of the garages to be provided by the Council an estimate has been made of how many spaces would be provided by owners of future developments.

The third feature of the parking plan is the proposed provision of smaller garages within the Inner Cordon Area specifically to cater for the medium-period parker.

The parking spaces required, based on the standards discussed previously, together with the deficiencies are given in Tables 6.5 and 6.6 respectively for long-period and short-period parking.

TABLE 6.5 : LONG-PERIOD PARKING SPACES

District	Total Required [2]	1965 Provision [2]	Short Fall	Private Provision	By Council
30 E [5]	3460	- [4]	3460	860	2600
30 W [6]	3370		3370	770	2600
40	840 [1]	110	730	280	450
41	4760	1680	3080	1540	1540
Total 40 & 41	5600	1790	3810		1990
42 [8]	1510	- [9]	1510	200	1310
43	7480	4410	3070	400	2670
44	6410	4020	2390	800	1590
45	11110	5700	5410	1200	4210
46	7380	1600	5780	1850	3930
Total 43 - 46	32380	15730	16650		12400
47	1580	- [4]	1580	250	1330
48	3910	- [4]	3910	300	3610
Total 47 - 48	5490		5490		4940
50	2290	380	1910	270	1640
60	2530	350	2180	180	2000
Total 50 - 60	4820	730	4090		3640

1. Excludes Education fringe and Showgrounds and S. A. R. complex
2. Excludes privately owned open lot parking and residential parking
3. Estimated
4. Private off-street parking unknown assumed to be negligible
5. Within Central Area
6. Outside Central Area
7. Excludes parking for residential buildings
8. Portion of District 42 south of Van der Merwe Street but excluding the Hospital Zone
9. 1965 Provision of off-street parking assumed pre-empted by residents

TABLE 6.6 : MEDIUM- AND SHORT-PERIOD PARKING SPACES

	District	Total Required	On-street Parking [2]	Existing Off-street Parking	Short-Fall
	30 E	1070	1040	-	30
	30 W	1010	2050		Surplus
	40	240 [1]	480	-	Surplus
	41	1620 [1]	1370	-	250
Total	40 + 41	1860	1850		
	42 [3]	750	2510	-	Surplus
	43	3140	940	570	1630
	44	2290	1620	390	280
	45	3680	1420	350	1910
	46	2360	2070	-	290
Total	43 - 46	11470	6050	1310	4110
	47	390	350	-	40
	48	970	1470	-	Surplus
Total	47 - 48	1360	1820		
	50	530	1140	-	Surplus
	60	690	2140	-	Surplus
Total	50 & 60	1220	3280		

1. Excludes Educational fringe and Showgrounds and S. A. R. complex
2. 1965 on-street parking reduced by 20% to allow for possible all day no parking on additional streets
3. Portion of District 42 south of Van der Merwe Street but excluding the Hospital Zone

It will be noted from Table 6.6 that provided the long-period parking is accommodated off-street the 1985 medium- and short-period parking can be handled at the kerb outside the Inner Cordon Area and Braamfontein East. To ensure that kerb side parking is available for this type of parking, the parking meter area must eventually extend over the whole Central Complex. When no medium-period garages are to be provided, the parking meters should permit longer parking than the usual one hour.

The proposed parking garages, in and around the Central Complex, to cater for the deficiencies outlined above, are shown in Figure 6.2 and summarised in Table A7 in the Appendix. The estimated costs of these

garages are summarised in Table 6.7.

The land for the majority of the parking garages in the Central Complex has already been purchased, thus the estimated cost of land still to be purchased is estimated to cost only R6.0m.

If the parking policy outlined in section 6.1.1 is accepted, then private enterprize will contribute a proportion of the capital required for garage construction. Provided the parking fees are made realistic for the type of parking provided, the garages as a whole will be self-supporting and once constructed will not be a drain on the Council's finances, in fact, they could contribute to other aspects of the transportation plan.

The proposed long-period garages will provide sufficient parking space for the anticipated parking demand on the basis of private enterprize providing a certain number in developments on sites over 15 000 ft^2. If a smaller number of developments take place on sites in excess of 15 000 ft^2 than estimated, then the proposed garages will not be sufficient. The position will have to be carefully watched as the city develops.

It has not been possible to provide, economically, on a district basis, sufficient sites in the Inner Cordon Area for the anticipated medium-period parking demand. With the garages proposed Districts 43, 45 & 46 will be about 600, 300 and 300 spaces short respectively. However, it is anticipated that District 44 will have a surplus of nearly 400 and in District 46 the Carlton Centre development will provide about 1 200 medium-period spaces. Thus, although there will be a shortage of conveniently located medium-period parking, on the whole sufficient should be available. The position, however, must be carefully watched and when necessary some of the long-period garages within the Inner Cordon Area must be changed to cater for medium-period parking. This will probably cause a change in the modal split in favour of public transport.

The proposed garages are now briefly described.

TABLE 6.7 : ESTIMATED COSTS OF PROPOSED COUNCIL GARAGES

District	Area	Type[1]	Spaces	Construction Cost
30	Newtown District	L	6 100	R 6.19m
40 & 41	Braamfontein	L	3 800	R 3.82m
42	Hillbrow	L	1 330	R 1.37m
		M	140	R 0.14m
		R	750	R 0.68m
43 to 46	Inner Cordon Area	L	11 240	R12.14m
		M	3 240	R 3.24m
47 & 48	Selby-Village	L	5 400	R 5.22m
50 & 60	Doornfontein-Wolhuter	L	3 550	R 3.20m
	Total		35 550	R36.00m

1. L = Long-period, M = Medium-period, R = Residential parking

(a) Inner Cordon Area : Long-Period Garages

1. Kazerne 2 Garage extension: This consists of the extension of the existing garage over the small open parking area on the west to provide an additional 540 spaces. This project is already under construction.

2. Kazerne 3 Garage: This is a new garage over the existing open parking area on the west of Kazerne 1 and will provide an additional 600 spaces.

3. West Street Garage: This is a very large new garage to be erected over the site of the old No. 1 tram sheds at the corner of West and President Streets. This will provide 2 000 spaces and although in District 30 just outside the Inner Cordon Area, it will be used mainly by drivers with destinations in Districts 43, 45.

4. Mooi-Jeppe Streets Garage: This garage will span over Mooi Street between Jeppe and Kerk Streets. The first notice of expropriation has already been served on the property owners and the result of the Commission of Inquiry is awaited. This garage will provide 640 spaces.

5. Jack Mincer Garage Extension: This project will extend the Jack Mincer Garage northwards under the proposed underground Bantu Bus Terminus. This project which involves the replacement of the Noord Street bus terminus by a facility under the extension of Joubert Park southwards into Union Grounds, will depend on the evacuation of the northern portion of the Union Grounds by the military. This extension will provide an extra 400 spaces.

6. End Street Park Garage: This is an underground garage under the End Street Park to provide 700 car spaces.

7. Wemmer Garage: This garage will be built on the existing Wemmer open parking area to provide an extra 2 000 car spaces. It will operate in conjunction with the southern busway when it is used by private cars after the opening of the rail rapid system. The ground is undermined and special structural precautions may be necessary.

8. Hall Street Garage: This garage on the south side of Hall Street will provide 2 000 car spaces.

9. Anderson/Nugget Street Garage: This garage will be built on a site bounded by Anderson, Nugget, Albert and Goud Streets and will extend under Port Plein north of Anderson Street. The first notice of expropriation has already been served on the owners of the required property and the result of the Commission of Inquiry is awaited. This garage will provide 1 000 car spaces.

10. Wright Boag Garage: This garage will replace the present open parking on this site and will provide an extra 500 parking spaces.

11. Bantu Sportsground Garage: This garage will be built on the site of the old Bantu sportsground to provide parking for 2 500 cars. The ground is undermined and special structural precautions may be necessary.

(b) Inner Cordon Area : Medium-Period Garages

1. Atwell Gardens Garage: This will be an underground garage under the park and will provide 400 spaces.

2. Pritchard St Terminus Garage: This garage will be built over the proposed Pritchard Street off-street bus terminus between Harrison and Loveday Streets. It will span over Pritchard but can only be built after the opening of the rail rapid system when the full bus terminus will no longer be required. The garage will provide 600 spaces.

3. Market/Mooi Streets Garage: This garage will span over Market Street between Mooi and Polly Streets. The first notice of expropriation has already been served on the owners of the required property and the result of the Commission of Inquiry is awaited. This garage will provide 640 spaces.

4. Marshall Square Garage: This is an underground garage under the park to be made on Marshall Square. The site is rather small and the garage will have to project under the adjoining roads. This garage will provide 600 spaces.

5. Vanderbijl Garage Extension: This extension will use the extra bus floor to be built over Vanderbijl bus station. This floor will become redundant when the rail rapid system is opened and by the construction of another level above this, 400 extra car spaces can be obtained. This extra level will have to be investigated to verify that it is structurally possible.

6. Market/Kort Streets Garage: This garage will require the expropriation of property between President and Market Streets west of Kort Street. This garage will provide 600 car spaces.

(c) Braamfontein Area: Long-Period Garages

1. Jorissen/Simmonds Streets Garage: This garage is situated on the west side of Simmonds Street between Jorissen and Stiemens Streets. The site has already been expropriated and the proposed garage will provide 850 car spaces.

2. Smit/Melle Streets Garage: This garage is situated on the east side of Melle Street between Smit and Juta Streets. The site has already been expropriated and is being used for open lot parking. The garage will provide 600 car spaces.

3. Smit/Harrison Streets Garage: This garage is situated on the east side of the Harrison/Simmonds Streets link between Smit and Juta Streets. The site has already been expropriated and will provide a garage of 600 car spaces.

4. Henri/De Korte Streets Garage: This garage is situated on the west side of Henri Street between De Korte and Juta Streets. The site has already been expropriated and the garage will provide 750 parking spaces.

5. Hoofd Street Garage: This garage is situated underground on the north side of the Civic Theatre and under Hoofd Street. It is to be built in conjunction with the proposed Civic Centre road scheme

through the Fever Hospital. The garage will take traffic from the proposed M6-Simmonds Street Link. This garage will provide 1 000 parking spaces.

6. Old Brewery Site Garage: This garage, situated west of Melle Street and north of Ameshoff, is not proposed for construction by 1985 if the other garages are built but the reservation of the site is necessary. It will be found necessary at some future date, to convert possibly the Jorissen/Simmonds Streets Garage into a medium-period garage and then it will be necessary to build the Old Brewery site garage for long-period parkers. A 1 000 space garage should be considered.

(d) Hillbrow Area : Long-Period Garages

1. Berea Park Garage: This is an underground garage at the west end of Berea Park. It is on the east boundary of Hillbrow bounded by Caroline, Alexandra Streets and Joel Road. It will provide the Hillbrow area with 430 car spaces. The park will be carried over the garage. The Council owns the property.

2. Caroline/Olivia Garage: This garage is also on the east boundary of Hillbrow on Olivia Road. It will provide the Hillbrow area with parking for 300 cars. The Council owns the property which is narrow and more suited to medium-period parking than long-period.

3. Esselen/Claim Garage: This garage is situated north of Esselen Street between Claim and Banket Streets immediately behind the shopping area. This garage will provide excellent medium-period parking for this area but because of the shortage of long-period parking is recommended for long-period parking initially. The garage will provide 300 car spaces. The Council owns the property. The site is narrow and more suited to medium-period parking than long-period.

4. Leyds/Claim Garage: This garage is situated in Leyds Street between Claim and Banket Streets. The garage will provide 300 car spaces. The Council owns the property which again is narrow and more suited to medium-period parking.

(e) Hillbrow Area : Medium-Period Garages

1. Esselen/Edith Cavell Garage: This small garage, combined with a Bantu bus stop, is situated on the north-west corner of Esselen and Edith Cavell Streets. The Administrator has approved the expropriation of the property. The garage will provide parking for 140 cars.

(f) Hillbrow Area : Residential Parking Garages

1. Jager Street Garage: This garage is situated on Jager Street between Claim and Banket Streets. The property is owned by the Council. The garage will provide about 250 spaces for residents of the area.

2. Goldreich/Claim Garage: This garage is situated on Goldreich Street between Claim and Quartz Streets. The property is owned by the Council. The garage will provide about 200 parking spaces for residents of the area.

3. Pietersen/Twist Garage: This garage, situated on Pietersen Street between Twist and Quartz Streets, was proposed some years ago but the property has not yet been acquired. The garage will provide about 300 parking spaces for residents in the area.

(g) Selby-Village Area : Long-Period Garages

1. Webber Street Garage: This garage is in mining land at the intersection of Webber Street and Earp Street Extension. It will provide parking for 1 500 cars.

2. Railway Siding Garage: This garage will be built above the railway exchange yard west of Loveday Street immediately north of Park Central. It will provide parking for 1 200 cars.

3. Rosettenville Road/Hulbert Streets Garage: This garage will be built on mining ground east of Rosettenville Road. It will provide parking for 1 500 cars.

4. Loveday/John Streets Garage: This garage will be built south of John Street in connection with the spur from the proposed motorway M4 It will provide 1 200 parking spaces.

(h) Doornfontein/Wolhuter Area: Long-Period Garage

1. Rockey/Sherwell Streets Garage: This garage will be situated on the south side of Rockey Street between Sherwell and Buxton Streets. The first notice of expropriation has been served on the owners of the required property and the result of the Commission of Inquiry is awaited. It will accommodate 600 cars.

2. Error Street Garage: This garage will be situated between Error, Staib, Angle and Van Beek Streets. The first notice of expropriation has been served on the owners of the required property and the result of the Commission of Inquiry is awaited. The garage will provide 850 spaces.

3. Mia Mia Garage: This garage will be situated on the site of the old Mia Mia Beerhall east of Berea Street. It will accommodate 1500 cars. Open lot parking can also be associated with it under and around the on- and off-ramps of the Berea Street viaduct.

4. Gilfillan Park Garage: This garage will be situated on the north side of the proposed extension of Fawcus Street through the park. The garage will provide 600 spaces and can be extended on the southern portion of the park well in the future.

(j) Newtown : Long-Period Garages

1. Abattoir Garage: This garage will fit in with the redevelopment of Newtown and the spur from Motorway M3. It will accommodate 1 500 cars.

2. Anderson/Wolhuter Streets Parking Area: This parking area is situated on mining ground south of Anderson Street opposite Wolhuter Street. A parking area is presently run by Rand Mines. This must continue either as a private enterprize or expropriated by the Council. If ground conditions permit, a garage should be built for 1 000 cars.

3. Bree/Malherbe Streets Garage: This garage will be situated on the south-east corner of Bree and Malherbe Streets. It will accommodate 1 000 cars.

4. May Street Garage: This garage wil lbe situated south of Clare Street on the improved May Street link from Motorway M3 and either between the two one-ways of Crown and Mint Streets from the Solomon Street scheme or east of Lilian if it proves more convenient to link Solomon Street with Central and Lilian. The garage will accommodate 600 cars.

6.3.2 Park and ride facilities

The proposed transportation plan is heavily dependent on the success of public transport and it is considered that the best chance of ensuring this success is the provision of easily accessible parking garages connected to the proposed rail rapid transit system. These garages must be located just outside the congested roads that will develop on the fringe of the Central Complex. They must be designed to provide easy, quick, comfortable, weather protected transfer from the motorist's car to comfortable, fast rail rapid transit.

Consideration should be given to reasonably priced parking on a daily basis such that the parking fee includes the cost of a return train ride to and from the Inner Central Area. This parking fee must be reasonable and will probably have to be subsidised by the long-period parking fees within the Central Complex.

The park and ride garages must be integrated with the rail rapid transit stations and those proposed for 1985 have been discussed in section 5.3. For completeness these are summarised below in Table 6.8.

TABLE 6.8 : PARK & RIDE GARAGES AT RAIL RAPID STATIONS

Station	Capacity	Construction Cost
Houghton Golf Course	2 000	R 1.80m
Yeoville (43)[1]	700	R 0.63m
Parktown (44)	2 500	R 3.25m
San Souci (45)	1 500	R 1.35m
Parkview	3 000	R 2.70m
Rosettenville Corner	3 000	R 3.60m
Trojan (46)	4 500	R 4.05m
Mayfair (47)	1 500	R 1.95m
Bertrams (48)	1 500	R 1.35m
Jeppe (49)	1 000	R 0.90m
Total	21 200	R21.58m
Estimated cost of property	R1 000 000	

1. Numbers in brackets refer to Figure 6.2

6.3.3 Outside Central Complex

The Council should not have to provide any parking facilities to new developments outside the Central Complex but many of the older developments are critically short of parking and it might be necessary for the Council to provide parking facilities in these areas.

At present a certain amount of parking takes place at several bus termini and with improved public transport particularly when the rail rapid transit is operating this parking at bus termini could quite easily increase. This would necessitate the Council providing more off-street parking facilities. No recommendations are made for these in this report but this is a phenomenon that should be studied in the continuing transportation study process mentioned later.

6.4 Truck Loading

Wherever possible new developments must allow for all truck loading and un-loading to take place within the development. On-street loading and un-loading should be done away with whenever possible. Within the Central Area, however, and indeed in many places within the remainder of the Central Complex, it is only development on large properties that will be able to handle loading and un-loading within the property.

In areas where loading and un-loading has to be done from the street, this must take preference over on-street parking. Sufficient loading bays must be provided to ensure that all trucks can load next to the kerb and are not forced to double park for loading.

6.5 On-Street Parking

Within the Central Complex on-street parking, where permitted, should be reserved for the short-period parker. The most satisfactory way of controlling this is by parking meter. It is therefore proposed that the present parking meter zones in the Inner Central Area, Braamfontein and Hillbrow be gradually extended

7. TRAFFIC ENGINEERING, EDUCATION AND ENFORCEMENT

The transportation facilities outlined in the preceeding chapters do not constitute the total transportation plan - it will still be necessary to ensure that traffic uses these facilities safely and efficiently. This can only be accomplished by the three 'E's of traffic, viz. traffic engineering, education and enforcement. Certain aspects of traffic engineering (viz. traffic control devices and regulations) together with enforcement, are discussed under traffic control.

7.1 Traffic Control

One of the objectives of the transportation plan is the alleviation of congestion and the reduction of travel time. Another objective is the increase of road safety. The elements of the plan already recommended go a long way to the realisation of these objectives but traffic control, in the form of traffic control devices, regulations, enforcement and education, is essential for the full realisation.

7.1.1 Traffic control devices

The most important traffic control device is the traffic signal and recommendations are made for the control of signals in the manner in which they are presently used and for the control of signals in the manner required by the aforementioned highway recommendations.

Johannesburg has a very great number of traffic signals. In the 3.9 sq. km (1½ sq. miles) of the Central Area there are just on 200 signals. This is brought about by the very small blocks that have been the curse of the city from a traffic point of view. The design of the optimum settings for this number of signals is an immense task and the use of computers must be investigated.

For the improvement of the control of signals used at normal street intersections to cater for the continual growth of traffic, the following recommendation of the Chief Traffic Officer in his report "Traffic Control Study Tour - 1968" should be carried out.

> "That the Council requests firms to carry out studies in Johannesburg and recommend improvements to the existing system by the incorporation of computer control or the introduction of a new computer control system."

The installation of television surveillance equipment at selected key intersections should be considered. This was recommended in the Urban Transportation Report approved by Council in November 1964 but its implementation becomes more urgent now. The Operational Traffic Engineering Branch, (see 7.3.1) must investigate the best means by which these recommendations can be put into effect.

To further the attainment of the objectives of reductions of travel time, serious consideration must be given to the greater use of vehicle actuated signals.

Vehicle actuation should be used in all isolated installations and even in some instances where a series of signals are synchronised or under a master controller. Vehicle actuated signals certainly cost more to install and maintain but the reduction of delays and frustrations caused by unnecessary long stops are well worth the extra cost.

The proposed motorway system, as well as the present motorway system, will be required long before it can be constructed. This will result in the existing motorway and sections of the proposed system, as they are opened, being subjected to severe overloading. In order to ensure that reasonable operating conditions are maintained, a motorway surveillance system using television and possibly a metering system controlling signal at on-ramps will be essential on the present as well as on the future motorway system.

Television surveillance is being increasingly used overseas on urban motorways and its purpose is to inform control centres how traffic is running on various sections of the motorways so that any necessary control or emergency measures can be taken as early as possible to prevent congestion.

The state of the techniques of motorway surveillance in numerous countries was studied by the Chief Traffic Officer and is well covered in his report "Traffic Control Study Tour - 1968".

A motorway surveillance system must be installed in Johannesburg and the Operational Traffic Engineering Branch must investigate with specialist firms the design of a suitable system.

The computer control systems for signals and motorway surveillance systems are highly technical and specialised so no estimate of their cost can be given at this stage. It is, however, recommended that R20m be allowed at this stage.

7.1.2 Regulations

It is not proposed to recommend any detailed regulations in this report. The promulgation of regulations is an operational function and any new regulations that may be required will be determined by the Traffic Department and the Operational Traffic Engineering Branch in the course of their duties and studies.

The following items, however, should be emphasised:

Great care must be given to the design and placement of regulatory signs to ensure the message is unambiguous and attention-attracting. Consideration should be given to the use of internally illuminated signs particularly in connection with movement restrictions at signalised intersections.

One of the objectives of the transportation plan is the maximum use of existing transportation facilities. This is extremely important because in analysing the road requirements, it was assumed that their capacity in peak periods would not be reduced by parked vehicles. It is therefore essential that the "No Stopping" regulation be still more widely used not only in peak periods but in some places all day. In the

morning its starting time must be earlier than the 7.45 a.m. currently used in some areas. This earlier starting time was recommended in the Urban Transportation Report approved by Council in November 1964 but its implementation is now essential. The morning "No Stopping" regulation should start not later than 7.15 a.m. and in some places outside the Central Complex 7.00 a.m. would be more appropriate.

With the predicted increase in traffic volumes the all day "No Parking" regulation will have to be more widely used on arterial roads. In fact the time must arrive when all designated arterial roads in the Central Complex must be cleared of parking.

Loading zones for trucks serving businesses must take priority over kerb side parking. It is essential that a sufficient length of loading zone be allocated to each block face to prevent the excessive double-bank loading that takes place at present.

Having due regard for the requirements of free movement and truck loading, all on-street parking should gradually be designated for short term parking throughout the Central Complex. For ease of control this will necessitate the gradual extension of the parking metered areas.

7.1.3 Enforcement

One of the principles adopted in developing this plan was that the necessary manpower would be available for traffic enforcement. The availability of sufficient enforcement personnel is absolutely vital to the success of this plan.

The growth of traffic volume will be faster than the speed with which the necessary road capacity can be provided. It is therefore essential that ways and means be found to overcome the present shortage of enforcement personnel and that the establishment be suitably increased in keeping with the growth of traffic.

A vigorous continuing campaign against moving violations and double parking, the enforcement of all regulations affecting the moving vehicle e.g. lane usage, entry and turn restrictions, pedestrian regulations, etc., is necessary for the smooth, safe operation of the roads. The enforcement of the on-street parking time limits is no less important as the success of the short-period parking plan is dependent on parking space being available at the kerbside. This in turn will help alleviate congestion by reducing cruising in search of parking.

7.2 Education

With the heterogeneous vehicle driver population of Johannesburg and its environs, education is an aspect of traffic management which has been but which cannot continue to be neglected. This matter was discussed in the Urban Transportation Report approved by Council in November 1964 but it is now critical that a realistic and vigorous continuing campaign be formulated.

Education is so important that it can no longer be vaguely included in the function of the Traffic Department. A specific section, preferably in the Traffic Department, must be set up with the sole responsibilities of educating all racial groups of the metropolitan driving and pedestrian public who frequently use Johannesburg's road system.

This education section must be allocated an adequate annual budget, which must be substantial to enable it to tackle this extremely difficult task by the best means available. The use of private advertising and public relations organisations to get the message across to the various racial groups, should not be overlooked.

7.3 Traffic & Transportation Engineering

The transportation plan outlined in the preceeding chapters is a colossal proposal designed for anticipated 1985 traffic. However, the growth of the city will not stop at 1985 so it is therefore essential that this plan be reviewed at least every five years in the light of current developments. This will enable the transportation plan to be adjusted so that it will continually be able to cater for anticipated traffic 15 to 20 years ahead.

This will virtually mean a continuing transportation and land use study by a small team of engineers and planners.

The proposed transportation plan entails a vast construction programme and it will take manyy years to catch up the back-log. In the meantime the traffic will increase and so will congestion; it is therefore absolutely essential that everything be squeezed out of the present transportation system to keep congestion within reasonable bounds. In order to do this a really strong, active operational traffic engineering branch is vital.

7.3.1 Operational Traffic Engineering Branch

An adequate staff of technical personnel, with a suitable organisation is essential to the proper performance of the traffic engineering function. From a study of leading cities in the U.S.A., as reported by the National Safety Council, it would appear that there are an average of 4.0 fulltime traffic engineers per 100 000 people in the cities. This figure does not include non-professional personnel. From another source it appears that in large cities in California the average is about half this figure being 1.73 professional traffic engineers and 1.04 technical aides for every 100 000 people.

Using these criteria and the White population of Johannesburg, it would mean in the first case Johannesburg needed about 16 traffic engineers in 1965 and about 26 in 1985. In the second case 7 traffic engineers and 4 technical aides were needed in 1965 and about 11 traffic engineers and 7 technical aides in 1985. At present there are 6 qualified traffic engineers in Johannesburg. It would therefore be necessary to double the number of qualified traffic engineers by 1985 and to ensure there is an adequate supporting staff of technicians.

In very large cities in the U.S.A. (e.g. New York, Los Angeles) the traffic engineering functions are carried out by a separate department but normally in cities over a population of 200 000 the traffic engineering functions are performed by a branch in the city engineer's department. The traffic engineering branch, of course, works in very close co-operation with the enforcement department.

(a) Traffic Engineering Functions

The main functions of the operational traffic engineering (T.E.) branch should be:

(1) collect and analyse statistics
(2) to carry out studies to improve traffic flow

(3) investigate all road designs and building developments from an operational aspect

(1) Statistics

Statistics are vital in any management position and this is no less the case in traffic management, to use the British term or in traffic engineering to use the American term.

Statistics must be continuously collected so that trends can be studied and so that trouble spots can be highlighted for subsequent detailed study.

A vehicle counting programme, using automatic counters, was started about a decade ago. This valuable programme must now be extended considerably and the motorway system brought into the programme. More sophisticated permanent counting facilities should be installed at key counting stations.

A programme for the regular counting of certain key intersections should also be instituted.

At the start of the Greater Johannesburg Area Transportation Study, a series of screenline and cordon counting programmes were started and have been continued at regular intervals. These counting programmes are invaluable for obtaining trends and should now be taken over by the operational T. E. branch.

A series of speed and delay surveys were carried out at the start of the study; these should become a regular survey of the T. E. branch. It is recommended that instrumentation such as that developed by the Road Research Laboratory in Britain and used in London and Glasgow be obtained for the collection and speedy analysis of data for these surveys.

The T. E. branch must also make a detailed study of accidents co-ordinating these data with the vehicle counting and speed and delay data.

(2) Studies

It will always be necessary, because of restricted finances and the desire of the people to use their cars, to operate the existing transportation system in the most efficient way possible. The best way to achieve this is for the operational traffic engineering branch to set up a comprehensive programme of detailed studies to improve the operating deficiencies shown up by the statistical surveys mentioned in 1 above.

A programme should be set up to correct say the worst ten accident or congestion points each year.

An essential programme mentioned in Chapter 5 is a detailed study of the major bus routes in an attempt to speed up the bus service by the use of traffic engineering techniques.

Trouble spots can often be alleviated by inexpensive schemes and it is essential, if relief is to be had expeditiously, that a vote be available in the estimates to permit these small improvements as and when required. This point was also raised by the Chief Traffic Officer in his "Report on Traffic Control Study Tour - 1968".

(3) Plans Investigations

The operational T. E. branch must study all road schemes prepared by other branches and consultants for adequate geometric features and consistency and safety in operation. All developments, private or public, which attract or generate traffic must be studied by the T. E. branch to ensure that the operational characteristics of the surrounding roads are not unnecessarily adversely affected.

Traffic conditions in Johannesburg have reached the stage where a dynamic operational T. E. branch is now essential. There is the need for more traffic engineers and many more technicians.

Traffic engineering is no substitute for the transportation facilities recommended in Chapters 4, 5 and 6 and it cannot perform miracles but it can ensure that full value is obtained from the existing road system.

The importance of a strong operational traffic engineering branch cannot be stressed strongly enough.

7. 3. 2 Public Transport Operational Traffic Engineering Section

The T. E. branch discussed in 7. 1 above will have to deal with all traffic operations on a city-wide basis and may not therefore be aware quickly enough of operating difficulties of the bus service. It is therefore considered that the Transport Department should have a small traffic engineering section to survey bus routes and bring to the notice of the T. E. branch any operational difficulties that may need detailed study.

The functions of such a traffic engineering section would be to carry out and analyse a regular bus timing programme, (in Glasgow certain bus routes are timed every Friday) speed and delay studies on buses, regular cordon and screenline passenger counts and load studies similar to those done at the start of the Greater Johannesburg Area Transportation Study.

Close co-operation between this section, the T. E. branch in the City Engineer's Department and the Traffic Department, the enforcement department, is of course, most essential.

7. 3. 3 Continuing transportation and land use study

The Greater Johannesburg Area Transportation Study (GJATS) was seriously delayed by the lack of past statistics. This should never be permitted to occur again. In 7. 3. 1 it has been recommended that the traffic engineering studies started for the GJATS should be continued by the operational T. E. branch.

While short range planning can and should be handled by the operational T. E. branch, the long range planning is best handled by a small group of engineers in the Forward Planning Branch, removed from the hurly burly of day to day operations.

This group should, in fact, carry out a continuing transportation and land-use study making adjustments to the plan as more information and data on trends become available.

Because of the phenomenal growth of the greater Johannesburg area in the last decade, the 1970 national population census will be vital for checking the predictions made in the transportation plan. When the results of this census become available, the present plan will have to be reviewed and extended to 1990 or 1995.

While it may not be necessary to carry out the extensive surveys done by the GJATS e. g. the Home Interview Origin Destination Survey, the External Origin Destination Survey etc., it will be necessary to carry out updating surveys on a smaller scale. These surveys should be carried out by the Forward Planning Branch but all the trend data of traffic operation should be obtained from the operational T. E. branch.

Once a decision has been taken on the Transportation Plan and action taken to safeguard the corridors and to implement the Plan, steps must be taken to produce a Comprehensive Plan to integrate the future Land-Use pattern with that of the Transportation Plan.

The approved Transportation Plan will provide the framework of the form of Johannesburg of the future. The most important question to be answered is "What form do we want for our city?". A report on this issue will be the first to be submitted following adoption of the Transport Plan.

High on the priority of the studies to be undertaken will be that of the Central Area. Underground stations, bus termini and the proximity of parking garages will cause a rethinking by developers and planners alike on the development potentialities of different zones in the Central Area. New pedestrian movement patterns will develop. The clash between the pedestrian and the vehicle will become more acute and major planning action will have to take place.

Each of the cells created in the city will have to be studied in detail in respect of its population, its environment, its amenities and facilities, and recommendations made in regard to improvements which should be effected.

The Transportation Plan will bring in its wake pressures from private investors for new shopping centres, decentralised work centres, higher densities and so on. The Comprehensive Plan must anticipate these pressures and ensure that any future changes are made in terms of the overall plan and not decided on an ad-hoc basis. The huge investment of public money in the transportation facilities must be protected against wrong land-use decisions which may weaken the efficiency of the system.

It is essential that the valuable and extensive Land-Use data bank is kept up to date by the Forward Planning Branch as this provides the statistical base for future decision-making action.

An associated task of the continuing transportation and land use study will be the preparation and giving of evidence for the acquisition of property needed for the transportation plan. A great deal of property will have to be expropriated and it is fairly certain that there will be objections to the expropriation in almost every individual scheme. This will entail numerous commissions of inquiry and the preparation of evidence for and attendance at these commissions can be very time consuming.

The continuing study must therefore have sufficient staff to handle these functions if the continuing study itself is not to suffer.

8. PROGRAMME OF DEVELOPMENT

8.1 Priorities

The foregoing proposed transportation plan is staggering in its magnitude, property requirements and cost. The implementation of the plan cannot be financed from the City's resources. Approaches will have to be made immediately to the Provincial Administration and Central Government for financial aid. From past experience it is known that the negotiations will be protracted. In the interim period, it is essential to take stpes to ensure that the proposed plan will not be prejudiced by costly development on the land affected. It will also be necessary to determine priorities in respect of action which should and could be undertaken within the limits of the Council's available resources.

The protection of the required rights of way is the first priority. This requires an investigation into existing legislation to ascertain the extent and implications of the powers already vested in the Council. For instance, the rights of way could be defined as "Red Roads" in the Town Planning Scheme. This would necessitate the submission of an amending scheme for the Administrator's approval but it may also lead to the Council having to acquire the land before it is in a financial position to do so. Ways and means of freezing costly redevelopment of the land affected must be devised.

An accurate definition of the "Red Roads" is essential in areas where development pressures are greatest. Consequently at the earliest possible stage more detailed route location studies must be put in hand. In general this would apply to the transportation box around the Central Complex.

It will be a recommendation to the Council that, in view of the magnitude of the proposals, it is most desirable, in order to satisfy the citizens and higher authorities that the proposals are essential, to obtain a second opinion. The employment of consultants for this purpose is of immediate priority.

At the top of the priorities is the action to be taken to improve the public transport system. The interim measures to assist the bus service should be put in hand immediately and the crux of the whole transportation plan is the early operation of the rail rapid transit system. Consultants should therefore, be engaged immediately to conduct a feasibility study to finalise the system. As soon as the feasibility report has been accepted, consultants should be engaged to prepare working drawings and contract documents for construction.

Linked in the top bracket of priorities will be the major road and parking garage programme (particularly the medium-period garages). The outstanding projects of the present Ten Year Major Road Programme due for completion in 1975 are estimated to cost R25m, but at the present rate of spending the programme will not be finished before 1982. The new major road projects will cost an additional R86m, and if the target date of 1985 is to be met, finances and construction resources will have to be increased considerably. The early acquisition of land for these purposes is essential.

A summary of the immediate priorities follows and virtually all of these require simultaneous action.

* Consultants to be engaged to provide a second opinion on the transportation proposals.

* Consultants to be engaged to conduct a feasibility study of the rail rapid system.

* An approach to be made to the Province and the Central Government for financial aid.

* Steps to be taken to protect the rights of way.

* Consultants to be engaged to conduct detailed route location studies of sections of the project most liable to development pressures.

* Steps to be taken to obtain additional sources of revenue to meet the costs which will be to the Council's account.

* The implementation of the interim measures to assist the bus service to be put in hand.

* The implementation of the major road and parking garage programme to be put in hand.

8.2 Estimates

The estimated costs of the various schemes given in the preceeding chapters are based on present day costs, that is the estimates would apply if the schemes were built immediately. However, even to build the schemes over the next fifteen years will be no mean task and since costs have been increasing each year in the past and are likely to continue increasing in the future, many of the schemes will cost a lot more than their present estimate.

It is impossible to judge with any degree of accuracy how costs will increase in the future particularly because of their irregularity in the past.

From a study of wages paid and personnel employed it would appear that from 1954 to 1962 labour costs have risen at a steady 2.7% per annum but from 1962 onwards the rate increased enormously to 7.9% p.a. This latter rate is equivalent to labour costs doubling every nine years. The overall growth from 1954 to 1967 is equivalent to 4.3% p.a.

Discussions with consultants and contractors indicate that a project constructed 10 years from now would cost about twice its present day estimate.

The rate of increase of property costs has also gone up enormously over the last few years. A study of the past valuation rolls shows that from 1964 to 1967 property valuation has increased at an average equivalent rate of $9\frac{3}{4}$% p.a. However, looking at the long term growth the average rate is just under 6%. Higher rates of increase in value can be expected from undeveloped property as the owner is expecting ultimate capital appreciation while getting no interim return.

A look at the depreciation of money reveals that the rand is depreciating at about 2.6% p.a. This is equivalent to costs doubling in about 25 years. Using this rate to estimate future monetary requirements would mean that the standard of living of workers and the value of property remains constant. This is clearly unrealistic.

From the above it is evident that costs could increase by about 6% per annum based on past trends. This would mean that estimated costs could double in 12 years. This is a factor which must be borne in mind when negotiating for financial aid. A recession or a major slump in the property market could of course bring relief to this escalation of costs.

8.3 Highways

The highway proposals are designed to accommodate the 1985 predicted traffic so if all proposals are constructed by 1985 most of them will be running at capacity when opened. This means that to get full benefit from the proposals they should be completed before 1985, say by 1980. To construct these enormous proposals in ten years is clearly impossible and even to do it in fifteen years is doubtful. It is therefore clear that Johannesburg will be continually short of road space in most areas over the next two decades.

The road system outside the motorway box around the Central Complex is based on a free modal choice. Therefore, if the road proposals are built steadily from now and completed by 1985 the available road space will keep a reasonable relationship with the traffic growth. However, conditions are different within the motorway box. Here the road system is designed to accommodate traffic based on a restricted modal choice with considerable parking taking place at rail rapid stations on the periphery of the motorway box. Unfortunately the rail rapid system is not expected to be operating until 1985 so, unless the bus park & ride is successful, traffic volumes within the box will increase on the basis of free modal choice. In most cases the proposals within the motorway box will only handle the predicted 1975 volumes within this area. Thus the area within the motorway box, particularly the Central Complex, will be even more short of road space than the rest of the city until the rail rapid system is opened.

The programme outlined below is based on completing the proposed plan by 1985 with individual schemes being constructed when required to meet the anticipated growth of traffic in their area. The schemes have not been arranged to meet constant annual expenditure and many of the schemes will be running at capacity when complete.

The highways required to be constructed by 1975, 1980 and 1985 to meet the anticipated traffic demand at those years are shown in Figures 8.1, 8.2 and 8.3 respectively and are detailed with their 1969 estimated cost and probable construction cost based on a 6% p.a. increase, in Tables A2, A3 and A4 for major roads and Table A1 for motorways, in the Appendix. The estimated expenditure for each five year period is summarised in Table 8.1.

As far as the major roads are concerned, the first five years are the worst. Most of the remainder of the 1964/74 Ten Year Major Road Programme together with many new schemes, should be completed within this period. In order to do this it will be necessary to spend just over R5m per year on construction and over R1m per year on property.

In the second and third 5-year periods the construction requirements reduce, on 1969 estimates, to about R3$\frac{1}{2}$m per year. However, the property requirements increase to about R2m per year.

The construction of the new motorways has been put back as late as possible with the first five-year period being allowed for finalising the financial policies. In the second five-year period motorway construction has been kept to the minimum being equal to about R6$\frac{3}{4}$m per year with property at nearly R12m per year on 1969 estimates. The bulk of the motorways will be required in the third five-year period when the required expenditure on construction, at 1969 prices, would be over R17m per year with property at just under R11m per year.

Obviously, if a start could be made as soon as possible and the work spread evenly over, say, 13 or 14 years, the annual cost on construction, at 1969 prices, would be less and would be about R9m per year. The expenditure on property would also be about R9m.

TABLE 8.1 : SUMMARY OF EXPENDITURE IN EACH 5-YEARLY PERIOD

Item	1969 Estimated Cost[1]
1970 - 1975	
Major Roads[2]	R32.6m
Motorways	1.5m
Public Transport	7.7m
Garages	26.1m
Operational Traffic Engineering[3]	2.0m
Total for 1970 - 1975	R69.9m
1975 - 1980	
Major Roads	R27.6m
Motorways	91.9m
Public Transport	60.0m
Garages	16.5m
Operational Traffic Engineering[3]	2.0m
Total for 1975 - 1980	R198.0m
1980 - 1985	
Major Roads	R26.1m
Motorways	140.0m
Public Transport	62.0m
Garages	22.5m
Operational Traffic Engineering[3]	1.0m
Total for 1980 - 1985	R251.6m
Grand Total for 1970 to 1985	R519.5m

1. Including construction and land costs
2. Excluding current motorway programme i.e. M1 & M2
3. Includes for motorway surveillance & computer installations

8.4 Public Transport

8.4.1 Rail Rapid Transit System

It is anticipated that the feasibility study for the rail rapid will start immediately and that design work will start shortly afterwards with

construction starting in 1975. This should give sufficient time to arrange the necessary financing. Ten years has been allowed as a reasonable time for constructing the 1985 proposals but the system is urgently required and should be started and constructed as quickly as possible. The aim should be to have workable sections opened as soon as possible.

Since the cost of the system will depend on the final recommendations of the consultants and is therefore not known now, the higher departmental estimate quoted in section 5.3.5 is used for the financing programme whick is given in Table A6 in the Appendix. These costs include all rolling stock for the rail rapid system but the costs of any new buses required in conjunction with the rail rapid system have not been included as these are considered to be part of the normal capital costs of the Transport Department.

A ten year construction programme would call for an average expenditure, at 1969 prices, of about R12$\frac{1}{2}$m per year.

Parking garages at mode change stations, although they may form an integral part of the rail rapid station and bus terminus, have been included below in section 8.5 Parking Garages.

8.4.2 Interim Proposals

The schemes required for the interim period, before the advent of the rail rapid system, must be built as quickly as possible. These schemes have therefore been placed in the first 5 year period.

The interim proposals make use of certain major road proposals. These too have been placed in the first 5 year period and are not a charge against public transport.

The interim public transport costs are included in Table A6 in the Appendix with the rail rapid costs. Again the cost of new buses for the increased peak hour passengers in the interim period have not been included as this is considered part of the normal capital costs of the Transport Department.

The estimated expenditure for each five year period is summarised in Table 8.1.

8.5 Parking Garages

While it is hoped to encourage some park & ride in the north and south using buses, the rate of providing garages in the Central Complex will depend on the growth of traffic based on a free modal choice rather than on the restricted modal choice. It is therefore considered that the parking garages required for 1985 should be constructed by 1980.

The park & ride garages associated with the rail rapid mode change stations will generally be built in conjunction with the rail rapid system except for the garages at Parktown and Trojan. These two garages will be used in conjunction with an interim bus park & ride system and must be ready when the St David's Place-Melle Street link and the busway from Trojan to Vanderbijl Square are ready.

The proposed programme for constructing the garages is given in Tables A8, A9 & A10 in the Appendix.

The estimated expenditure in each five-year period is summarised in Table 8.1.

The proposed programme calls for 17 Central Complex and 2 park & ride garages in the first five-year period. If a start can be made immediately this means that an average of 4 garages will have to be under construction at one time for an annual expenditure of R4.8m on construction and R0.5m on land. Some motorway property will be required in this period for the park & ride garages.

In the second five-year period 17 Central Complex garages are to be built. An average of 3 to 4 garages will have to be in hand at one time for an annual construction expenditure, at 1969 prices, of R2.4m and R0.8m for land.

In the third five-year period the remaining 8 park & ride garages, together with 7 Central Complex garages are required. This is equivalent to an average of 3 garages under construction at one time for a construction expenditure, at 1969 prices, of R4.2m and R0.3m for property.

8.6 Summary

In summary the proposed transportation implementation programme calls for an average expenditure, on construction and property, at 1969 prices, of about R12m per year in the first five-year period, nearly R40m per year in the second and nearly R52m per year in the third five-year period.

If the expenditure is evenly spread over the full 15-year period the annual expenditure for construction and property at 1969 prices would be just under R35m.

9. FINANCE

9.1 Present Financing Facilities

Full information on these aspects is not yet available.

9.2 Recommendations Of Various Commissions

Three commissions have been held on matters dealing directly or indirectly with the financing of road works. These are:

1. The Committee of Inquiry into the Financial Relations between the Central Government, the Provinces & Local Authorities. This is knows as the Borckenhagen Committee.

2. The Commission of Inquiry into the Financial Relations between the Central Government & the Province. This is knows as the Schumann Commission.

3. The Commission of Inquiry into the Co-ordination of Transport in South Africa. This is known as the Marais Commission.

In August 1969 the Deputy Minister of Transport stated that it was intended to table a White Paper on the contents of these three reports.

9.2.1 The Borckenhagen Committee

The final report of this committee has not been published but many interim reports have been published and the one dealing with the Financing of Roadworks was published in 1960.

The committee considered that any additional revenue required for road works should be obtained from import and excise duties on motor fuels and should accrue to the National Transport Commission.

The committee also suggested that cities like Johannesburg which impose no, or a disproportionally small assessment rate on improvements should consider differential rating on improvements such that large buildings, the main cause of traffic congestion, contribute proportionately more than small buildings.

Briefly the recommendations if applied to Johannesburg would mean:

(1) that higher authorities would contribute not less than 50% of the total capital cost of urban arterial roads and motorways.

(2) that the Province would not return a share of the annual licence fees to Johannesburg, and

(3) that Johannesburg would keep the full vehicle registration fees instead of only a part as at present.

These recommendations would by no means be sufficient to enable Johannesburg to carry out the proposed highway plan.

9.2.2 The Schumann Commission

The findings of the Commission have not been published .

9.2.3 The Marais Commission

The report of this Commission, which was published in 1969, did not deal with the financing of transportation facilities other than to

recommend that the present contribution to the National Road Fund should be substantially increased. It did, however, come to the conclusion that it was necessary to think in terms of large scale investment in roads and bridges and there must be very bold thinking on metropolitan transport. It also recommended that road construction should keep pace with the growth of the national economy.

The Commission also recommended that the technical and financial implications for mass transit facilities in the main metropolitan regions should be the subject of immediate study and report.

9.3 Financial Requirements

The proposed transportation plan can be broken down into three main parts requiring two or more different methods of financing. The main parts of the plan are:

(1) Highways including motorways and major roads

(2) Public transport including rail rapid transit and interim bus facilities, and

(3) Parking garages.

1. Highways

Highways are a non-revenue earning, depreciating, capital asset requiring considerable funds for their construction. They have a comparatively long life and could therefore be constructed from loan funds and paid off while they are being used as a benefit to the community. However, the highway proposals, motorways and major roads, for 1985 will not be the end of highway construction in Johannesburg. Both systems will have to be extended after 1985. Therefore, if possible, sufficient funds should be found to construct the facilities out of revenue in order to overcome loan repayments running concurrently with future highway programmes.

On the basis of uniform expenditure over the next fifteen years, on 1969 prices, the major road programme would require an annual revenue of R5.75m and the motorway programme R15.57m. Revenue at this level would enable the proposed motorway to start earlier than envisaged in Chapter 8 and would permit a more leisurely programme. The total annual requirement for highways would therefore be R21.32m on 1969 prices.

In order to finance the highway proposals on this basis, additional sources of revenue must be found and these sources must give rise to a growing annual revenue to overcome increases in land and construction costs. The revenue should be derived in the main from the people who create the demand for these highways but the revenue should not be obtained from sources that would consequently cause an excessive increase in the cost of living.

2. Public Transport

The rail rapid transit will be revenue producing but the first call on the revenue will be from the running expenses of the system. In view of the general experience in other countries, if the fares are to be reasonable the revenue from the rail rapid system is not likely to contribute much, if anything, to the servicing of any loans used for its construction.

If the system is built out of loan funds the servicing of the loan will, for the most part, if not entirely, have to come from other sources of revenue. Based on a capital cost of R124m at 1969 prices, the interest and redemption charges would rise to a peak of about R9.0m p.a. for about 20 years from about 1985 onwards. This is working on 1969 prices and 30 year loans.

The money required for the interim measures should come from revenue and loan funds. The main items are the land for the proposed off-street terminus in Pritchard Street and the decking of the Vanderbijl Square. These should be financed from loan funds and most of the interest and redemption costs taken over by the parking garage account when garages are built on the sites when the rail rapid system is opened. The interest and redemption for these projects would be about R0.29m per year. The temporary elevated structure to the Vanderbijl Square should be financed out of revenue over five years and would require about R0.34m per year.

3. Parking Garages

Parking garages are revenue producing and the municipal parking garage system as a whole can be, and must be, made completely self-supporting. If the proposed parking policy in regard to contributions by private developers is adopted, some capital will be forthcoming from this source but the main source of capital will have to come from loans. The important need is for government treasury authority to float the required loans. There may be some drain on the Council's other sources of revenue in the early stages when property is being bought and is not yet being used economically. However, with an adequate fee structure and help from parking meters, this should not last long.

In view of the continual restriction on the raising of loans, consideration should be given to a parking authority to build and operate the whole parking garage venture subject to the Council's parking policy. If this authority has the powers to raise money with no more restrictions than private enterprise, then a realistic parking garage development programme may be possible.

9.4 Possible Sources Of Revenue

From the foregoing, neglecting the self-supporting parking garages, an annual revenue of R21.95m will be necessary for 1970 to 1975 to finance the highway and interim public transport proposals. This annual revenue will have to increase over the ten years from 1975 to about R30.6m in 1985 to cover the additional cost of servicing the rail rapid transit loans.

Sources from which revenue can be obtained are outlined below but emphasis should be on additional sources not presently available to the Council. The following discussion gives an indication of what monies would be forthcoming from the various suggestions; these are not firm proposals.

9.4.1 Rates on property

Assessment rates levied on land value are the main source of revenue to the Council. No rates are levied on buildings. The rate was increased in July 1969 from 3c to 4c in the rand and the income from this source was estimated at R23.1m for the year 1969/70. The 1c increase was brought about to a large extent by the need to service the present motorway programme.

An increase of 1c in the rand in the assessment rate would bring in an extra R5.8m approximately.

The property required for the highway system will mean a direct loss to the assessment rate fund of about R0.8m but because of the improved access brought about by the transportation plan as a whole, the values of properties will increase overcoming the direct loss.

It is considered that, unless other sources of revenue can be found, the rail rapid system loan charges should be financed out of an increase in assessment rates. Based on 1969 prices an additional 1.5c in the rand would be necessary by 1985 to cover the peak loan charges of about R9m per year.

This increase can be staged over ten or twelve years and would also help to finance the highway programme. Thus to help with the financing of the transportation plan, the rates would need to be increased by 0.5c in the rand now (i.e. 4.5c in the rand), a further 0.5c in 1975 (i.e. to 5c) and a further 0.5c (making up the 1.5c mentioned above) in the early eighties (i.e. to $5\frac{1}{2}$c/R).

9.4.2 Parking fees

Parking fees are obtained from parking garages, open parking areas and parking meters. The estimated revenue from off-street parking facilities is R0.56m and from parking meters R0.45m for the year 1969/70. This total revenue does not cover the annual charges on the present parking garage account and an increase in fees is necessary to make the account self-supporting besides making the fees more realistic from a modal choice control aspect.

The first call on parking revenue is for meeting the annual costs of parking facilities so help from this source for the financing of highways and public transport has been neglected in this analysis.

9.4.3 Loans

The raising of loans is an accepted means of financing capital works; the annual costs of the loans have to be paid out of revenue. This is therefore an admirable way of financing revenue producing capital works provided the revenue can be made to cover the total annual costs i.e. running costs, repair and maintenance and interest and redemption.

The Council can only raise loans on the authority of the Administrator and is also controlled by the Government Treasury depending on the economy of the country.

9.4.4 Subsidies

Subsidies from the National Transport Commission and the Provincial Roads Department have been obtained to help finance the present motorway system. The Province also gives subsidies to help finance certain roads that are continuations of Provincial roads.

The National Transport Commission has stated that it will no

longer provide subsidies for urban motorways because it does not have sufficient funds for its rural roads programme and because it does not accept that urban motorways will help in the solution of the urban transportation problem.

From correspondence with the National Transport Commission and the South African Railways these authorities are not authorised to provide subsidies for urban rail rapid transit systems.

It therefore does not appear that help in the form of subsidies can be expected from Government sources.

This matter must, however, be taken up again with the Government and the Province.

In sections 1.1.6 and 1.1.7 of this report a brief indication is given of the substantial aid cities obtain in other countries from their governments for rail rapid transit and highways.

9.4.5 Road tolls

Road tolls have been used extensively in the past in other countries, particularly in the United States of America, to finance highways, bridges and tunnels. In the U.S.A., tolls have been used on rural long distance freeways built by turnpike authorities before the advent of the National System of Interstate & Defence Highways programme in the middle fifties. Tolls are also extensively used for financing expensive bridges or tunnels which short cut existing routes.

Toll collection in itself is an expensive operation and the road user must decide whether the use of the toll facility is worth more to him than the cost of the toll.

On the U.S.A. turnpikes it is usual to have a toll gate at each access point to the road. In order to economise on collection costs, the ramps at each access point all pass through one toll gate. This is usually quite easy to arrange in the country but will be exceedingly difficult to do on a city motorway with its numerous access points and multiplicity of ramps.

For tunnels or bridges the roadway is usually flared out on one side of the facility to two or three times its normal width to house two to three times as many toll booths as there are traffic lanes. This method has also been used on some rural highways viz. the Merrit Parkway and Wilbur Cross Parkway in Connecticut. With this method the toll plaza is placed on the highest volume section of the route. It is, however, possible to use the route for certain journeys without paying the toll and it is also possible, although often inconvenient, to leave the highway before the toll plaza and join it again afterwards. This type of toll plaza, being across the main carriageways, is also accident prone and would not be suitable for urban motorways where the frequent access points would make bypass of the toll plaza a simple matter.

Road tolls are therefore not recommended as a means of financing urban roads.

9.4.6 Petrol tax

At the present time petrol carries a tax of 13c per gallon of which 6c is allocated to the National Road Fund. An increase in the tax on motor fuel for highway construction would mean that the road user is contributing more towards the cost of roads needed and used by him and the more he used the roads, the more he contributed. A tax of this nature, even if restricted to petrol, will to some extent contribute to an increase in the cost of living.

If a tax of this nature is applied it must be done on a regional basis and a suitable distribution formula derived to give each town a share commensurate with its traffic problems. The imposition of a tax of this nature is of course in the hands of the Government.

It is estimated that the gallonage of petrol purchased in the Johannesburg area has been increasing at about 7% p.a. and that about 110m gallons were sold in 1969. A 1c tax per gallon would yield about R1m per year and would be a growing source of revenue.

It is considered that a 2c per gallon tax be placed on petrol i.e. about a 5% increase and this to accrue to the local authority on the basis of a suitable formula. This would, depending on the distribution formula, provide Johannesburg with an additional R2m per year approximately. If the tax was applied on a country-wide basis and distributed only to cities with approved proposed urban motorway systems, a larger sum would be forthcoming.

9.4.7 Vehicle licences

Vehicle licences are issued for the Province and a proportion of the fees accrues to the Council. In the year 1969/70 it is estimated that about R6.1m will be collected from motor vehicle licenses and about R1.3m would accrue to the Council.

An increase in the licence fee for road construction would mean that the motor vehicle owner is contributing directly to the construction of roads available for his use. This is a tax on car ownership, not on use.

The number of motor vehicle licences issued is increasing annually and has had a long term growth of 6% p.a. in the past, although the current growth rate is higher.

If the licence fee was doubled and the increase accrued to the Council for road construction, an additional R6m would be available and this would be a growing source of revenue. It is considered that the licence fee structure should be amended so that the motor car, which creates the main demand for road space, has its licence fee approximately trebled but that the heaviest commercial vehicle licence fees are increased by a lesser extent, say $1\frac{1}{2}$ times. Another alternative would be to increase the licence fee by a fixed amount say R40.

The licence fee for an average car, say in the 2 500 to 3 000 lb group, is R21 p.a. Trebling this would make the fee R63 of which the additional amount accruing to the Council would be R42.

On the basis of R40 extra on the licence fee an additional R11m would accrue to the Council.

An increase in licence fees is, of course, in the hands of the Province.

9.4.8 Vehicle registration

The present registration fee for motor vehicles is R4. and the estimated annual income about R0.15m. Unless this fee is raised very considerably, which is not considered desirable, this source cannot be considered for financing the highways.

9.4.9 Motor Vehicle Purchase Tax

In 1969 the Government placed a purchase tax on motor vehicles. On a vehicle whose present purchase price is R2 500 between R100 to R110, or about 4% is purchase tax. Certain other customs and excise duties are, of course, incorporated in the basic price of the vehicle.

Final figures are not available but based on the first nine months of 1969 about 32 000 new motor cars are expected to be registered in the Johannesburg licensing district for the whole of 1969, having an estimated total purchase price of R75m, i.e. about R10m increase on the 1968 figure mentioned in section 3.1.4. The number of new cars registered has been increasing at an average rate of about $5\frac{1}{2}$% per year, although it was 14% from 1967 to 1968 thus any additional purchase tax levied on new motor cars would be a growing source of income. A tax of this nature is a tax on car ownership and not on car usage.

It is considered that an additional purchase tax of 5% should be levied on the purchase price of all motor cars for the use of the urban registration area for highway construction. Such a tax would yield about R$3\frac{1}{2}$m per year.

The imposition of this tax is of course in the hands of the Government.

9.4.10 General Purchase Tax

In 1969 the Government placed a purchase tax on certain commodities; the rate varying depending on the commodity. Any additional tax of this nature is not a direct road user tax and it should not be considered by the Council for financing transportation facilities.

9.4.11 Local Income Tax

With assessment rates being the Council's main source of revenue only property owners in the municipal area pay directly to this. Persons renting property of course pay rates indirectly through their landlord. Persons living outside the municipal area and making use of Johannesburg's facilities do not contribute at all to the cost of highways and do not contribute to the subsidy for public transport. As shown in Table 1.2, traffic entering the municipal area in the morning peak period from the north has been growing at the exceptionally high rate of $11\frac{1}{2}$% per year. It is this and other external traffic the owners of which are not Johannesburg ratepayers, that is adding to Johannesburg's traffic problem.

A local income tax accruing to the municipality in which the income is earned would make non-residents contribute to the cost of facilities such as roads and the subsidy on public transport.

It is estimated that there were about 216 000 people working in the Johannesburg municipal area in 1965 and that this is likely to grow to 347 000 in 1985. The Provincial personal tax varies up to R18 per year for a married person and up to R30 per year for a single person.

If an average of R10 per year per working person were levied for local income tax then Johannesburg would receive about R2m and this would be a growing income although not at the rate of the proposed road user taxes.

It is considered that R1m should contribute to the highway programme.

9.4.12 Direct road pricing

Road pricing is mentioned in section 1.1.5 of this report. The main purpose of road pricing is to control the entrance of vehicles into congested areas charging the driver by some means for the added congestion he causes. As mentioned in 1.1.5 no practical system is yet available so this source has not been considered in financing the proposed plan.

9.4.13 Summary

To cover the cost of the highways and interim public transport measures about R22m a year will have to be found from 1970 to 1985. Funds will have to be found to service the rail rapid system starting in 1975. These will reach and remain at a peak of R9m per year from 1985 onwards for about 20 years.

The above discussion on ways and means of financing this proposed transportation is summarised as follows:

Highways and Interim Public Transport Proposals

Petrol tax 2c per gallon	R 2.0m
Vehicle licenses R40/year extra	11.0m
Motor vehicle purchase tax 5%	3.5m
Local Income Tax	1.0m
Assessment Rate ($\frac{1}{2}$c increase)	2.9m
Existing spending on major roads 1969/70	1.3m
	R 21.7m

Rail Rapid Transit Proposal

Assessment Rate increasing to $1\frac{1}{2}$c from 1975 to 1985	R 9.0m

The above revenue has been based on 1969 figures. All sources will provide a growing revenue which will take care of rising construction costs.

9.5 Expenditure on Highway Transportation

It is estimated that the White motorists of the Greater Johannesburg Study Area will spend, under existing prices, about R3 200m on their cars in the next 15 years. This excludes parking and garaging charges (see Table A11 in Appendix). The proposed highway proposals will require R320m in this same period i.e. 10% of what the motor car owners will spend. The proposed increases in taxes will raise the total expenditure to about R3 500m.

At present it is estimated that the White motorists of Johannesburg are spending R150m on their cars per year while the current expenditure on motorways and major roads in 1969/70 is estimated to be R7.7m or 5.1% of what the motorists spend.

At present, neglecting taxes on the purchase of the car, the average motorist doing 10 000 miles per year pays per year R18 licence, about R52 tax on petrol and smaller tax amounts on spares; giving a total tax of about R70 of which about R24 would go to the National Road Fund. With the proposed licence fee, petrol tax increases the average motorist would pay R118 per year in taxes. In Britain it is estimated by the British Automobile Association that the average motorist in the U.K. pays about R190 a year in taxes to keep his car on the road.

9.6 Recommendations

The above discussion indicates a way of financing the proposed transportation plan. All methods of raising the necessary finance are, however, dependent on Central Government or Provincial Government approval and action. This must be taken up with these authorities as soon as the proposed transportation plan is approved in principle.

TABLE A1 : MOTORWAY CONSTRUCTION PROGRAMME

Motorway	Estimated Cost[1] in 1969 Construction	Prop.	Total
Up to 1975			
M2: Extension westwards	R 1.3m	R 0.20m	R 1.5m
1975 to 1980			
M3: Craighall to Richmond (M6)	9.7m	15.1m	
M6: Richmond (M3) to Bellevue (M5)	17.8m	31.0m	
M5: Cheltondale to Bellevue (M6)	5.2m	9.2m	
M5: C-D roads Kenilworth[2]	1.0	3.0	
Total 1975 to 1980	R33.7m	R58.3m	92.0m
1980 to 1985			
M4: Western bypass to Rand Airport Rd	19.7m	10.1m	
M3: Richmond to M4	17.3m	9.0m	
M3: M4 to Baragwanath	7.4m	0.8m	
M5: Bellevue (M6) to M4	21.6m	14.6m	
M6: M3 to Melville	2.8m	2.0m	
M8: Oaklands to M3	10.0m	15.0m	
M10: Bruma to M5	7.8m	2.0m	
Total 1980 - 1985	R86.6m	R53.5m	R140.1m
Total up to 1985	R121.6m	R112.0m	R233.6m

1. m = millions of rands

2. Total property cost in Kenilworth

Appendix

TABLE A2 : MAJOR ROAD CONSTRUCTION PROGRAMME PERIOD 1970 TO 1975

Scheme	Proposed Lanes [1]	1969 Estimated Cost (R1000's) C2	P2
Main Reef Road (West) (1)[3]	2/3 E	2 127	365
Jan Smuts Avenue (2)	2/3	1 635	858
Broad Way - Allum (3)	2/3 E	970	10
Perth Road (4)	2/3 E	24	50
Empire Road (West) (5)	2/3 E	139	-
Oxford Road (6)	2/3	989	336
Central Ave Illovo (7)	2/3	231	100
D. F. Malan (8)	2/3 E	766	-
Empire Road (east) (9)	2/3	289	-
Kingsway (10)	2/3	513	100
Stanley Avenue Empire Rd (11)	2/2	159	-
Victoria Ave (12)	2/3 E	128	-
Tudhope Ave (13)	1/4 E	48	-
New Goch Rd (14)	2/3 E	79	-
Bertrams Road (15)	1/4 E	160	150
Tana Rd (16)	1/4 E	99	-
Melle St - St David's (17)	1/4 E	1 425	100
Anderson St (18)	1/4 E	282	-
Trump St (19)	1/4 E	40	-
Stott St (20)	1/4 E	42	-
Mooi St Ext. (21)	1/4	150	100
Treu Rd (22)	1/4 E	198	50
Maritzburg (23)	2/2 E	63	-
Chilvers St (24)	1/4 E	182	250
Cleveland Rd (25)	1/4 E	273	-
11th Ave Houghton (26)	local E	164	-
Glenhove Rd (27)	local E	137	-
Pretoria St - 12th Ave (28)	widening E	182	5
Ruven Road (29)	2/2 E	64	-
Corlett Dr (30)	1/4 E	275	175
Heidelberg Rd (south) (31)	2/3 E	1 221	-
Marjorie-Vickers (32)	1/4 E	441	
Joubert St Ext (33)	2/3 E	98	
Kitchener Av (34)	widening E	57	-
Eloff St Ext (35)	2/3 E	284	

Scheme	Proposed lanes [1]	1969 Estimated Cost (1000's) C [2]	P [2]
Wemmer Pan Rd (36)	2/2 E)	2508	150
Heidelberg Rd (north) (37)	2/3 E)		
Old Pretoria Rd (38)		50	160
Simmonds Street (39)	1/3 E	33	-
Road under E/W motorway M2 (40)	1/4 E	206	-
Garden - Bellavista (41)	1/4 E	715	-
Maraisburg Road (42)	2/3 E	557	-
Muldersdrift (43)	2/3	983	-
Main Rd - Melville - Windsor (44)	2/3	365	300
Barry Hertzog Realignment & Owl (45)	2/3	776	916
Annet - Solomon (46)	2/3	470	100
Solomon St Bridge (47)	2/3	2418	572
Kitchener Ave (48)	2/3	559	200
Earp - Webber (49)	2/2	474	-
Webber - West - Usher (50)	1/4	257	-
9th/8th St Orange Grove (51)	End connection	15	200
Oxford Rd/Victoria Ave (54)	Widening	111	30
Loveday St Scheme (busway) (53)	1/3	1253	1000
Central Rd Fordsburg (54)	1/4	174	-
Lilian Rd (55)	1/4	156	-
Houghton Drive Flyover (56)	1/4	250	66
Total		R26264	R6343
Total land costs		6343	
Grand total 1970 - 1975		R32607	

1. E = on existing Ten Year Major Roads Programme
   2/3 = two 3-lane carriageways; 1/4 = one 4-lane carriageway
2. C = construction ; P = property
3. Numbers in brackets refer to Figures 4.9 & 8.1

TABLE A3 : MAJOR ROAD CONSTRUCTION PROGRAMME : PERIOD 1975 - 1980

Scheme	Proposed Lanes[1]	1969 Estimated Cost (R1000's) C[2]	P[2]
Main Reef Road (East) (57)[3]	2/3 E	1332	179
Carse O'Gowrie (58)	1/4 E	171	50
North view Rd (59)	1/4 E	92	9
Durham - Zuid Sts (60)	1/4 E	230	326
Club St (61)	1/4 E	414	-
Jules (62)	2/3 E	1369	-
Linden Rd - 3rd Av (63)	1/4 E	619	1
Bertha - West St Link (64)	2/2	2960	572
Clarendon Pl. Yord Rd (65)	2/3	183	600
Boundary Rd (66)	1/4	108	15
Fortesque - Elm (67)	1/4	48	48
Voorhout St Ext (68)	1/4	498	2209
Collin Expressway (69)	2/3	766	1300
Rosettenville Rd - Turf Rd (70)	2/3	538	50
Rosettenville Rd (north) (71)	1/4	349	-
Troye St - Spring St (72)	1/4	210	579
Hulbert Rd - Heidelberg Rd Link (73)	1/4	200	28
Turf Club St - South Rd Link (74)	2/3	339	524
Queen St Kensington (75)	2/3	593	1276
Queen St - Cleveland Rd link (76)	2/3	411	428
Rifle Range (77)	2/3	513	763
Rifle Range Rd - Quaggashoek link (78)	2/3	418	100
Cotswold (79)	1/4	222	-
11th Ave Houghton (80)	1/4	228	-
Athol Oaklands & Ext. (81)	1/4	467	74
Cheltondale Oaklands Link (82)	2/2 & 2/3	363	833
Johannesburg Rd Pretoria Rd Lyndhurst (83)	1/4	564	200
Jeppe St - Avenue Rd Link/Bree St 1 way (84)	1/4	360	347
Alamein Webb Turf Club (85)	1/4	428	-
Third Ave The Hill (86)	1/4	285	-
Fawcus St (87)	1/3	232	149
Pim St Extension (88)	1/4 & 1/2	210	-

TABLE A3 (cont)

Scheme	Proposed lanes[1]	1969 Estimated Cost (1000's) C[2]	P[2]
Harrow Rd - Abel Rd Flyover (89)		300	176
Queen Elizabeth Dr - Melle St link (90)		50	-
Klein St Flyover (91)	1/4	565	-
Total		R16768	R10835
Total land costs		10835	
Grand Total 1975 - 1980		R27603	

1. E = On existing Ten Year Major Roads Programme
   2/3 = two 3-lane carriageways; 1/4 = one 4-lane carriageway
2. C = construction; P = property
3. Numbers in brackets refer to Figures 4.9 & 8.2

Appendix

TABLE A 4 : MAJOR ROAD CONSTRUCTION PROGRAMME PERIOD 1980 to 1985

Scheme	Proposed Lanes [1]	1969 Estimated Cost (1000's) C [2]	P [2]
Civic Centre Roads (92) [3]	E	1042	-
Kimberley Road (south) (93)	2/3 E)	543	-
Kimberley Road (north))94)	2/2 E)		
Oxford Rd (Realignment) (95)	2/3	720	500
M6 - Simmonds St Link (96)	1/4	508	970
Rosherville Expressway (97)	2/2	1105	266
South Rand Road (98)	2/2	1047	-
Rifle Range Road (99)	2/2	1013	-
Shakespeare Rd (100)	1/4	108	-
Xavier St (101)	1/4	194	-
West Turffontein Expressway (102)	2/3	1290	703
Turffontein Rd (103)	2/3	418	-
Long Rd (104)	1/4	531	865
8th St Newlands (105)	1/4	205	185
Tana - Jellicoe Link (106)	2/2	796	2159
Jellicoe Ave (107)	2/3	255	-
11th Ave, Ivy, Louis Rds (108)	1/4	496	789
Carr St Spur (109)	1/4	866	1211
May Road Widening (110)	2/3	266	845
Jan Smuts Viaduct (111)	2/2	3286	50
Turf Club St (112)	2/2	265	50
Troye St Spur (113)	2/3	540	77
South Road (west) (114)	2/3	102	-
South Road (east) S Klipriviersberg (115)	1/4	619	-
South Klipriviersberg (116)	2/3	156	-
Marjorie St (117)	1/4	131	277
Marshall - M R Road link (118)	1/3	102	282
Kangnassie (119)	1/4	240	-
Total		R16844	R 9229
Total land costs		R 9229	
Grand Total 1980 - 1985		R26073	

1. E = on existing Ten Year Major Roads Programme
   2/3 = two 3-lane carriageways ; 1/4=one 4-lane carriageway
2. C = construction; P = property
3. Numbers in brackets refer to Figures 4.9 & 8.3

TABLE A5: CITIES WHICH HAVE RAIL RAPID TRANSIT SYSTEMS

City	Population [1.] m (000)	Route [1.]	Miles per million population
Athens	1852	15.9	8.6
Baku	1137	1.1	1.0
Barcelona	1696	11.2	6.6
Berlin (W)	2201	57	25.9
Boston	3177	40.9	12.9
Budapest	1928	2.3	1.2
Buenos-Aires	7000	19.6	2.8
Chicago	6591	85.4	13.0
Cleveland	1958	14.9	7.6
Essen	728	2	2.7
Glasgow	1018	6.5	6.4
Hamburg	1856	47.2	25.4
Kiev	1332	5.9	4.4
Leningrad	3641	15.2	4.2
Lisbon	813	5.3	6.5
London	8186	244.2	29.8
Madrid	2558	20.7	8.1
Milan	1661	9.0	5.4
Montreal	2260	14.9	6.6
Moscow	6423	80.8	12.6
Nagoya	1935	6.1	3.1
New York	11260	237	21.0
Osaka	3156	20.1	6.4
Oslo	484	16.6	34.3
Paris	7369	127.1	17.2
Philadelphia	4617	28.9	6.3
Rome	2417	6.8	2.8
San Francisco [2.]	2894	73.9	25.6
Stockholm	1179	35.7	30.3
Tbilisi	805	6.2	7.7
Tokyo	11370	51.3	4.5
Toronto	1989	14.5	7.3
Vienna	1640	10.2	6.2

1. Data obtained from "Manchester Rapid Transit Study" Volume 1 Sept. 1967
2. Under construction

TABLE A6 : PUBLIC TRANSPORT CONSTRUCTION PROGRAMME

Scheme	Estimated Cost[1] in 1969
1970 - 1975	
Interim Schemes	
North-west bus project	R0.20m
Pritchard St Terminus	R4.00m
Southern busway & terminus	R1.50m
Rail Rapid (preliminary)	R2.00m
Total for 1970 - 1975	R7.70m
1975 - 1980	
Rail rapid	R60.00m
1980 - 1985	
Rail rapid	R62.00m

TABLE 7 : PROPOSED COUNCIL PARKING GARAGES

District	Garage	No. Spaces	Capital Cost (R1 000's) Construction	Land[1]
	Long - Period			
30	West & President Sts	2000	2400	owned
	Abattoir	1500	1350	owned
	Bree/Malherbe Sts	1000	900	440
	May Street	600	540	110
	Anderson/Wolhuter Sts	1000	1000	600
		6100	6190	1150
40	De Korte/Henri Sts	750	675	acquired
41	Jorissen/Simmonds Sts	850	765	acquired
	Melle/Smit Sts	600	540	acquired
	Smit/Harrison Sts	600	540	acquired
	Hoofd St	1000	1300	owned
	Total 40 & 41	3800	~~3145~~ 3520	
42	Berea Park	430	559	owned
	Esselen/Claim Sts	300	270	acquired
	Leyds/Claim Sts	300	270	acquired
		1030	1099	
	Caroline/Olivia Sts	300	270	acquired
	Total 42	1330	1369	
43	Kazerne 2 extension	540	in hand	owned
	Kazerne 3	850	765	owned
44	Mooi/Jeppe Sts	640	592	844 E
	Jack Mincer Extension	400	520	owned
	End St Park	700	910	owned
45	Wemmer Garage	3500	3500	owned
	Hall St	2000	1800	500
46	Anderson/Nugget Sts	1000	900	412 E
	Bantu Sports Ground	2500	2500	owned
	Wright Boag	500	650	owned
	Total 43 to 46	11240	12137	1256

TABLE 7 (cont.)

District	Garage	No. Spaces	Capital Cost (R1 000's) Construction	Land[1]
47	Webber Street	1500	1350	120
48	Selby over S.A.R. sidings	1200	1440	
	Rosettenville Rd	1500	1350	120
	Loveday St Extension	1200	1080	120
	Total 47 & 48	5400	5220	360
50	Rockey/Sherwell Sts	600	540	294 E
	Error St	850	765	222
60	Mia Mia	1500	1350	owned
	Gilfillan	600	540	owned
	Total 50 & 60	3550	3195	516
	Medium - Period			
42	Esselen/Edith Cavell	140	140	Exprop.
43	Atwell Gardens	400	520	owned
	Pritchard St	600	555	bus terminus
44	Market/Mooi Sts	640	592	1082
45	Marshall Square	600	780	owned
	Vanderbijl Extn	400	250	owned
	Market/Kort	600	540	1300
	Total 43 to 45	3240	3237	2382
	Residential Garages			
42	Jager St	250	225	acquired
	Goldreich/Claim	200	180	acquired
	Pietersen/Twist	300	270	376
	Total 42	750	675	376
	Grand Total	35~~410~~ 550	35~~168~~ 983	6040

1. E = First notice of expropriation has been served on owners.

TABLE ~~33A~~ 98 : PARKING GARAGE CONSTRUCTION PROGRAMME : PERIOD 1970 to 1975

District	Garage	Capital Cost (R1000's) Construction
30	West & President St	2400
30	May St	540
30	Anderson/Wolhuter St	1000
40	De Korte/Henri St	675
41	Jorissen/Simmonds St	765
41	Melle/Smit St	540
42	Berea Park	559
42	Leyds/Claim St	270
44	Mooi/Jeppe St	592
45	Wemmer Garage	3500
46	Anderson/Nugget St	900
48	Rosettenville Rd	1350
50	Rockey/Sherwell St	540
60	Mia Mia	1350
42	Esselen/Edith Cavell	140
43	Atwell Gardens	520
45	Marshall Sq.	780
	Parktown (park & ride)	3250
	Trojan (park & ride)	4050
	Total	23721
	Total land costs	2380
	Grand Total 1970 - 1975	26101

TABLE ~~33B~~ 89 : PARKING GARAGE CONSTRUCTION PROGRAMME : PERIOD 1975 to 1980

District	Garage	Capital Costs (R1000's) Construction
30	Abattoir	1350
30	Bree/Malherbe St	900
41	Smit/Harrison St	540
42	Esselen/Claim St	270
43	Caroline/Olivia St	270
43	Kazerne 3	765
44	End St Park	910
45	Hall St	1800
46	Wright Boag	650
47	Webber St	1350
48	Loveday St Extn	1080
50	Error St	765
60	Gilfillan	540
44	Market/Mooi St	592
45	Market/Kort St	540
42	Jagerr St	225
42	Goldreich/Claim	180
	Total	12727
	Total Land Costs	3784
	Grand Total 1975 to 1980	16511

TABLE ~~336~~ A10 : PARKING GARAGE CONSTRUCTION PROGRAMME
PERIOD 1980 to 1985

District	Garage	Capital Costs (R1000's) Construction
41	Hoofd St	1300
44	Jack Mincer Extn	520
46	Bantu Sports Ground	2500
48	Selby over S. A. R. Sidings	1440
43	Pritchard St	555
45	Vanderbijl Extn	250
42	Pietersen/Twist St	270
	Houghton Golf Course (park & ride)	1800
	Yeoville " "	630
	San Souci " "	1350
	Parkview " "	2700
	Rosettenville Corner " "	3600
	Mayfair " "	1950
	Bertrams " "	1350
	Jeppe " "	900
	Total	21115
	Total Land Costs	1376
	Grand Total 1980 to 1985	22491

TABLE A 11 : ESTIMATED AVERAGE EXPENDITURE ON CARS

	Expenditure at rates: Existing	Proposed
Fixed Charges[1]		
Loss of interest 6% p.a. on original cost[2]	788	827
Licence fee[3]	108	348
Registration fee	4	4
Insurance[2]	470	470
Depreciation	1629	1738
Total fixed charges over 6 years	2999	3387
Average annual fixed cost	R 500	564
Annual Running Costs[4]		
Petrol[5] 400 gal.	156	164
Oil[2]	11	11
Lubrication[2]	3	3
Tyres[2]	30	30
Servicing and adjustments[2]	44	44
Replacements etc.[2]	89	89
	R 333	R341
Grand Total Annual Cost	R 833	R905
Cars in White ownership mid 1969 =	180 400	
Total expenditure per year	150m	R163m
Without growth of cars to 1985 i.e. 180 400 cars over 15 years. Total expenditure	R2 250m	R2 440m
With growth of cars to 1985 (Estimated average 257 000) - Total expenditure	R3 210m	R3 490m

1. Based on present average new car cost of R2 189 and resale, 6 years later, for R560. From "The Motorist" July 1969 page 47.
2. From "The Motorist" July 1969 page 47.
3. Based on R18 at present and R58 proposed.
4. Based on 10 000 miles per year and 25 mpg.
5. Based on average of 39c at present and 41c proposed. Equivalent to about 70% regular and 30% premium petrol.

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