The density of residential areas.

THE DENSITY OF RESIDENTIAL AREAS

PUBLISHED FOR THE MINISTRY OF HOUSING & LOCAL GOVERNMENT
BY HER MAJESTY'S STATIONERY OFFICE · 1952 · PRICE 5s. 0d. NET

MINISTRY OF HOUSING AND LOCAL GOVERNMENT

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LONDON
HER MAJESTY'S STATIONERY OFFICE
1952

FOREWORD

By the Minister of Housing and Local Government

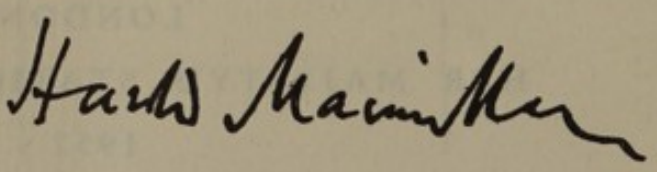
Many thousands of acres of land are being taken for development every year; and much of this is good agricultural land. Some loss of agricultural land cannot be prevented if we are to have more houses, schools and factories; if we are to meet the requirements of defence; and if we are to get the minerals we need. But it is essential that the amount of land taken should be kept as small as possible.

This book deals with the amount of land needed for residential areas. In the past an unnecessary amount of land has too often been used for this purpose; and while I believe that we are becoming more careful, I have myself frequently noticed, in quite recent development, unnecessarily wide streets and houses too loosely scattered.

Close and compact development not only saves land; it is often more satisfactory than loose and open development. In putting out this book I am not intending to suggest that desirable standards must be cut; but rather that, with more flexible ideas about the use of terraces and with better layout, land can be saved without any sacrifice of desirable standards—and perhaps with some actual improvement in the overall design.

I hope that the suggestions in this book will help both public authorities and private developers to save land. It is important to save every acre that can be saved.

I must, however, emphasise that this is largely a technical publication. One of its main purposes is to assist technical officers in the measurement of density and in methods of achieving particular densities. The figures and illustrations are intended as diagrams amplifying the text; they are not intended to suggest that the arrangements illustrated would necessarily be good ones. Further it should be noted that this Handbook was in preparation before the issue of Houses 1952 and takes no account of the modifications in house design suggested in that publication.



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THE DENSITY OF RESIDENTIAL AREAS

INTRODUCTION

The Scope of the Handbook

1. The term " residential density " is clear enough in its general meaning. It signifies the degree of closeness with which dwellings, and hence the people occupying them, are arranged in the residential areas of towns and villages. The connection between residential density and living conditions is also clear in a general way — the evils resulting from high density in many of our large towns are widely recognized, and so also are the evils of low-density " urban sprawl " which was characteristic of so much inter-war development, and which was in part a reaction against the crowded conditions in the big towns. But for those who have to tackle the complex problems of urban development and redevelopment, a closer understanding of the subject is needed. What considerations govern the spacing of dwellings? What are the best ways of measuring and comparing densities? Where is the line to be drawn between high density and sprawl? These are but a few of the questions which face anyone concerned with urban planning, and it is to questions of this kind that this handbook is directed. The problems are complex and it is not to be expected that hard and fast rules can be worked out to set precise densities for general adoption. It is hoped, however, that an analysis of the subject into its constituent elements will at least disclose the factors which must be taken into account in reaching a decision in any particular case and will thus ease the task of those upon whom such responsibilities fall.

2. The handbook is concerned only incidentally with the detailed design or aesthetics of residential areas. This is not to imply that these are unimportant subjects, but at the planning stage the problems arising are mainly connected with the allocation, arrangement and intensity of use of land and it is important that these should not be obscured by details. It is, of course, necessary to ensure that major planning decisions are in fact capable of being translated into bricks and mortar with satisfactory results, and for this reason a number of layouts which have been worked out in some detail will be found in the handbook. It is however, emphasized that the handbook is primarily concerned with the planning of land use and not with architectural design and layout.

3. The general plan of the handbook is first to consider in some detail the background of the problem, then to proceed to the practical application of this groundwork to the process of making a development plan and finally to discuss some of the problems connected with the density of residential areas that are likely to arise in the day-to-day control of development. In the first section covering the background of the subject an attempt has been made to work afresh from first principles, and terms are defined as they are evolved ; this approach even though it results in terms which are for the most part already in general use, has been thought preferable to starting with a list of definitions that would be only too likely in many instances to beg the questions they are designed to clarify.

CHAPTER I

The Background

I. THE MEANING OF RESIDENTIAL DENSITY

4. In physical planning the fundamental problem of the relationship between people and the amount of land they need for their accommodation may arise in various forms. It may, for instance, be necessary to estimate the amount of land which a given number of people will require for their dwellings and other associated purposes, or it may be necessary to ascertain whether in an existing city there are too many, or even too few, people living within a certain area. In all this work, which inevitably involves calculations of the density at which land is occupied, there are two main purposes apparent. The first is connected with rate of land use ; density calculations are made for the estimation of land needs. The second purpose is connected with living conditions ; density calculations are made to ensure that, in new development, certain standards are obtained, or in the case of existing development, to convey an idea of present standards.

5. The purpose of density calculations in relation to the estimation of land needs is clear enough and the only point to be emphasized is that in this small country the planner must now take it as axiomatic that no more land should be used for urban purposes than is absolutely necessary. This means in practice that he is involved, particularly in connection with residential areas, in the difficult task of finding compromises between the needs of urban dwellers and the demands of agriculture, mineral extraction, and other important uses of land. On this account the general line of investigation in the paragraphs that follow is to try to define first the *essential* needs that must be met in a residential area, then to ascertain the *least* amount of land necessary to satisfy those needs, leaving for further consideration the relaxations that may be desirable in the way of more generous spacing.

6. The significance of density figures in relation to living conditions is more complex and it is first necessary to gain an idea of the essential needs that must be met in a residential area and which would obviously be affected by alterations in density. It is suggested that these needs can be broadly summarized under four headings :—

(i) There must be enough living accommodation arranged in a suitable variety of dwellings.

(ii) The dwellings themselves must be so arranged on the ground that the rooms get sufficient light, air, and sunshine, and there should be some open space near the dwellings which can be used for casual exercise and sitting out and as a visual relief from bricks and mortar.

(iii) The dwellings should be conveniently sited in relation to shops, schools, open space, and other places that the residents have frequent need to visit, that is to say certain other land uses will normally be required *within* a residential area for the general convenience of the residents.

(iv) The residential area as a whole should be conveniently related, in both position and scale, to the rest of the town, allowing reasonably good access to the town centre, the main areas of employment, and the other residential areas.

7. These four needs correspond to four distinct physical aspects of residential density. These aspects are separable, for residential conditions in a town can be deficient in any of them separately or in combinations of them. The truth of this can be readily seen in any large city. In London, for instance, there are districts originally laid out for elegant living, where the spacious houses, though providing ample light, air, and space about buildings, are now seriously overcrowded, or in other words there is not enough accommodation ; in other parts there are small houses that in themselves are not unsatisfactory, but they are spread monotonously over enormous areas so that the people have no space readily accessible for exercise and

recreation ; there are blocks of flats where the interior space is all that could be desired, but where the space about the building is almost non-existent ; there are other blocks of flats that are overcrowded, dark, and cramped on the site, but yet have the merit of convenient location ; and finally there are low-density peripheral estates where the first three aspects of density are not unsatisfactorily met but where most of the residents are remote from their workplaces and the main centres of activity.

8. Unfortunately for the physical planner the relationship between the four aspects of density is by no means a simple one. This is due to the fact that some of the factors concerned are more or less contradictory in nature. On the one hand there is the desire for ample dwellings, spacious surroundings, and plenty of room close at hand for outdoor activities, the satisfaction of which makes for open low-density development ; and on the other hand there is the desire for convenience, accessibility and sociability, which are all factors tending to make for compact high-density development. So, quite apart from the main compromise implicit in the need to economize land, the planner is faced with the need to strike a further balance between the factors that control residential density itself, and the point at which to strike the balance will be a matter of opinion, often of controversy, and will involve decisions of policy on such vital matters as the proportion of people to be accommodated in houses and flats.

9. A further complication for the physical planner arises from the fact that a balance struck in relation to one locality may be quite unsuitable for another, because communities in different parts of the country, even, in fact, in different parts of the same town, have varying structures and needs, differing levels of income, and different methods of recreation. Then again, a compromise suitable for one area will be related to the physical relief and climate of that area and will almost certainly be unsuitable for another area where the conditions are quite different.

10. At the outset of this investigation, therefore, the fact must be faced that there are so many variables in this subject of residential density that there is little possibility of being able to define absolute desirable standards of density applicable all over the country. An attempt will be made to define absolute minimum standards of density, but it should be recognized that minimum standards always carry with them the risk that they will be universally adopted and result in a generally lower standard than might actually be necessary.

11. A good deal of confusion of thought on residential density has resulted from a failure to distinguish the four separate aspects previously described, and the rest of this chapter will be directed to a more detailed examination of each. These aspects of density are, however, merely physical aspects concerned with the actual spacing on the ground of dwellings and other forms of development in order to meet people's needs. No general study of residential density would be complete without consideration of the relationship between density and cost of development, for in all town planning the way in which any project finally works out is liable to be governed as much by considerations of cost as anything else. Prima facie, it would appear that the cost of low-density development with spread-out roads and services and two-storey houses would be different from the cost of providing the same amount of accommodation in the form of high blocks of flats compactly developed but it is obviously of great importance to the planner to know the extent of the differences and where they lie. It is therefore proposed to treat cost of development as a fifth aspect of residential density but to postpone consideration of it until the four physical aspects have been dealt with.

II. DENSITY WITHIN DWELLINGS

12. For satisfactory living conditions in any area there must be enough variously-sized dwellings to meet the needs of all the different households, from single persons living alone to large families with children. In practice it is not unusual for an architect to design a single

dwelling exactly " to measure " for a particular household, but when it comes to the design of large groups of dwellings where the future occupants are unknown, all that can be done is to estimate their needs in general terms. The physical planner stands even more remote from actual needs, for his general problem is to say, perhaps years in advance of the need actually arising, how much accommodation a certain number of people will require and how much land will be needed for that accommodation. In most cases the best he can do is to state the accommodation requirement as a bulk quantity in some convenient unit, with only the broadest idea of what the eventual breakdown into dwellings is likely to be.

13. There are several possible bases for the bulk measurement of accommodation:—

(i) The Dwelling. This suffers from the disadvantage that it does not convey accurately the real amount of accommodation in an area unless the separate sizes of the dwellings are also stated.

(ii) Floor Space. This is a useful basis but it is difficult to measure and is unnecessarily precise. It also has the disadvantage that it requires relation to the type of property in order to convey a real idea of the amount of accommodation ; in expensive property, for instance, there may be a great deal of floor space but it may provide accommodation for relatively few people.

(iii) The Habitable Room. On this basis the amount of accommodation in an area is stated as comprising so many habitable rooms (e.g. bedrooms, living rooms and dining rooms, but not kitchens, bathrooms or W.C.'s). It is the number of habitable rooms that constitutes the real difference between dwellings of various sizes, and the unit is already widely used as a means of describing the size of a dwelling.

(iv) The Bedroom. If certain conditions are specified regarding the number of people who can use bedrooms of various sizes and the extent to which they can be shared, then the bedroom can be used for the measurement of accommodation in bulk. It has the disadvantage, however, that bedrooms may not always be used as such, for example two dwellings may have identical accommodation but a quite different number of rooms in use as bedrooms.

14. None of the units suggested above is entirely satisfactory from all angles, each has advantages and disadvantages. On balance however it appears that the habitable room is probably the most useful of the four as being able to convey the readiest idea of the amount of accommodation in an area, and hence of the number of persons who can be accommodated. This is the unit which has been recommended by the Ministry for the measurement of accommodation densities in survey and development-plan maps prepared under the Town and Country Planning Act, 1947.

15. In a single dwelling the ratio of occupants to the number of habitable rooms will give a measure of the intensity of occupation of the dwelling. This ratio has been given the name of " Occupancy Rate." In the Housing Manual*, against each dwelling type is stated the number of persons (based on a bedroom standard) such a dwelling would normally be expected to contain, and the resulting Occupancy Rates vary from 1·0 to 1·3 persons per room. These dwelling types all represent the least amount of accommodation necessary to give reasonable standards of comfort and privacy, and the Occupancy Rates might therefore be regarded as maxima for new dwellings. The Rates are equally a guide to conditions in existing dwellings judged against the same standards, and if, in any such dwelling, the Occupancy Rate is found to be much in excess of 1·0 it is probably evidence of shortage of accommodation. The latter will not always be true, for the composition of the family may be such that a fairly high Occupancy Rate causes no great discomfort, but in general a rate above 1·0 may be taken as a warning. It should be noted however, as far as Occupancy Rate is concerned, that statutory overcrowding in a single dwelling is not deemed to exist until the

* Ministry of Health. Housing manual 1949. H.M.S.O., 1949.

Occupancy Rate rises between 1·5 and 2·0, children under 1 year not being counted and children between 1 and 10 years being counted as half persons.

16. If a large number of dwellings were being built over a big area it would not be satisfactory to assume a maximum Occupancy Rate in each and every dwelling. A proportion of more spacious dwellings would be required, and allowance would have to be made for some of the dwellings being under-occupied some of the time. The *average* Occupancy Rate for the whole area (i.e. total number of persons divided by total number of habitable rooms) would therefore in all probability stand at less than 1·0. This is the case already over large parts of England and Wales. On the other hand there are considerable areas of large towns where the *average* Occupancy Rate stands well above 1·0, and where this is so it is almost certain evidence of a shortage of accommodation.

17. There is no guide to the average Occupancy Rates suitable for various circumstances. One survey has shown that for areas of local authority housing, where a strict attempt is made to keep the accommodation full, then the average Occupancy Rate stands at about 1·0, and for areas of private housing that the Rate stands at 0·8. In any particular case it would seem that a planning officer will need to study existing Rates for various classes of property before deciding upon new figures for use in planning. It is very likely, however, that as more information becomes available it will be possible to make valid generalizations about the Rates applicable to various cases. In the various examples given later in this handbook an Occupancy Rate of ·89 persons per room has been assumed.

18. The preceding paragraphs have established the habitable room as a convenient unit for the bulk measurement of accommodation, and Occupancy Rate as a means of measuring the density of people within accommodation. The two together enable the physical planner to say how much accommodation in bulk a given number of people will require. For the planner to say how much land is required for the bulk quantity of accommodation he will clearly have to consider the way the accommodation is arranged, that is to say the way the rooms are allocated to dwellings and the way the dwellings are themselves arranged on the ground. It is evident that a serious difficulty arises here, for, as already shown, the planner is seldom in a position to be precise about such matters. There is no straightforward way out of this difficulty. The best the planner can do is to be knowledgeable about the kind of dwelling requirements likely to arise, and to have a good idea of the possibilities in dwelling arrangement at various stated ratios of accommodation to land. Thus if the planner wishes to know how much land would be needed for 5,000 habitable rooms and he knew that a ratio of 100 habitable rooms per acre would give roughly suitable living conditions, then he could quickly calculate the area of land required. Fortunately, as will be shown later, the range of building possibilities at any particular ratio, or density, of accommodation to land is considerable and this gives the planner a useful factor of safety.

III. DENSITY OF DWELLINGS ON THE GROUND

19. In this section a study is made of the practical possibilities that exist in the way of arranging accommodation, with a view to building up an idea of the significance of various densities. It should perhaps be re-emphasized that what is being considered at this stage is the arrangement and spacing of dwellings inclusive of their immediate surroundings but excluding other uses such as shops, schools and major open space. It is, in fact, the density of areas consisting of dwellings only that is being considered, to which has been given the name of " Net Accommodation Density ".*

20. Dwellings can vary from bed-sitting-rooms in hostel blocks at the one extreme to

* See Appendix 3 for definition of the area of land to be included.

large houses with private garages and outbuildings at the other. Dwellings consisting of 3-7 habitable rooms can be built in the form of houses or flats. Larger dwellings are usually more conveniently built as houses, and smaller dwellings as flats though sometimes the small bungalow is useful, particularly for old people. One of the main purposes of dwellings constructed as houses is to have a private garden directly attached to the house. Dwellings built as flats cannot generally be provided with private outdoor space at ground level though sometimes it is possible to arrange it for a proportion of the flats in two- or three-storey blocks. It is fairly clear therefore that the density considerations applying to houses are likely to be somewhat different from those applying to flats and it will be best to consider these two main forms of construction separately.

21. There is, however, one point common to both houses and flats which should be considered first. This is the question of the actual physical area of the dwelling, for it is clear that a dwelling composed of very large rooms takes up more space than a dwelling containing the same number of rooms of a smaller size, and would therefore tend to be associated with a lower density. Room sizes are, of course, subject to considerable variation largely depending upon what the occupants can afford, but on the assumption that municipal housing is being considered then an analysis of the designs shown in the Housing Manual shows that the ratio of net dwelling area divided by number of habitable rooms ranges broadly between 200 and 300 sq. ft. In more expensive dwellings this ratio may be as high as 500 sq. ft. per habitable room. In the paragraphs that follow, the Housing Manual ratios will be followed generally, but it should be understood that if room sizes are substantially increased then the effect on the density of dwellings may be considerable.

(i) Areas developed with Houses

22. The principal factors governing the arrangement, and hence the density, of houses are:

(i) The type of house, that is to say whether terrace, semi-detached, or detached.

(ii) Garden size.

(iii) Space required to ensure sufficient daylighting and sunlighting.

(iv) Space required for privacy.

(v) Space required for access.

(vi) Space required amongst the houses for tree planting, small greens, etc. (Referred to hereafter as " incidental open space ").

23. The first two factors mentioned in para. 22 are linked because it is broadly true to say that each type of house must be associated with a fairly definite range of garden sizes resulting from the frontage dimensions of the house and the need to give a useful garden shape. Thus it would be impossible to design normal terrace houses at 4 sites per acre unless the gardens were made absurdly long. Therefore, although it is attractive at first sight to try to work out a rule connecting garden size with, say, the amount of accommodation in the house, the fact is that garden sizes are broadly controlled by the type of house to which the garden belongs. For terrace houses with frontages varying from 18 ft.-30 ft. the range of back garden sizes is roughly from $\frac{1}{70}$–$\frac{1}{16}$ acre, the smaller of these extremes being little more than an " outdoor room ". For semi-detached houses with frontages varying from 30 ft.-45 ft. the range of back-garden sizes is roughly from $\frac{1}{30}$–$\frac{1}{7}$ acre. For detached houses with a minimum frontage of 40 ft. the range of garden sizes is from about $\frac{1}{14}$ acre upwards. This is not to say that houses may not be found with gardens outside these ranges but these are the usual limits in urban development.

24. It is generally agreed that obstruction of daylight can be avoided, as far as rows of houses are concerned, by ensuring that the houses in one row do not rise above an imaginary line drawn at an angle of 25° from the foot of the adjoining row. This is explained diagrammatically in Fig. 1 for two-storey and three-storey buildings. It will be seen that the critical angle of 25° results in a minimum dimension between two-storey houses of 46 ft. 6 ins., and between three-storey houses of 68 ft. With regard to sunlighting, it is impossible to design buildings so that they get sunlight into all rooms at all times of the day throughout the year, and it has been recommended by the

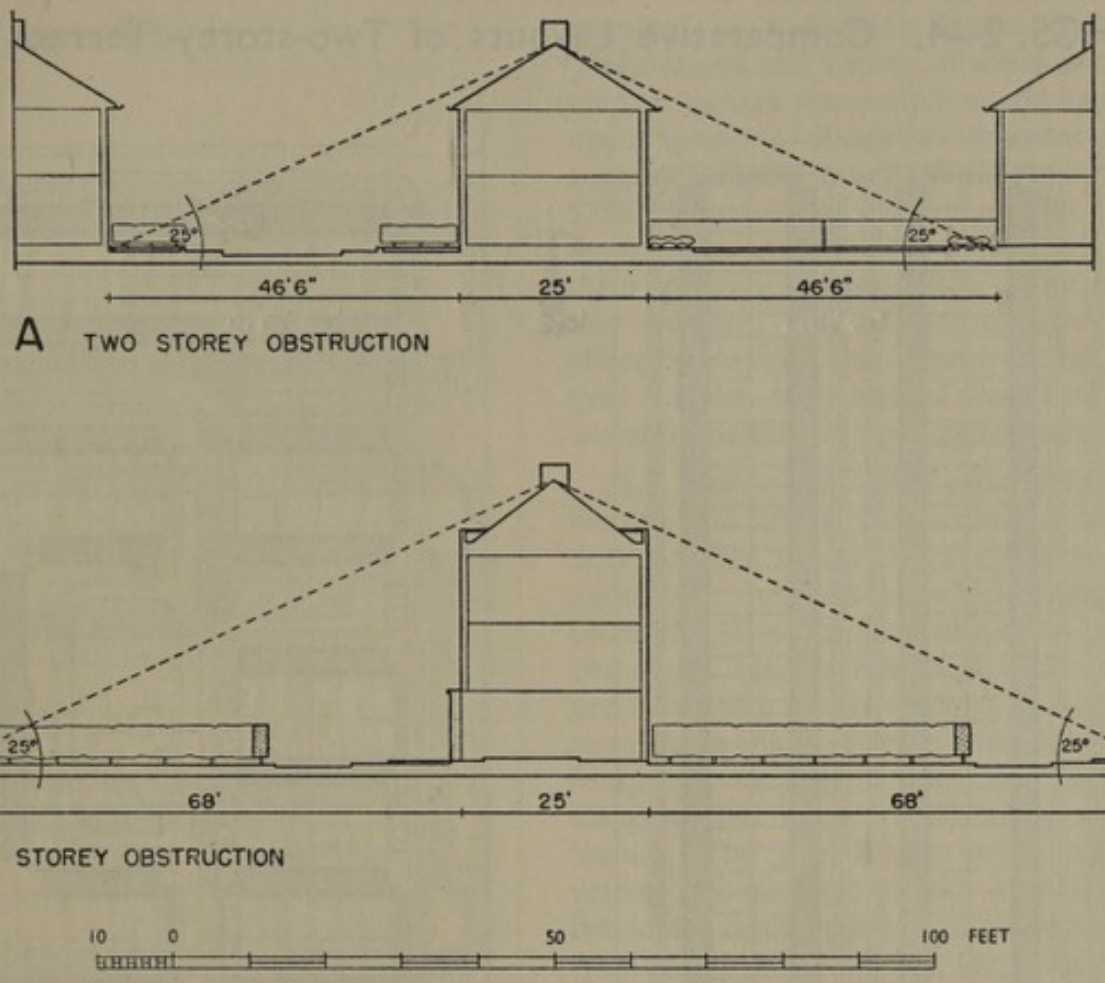


Fig. I. OBSTRUCTION OF DAYLIGHT

This figure shows how a critical daylighting angle of 25° affects the spacing of continuous rows of 2- or 3-storey houses.

Codes of Practice Committee* that the standard to be aimed at is to provide one window in the principal living room, so placed that sunlight can enter for at least one hour of the day during not less than ten months of the year from February to November. On occasion this standard may impose a severe limitation on the spacing of buildings, because in England, even in the south, the sun at mid-winter has a maximum elevation of only 15°. In general, however, it is true to say that, whereas the need for sunlight must have a profound effect upon the *design* and *orientation* of houses, it does not necessarily have any great effect upon *density*, provided the buildings are so arranged as to admit sufficient daylight.

25. Privacy in housing layouts can only be secured by attention to a number of points. The windows of one dwelling should not directly face those of another unless there is a reasonable distance between them. A dimension of 70 ft. seems to be generally agreed as the minimum between rows of houses to secure privacy in this respect. Ground floor rooms should be private from the view of passers-by in the street; this can be secured by raising the level of the ground floor or even by

* British Standards Institution. Code of functional requirements of buildings, chapter I(B); sunlight; houses, flats and schools only. (British Standard Code of Practice, C.P.3: 1945. Codes of Practice Committee, Ministry of Works.) British Standards Institution, 1945.

FIGS. 2—4. Comparative Layouts of Two-storey Terrace Houses

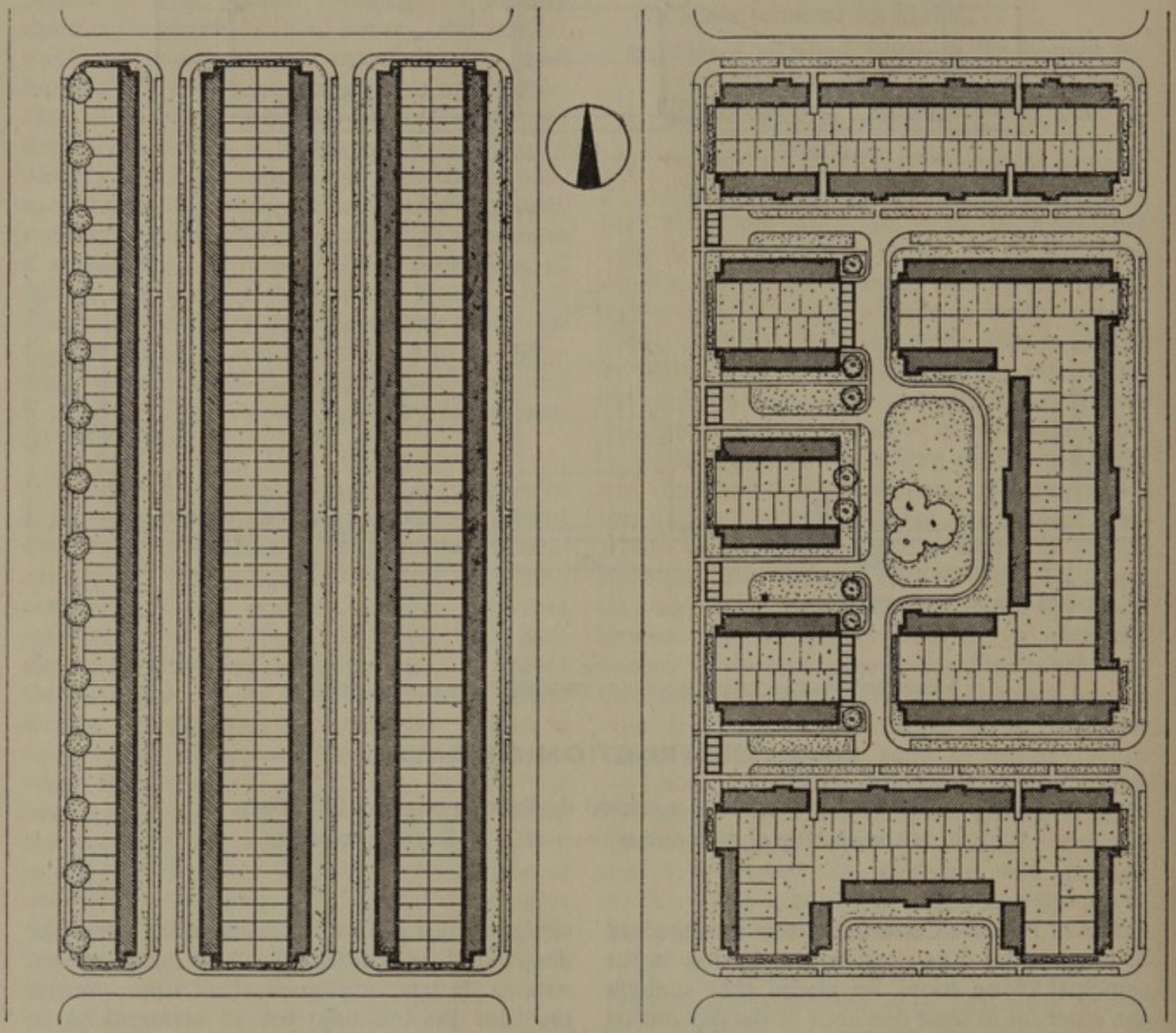
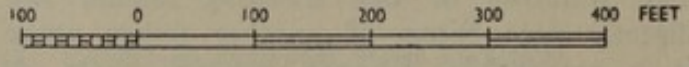


Fig. 2. 105 ROOMS PER ACRE

Fig. 3. 72 ROOMS PER ACRE



curtaining, but the simplest and more normal way is to set the buildings back a few feet from the edge of the street. Finally there is privacy in the garden. This is difficult to achieve for terrace and semi-detached houses because some degree of overlooking from adjoining houses is inevitable, but skilful site-planning can help to reduce this.

26. In the last few years there has been some revision of ideas on the space required amongst dwellings to give access to them and the schedule accompanying the Ministry of Local Government and Planning's Circular No. 19 sets out the latest advisory standards for minimum street

on a 12-acre Site

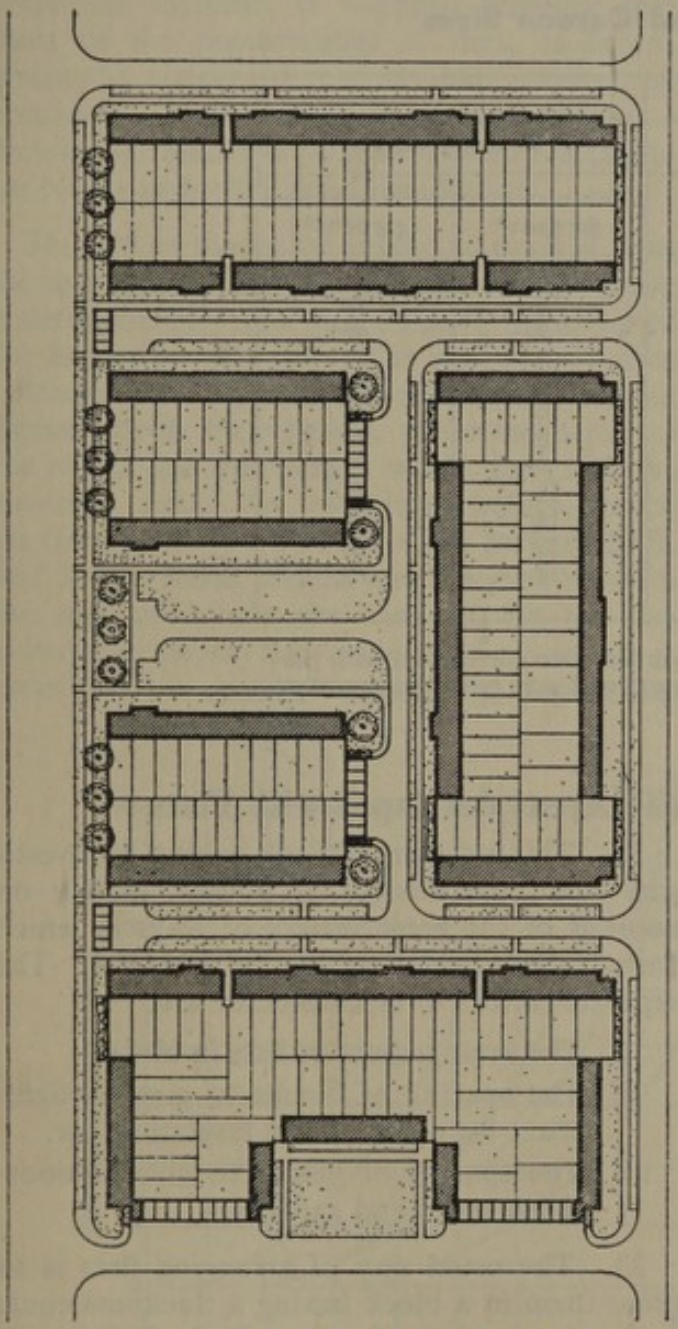


Fig. 4. 65 ROOMS PER ACRE

widths. The parts of this schedule which relate to residential areas are reproduced for convenience in this volume at Appendix 1. This schedule does not in fact differ greatly from most urban by-laws as regards the *space* required for access purposes except that there is a useful provision for footpath access provided the building is not more than 150 ft. from a carriageway.

27. The amount of incidental open space required in a housing layout to give some pleasantness and variety of scene is a debatable matter, though few people would say that such open space is altogether unnecessary. It is suggested that a standard of about 1 acre per 1,000 rooms is the minimum that is required irrespective of any other provision for public open space or playing fields. Any increase on this standard will of course have a marked effect on density, and regard should always be paid to the problems of maintenance which excessive incidental open space may cause.

28. Having considered separately the various factors that affect the spacing of houses, it is now possible to set down some general ideas about the densities at which houses can be planned. The absolute maximum density for two-storey terrace houses is about 105 rooms per acre, and this is secured by arranging the terraces in close rows 70 ft. apart. This is illustrated in Fig. 2, and few people would disagree that it is an extremely monotonous layout. The introduction of a minimum of variety into the layout, with a small amount of incidental open space, but retaining the 70 ft. spacing between rows, has the effect of reducing the density to about 72 rooms per acre (See Fig. 3.) Enlarging the back gardens to a minimum of 50 ft., giving 100 ft. between backs of houses, has the effect of further reducing the density to about 65 rooms per acre (See Fig. 4.) This last figure might be regarded as a practical working standard though it should be remembered that higher figures are possible if minimum gardens are acceptable. On the other hand it is to be noted that these figures relate to a flat, rectangular site with no allowance for waste; hilly or irregularly shaped sites would make for lower densities. In Figs. 3-4 the incidental open space amounts to roughly 1 acre per 1,000 rooms.

29. The densities for three-storey terrace houses corresponding to those shown in Figs. 2-4 are roughly 135, 95, and 85 rooms per acre respectively.

30. Below these densities there is a wide range of possibilities with the house types mixed in various proportions, and with gardens of

TABLE I

Densities corresponding to Various Combinations of House Types and Garden Sizes

Combinations of House Types (Two-storey) % of total rooms			Average Density in Habitable Rooms per acre	
Detached	Semi-detached	Terrace	With maximum gardens*	With minimum gardens*
100	0	0	5	36
80	10	10	6	38
60	20	20	7	40
40	30	30	9	43
20	40	40	13	47
0	50	50	30	52
50	50	0	8	39
40	40	20	9	42
30	30	40	11	46
20	20	60	14	51
10	10	80	20	58
0	0	100	39	72

* These maximum and minimum garden sizes correspond with the ranges quoted in para. 23. A maximum of 1 acre has been assumed for a detached house.

various sizes. To give some idea of the possibilities Table 1 has been compiled to show the density range for various combinations of detached, semi-detached and terrace houses according to the size of garden. Allowance is made in these figures for some variety of layout and for incidental open space at about 1 acre per 1,000 rooms.

31. It will have been noted from the previous paragraphs that garden size has a great effect on the density at which houses can be planned. It has been shown that garden size is bound to depend broadly upon the type of house provided, but even so there is a range of choice with each type. It is difficult to give general advice about the choice of garden size but it might perhaps be said that, if one of the main purposes of building dwellings in the form of houses is that there may be private gardens, there is much to be said for making the gardens at least big enough to provide playing or sitting-out space and some space for flowers and fruit trees. The minimum back garden which will meet these requirements is about 150-200 sq. yds. The gardens in Fig. 4 showing a layout of terrace houses at 65 rooms per acre are roughly of this size.

(ii) Areas developed with Flats

32. This is a more difficult subject to investigate than the density of houses, mainly on account of the great variety of ways in which flatted accommodation can be arranged. The separate factors to be considered are:

(i) The arrangement of flats in blocks.
(ii) The spacing of blocks to give daylight, space for access, noise insulation, etc.
(iii) The spacing of blocks to give outdoor-living space and gardens.

33. The usual way of arranging flats is to place them in a block having a thickness equal to the depth of one flat (usually 24-30 ft.), with access by means of balconies or by lifts running up between pairs of flats on each floor. From this basic type there are many variations. The flats may be in a simple rectangular block standing by itself, or in long blocks planned in various shapes such as E or L, or in wings radiating from a central point. Even with plain rectangular blocks there are many ways in which the blocks themselves can be arranged; they can, for instance, be set out in parallel rows on both sides of a street rather as though

they were terrace houses, or they can be placed at right angles to a street, or they can be arranged in variations of the broken square or broken cruciform layouts. It happens however that most of the potentialities of flats, as far as density is concerned, can be demonstrated by considering two main forms of layout — rectangular blocks in parallel rows and rectangular blocks in broken cruciform layout.

34. When blocks are placed in parallel rows the spacing required to give adequate daylighting is determined by a 25° angle exactly as explained for houses in para. 24. The amount of space between the buildings would then depend directly upon their height, while the depth of the blocks and their length would determine the coverage area. As explained before, block depths are likely to be somewhere between 24 ft. and 30 ft. Block lengths and the gaps between the ends of blocks are variable, but for any given dimensions and number of storeys it is clear that the spacing required for daylighting will fix the amount of accommodation that can be placed on a given area of ground. If the number of storeys is increased, thus increasing the amount of accommodation, then rows must be farther apart to give adequate daylighting and this in turn will affect the amount of accommodation on the given area. Curve B in Fig. 5 shows quite clearly that for this pattern of block arrangement the relationship between number of storeys and density of accommodation is not in direct proportion, doubling the number of storeys does not double the accommodation on a given area because the need for daylighting makes it necessary to place the blocks farther apart. Also shown in Fig. 5 are similar curves for blocks of various other lengths and depths.

35. Fig. 5 gives a rough idea of the maximum densities likely to be achieved, consistent with good daylighting, in areas developed with continuous frontages along both sides of a street. The question of space required for daylighting

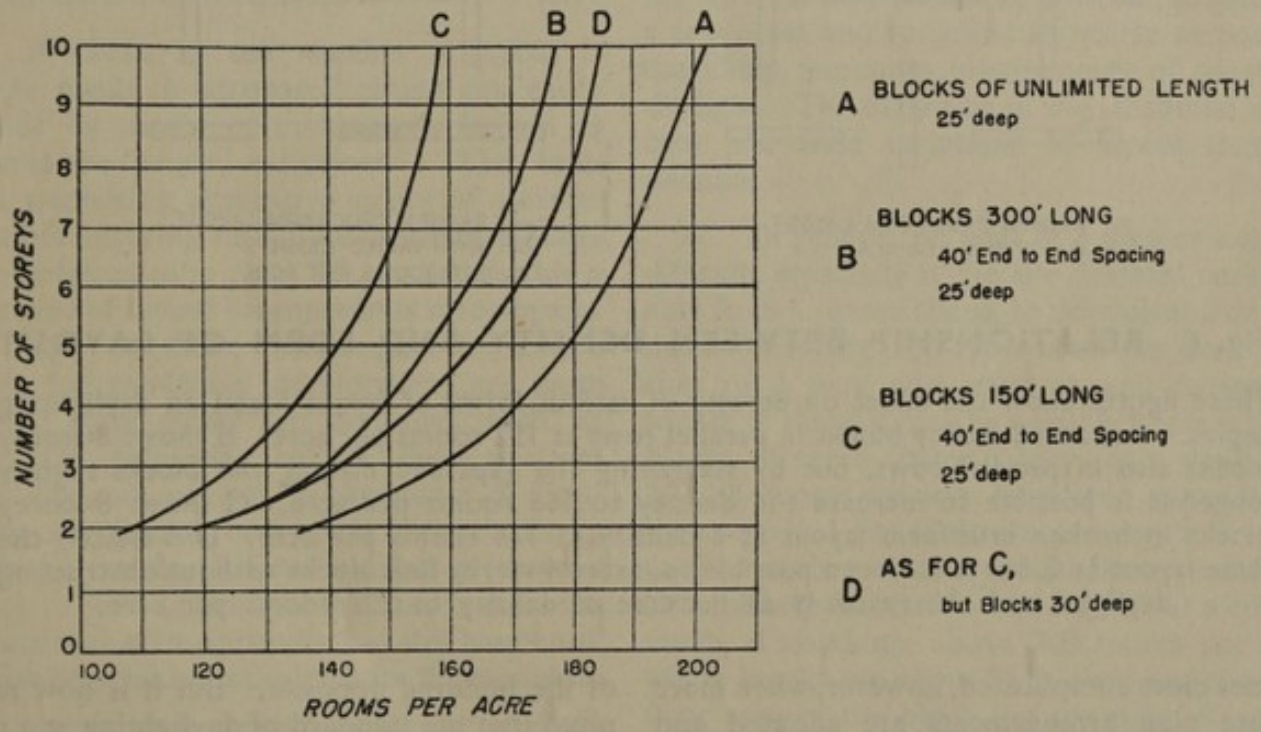


Fig. 5. RELATIONSHIP BETWEEN DENSITY AND NUMBER OF STOREYS

These curves all relate to blocks of flats in parallel layout, and they show the maximum densities for various numbers of storeys on the assumption that the blocks are spaced on a 25° daylighting angle.

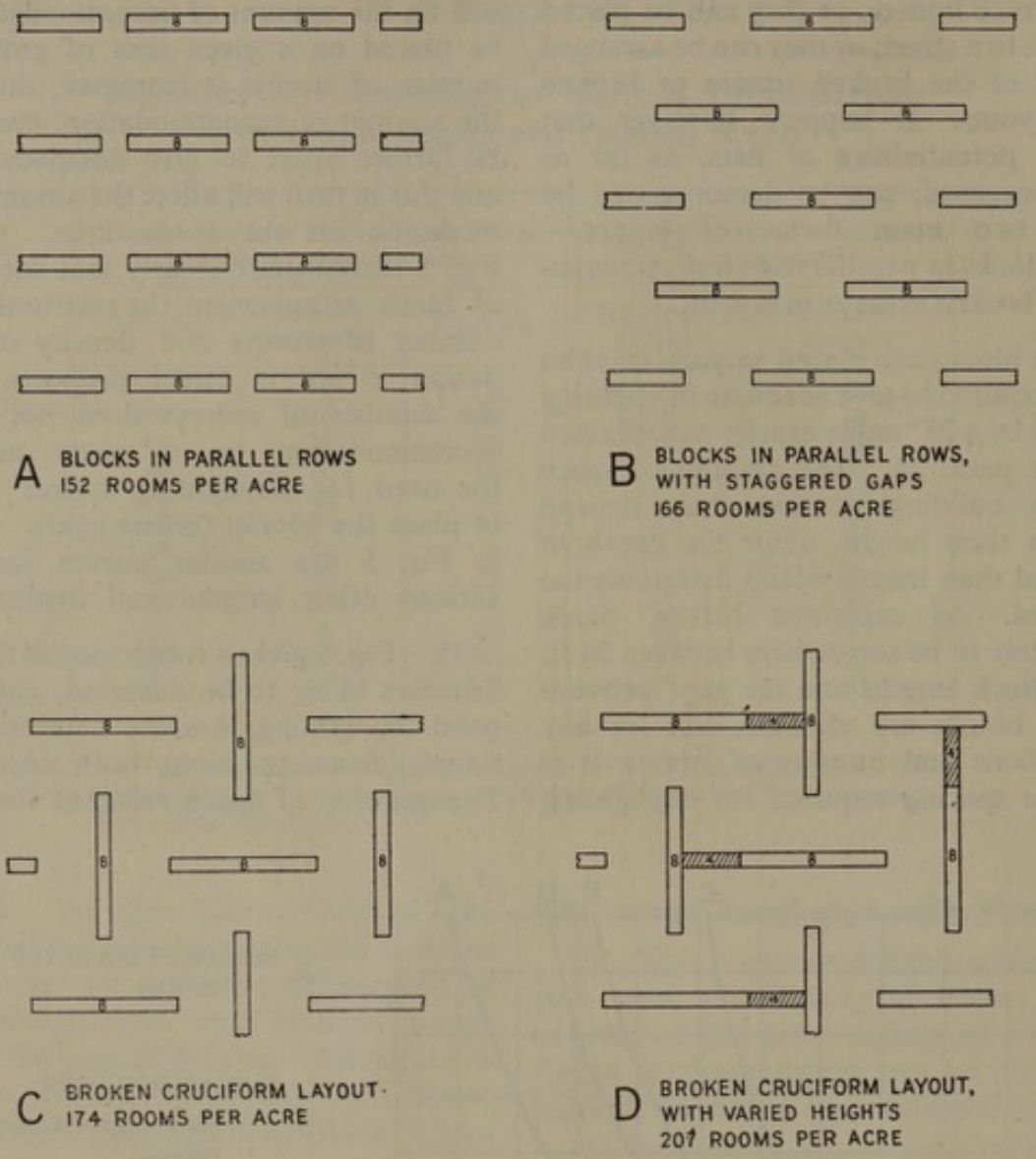


Fig. 6. RELATIONSHIP BETWEEN DENSITY AND FORM OF LAYOUT

These figures show the effect on density of various forms of layout based on daylighting angles. A shows 8-storey blocks in parallel rows at 152 rooms per acre. B shows 8-storey blocks also in parallel rows, but by staggering the gaps and making the blocks slightly longer it is possible to increase the density to 166 rooms per acre. C shows 8-storey blocks in broken cruciform layout at a density of 174 rooms per acre. D is exactly the same layout as C but it has been possible to insert 4-storey link blocks without obstructing daylight, and the result is an increase of density to 207 rooms per acre.

becomes more complicated, however, when more intricate plan arrangements are adopted and when heights and dimensions of blocks vary. Previous methods of determining space requirements for daylighting were based on the assumption that development would be in the form of parallel blocks much as described in the last paragraph, and that any daylight penetrating into buildings would come from over the top of the building opposite. But it is now recognized that the standard of daylighting in a room should be based upon the amount of sky visible from a point inside the room, and it does not matter whether the patch of sky is seen over or round obstructions or even whether it is seen in one piece. The significance of this is that adequate daylighting can be secured with buildings arranged in a great variety of ways,

TABLE 2

Effect on Density of Varying the Block Depths and Floor Space Standard

Block Depth		25 ft.		30 ft.
Floor Area Standard		250 sq. ft. per Room	200 sq. ft. per Room	200 sq. ft. per Room
Habitable Rooms per acre		187	234	280
Persons per Acre assumed Occupancy Rate	0·89	166	208	250
	1·0	187	234	280
	1·15	215	268	322

and it has been shown elsewhere* that there are certain arrangements based on cruciform, H and E forms which at a given density will provide better daylighting than other arrangements such as blocks in parallel rows. The converse of this is that for a given standard of daylighting these arrangements will give higher densities of accommodation than others.

36. A check to see whether a layout is likely to result in adequate lighting can easily be made by means of instruments known as "permissible height indicators". The indicators, permitting alternative angles of obstruction while ensuring roughly equivalent patches of sky (referred to in para. 35), make possible a wide range of layout arrangements at comparatively high densities. Although the angles suitable for residential development are more stringent than those for buildings such as offices, the principles behind their use are similar and are set out in Appendix 3, Daylighting of Buildings, on page 95 of the Advisory Handbook on the Redevelopment of Central Areas.† The angles suitable for residential areas are set out in Appendix 2 of this handbook and have been taken as the basis for the minimum spacing of buildings in Figs. 6 and 7. The use of the indicators permits such a variety of building arrangements that the amount of space required to ensure adequate daylight cannot easily be predetermined and defined, since it depends upon the dimensions and layout of the building blocks and the shape and size of the site. It may be useful, however, to examine a few cases and to define as nearly as possible the likely minimum requirements of space for daylight. The diagrams in Fig. 6 should make clear the wide variations of layout that are possible.

37. In general, on sites of $\frac{1}{4}$ acre or less it is difficult, especially if the site deviates considerably from a square shape, to develop at a density much exceeding 150-190 rooms per acre. On sites of $\frac{1}{2}$ acre and upwards and reasonably square in shape it may be possible to place tower blocks of seven to ten storeys at a density of 200-300 rooms per acre. However, except where the shape and size of the site are very well suited to the number of storeys and the layout form, it is unlikely that flats would be built at a density much, if anything, above 200 rooms per acre, where blocks are about 25 ft. deep and the total floor area of the block per room is 250 sq. ft.; these figures could be considerably higher with different block depths and floor space standards. Table 2, based on a layout with blocks of five and ten storeys, broken cruciform arrangement, may serve to illustrate this point. Three different Occupancy Rates are also given to show how much variation in density of people

* *See* Ministry of Works. Post-war building studies, No. 12. The lighting of buildings; by the Lighting Committee of the Building Research Board of the Department of Scientific and Industrial Research, H.M.S.O., 1944.

† Ministry of Town and Country Planning. Advisory handbook on the redevelopment of central areas. H.M.S.O., 1947.

per net acre there may be, depending on the standards adopted.

38. The next point to consider is the extent to which the space-about-buildings necessary to give adequate daylighting is sufficient also to meet the needs of sunlighting, access, privacy, and noise and fire insulation. Unfortunately the effect of these other needs on space-about-buildings is too indefinite and too dependent upon the characteristics of individual sites to permit any precise statement about maximum densities or minimum space required; daylighting is peculiar in this respect that it does lend itself to fairly precise measurement and is therefore invaluable as a basis for spacing of buildings. The more open forms of layout found advantageous for daylighting purposes are also helpful in dealing with problems of noise and fire insulation, some aspects of privacy, and in some cases of sunlighting. It is probably a fair general statement to say that *the space required for daylighting should be sufficient for these other needs with the exception of sunlighting*. Even with sunlighting, however, it is not necessary to say that it demands in all cases a more generous spacing than daylighting, because good sunlighting is very largely a matter of design and orientation; but it is necessary to give the caution that in individual cases, for the reasons given in para. 24, it may be necessary to increase spacing substantially in order to admit winter sunshine. Again, it is probably a fair statement to say that given skilful design and orientation the space-about-buildings resulting from attention to daylighting should also meet the need for sunlighting up to a density of about 100 rooms per acre. On some sites, however, particularly on small ones, it may not be possible to design for high densities without too great sacrifice of sunlighting.

39. Having gained some idea of the way in which blocks of flats must be spaced in order to secure adequate daylighting, and having seen that the spacing for daylighting will normally cover the minimum requirements for the other factors, such as sunlighting and access, it is now possible to consider the question of outdoor-living space in order to ascertain the extent, if any, to which its provision is covered by space for daylighting.

40. It will first be useful to have a quantitative idea of the minimum space-about-buildings which results from planning for daylight. This is difficult because, as explained in para. 35, the new ideas about daylight permit of a great variety of building forms and heights, but nevertheless the following examples will be a guide. Taking first the simple case in which flats are laid out in parallel blocks (exactly as for curve B in Fig. 5), the space-about-buildings per habitable room at various densities which results is shown in Table 3.

TABLE 3

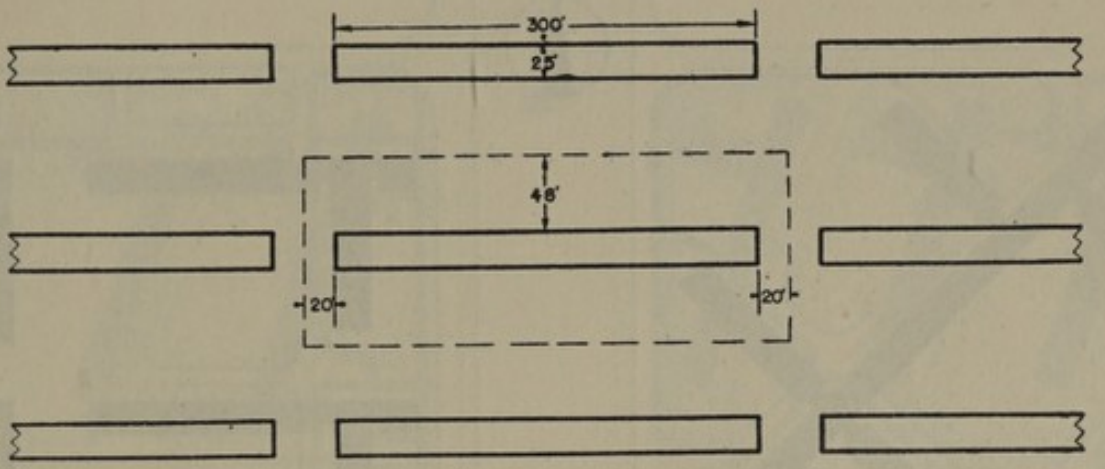
Space-about-Buildings per Habitable Room for Various Densities

Densities based on spacing of parallel blocks (300 ft. long, 25 ft. deep, 40 ft. end to end), with 25° daylight angle.

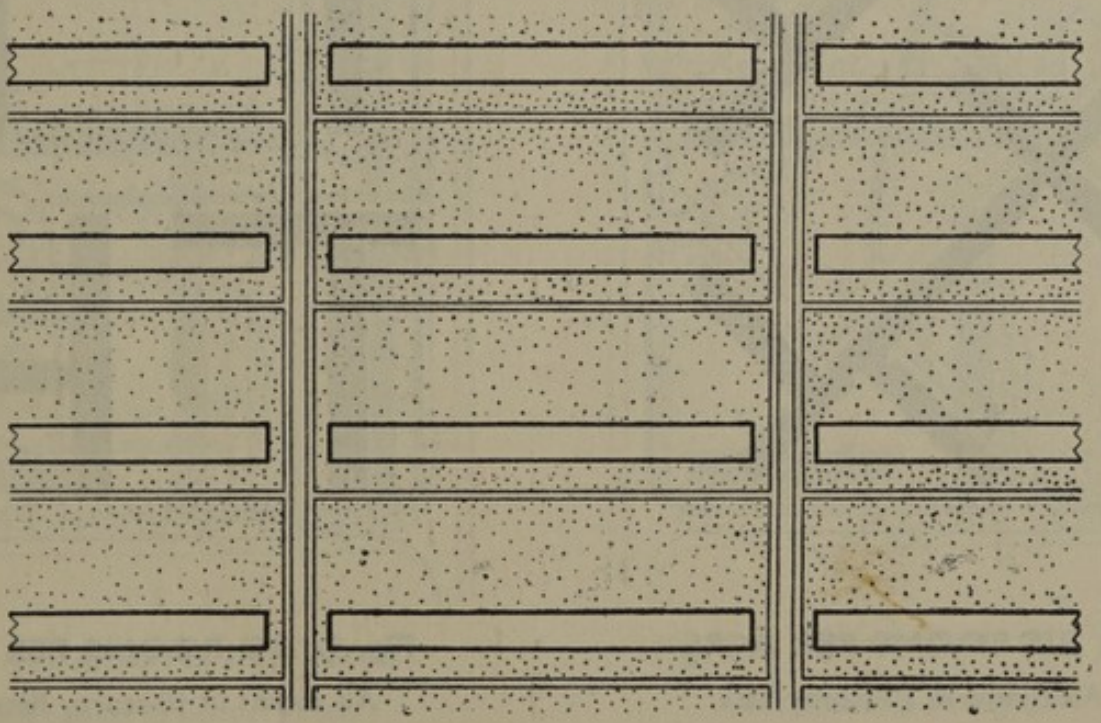
Number of Storeys	Rooms per Net Acre*	Gross Space about Buildings per Habitable Room (sq. ft.)
3	139	230
4	151	227
5	158	225
6	164	224
7	168	224
8	171	223
9	174	222
10	177	222

* On the assumption of 250 sq. ft. total floor area per habitable room.

41. The two points of interest in Table 3 are firstly the comparatively small range of variation in space-about-buildings per habitable room which results from development in parallel blocks at various densities at the higher end of the density scale, and secondly the average figure of 225 sq. ft. of space-about-buildings per habitable room. It is not easy, however, to grasp what this figure would actually mean to people living in the flats. Purely as a matter of space, it would mean that for each habitable room there would be 225 sq. ft. of open space (about equal itself to a habitable room) lying around and between the flats. For five-storey blocks (which would each contain 150 rooms) the total open space per block would be



A GROSS OPEN SPACE PER ROOM — 225 SQ. FT.



B EFFECTIVE OPEN SPACE PER ROOM — 170 SQ. FT.

Fig. 7. SPACE-ABOUT-BUILDINGS

These figures show the space about buildings resulting from spacing of blocks for daylight. A shows the gross space for 5-storey blocks and B shows the effective space available for amenity and recreation after allowance has been made for roads and paths.

FIGS. 8-11 Comparative Layouts of

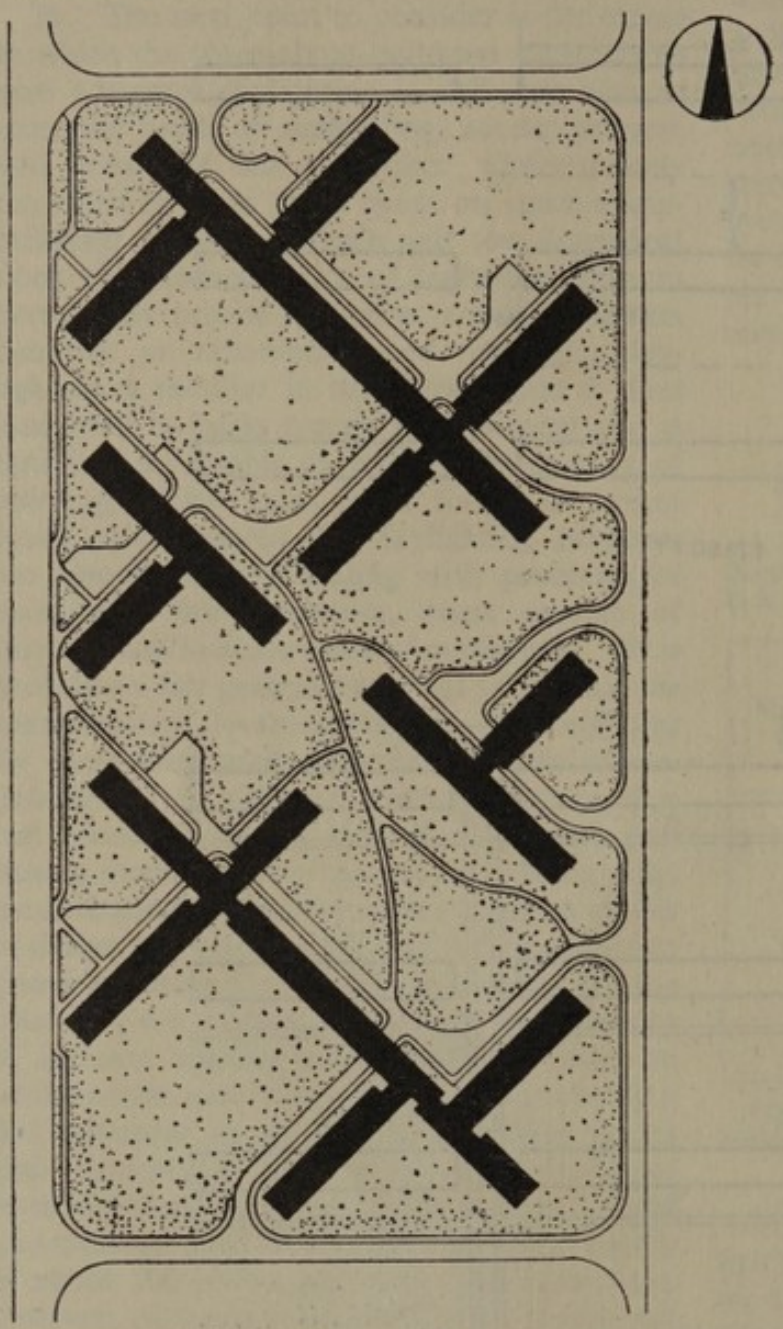


Fig. 8. 275 ROOMS PER ACRE

All rooms in 10-storey flats

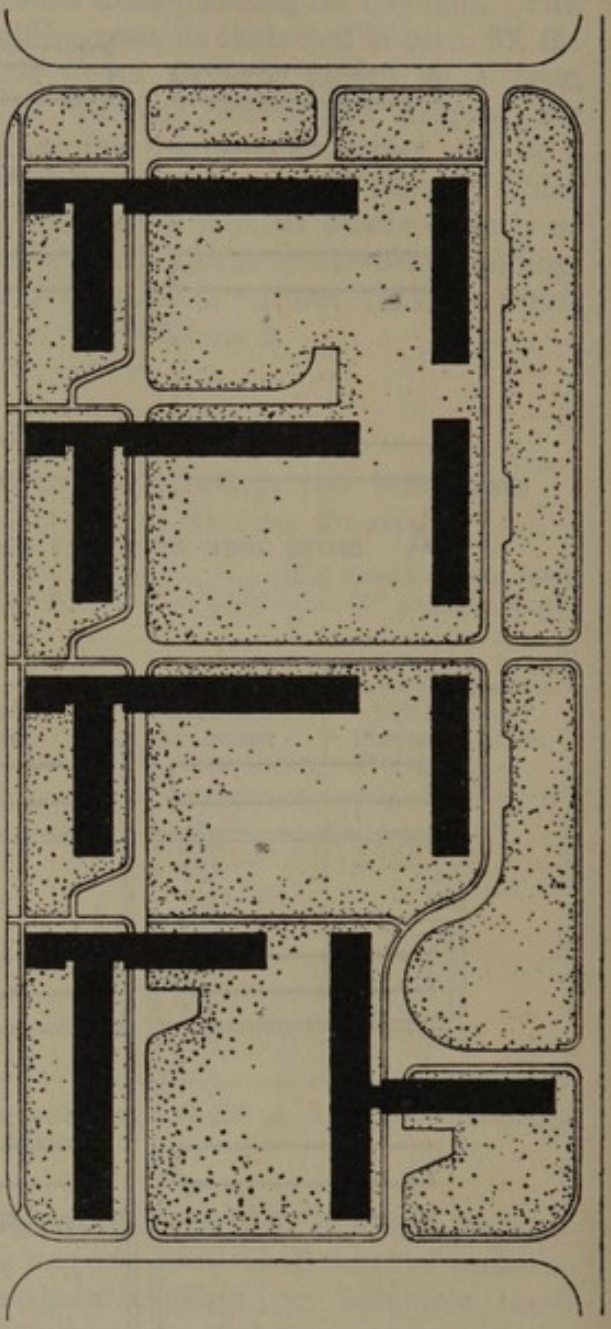
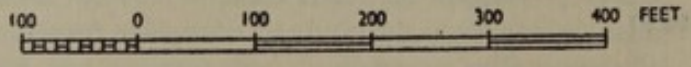


Fig. 9. 240 ROOMS PER ACRE

All rooms in 10-storey flats



32,750 sq. ft. and this would be disposed around each block as shown in Fig. 7(A). Not all this open space would be available to the residents, however, because a certain amount (perhaps 15-25 per cent.) would be required for roads, paths, garages, and other miscellaneous uses. Probably the best way to lay out the area to extract the best value from the open space would be as in Fig. 7(B). In this layout the blocks would share an effective open space about 320 ft. x 80 ft. or, say, about 170 sq. ft. per habitable room.

Flats on a 12-acre Site

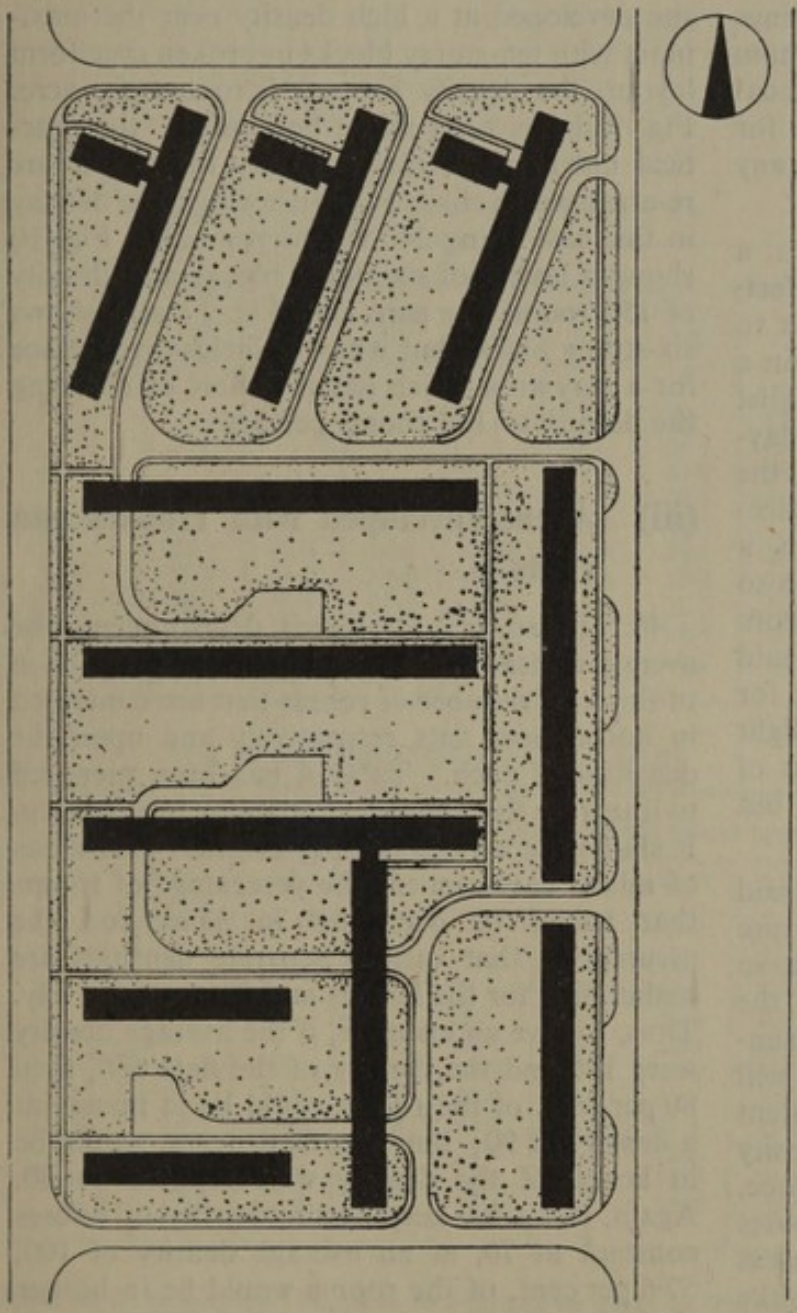


Fig. 10. 155 ROOMS PER ACRE

All rooms in 6-storey flats

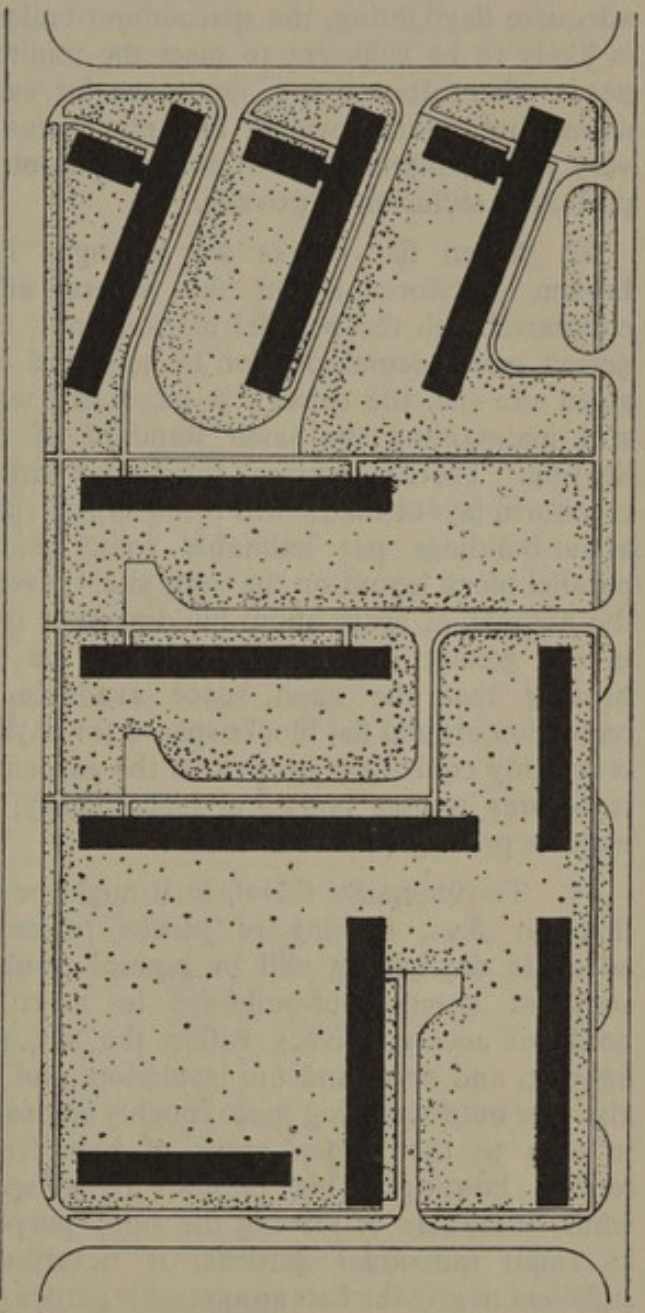


Fig. 11. 128 ROOMS PER ACRE

All rooms in 6-storey flats

42. It is still difficult to appreciate what this effective open space amounting to 170 sq. ft. per room would mean in amenity to the residents. Perhaps the best way to an understanding is to regard the effective space-about-buildings in the case of flats as the direct equivalent of the garden space of houses but lacking of course the privacy and seclusion and ease of access. In the layout of two-storey terrace houses shown in Fig. 3, the total net back-garden area amounts to roughly 4·2 acres per 1,000 rooms. In comparison the effective space-about-buildings for flat blocks in parallel layout spaced to give adequate daylighting would amount to about

4·0 acres per 1,000 rooms. It might therefore be said as a generalization, that if flats are arranged in parallel blocks so as to secure adequate daylighting, the space-about-buildings is likely to be sufficient to meet the minimum needs of outdoor living, i.e. space for casual sitting out, pram parking, and play areas for very young children, but of course without any particular seclusion or privacy.

43. When flat blocks are arranged in a broken cruciform layout the general effect, compared with the parallel block layout, is to permit more accommodation to be placed on a given site (i.e. the density is increased) whilst still maintaining the same standard of daylighting. There is therefore the danger with the cruciform layout that it will result in less space-about-buildings per habitable room than a parallel block layout on the same site. Even so the amount of space-about-buildings per room is not greatly different, and it can be said broadly that the open space available for recreation around flat blocks spaced for daylight is roughly equivalent in area to the gardens of two-storey terrace houses at high density, but without privacy or ease of access.

44. To summarize therefore, it might be said that for flats, spacing of blocks to ensure adequate daylighting will in general result in sufficient space-about-buildings to meet the needs of access, privacy within the flat, sunlighting, and noise and fire insulation, and will also give outdoor-living space roughly equivalent in area to the garden space of high-density terrace housing. This outdoor-living space, whilst incapable of serving the same purposes as small individual gardens, is nevertheless sufficient to give the flats an agreeable garden-like setting, and, since it tends to occur, particularly in cruciform layouts, in sizeable rectangular areas, can be used to some extent for minor play areas or even for occasional tennis courts. It would, however, be a mistake to assume that this outdoor-living space, even though it may amount to the apparently impressive figure of 4 or 5 acres per 1,000 persons, is any substitute for public parks and playing fields in the true sense of those terms.

45. To illustrate these remarks about flats, Figs. 8-11 have been prepared. All these Figures relate to a 12-acre site and are therefore comparable not only with each other but also with the earlier diagrams of houses. Fig. 8 shows the site developed at a high density near the maximum with ten-storey blocks in broken cruciform layout, the density being 275 rooms per acre. Fig. 9 shows what might be termed " the practical maximum ", that is to say the blocks are re-arranged to eliminate north wings, the density in this case being 240 rooms per acre. Fig. 10 shows a layout of six-storey blocks at a density of 155 rooms per acre, and Fig. 11 also shows six-storey blocks but with the inclusion of space for a play area which has the effect of reducing the density to 128 rooms per acre.

(iii) Areas developed with Houses and Flats

46. In an area of mixed development, the average density will depend upon the proportion of the total number of rooms that are contained in houses and flats respectively and upon the densities of each. Table 4 has been prepared to illustrate this somewhat complex relationship. It shows for various *average densities* over areas of mixed development the percentage of rooms that would be contained in *houses* on the assumption that various separate densities are maintained for the houses and flats respectively. Thus, to give an example, if the average density were 100 and the density of the flats 180, then 80 per cent. of the rooms could be in houses at a density of 90; but only 64 per cent. would be in houses if the density were reduced to 80. Again, this time keeping the density of houses constant at 70, at an average density of 100, 57·6 per cent. of the rooms would be in houses if the flats were at a density of 240, 50·9 per cent. in houses if the flats were at 180, and 28 per cent. in houses if the flats were at 120.

47. The principle underlying Table 4 is of particular importance as a starting point in answering a question which is bound to face all local planning authorities. The question concerns the choice of a suitable *average* net density for an area to be developed or redeveloped. An answer can only be given by breaking the problem down into its three principal parts, viz.: the desired allocation of rooms to houses

TABLE 4

Mixed Development of Houses and Flats

This table is purely factual, i.e. it is based on a computation connecting average density, proportions of rooms in houses and flats, and the relative densities of each. The question of layout arises when it is considered how houses and flats can be treated at the separate densities deduced from the table. Clearly the possibilities for houses at 120 rooms per acre are strictly limited, but extremes of density have been included for the sake of completeness and also because it is occasionally useful to know what figure of density is likely to result from certain given conditions.

The average density of an area of mixed development depends on the separate densities of the houses and of the flats. Each of the small tables below shows for a given density of flats **the percentage of rooms that can be provided in houses** with the houses themselves at various densities. The tables also show the average density over the whole area of mixed development.

FLATS AT 80 ROOMS PER ACRE

Density of houses (rooms per acre)	Average net Density [Rooms per Acre] over the whole area									
	30	40	50	60	70	80	90	100	110	120
120										
110										
100										
90						100				
80										
70					100					
60				100	42·8					
50			100	55·6	23·8					
40		100	60·0	33·3	14·3					
30	100	60·0	36·0	20·0	8·6					
20	55·6	33·3	20·0	11·1	4·8					

FLATS AT 100 ROOMS PER ACRE

Density of houses (rooms per acre)	Average net Density [Rooms per Acre] over the whole area									
	30	40	50	60	70	80	90	100	110	120
120										
110										
100								100		
90							100			
80						100	44·5			
70					100	58·4	25·9			
60				100	64·3	37·5	16·6			
50			100	66·7	42·9	25·0	11·1			
40		100	66·7	44·5	28·6	16·6	7·4			
30	100	64·3	42·9	28·6	18·3	10·7	4·8			
20	58·4	37·5	25·0	16·7	10·7	6·3	2·8			

FLATS AT 120 ROOMS PER ACRE

Density of houses (rooms per acre)	Average net Density [Rooms per Acre] over the whole area									
	30	40	50	60	70	80	90	100	110	120
120										
110										
100								100	45·5	100
90							100	60·0	27·3	
80						100	66·7	40·0	18·2	
70					100	70·0	46·7	28·0	12·7	
60				100	71·4	50·0	33·3	20·0	9·1	
50			100	71·5	51·0	35·8	23·8	14·2	6·5	
40		100	70·0	50·0	35·7	25·0	16·6	10·0	4·5	
30	100	66·7	46·6	33·3	23·8	16·6	11·1	6·7	3·0	
20	60·0	40·0	28·0	20·0	14·3	10·0	6·7	40·0	1·8	

FLATS AT 140 ROOMS PER ACRE

Density of houses (rooms per acre)	Average net Density [Rooms per Acre] over the whole area												
	30	40	50	60	70	80	90	100	110	120	130	140	
120													
110									100	46·1			
100								100	68·2	61·1	28·2		
90							100	72·0	49·1	30·0	13·9		
80						100	74·0	53·3	36·4	22·2	10·3		
70					100	75·0	55·6	40·0	27·3	16·7	7·7		
60				100	75·0	56·2	41·7	30·0	20·5	12·5	5·8		
50			100	74·1	55·6	41·6	30·8	22·2	15·2	9·3	4·3		
40		100	72·0	53·4	40·0	30·0	22·2	16·0	10·9	6·7	3·1		
30	100	68·1	49·1	36·4	27·3	20·5	15·2	10·9	7·4	4·6	2·1		
20	61·1	41·6	30·0	22·2	16·7	12·5	9·3	6·7	4·5	2·8	1·3		

FLATS AT 160 ROOMS PER ACRE

Density of houses (rooms per acre)	Average net Density [Rooms per Acre] over the whole area												
	30	40	50	60	70	80	90	100	110	120	130	140	
120										100	69·1	42·8	
110									100	73·5	50·7	31·4	
100								100	75·8	55·6	38·5	23·8	
90							100	77·1	58·5	42·8	29·7	18·3	
80						100	77·7	60·0	45·5	33·3	23·1	14·2	
70					100	77·7	60·4	46·6	35·4	25·9	17·9	11·1	
60				100	77·1	60·0	46·6	36·0	27·3	20·0	13·8	8·6	
50			100	75·8	58·4	45·4	35·4	27·2	20·6	15·1	10·5	6·5	
40		100	73·4	55·6	42·8	33·3	25·9	20·0	15·3	11·1	7·7	4·8	
30	100	69·1	50·7	38·5	29·7	23·1	17·9	13·9	10·5	7·7	5·3	3·3	
20	61·9	42·8	31·5	23·8	18·3	14·3	11·1	8·6	6·5	4·7	3·3	2·1	

FLATS AT 180 ROOMS PER ACRE

Density of houses (rooms per acre)	Average net Density [Rooms per Acre] over the whole area												
	30	40	50	60	70	80	90	100	110	120	130	140	
120										100	76·9	57·1	
110									100	78·6	60·5	44·9	
100								100	79·5	62·5	48·1	35·8	
90							100	80·0	63·5	50·0	38·4	28·5	
80						100	80·0	64·0	50·9	40·0	30·8	22·9	
70					100	79·6	63·5	50·9	40·5	31·8	24·5	18·2	
60				100	78·5	62·5	50·0	40·0	31·8	25·0	19·2	14·3	
50			100	77·0	60·5	48·1	38·5	30·8	24·5	19·2	14·8	11·0	
40		100	74·4	57·1	44·9	35·8	28·6	22·8	18·2	14·3	11·0	8·2	
30	100	70·0	52·0	40·0	31·4	25·0	20·0	16·0	12·7	10·0	7·7	5·7	
20	62·5	43·7	32·6	25·0	19·7	15·7	12·5	10·0	7·9	6·2	4·8	3·6	

FLATS AT 200 ROOMS PER ACRE

Density of houses (rooms per acre)	Average net Density [Rooms per Acre] over the whole area													
	30	40	50	60	70	80	90	100	110	120	130	140	200	
120														
110									100	81·5	65·7	52·3		
100								100	81·6	66·7	53·8	42·9		
90							100	81·8	67·0	54·5	44·1	35·1		
80						100	81·5	66·7	54·5	44·5	35·9	28·6		
70					100	81·0	65·7	53·8	44·1	35·9	29·0	23·1		
60				100	79·6	64·4	52·4	42·9	35·1	28·6	23·1	18·4		
50			100	77·8	61·9	50·0	40·7	33·3	27·3	22·2	17·9	14·3		
40		100	75·0	58·3	46·4	37·5	30·5	25·0	20·5	16·6	13·5	10·7		
30	100	70·6	53·0	41·2	32·8	26·5	21·6	17·7	14·4	11·8	9·5	7·6		
20	63·0	44·4	33·3	25·9	20·6	16·7	13·6	11·1	9·1	7·4	5·9	4·8		

FLATS AT 240 ROOMS PER ACRE

Density of houses (rooms per acre)	Average net Density [Rooms per Acre] over the whole area													
	30	40	50	60	70	80	90	100	110	120	130	140	200	
120														
110									100	84·6	71·4	60·5	16·9	
100								100	84·2	71·4	60·5	51·1	14·3	
90							100	84·0	70·9	60·0	50·7	42·8	12·0	
80						100	83·3	70·0	59·0	50·0	42·3	35·8	10·0	
70					100	82·4	68·7	57·6	48·6	41·1	34·8	29·4	8·3	
60				100	81·0	66·7	55·6	46·6	39·5	33·3	28·2	23·8	6·7	
50			100	78·9	64·0	52·6	43·8	36·8	31·1	26·3	22·3	18·8	5·3	
40		100	76·0	60·0	48·6	40·0	33·3	28·0	23·7	20·0	16·9	14·3	4·0	
30	100	71·4	54·3	42·9	34·7	28·6	23·8	20·0	16·9	14·3	12·1	10·2	2·9	
20	63·6	45·4	34·5	27·2	22·1	18·2	15·1	12·7	10·8	9·1	7·7	6·5	1·8	

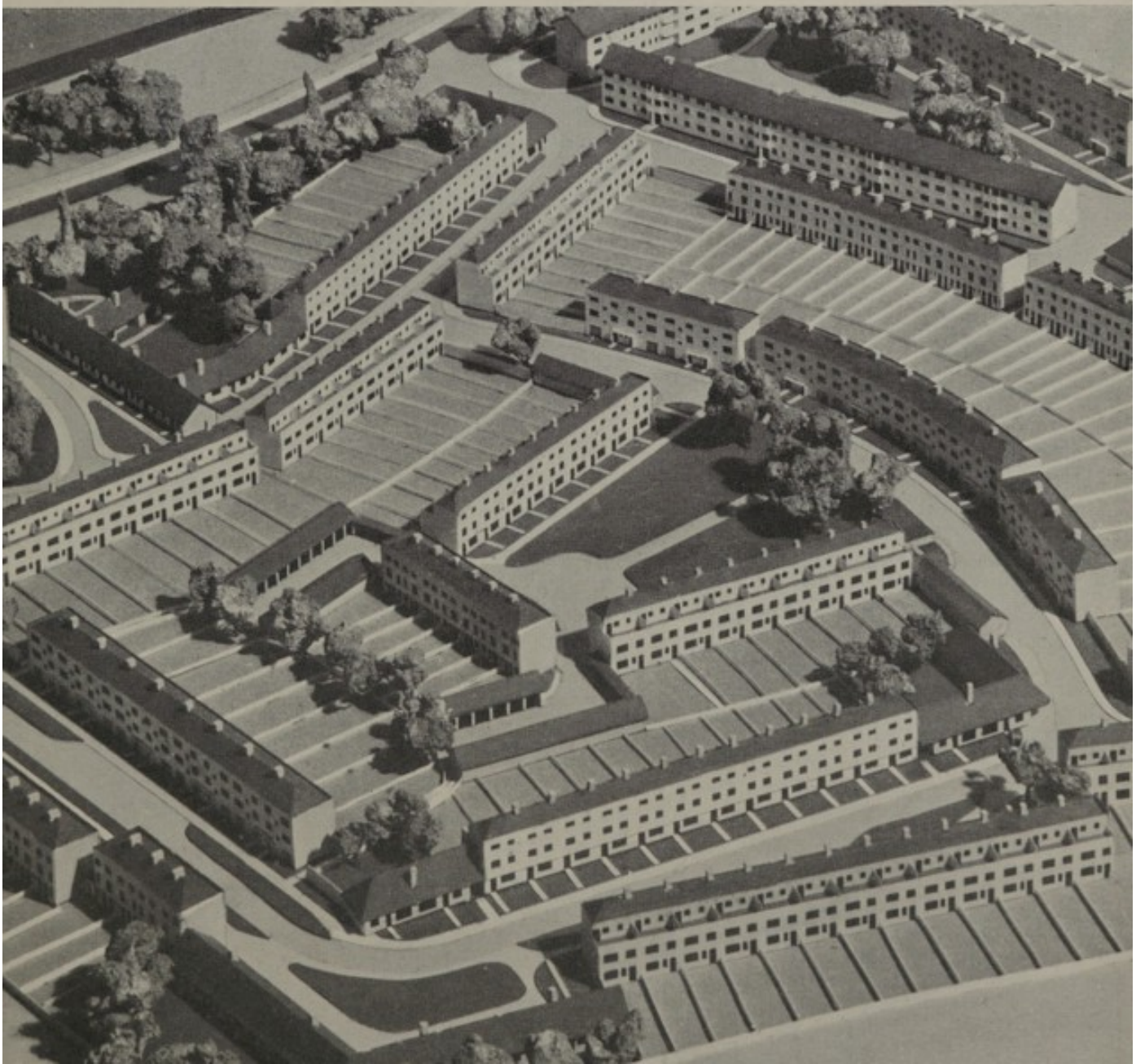
Examples of the Kind of Development Possible in Houses or Flats at Various Average Densities

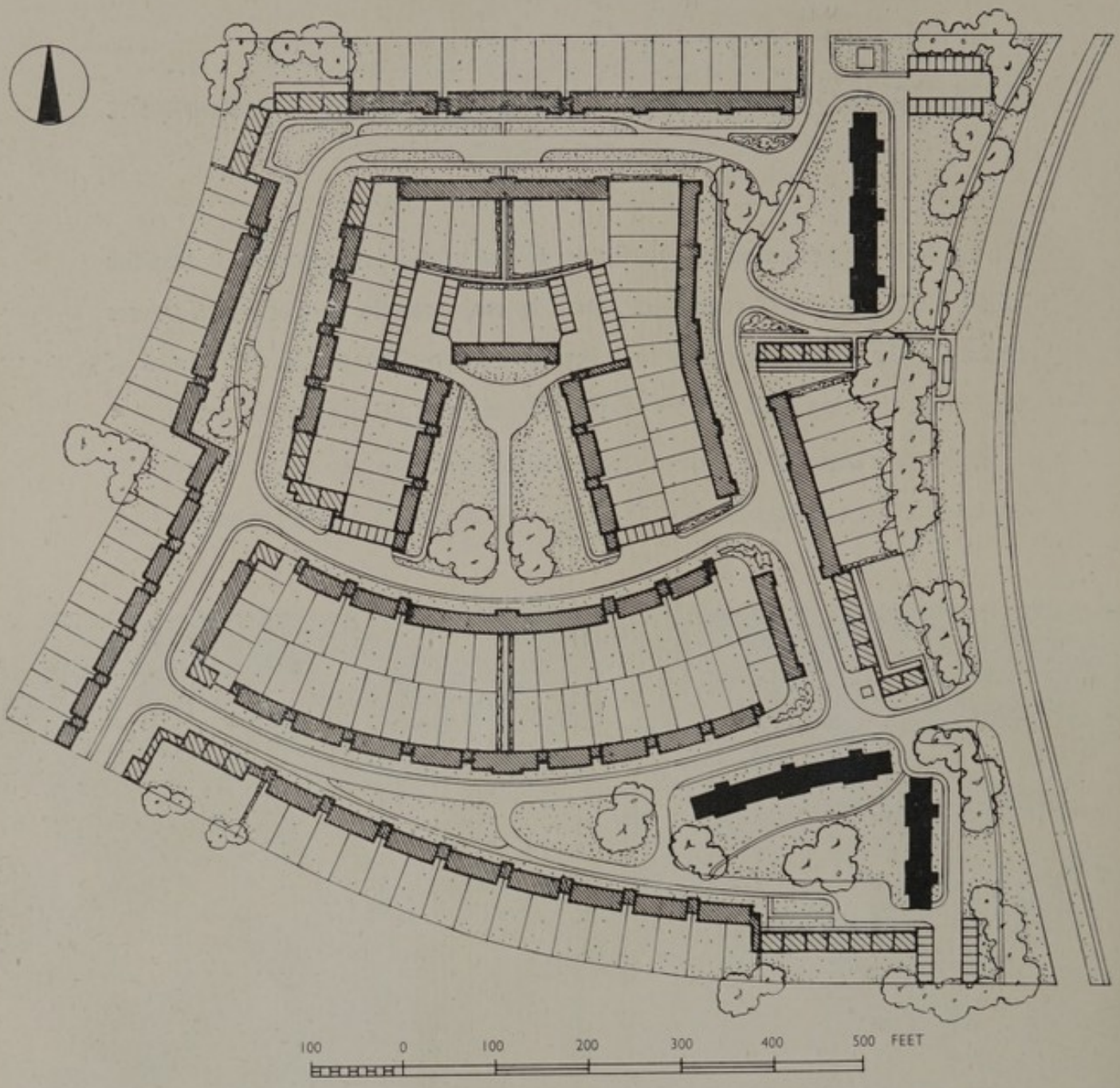
Rooms per Acre	Houses	Flats
20-30	Detached	—
30-50	Semi-detached and 2-storey terrace	—
50-80	2-storey terrace	—
80-100	3-storey terrace	3 or 4-storey blocks generous spacing
100-120	—	4 to 7-storey blocks generous spacing
120-160	—	As above, but minimum spacing for daylight
180	—	10-storey blocks parallel layout
200-240	—	10-storey blocks in broken cruciform layout

FIGS. 12-16. Comparative Layouts of Mixed Development on a 20-acre Site

On the following pages are shown five layouts of mixed developments at densities of 50, 60, 70, 80 and 90 rooms per acre. In each case the proportion of houses to flats is the same. Opposite each layout are two photographs of a model of the layout showing high- and low-angle oblique views taken from the south.

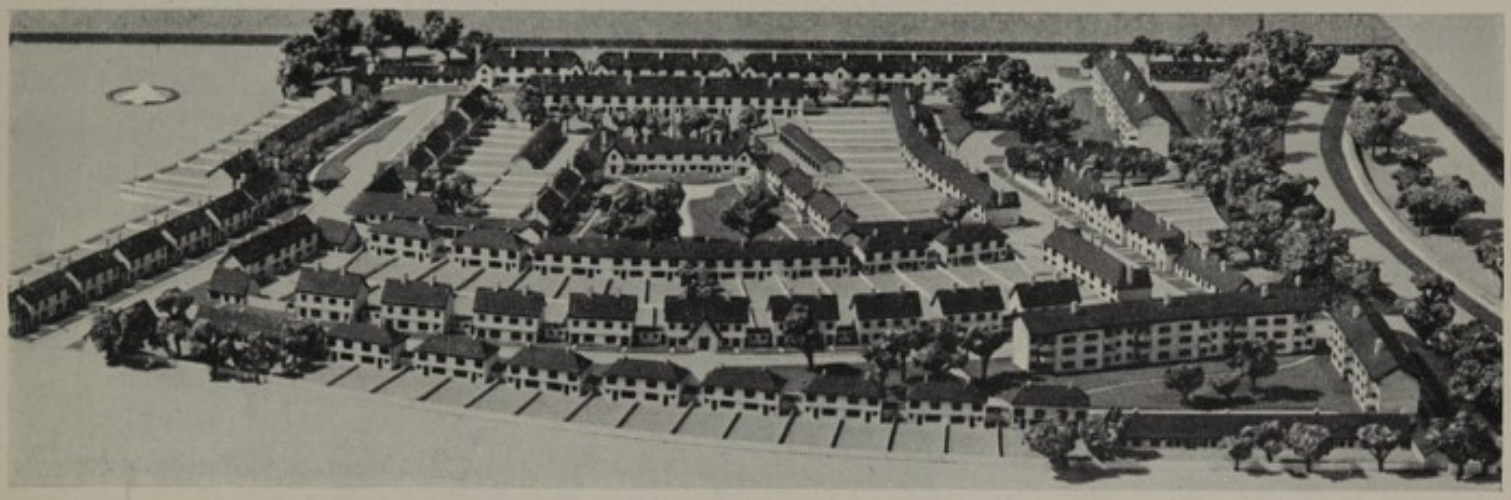
Below is a close-up of part of the layout at 90 rooms per acre. On page 30 are two further close-up views of the layouts at 80 and 90 rooms per acre.

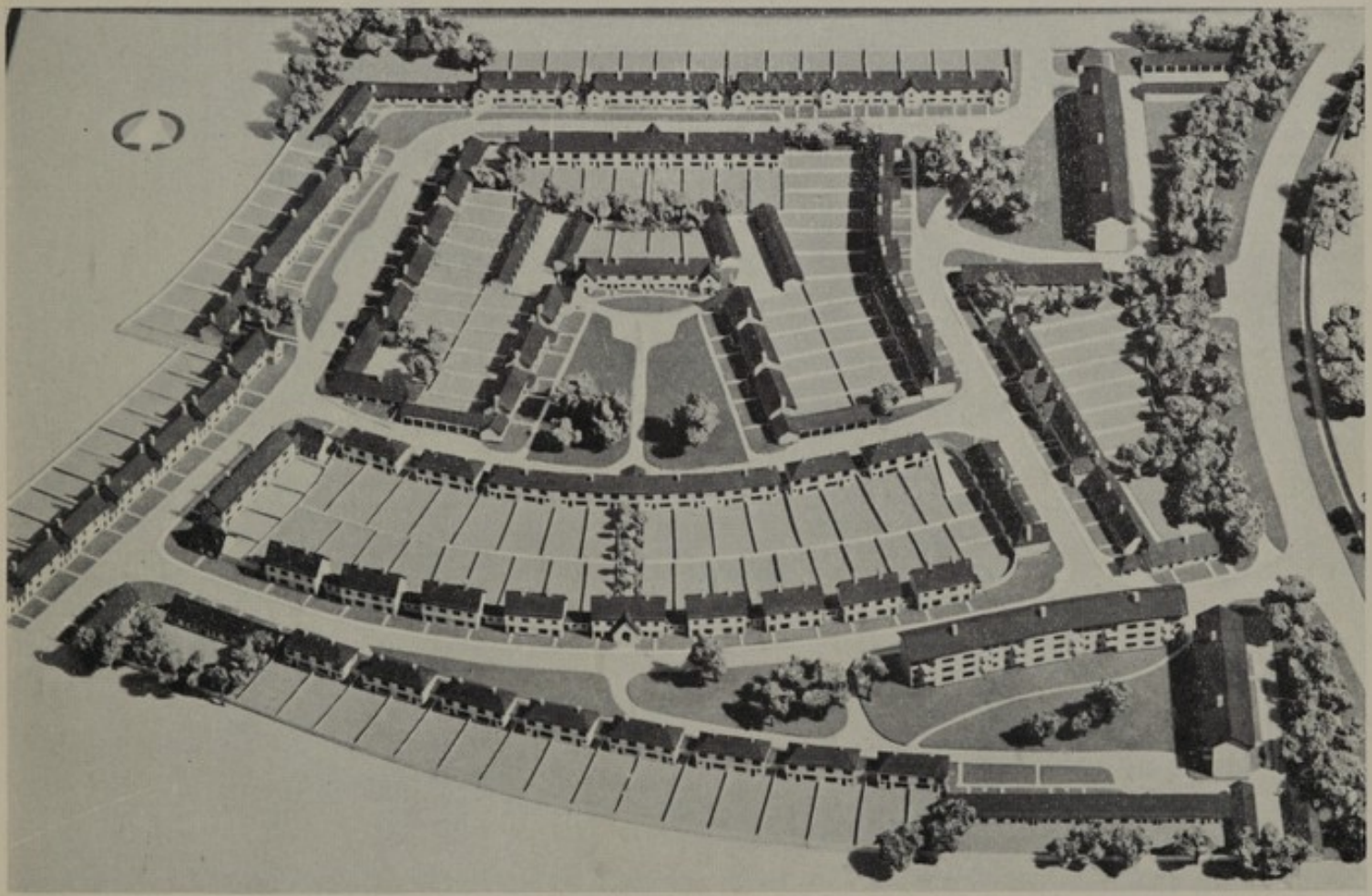




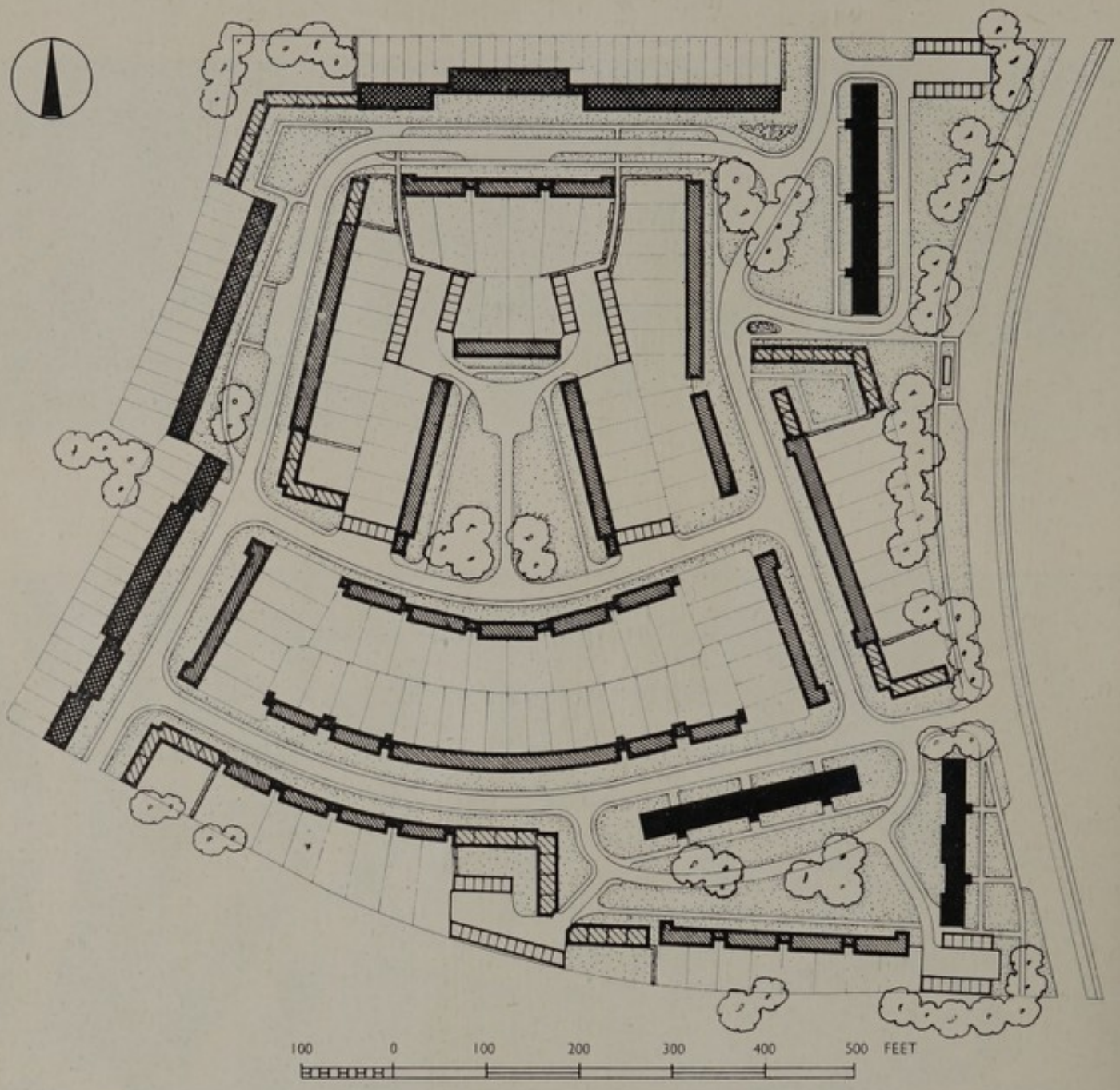
KEY	TYPE	ROOMS	No. OF DWELLINGS	TOTAL No. OF ROOMS	PERCENTAGE OF GRAND TOTAL
	3 storey flats	5	40	200	20
	3 storey houses	-	-	-	
	2 storey houses	5	146	730	73
	Old peoples' dwellings	2	35	70	7
	Garages				
			GRAND TOTAL OF ROOMS	1000	

Fig. 12. 50 ROOMS PER ACRE



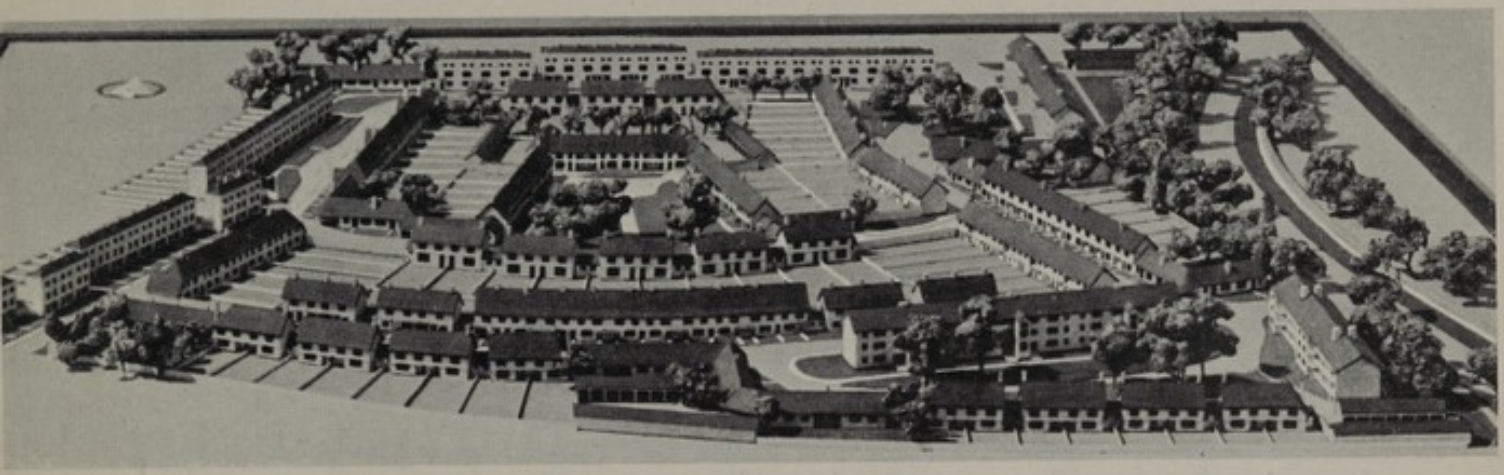


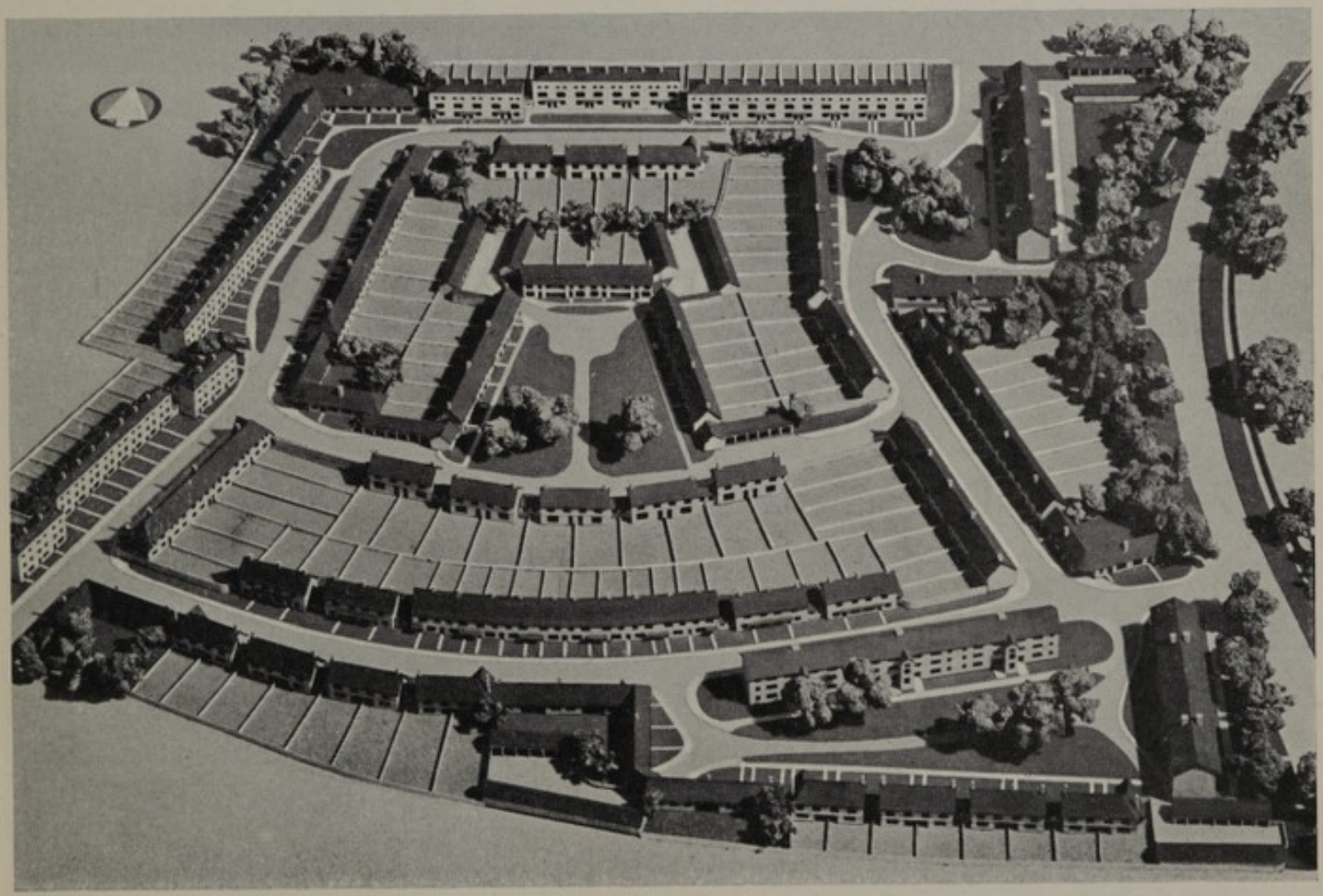
Aerial views of model of layout on opposite page



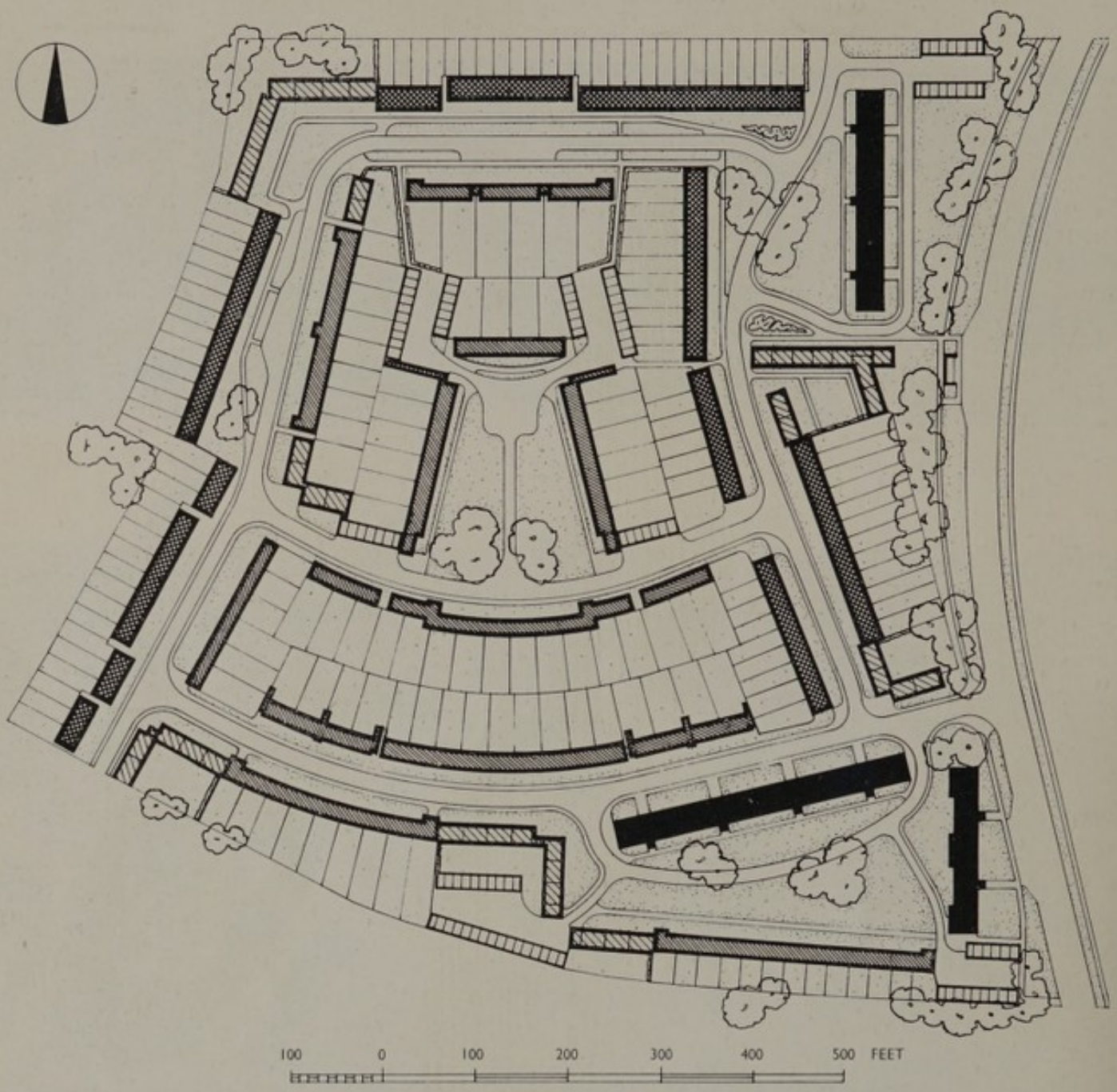
KEY	TYPE	ROOMS	No. OF DWELLINGS	TOTAL No. OF ROOMS		PERCENTAGE OF GRAND TOTAL
	3 storey flats	5	48	240		20
	3 storey houses	6	57	342	877	73
	2 storey houses	5	107	535		
	Old peoples' dwellings	2	42	84		7
	Garages					
			GRAND TOTAL OF ROOMS	1201		

Fig. 13. 60 ROOMS PER ACRE



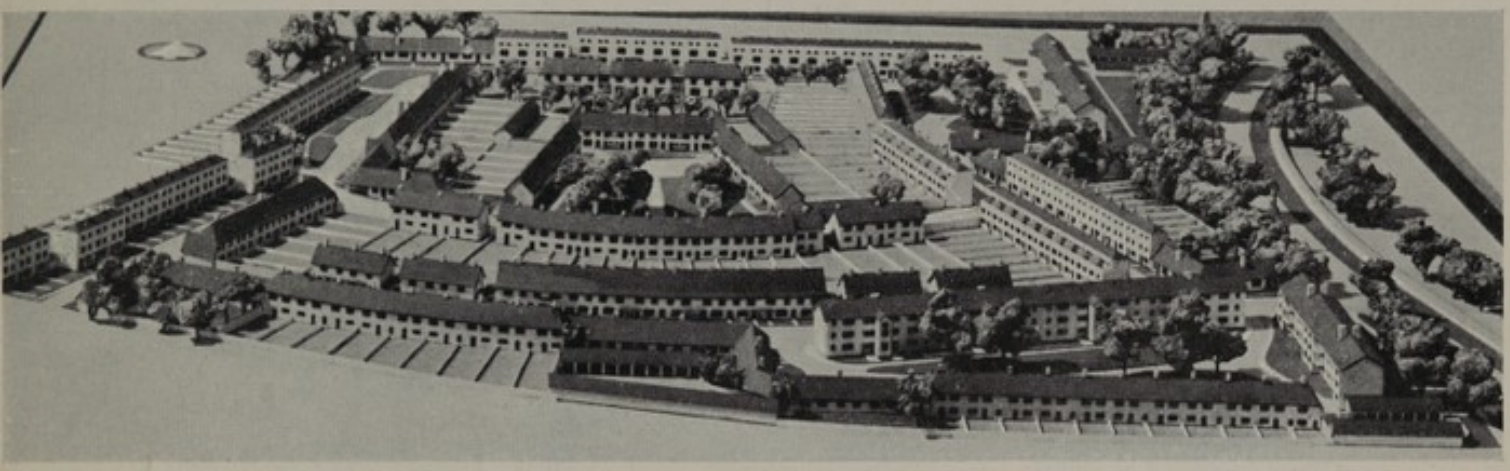


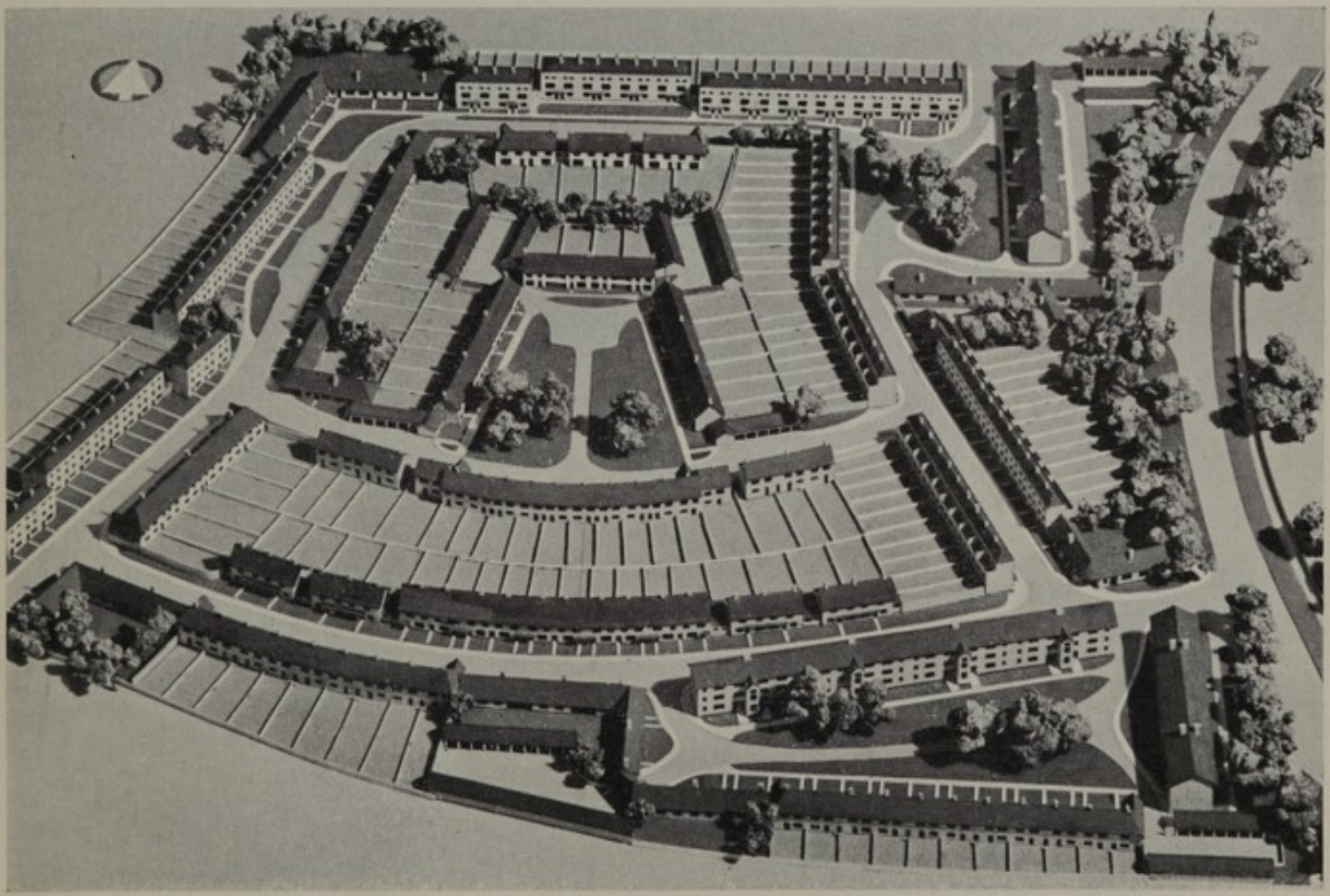
Aerial views of model of layout on opposite page



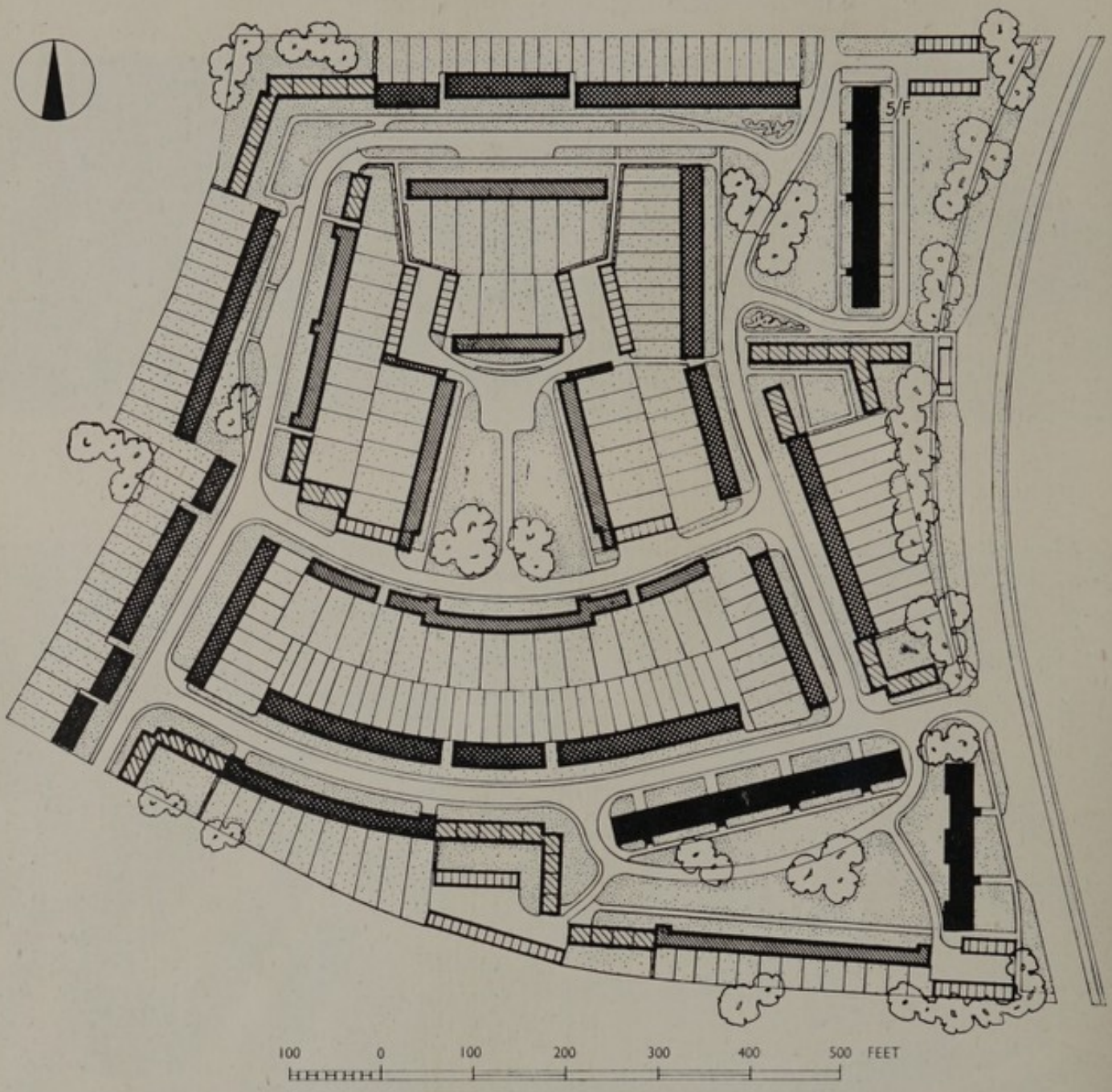
KEY	TYPE	ROOMS	No. OF DWELLINGS	TOTAL No. OF ROOMS		PERCENTAGE OF GRAND TOTAL
	3 storey flats	6	6	36	276	20
		5	48	240		
	3 storey houses	6	96	576	1021	73
	2 storey houses	5	89	445		
	Old peoples' dwellings	3	12	36	98	7
		2	31	62		
	Garages			GRAND TOTAL OF ROOMS	1395	

Fig. 14. 70 ROOMS PER ACRE



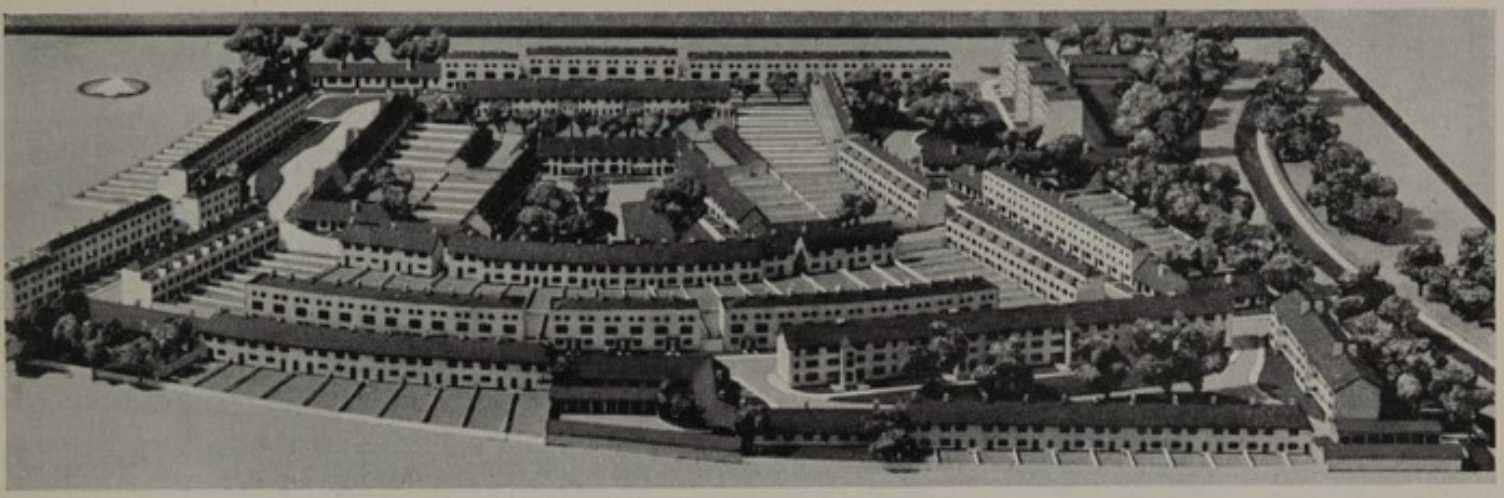


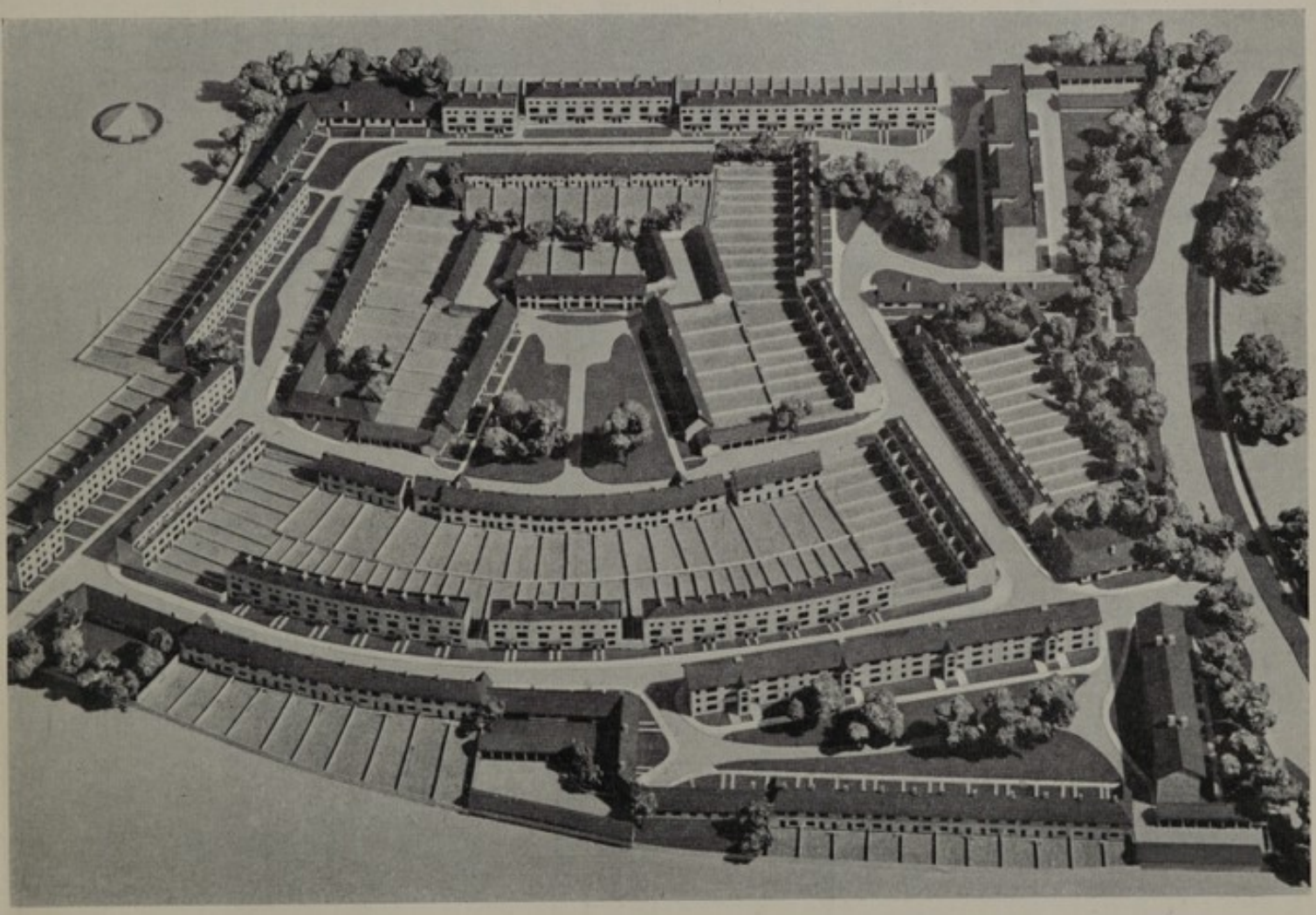
Aerial views of model of layout on opposite page



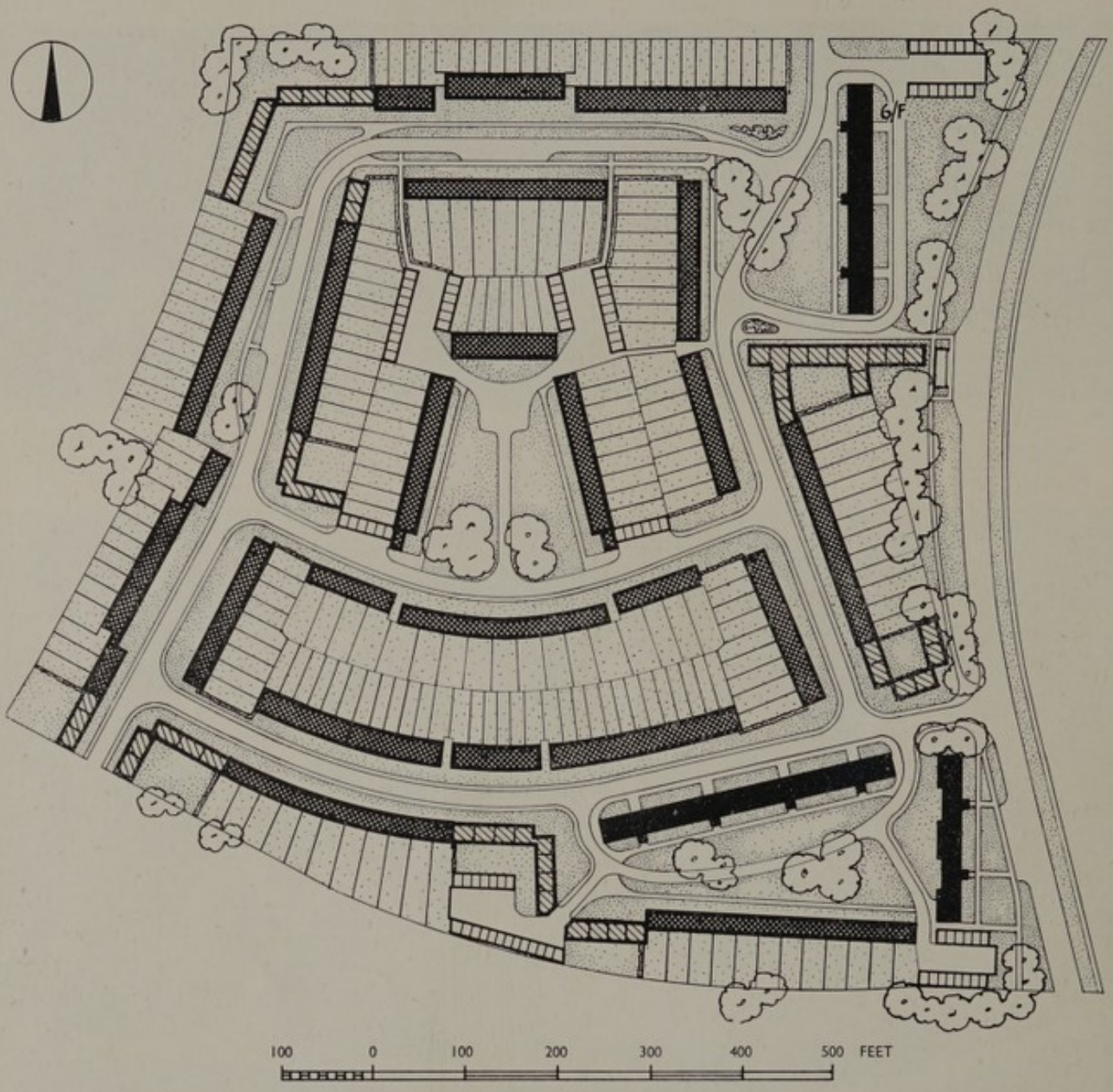
KEY	TYPE	ROOMS	No. OF DWELLINGS	TOTAL No. OF ROOMS		PERCENTAGE OF GRAND TOTAL
	5 storey flats (5/F)	4	10	40	320	20
		5	20	100		
	3 storey flats	5	36	180		
	3 storey houses	6	145	870	1165	73
	2 storey houses	5	59	295		
	Old peoples' dwellings	3	20	60	114	7
		2	27	54		
	Garages					
				GRAND TOTAL OF ROOMS 1599		

Fig. 15. 80 ROOMS PER ACRE



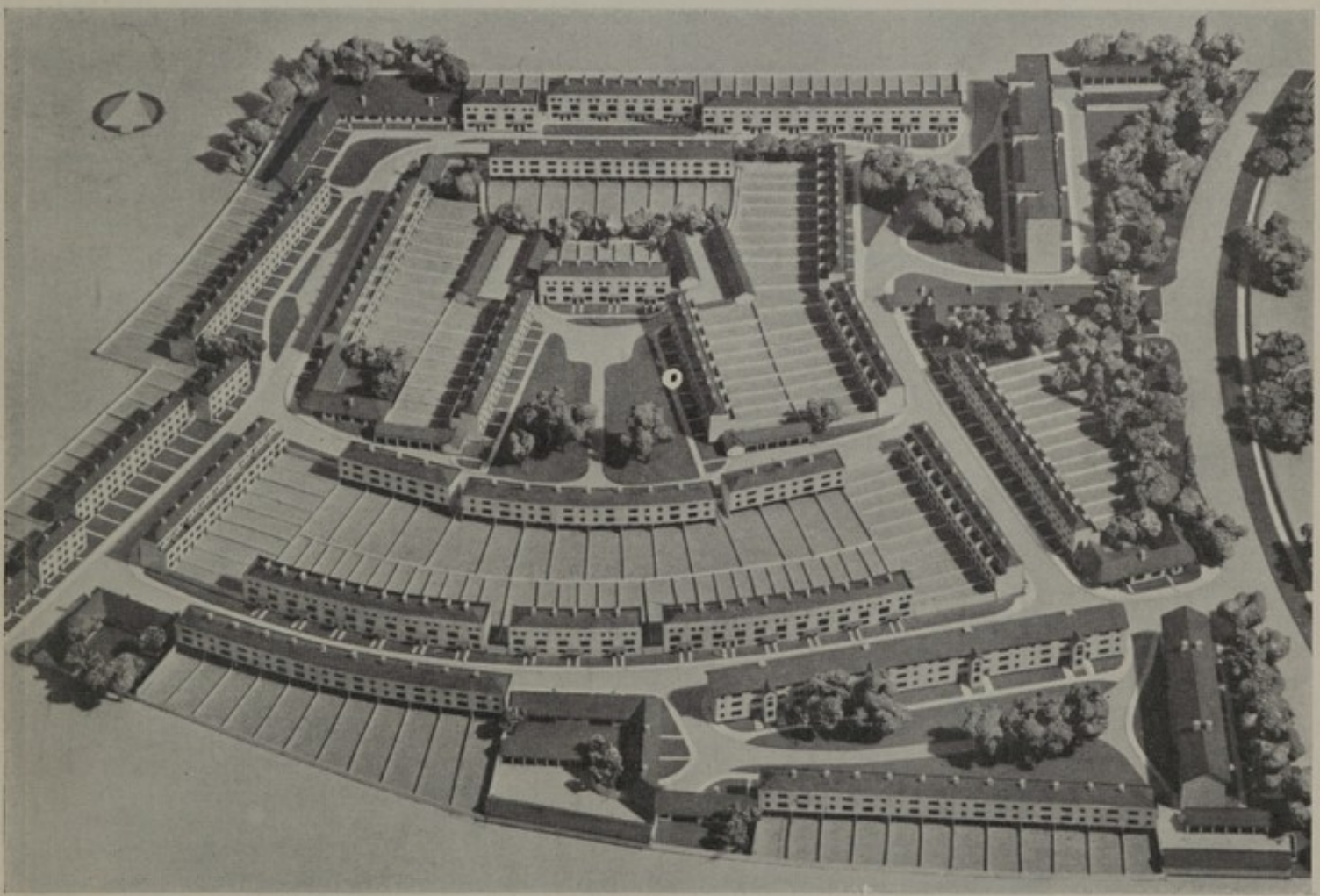


Aerial views of model of layout on opposite page. A close-up view of the south-east corner appears on page 30.

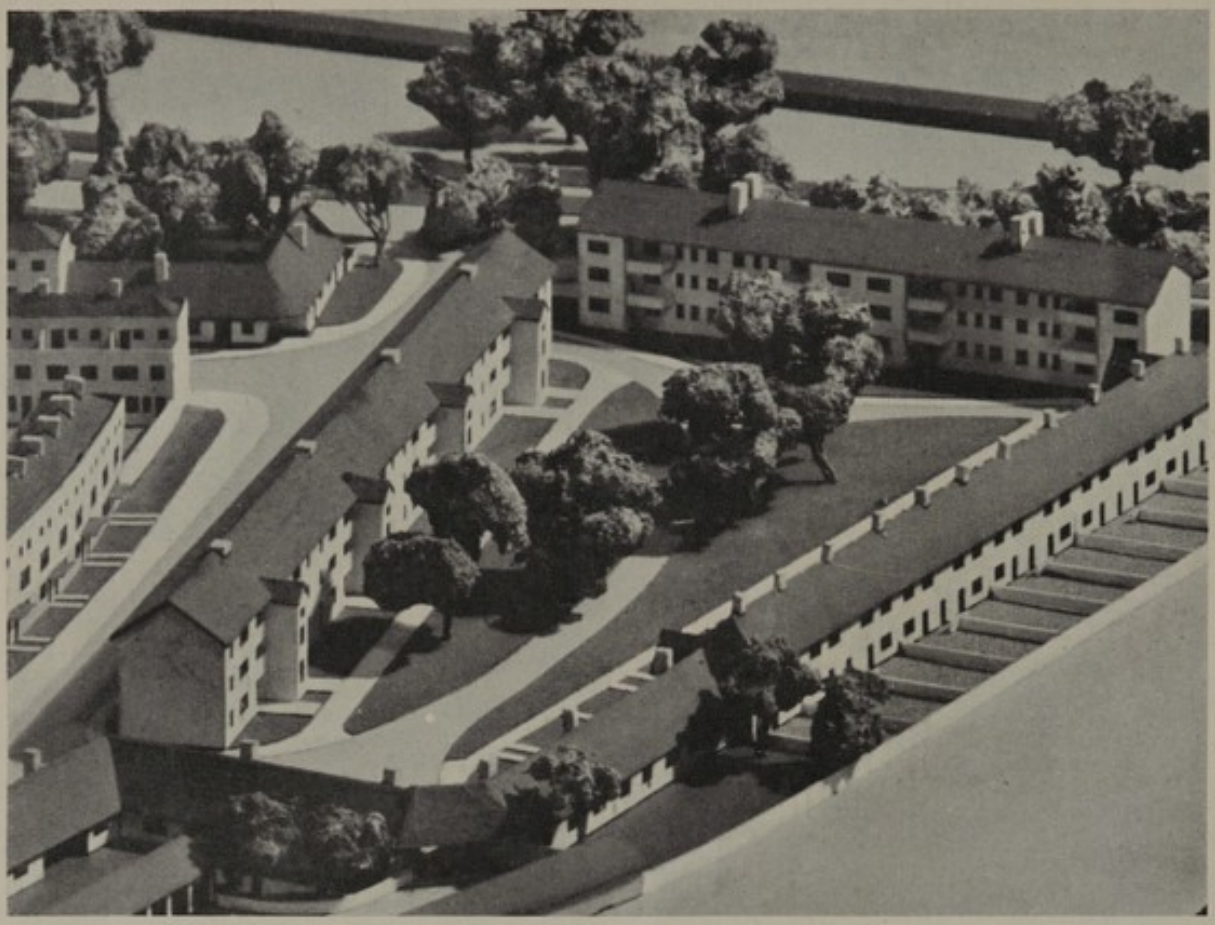


KEY	TYPE	ROOMS	No. OF DWELLINGS	TOTAL No. OF ROOMS		PERCENTAGE OF GRAND TOTAL
	6 storey flats (6/F)	5	36	180	360	20
	3 storey flats	5	36	180		
	3 storey houses	6	219	1314		73
	Old peoples' dwellings	3	22	66	126	7
		2	30	60		
	Garages					
			GRAND TOTAL OF ROOMS	1800		

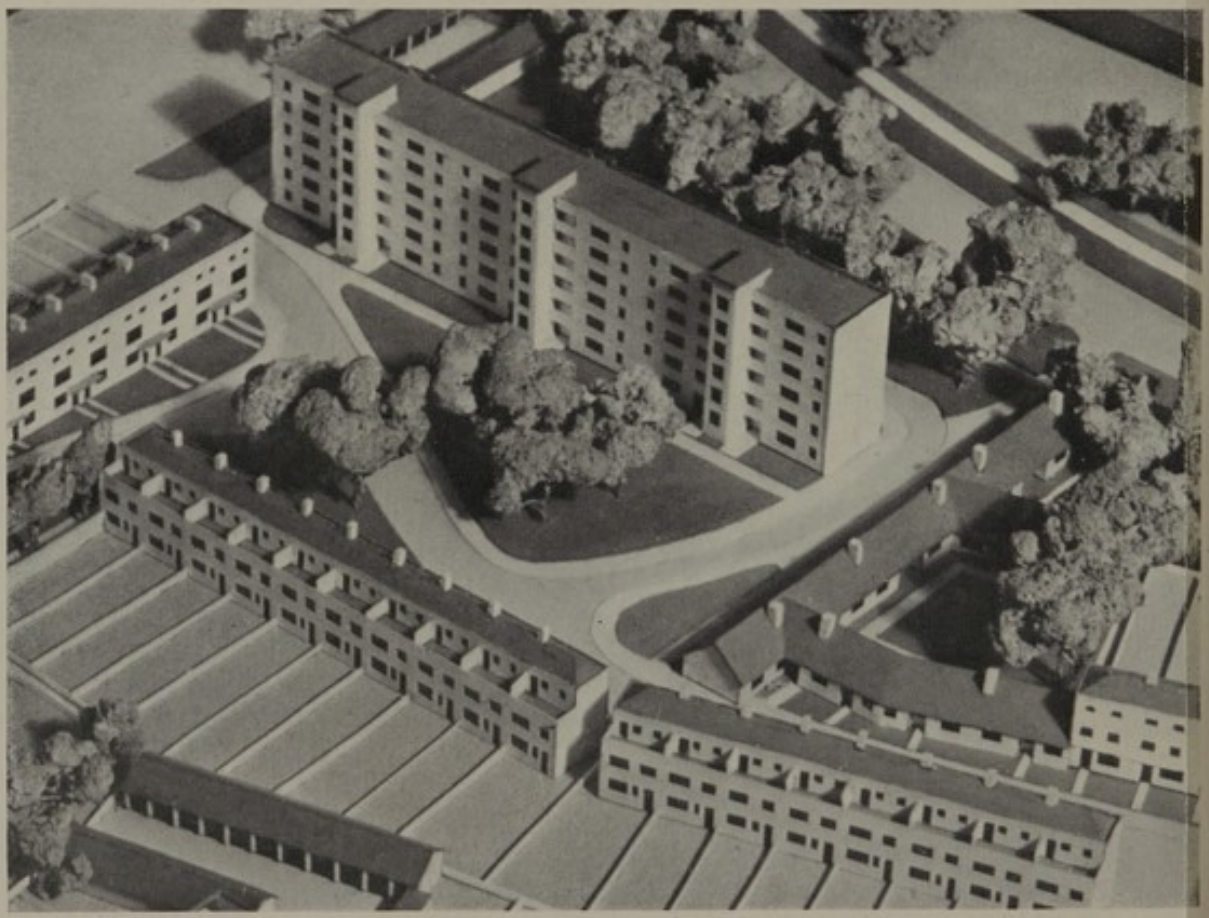
Fig. 16. 90 ROOMS PER ACRE



Aerial views of model of layout on opposite page. For close-up views see pages 19 and 30.



Close-up view of south-east corner of lay-out at 80 rooms per acre.



Close-up view of north-east corner of lay-out at 90 rooms per acre.

and flats, the desired density for houses, and the desired density for flats. An important point to be understood is that if, for an area, an average net density is fixed together with separate densities for houses and flats, then the distribution of rooms between houses and flats is thereby predetermined. In practice the distribution of rooms between houses and flats may well be a matter to which a local planning authority will desire to give considerable weight even to the extent of varying the average density or the separate densities for houses and flats.

48. Figs. 12-16 have been prepared to illustrate some of the possibilities of mixed development of two- or three-storey houses and flats. They show a 20-acre site developed with the same proportion of rooms in houses, flats and old persons' dwellings at average densities of 50, 60, 70, 80 and 90 rooms per acre. The layouts are all based on the same general plan so that the effect of the increase of density can be seen fairly clearly. It is to be noted that at 90 rooms per acre the houses are all of three-storey type. Aerial views of models of these layouts have been included to show the three-dimensional form of the development.

49. It was suggested in para. 47 that in choosing an average net housing density the really vital point that a local planning authority may wish to be satisfied about is that, without knowing the exact details of the people for whom they are providing, they are nevertheless choosing a density that will permit a suitable proportion of houses and flats. Table 4 is enlightening here, for it shows that at any average net density the range of possibilities in housing provision is considerable if the separate densities of the houses and flats are adjustable. Thus at an average net density of 70 rooms per acre it is possible to build houses and flats in any proportion up to a maximum of 80 per cent. of the accommodation being in houses without exceeding a separate density of 60 rooms per acre for the houses. Provided therefore that the planning authority do not commit themselves at the start to rigid ideas about the separate densities of houses and flats, there should normally be no difficulty in ultimately securing a satisfactory proportion of houses and flats within an average net density range up to about 70 rooms per acre. Above this figure, though there is still a useful range of possibilities, the proportion of flats must generally increase.

IV. DENSITY IN RELATION TO THE NEIGHBOURHOOD

50. It has been explained previously (para. 6) that within a residential area there should be situated, in addition to dwellings, certain other facilities which the residents can reasonably expect to have close at hand. It seems generally accepted that the following are the minimum facilities required:—

Everyday shopping

Schooling to at least primary standards

Some public buildings, e.g. clinics, branch libraries, churches

Some public open space

Some industry, mainly service industry.

The term " neighbourhood " has come to be applied to residential areas having a fair measure of self-containment for these facilities and it will be convenient to use this term henceforward.

51. The amount of land required for the whole neighbourhood will clearly depend partly upon the net densities of the various pockets of dwellings within the neighbourhood, and partly upon the amount of space devoted to the other facilities. All these other facilities will be for the use or enjoyment of the residents of the neighbourhood and the space required for them will therefore depend directly or indirectly upon the number of people using them. The first step to assessing total land requirements for a neighbourhood must therefore be to establish the quantitative relationships which exist between people and the space for each facility.

52. Before discussing the various facilities, however, some consideration must be given to the question of a unit of measurement for neighbourhood density, or, as it may usefully be

described, "Gross Density". The planner requires a unit either to enable him to gauge approximately the conditions in respect of the space available to people for their various needs in an existing residential area, or to enable him to estimate for given conditions the total amount of land a group of people will require for their accommodation and other needs. The total space of the neighbourhood is made up of the area occupied by the dwellings and their surroundings and the area occupied by all the ancillary uses, and with few exceptions the components of both these groups depend for size upon the number of people served. It would therefore appear that the fundamental relationship is one of people to space, and that a suitable unit in which to express density is the number of people occupying a unit area. This is, in fact, the basis of the now well-known method of expressing gross density in "persons per acre". Any particular figure of persons per acre can of course only be an approximate indication of conditions. Thus at a certain density it would be possible in theory to have the people housed at a high net density in flats but with a generous provision of public open space, or alternatively there could be no open space but the people could be housed at a low net density to produce the same gross figure of persons per acre. In practice, however, as will be shown later, a particular figure of gross density tends, where new development is being considered, to be associated with a set of conditions that does not range too widely, and the figure is therefore capable of conveying at once a rough idea of the conditions; at the same time, if a certain figure is used as a basis for calculating an area for a given number of people it will allow a useful margin for variations when the time comes to build the neighbourhood.

53. To return to the question of the space required for the various facilities, the needs of schools will be considered first because they have been defined more clearly than others. In the 1944 Education Act and accompanying Regulations* the minimum areas to be aimed at by local education authorities for schools and their playing fields are given with precision. These standards represent the Government's policy for school development, but it is recognized that in existing high-density urban areas the standards will take a long time to achieve in full. In the Regulations minimum acreages are specified in relation to the number of pupils to be accommodated in schools of different types; in order to deduce the amount of land needed for education for a given size of population, the numbers of children of appropriate school ages must be known. This relationship is conveniently expressed as a ratio of children per 1,000 population per year of school age. Since the purpose of this study is to show factually the effect upon gross density of the space needs of schools some average ratio of children per 1,000 population must be adopted. There are a number of considerations however which cause any such ratio to be a rough guide only and not one to be adopted in all circumstances. In the first place, the ratio of children differs from year to year, and also differs as between the several age groups. Secondly, the ratio of children to adults in any locality may differ widely from the national average, and the actual provision required must depend on local need at the particular time.

54. In this and subsequent studies in this handbook all types of educational provision are based on an assumed ratio of 16 children per 1,000 population for each year of school age. On the basis of this figure, which is considered reasonably liberal for planning purposes over the next 20 years, the following land requirements for school purposes have been derived for use throughout this handbook:—

(i) for nursery classes and infant and junior schools—1·3 acres per 1,000 population including about 0·65 for junior school playing fields.

(ii) for secondary schools—2·5 acres per 1,000 population including about 1·25 for playing fields.

(iii) therefore the total of (i) and (ii) is 3·75 acres per 1,000 population including about 2·5 for playing fields.

(iv) for "further" educational purposes, an allowance is made of about 1-1·5 acres per 1,000 population.

* Statutory Instruments, 1951, No. 1753: Education, England and Wales: the standards for school premises regulations, 1951. H.M.S.O., 1951.

55. The next need for which standards have been suggested is public open space. This includes public playing fields for organized games and parks for normal recreation. There has been a good deal of controversy and misunderstanding about the question of open space standards and it should be understood there are no figures that have been laid down to which planning authorities are *required* to adhere as in the case of schools. Various suggestions have been made from time to time about standards, but the amount of open space to be provided in any particular case remains primarily a matter for the local authorities to decide according to the circumstances and it may well be that what is attainable for one town is out of the question for another. Nevertheless it will be useful to record three suggestions. The first of these is the National Playing Fields Association's recommendation that 6 acres of public playing fields should be provided per 1,000 people exclusive of all school and educational playing fields and all private or club fields. The second suggestion contained in the Report of the New Towns Committee* is that the space for recreation (in New Towns) should not be less than 10 acres per 1,000 people apart from school playing fields. Finally in the Greater London Plan (1944)† it is recommended that a total of 10 acres per 1,000 is desirable, comprising 3 acres for school playing fields, 1 acre for parks, and 6 acres for playing fields (other than schools) of which about 4 acres would be publicly provided. These three recommendations are summarized in Table 5.

56. It is probably all to the good that there is no statutory standard for open space, and no more than a rough measure of agreement amongst the advisory recommendations. Not only will towns present quite different problems in the matter of securing more open space (in some cases it will obviously be an extremely difficult and costly process) but it is also possible that some towns (particularly those with natural amenities of coast or hill country close at hand) may not need as much open space as others. Furthermore, the standard of public open space, especially for public parks, may need to be varied with various net residential densities. For although in this handbook the question of small play areas, private gardens and other spaces-about-dwellings which are part of the net residential area are considered separately from public open spaces, the two are in practice very closely interrelated. It is reasonable to suppose that as the amount of space set aside for play and recreation in the net residential area is increased, the need for public parks would become rather less.

57. The amount of land required for the remaining facilities in the neighbourhood, viz.

TABLE 5

Recent Recommendations for Open Space

(acres per 1,000 population)

Source	Public Playing Fields	Public Parks	Private Playing Fields	Total
National Playing Fields Association	6	—	—	6 + ?
New Towns Committee	10 acres inclusive			10
Greater London Plan	4	1	2	7

* Ministry of Town and Country Planning *and* Department of Health for Scotland. New Towns Committee. Final report. Cmd. 6876. H.M.S.O., 1946.

† Abercrombie (Patrick). Greater London Plan 1944: a report prepared on behalf of the Standing Conference on London Regional Planning . . . at the request of the Minister of Town and Country Planning. H.M.S.O., 1945.

TABLE 6

Areas of Land per 1,000 Population required for Ancillary Needs at Various Gross Densities

Use	Areas in Acres per 1,000 Population required at Gross Densities of:—						
	10	20	30	40	50	60	70
Shops	1·2	·9	·8	·7	·6	·5	·5
Public Buildings..	1·5	1·1	·8	·6	·5	·5	·5
Service Industry..	1·1	·7	·6	·5	·4	·4	·4
Total	3·8	2·7	2·2	1·8	1·5	1·4	1·4

shops, public buildings, and service industry is to some extent simpler to deal with because it does not vary as widely as some of the other needs. The number of shops required for say 10,000 people may reasonably be assumed to remain more or less constant no matter what the gross or net density may be. Since these ancillary needs occupy relatively little space and therefore have relatively little effect on density, it is not proposed in this study to discuss the question of standards in detail. It will be sufficient to point out that there is *some* tendency for space needs to vary with gross density and to quote areas that have been suggested in recent years which, though they may be questionable within narrow limits, are quite sufficient for demonstrating their relationship to the total area. These standards are given in Table 6 and are in large part based on the " Design of Dwellings " Report of 1944 (the " Dudley " Report).*

58. One important land use in the neighbourhood, of which no account has yet been taken, is the land required for main streets† and car parking. The land required for minor streets and footpaths to give access to the dwellings themselves has been taken as part of the net housing area but the main circulation streets will require additional land. These need more land than any of the other ancillary items, and there is a greater range of variation for different gross densities, but like the other items the need does not tend to be variable at will. That is to say, for any particular gross density the land required for main streets works out to a definite figure which cannot be altered to any great extent by manipulating the layout. Average figures of the land needed for this purpose at various gross densities are given in Table 7. These again are based on the " Design of Dwellings " Report of 1944.

TABLE 7

Land Required in Acres per 1,000 Population for Main Streets and Car Parking at Various Gross Densities

Gross Density (persons per acre)	Land per 1,000 Population required for Main Streets and Car Parking (acres)
10	4·0
20	3·5
30	2·5
40	2·0
50	1·7
60	1·4
70	1·0

59. As separate assessments have now been made of the principal essential land uses in the neighbourhood, it is possible to attempt a synthesis with a view to learning how alteration of the standards of the components affects the gross density of the neighbourhood. It is actually rather more convenient to study this relationship in a converse manner, that is to say

* Ministry of Health. Central Housing Advisory Committee. Design of dwellings: report of the Design of Dwellings Sub-Committee of the Central Housing Advisory Committee appointed by the Minister of Health and report of a Study Group of the Ministry of Town and Country Planning on site planning and layout in relation to housing. H.M.S.O., 1944.

† The definition of main streets is here identical with the same term introduced in the Housing Manual (page 37).

TABLE 8

Effect of Variations of Gross and Net Density on the Open Space Standard

This table is designed to show the amount of land available for open space (or other allied uses) at various combinations of gross and net density. Each gross density (Col. 1) is first re-expressed as a land area per 1,000 persons (Col. 2). A deduction (Col. 3) is then made for the essential uses such as schools, shops, roads, etc., and a balance (Col. 4) is left which is available for open space and housing. In the remaining columns this balance is allocated between housing and open space for various net densities. Thus the table shows that at a gross density of 30 persons per acre, it would be possible to have an average net density of 60 rooms per acre with open space at 8·6 acres per 1,000 persons, or alternatively an average net density of 120 rooms per acre with open space at 18·0 acres per 1,000 persons. Below the thick black line the provision for public open space falls below 7 acres per 1,000 persons.

Gross Density (persons per acre)	Land Area (acres per 1,000 persons)	Deduction for Schools, Shops, Roads, etc. (acres per 1,000 persons)	Balance available for Housing and Open Space (acres per 1,000 persons)	Allocation of Column 4 between Housing and Open Space **for various net densities in rooms per acre** (Occupancy Rate = 0·89) Column a = acres of net residential area per 1,000 persons Column b = acres of open space per 1,000 persons																									
				20 rooms per acre		25 rooms per acre		30 rooms per acre		40 rooms per acre		50 rooms per acre		60 rooms per acre		70 rooms per acre		80 rooms per acre		90 rooms per acre		100 rooms per acre		120 rooms per acre		140 rooms per acre		160 rooms per acre		180 rooms per acre		200 rooms per acre	
1	2	3	4	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b	a	b
10	100·0	9·1	90·9	56·0	34·9	45·0	45·9	37·4	53·5	28·0	62·9	22·4	68·5	18·7	72·2	16·0	74·9	14·0	76·9	12·5	78·4	11·2	79·7	9·4	81·5	8·0	82·9	7·0	83·9	6·2	84·7	5·6	85·3
15	66·6	8·3	58·3			45·0	13·3	37·4	20·9	28·0	30·3	22·4	35·9	18·7	39·6	16·0	42·3	14·0	44·3	12·5	45·8	11·2	47·1	9·4	48·9	8·0	50·3	7·0	51·3	6·2	52·1	5·6	52·7
20	50·0	7·5	42·5					37·4	5·1	28·0	14·5	22·4	20·1	18·7	23·8	16·0	26·5	14·0	28·5	12·5	30·0	11·2	31·3	9·4	33·1	8·0	34·5	7·0	35·5	6·2	36·3	5·6	36·9
25	40·0	6·7	33·3							28·0	5·3	22·4	10·9	18·7	14·6	16·0	17·3	14·0	19·3	12·5	20·8	11·2	22·1	9·4	23·9	8·0	25·3	7·0	26·3	6·2	27·1	5·6	27·7
30	33·3	6·0	27·3									22·4	4·9	18·7	8·6	16·0	11·3	14·0	13·3	12·5	14·8	11·2	16·1	9·4	17·9	8·0	19·3	7·0	20·3	6·2	21·1	5·6	21·7
35	28·6	5·6	23·0											18·7	4·3	16·0	7·0	14·0	9·0	12·5	10·5	11·2	11·8	9·4	13·6	8·0	15·0	7·0	16·0	6·2	16·8	5·6	17·4
40	25·0	5·1	19·9													16·0	3·9	14·0	5·9	12·5	7·4	11·2	8·7	9·4	10·5	8·0	11·9	7·0	12·9	6·2	13·7	5·6	14·3
45	22·2	4·8	17·4															14·0	3·4	12·5	4·9	11·2	6·2	9·4	8·0	8·0	9·4	7·0	10·4	6·2	11·2	5·6	11·8
50	20·0	4·5	15·5																	12·5	3·0	11·2	4·3	9·4	6·1	8·0	7·5	7·0	8·5	6·2	9·3	5·6	9·9
55	18·2	4·2	14·0																			11·2	2·8	9·4	4·6	8·0	6·0	7·0	7·0	6·2	7·8	5·6	8·4
60	16·6	4·1	12·5																					9·4	3·2	8·0	4·5	7·0	5·5	6·2	6·3	5·6	6·9
65	15·4	3·9	11·5																							8·0	3·5	7·0	4·5	6·2	5·3	5·6	5·9
70	14·2	3·7	10·5																							8·0	2·5	7·0	3·5	6·2	4·3	5·6	4·9

to assume various figures of gross density and discover what variations of the components are possible at each gross density. Table 8 has been prepared to illustrate this. In this Table each gross density (column 1) is first re-expressed as a land area per 1,000 persons (column 2). A deduction (column 3) is then made for the essential uses such as schools, shops, roads, etc., and a balance (column 4) is left which is available for open space and housing. In the remaining columns this balance is allocated between housing and open space for a wide range of average net densities. Below the thick black line the open space provision drops below 7 acres per 1,000 persons. Thus the Table shows that at a gross density of 30 persons per acre it would be possible to have an average net density of 60 rooms per acre with open space at 8·6 acres per 1,000 persons or, alternatively an average density of 120 rooms per acre with open space at 17·9 acres per 1,000 persons or alternatively again if it was desired to have a net density of 50 rooms per acre then the open space would drop to only 4·9 acres per 1,000 persons.

60. As might be expected, this Table confirms that if, in respect of an area, a gross density is fixed, together with definite standards for schools and open space, *then the average net accommodation density for that area is predetermined.* Thus, suppose a local planning authority decided that a certain area should be developed as a neighbourhood at a gross density of 55 persons per acre with schools at 1·3 acres per 1,000, and open space at about 7·0 acres per 1,000, then the Table shows that *this can only be realized if the average net housing density is in the region of* 180 *habitable rooms per acre*, and this of course means (as reference to Table 4 will show) that practically all the accommodation will be in flats. This procedure (i.e. adopting a gross density and working to fixed standards for schools and open space) is in many ways a tempting one to adopt, but it has dangers when land is limited. In such conditions it is suggested that the authorities will need to consider carefully whether it is best to maintain a net density that will permit of a distribution of accommodation as between houses and flats roughly corresponding to needs, but at the same time accepting some cut in open space; or alternatively whether open space should stay at a fixed figure and the cut be accepted in the land for housing.

61. It may be observed that no account has been taken of allotments. This is because the assessment of the allotment needs for a district depends to a considerable extent on the size of private gardens and whether land conveniently situated, say within three-quarters of a mile of houses, can be allocated for allotment purposes. If private gardens in a district are small or even moderate in extent and allotment land can be provided nearby, it is likely that the provision of 4 acres per 1,000 population, recommended in the Allotments Advisory Committee Report (July, 1949),* will be required. In cases where it is doubtful whether the circumstances would result in or justify the full provision mentioned, a provisional allowance of about two acres per 1,000 population could be made. Although no allowance has been made for allotments in Table 8, it is not difficult to visualize the effect of introducing allotments in any particular set of conditions. Thus, wherever the Table shows a generous amount of land available for open space (say over 5 acres or thereabouts) then some of this land could be used for allotments. Where, however, the land available for open space is restricted, allotments can only be introduced by reducing open spaces, restricting playing fields, or by increasing net housing density. This last change, by reducing the number of houses with gardens, might in itself increase the demand for allotments.

62. It should be emphasized that the only educational requirement of which account has so far been taken is schooling up to primary standard. The land required for this forms a comparatively small part of the whole neighbourhood but there will of course be other more extensive educational needs to be taken into account when overall town density is considered in the next section.

63. The relative importance as consumers of land of the four components of a neighbourhood

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* Ministry of Agriculture and Fisheries. Allotments Advisory Committee. Allotments; report . . . to the Minister of Agriculture and Fisheries respecting amendment of existing allotments legislation. H.M.S.O., 1950.

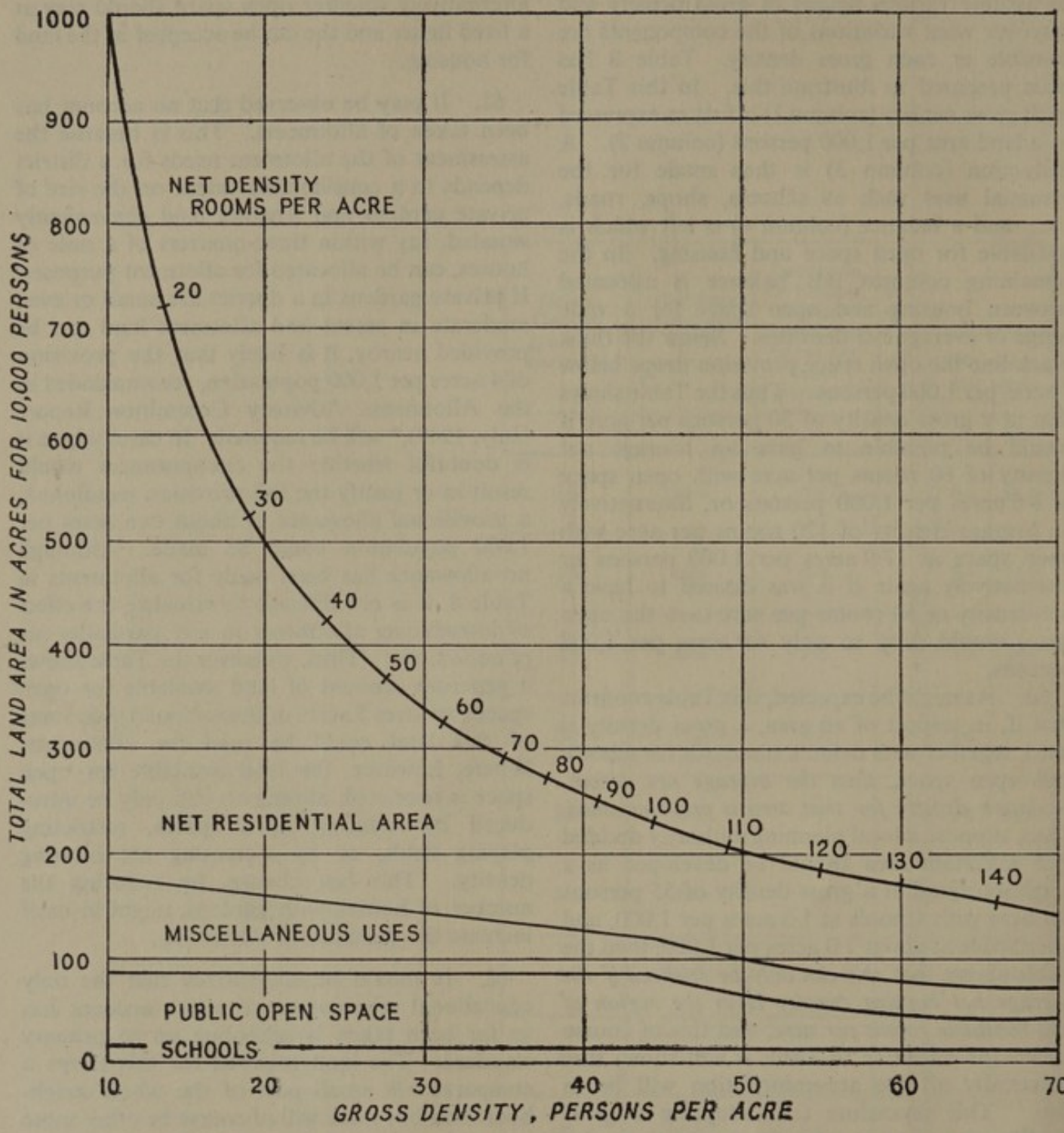

Fig. 17. RELATIVE IMPORTANCE OF THE MAIN LAND USES IN A RESIDENTIAL AREA AT VARIOUS GROSS DENSITIES

From this diagram it is possible to translate any gross density into a roughly equivalent net accommodation density and vice versa. Definite standards for non-residential uses have been assumed: 1·3 acres per 1,000 persons for schools, and 7·0 acres per 1,000 persons for open space, with an average allowance of space for other miscellaneous uses. Above a gross density of about 45 persons per acre, however, it becomes necessary to reduce the public open space standard in order to prevent the land available for housing becoming so reduced that excessive net densities result. An Occupancy Rate of 0·89 persons per habitable room has been assumed.

is illustrated in Fig. 17. In this Figure the areas required by the four components of a neighbourhood for 10,000 people have been plotted vertically above one another. Fixed standards of 7·0 and 1·3 acres per 1,000 for open space and schools respectively have been assumed up to a gross density of 45 persons per acre, thereafter reducing as described on the Figure. The land for the net residential area appears as a curve corresponding to a gradually increasing net density. The main point of interest in this Figure is the way in which increase of gross density causes a rapid reduction in the amount of land available for housing. Thus at a gross density of 10 persons per acre there would be some 828 acres available for housing resulting in a net density of about 13 rooms per acre, but if the gross density were trebled to 30 persons per acre the land available for housing would be about 188 acres and the net density would increase to approximately 59 rooms per acre with the result that the actual housing conditions would be very different. Over this range of gross density moreover the land occupied by housing is considerably greater in proportion to the other uses and therefore economies in the latter would not have any substantial effect either in the direction of overall saving of land or in making additional land available for housing.

64. Finally, to give visual significance to various figures of gross density diagrams have been prepared (Figs. 18-22) illustrating gross densities of 20, 30, 40, 50 and 60 persons per acre respectively. These diagrams are not intended to be good examples of neighbourhood planning, they are simply to give an idea of the relative amounts of space for the main uses that are available at various densities.

V. DENSITY IN RELATION TO THE TOWN

65. In section I of this chapter it was suggested that a residential area should be conveniently related in position and scale to the rest of the town, allowing reasonably good access to the town centre, the main areas of employment, and the other residential areas. This relationship is, of course, only partly a matter of density. If a town is considered as being an assembly of residential and industrial areas grouped round a central area (which is the fundamental plan of most of our towns), then the accessibility between the units will depend partly upon their size and density, and partly upon the way they are arranged in relation to one another and the barriers or spaces that may exist between them. It would be outside the scope of this handbook to consider the spatial arrangement of the various units that make up a town but it is a pertinent question to ask whether there are any rules governing the separate densities of the units or the overall density of the whole town.

66. As a preliminary it will be useful to have some idea of the state of affairs in our existing towns. How much land do the various uses occupy and what, in general, are the densities of the parts and of the whole?

67. Various classifications have been made from time to time of the land uses occurring in a town. One example is to be found in Appendix 1 of the handbook " The Redevelopment of Central Areas " in which the buildings that may occur in a town are placed in 13 main groups as follows:—

1. Dwelling houses
2. Residential buildings
3. Schools and residential colleges
4. Shops
5. Offices
6. Wholesale warehouses
7. Storage warehouses
8. Public buildings and places of assembly
9. Special places of assembly
10. Light industrial buildings
11. Industrial buildings
12. Special industrial buildings
13. Other buildings.

These building groups all correspond to distinct uses of land, but to make the list complete it is necessary to add the main land uses that do not carry buildings, i.e. open space, allotments, roads, car parks and railways. Thus altogether there may occur in a town, even

FIGS. 18-22. Comparative Studies of Gross Densities on a 200-acre Site

This series of figures is intended to show visually the effect of increasing the population on a site of given size. A site of 200 acres has been chosen and it has been planned to accommodate five different populations ranging from 4,000 to 12,000 persons. With the lowest of these populations the gross density is 20 persons per acre, the net density is about 32 rooms per acre, and it will be seen that the site planning as a whole is fairly simple. As the population is increased, however, the ancillary land uses become more extensive—more open space is required, for example, and the schools increase in number—and there is in consequence less land for housing. When 12,000 people are placed on the site the gross density is 60 persons per acre and the net density has risen to 130 rooms per acre.

These figures are intended to show space relationships at various densities and should not be taken as considered examples of neighbourhood layout.

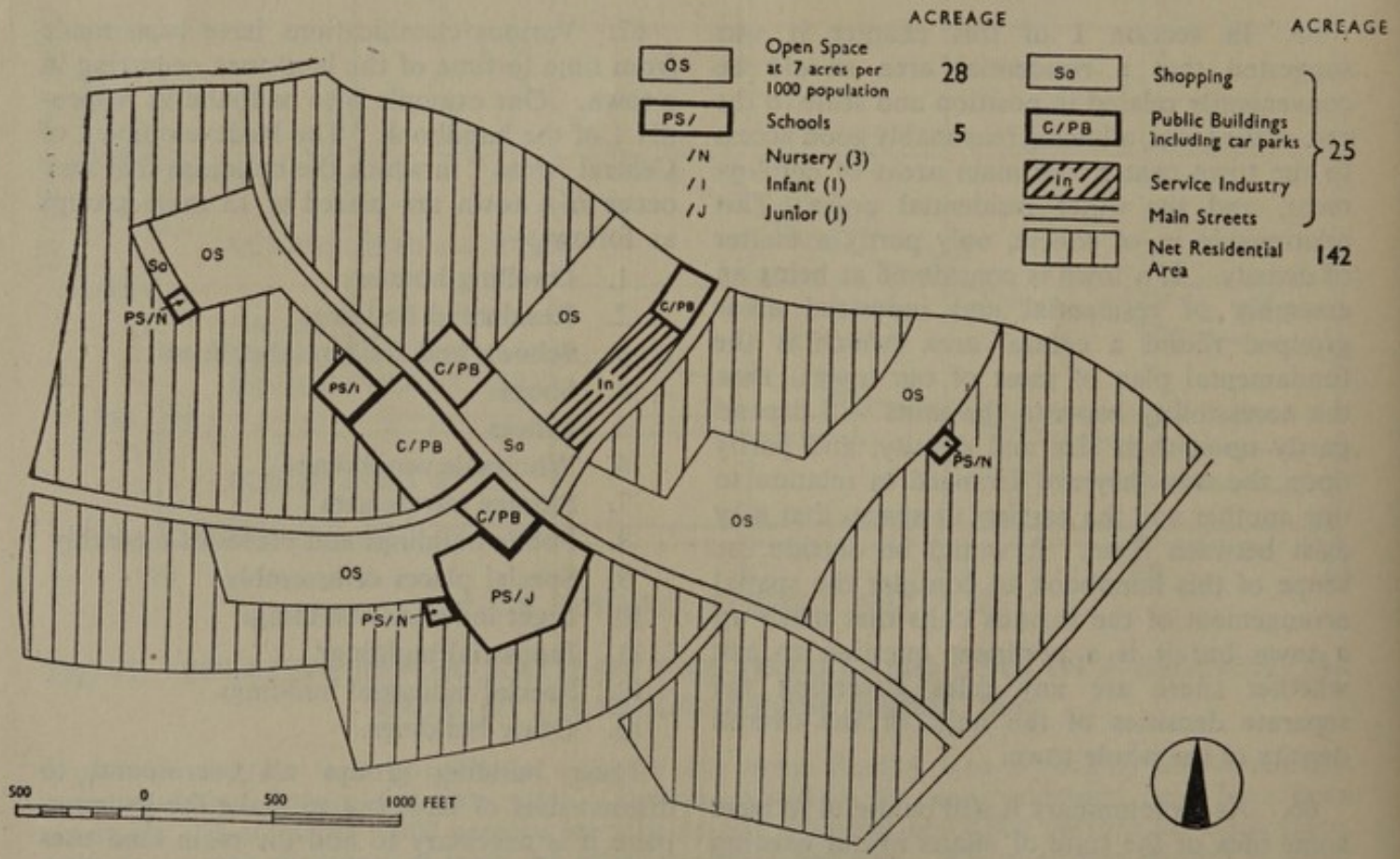

Fig. 18. GROSS DENSITY 20 PERSONS PER ACRE

4,000 people. Net density 32 rooms per acre (average)

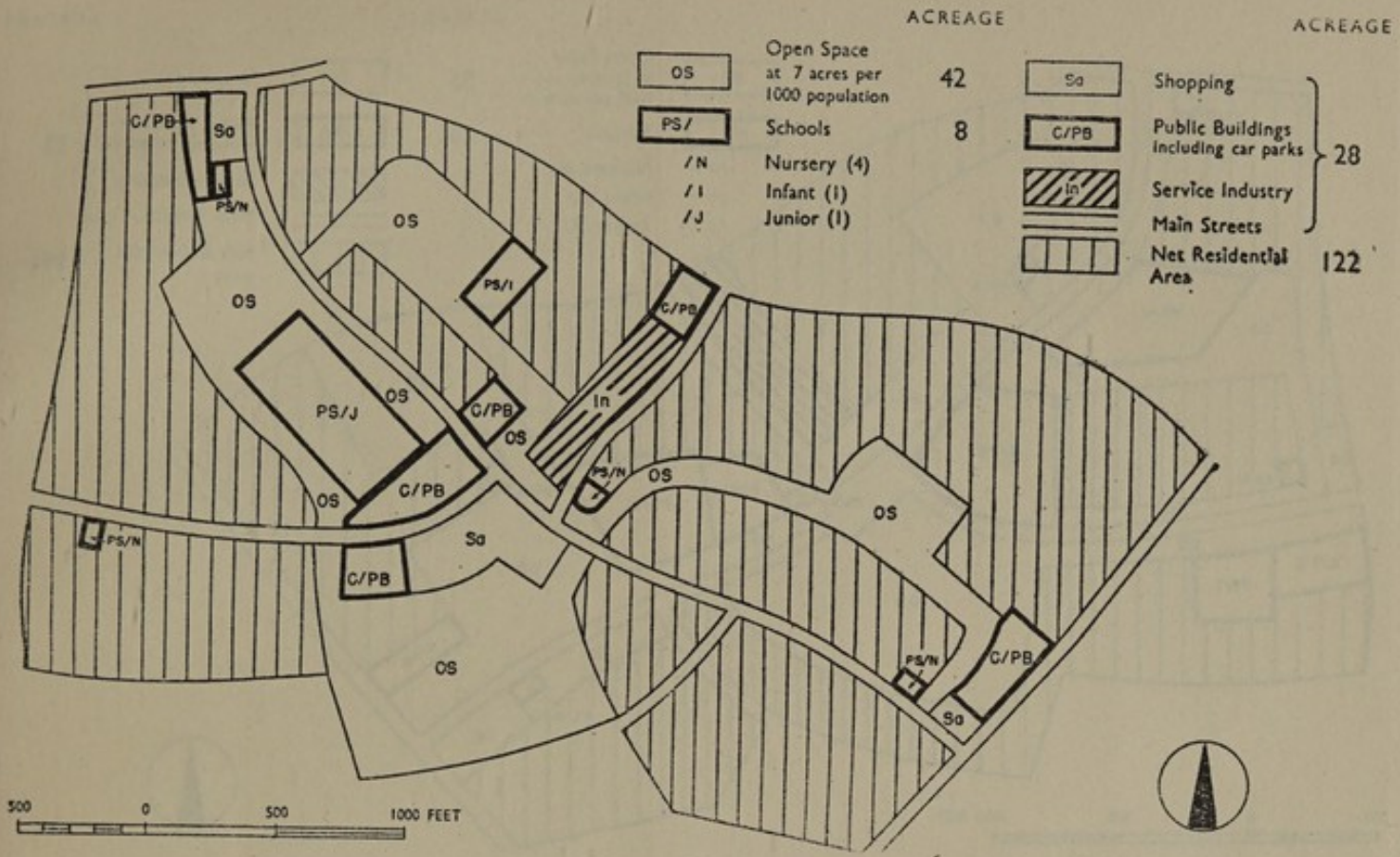

Fig. 19. GROSS DENSITY 30 PERSONS PER ACRE

6,000 people. Net density 55 rooms per acre (average).

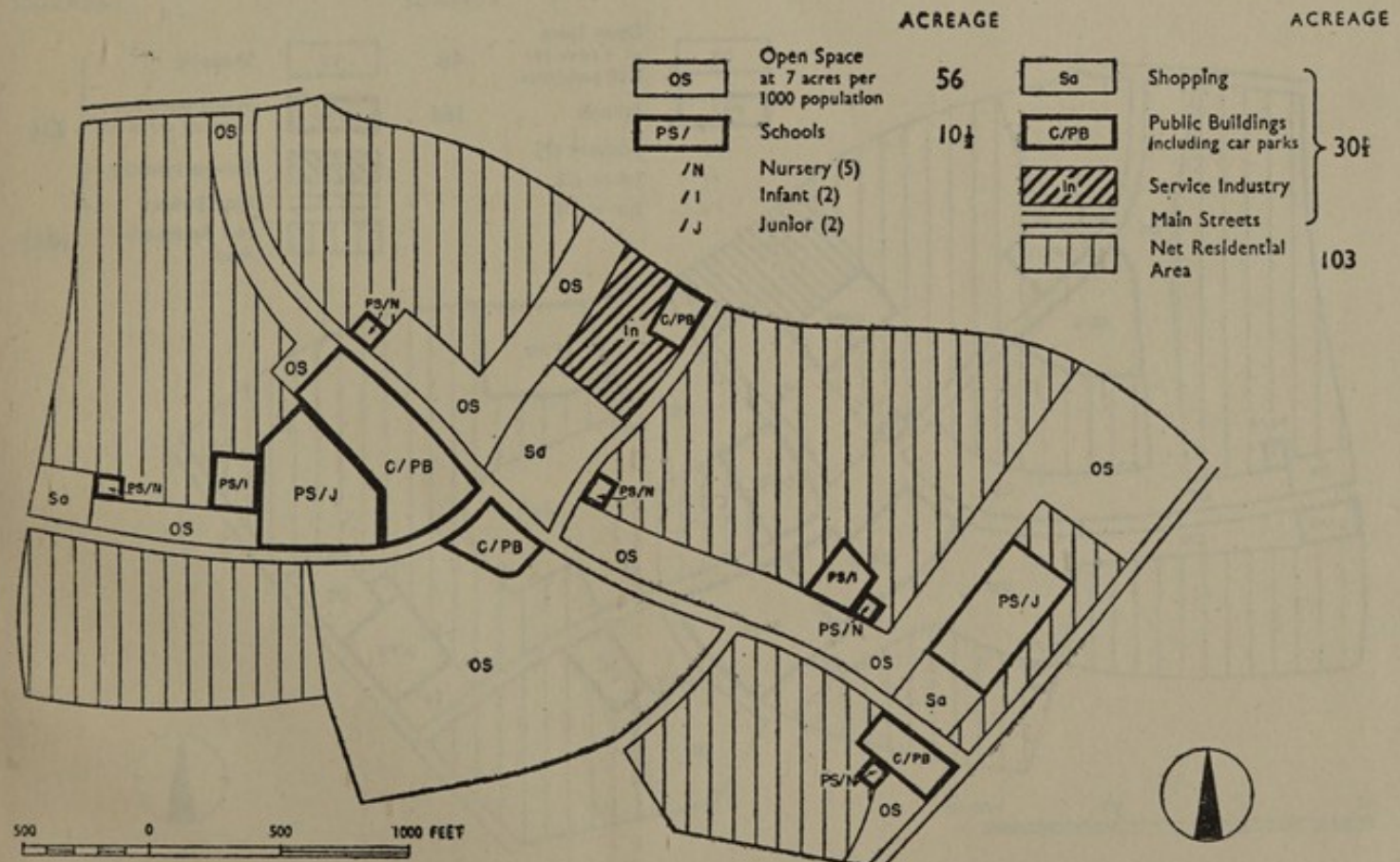

Fig. 20. GROSS DENSITY 40 PERSONS PER ACRE

8,000 people. Net density 91 rooms per acre (average)

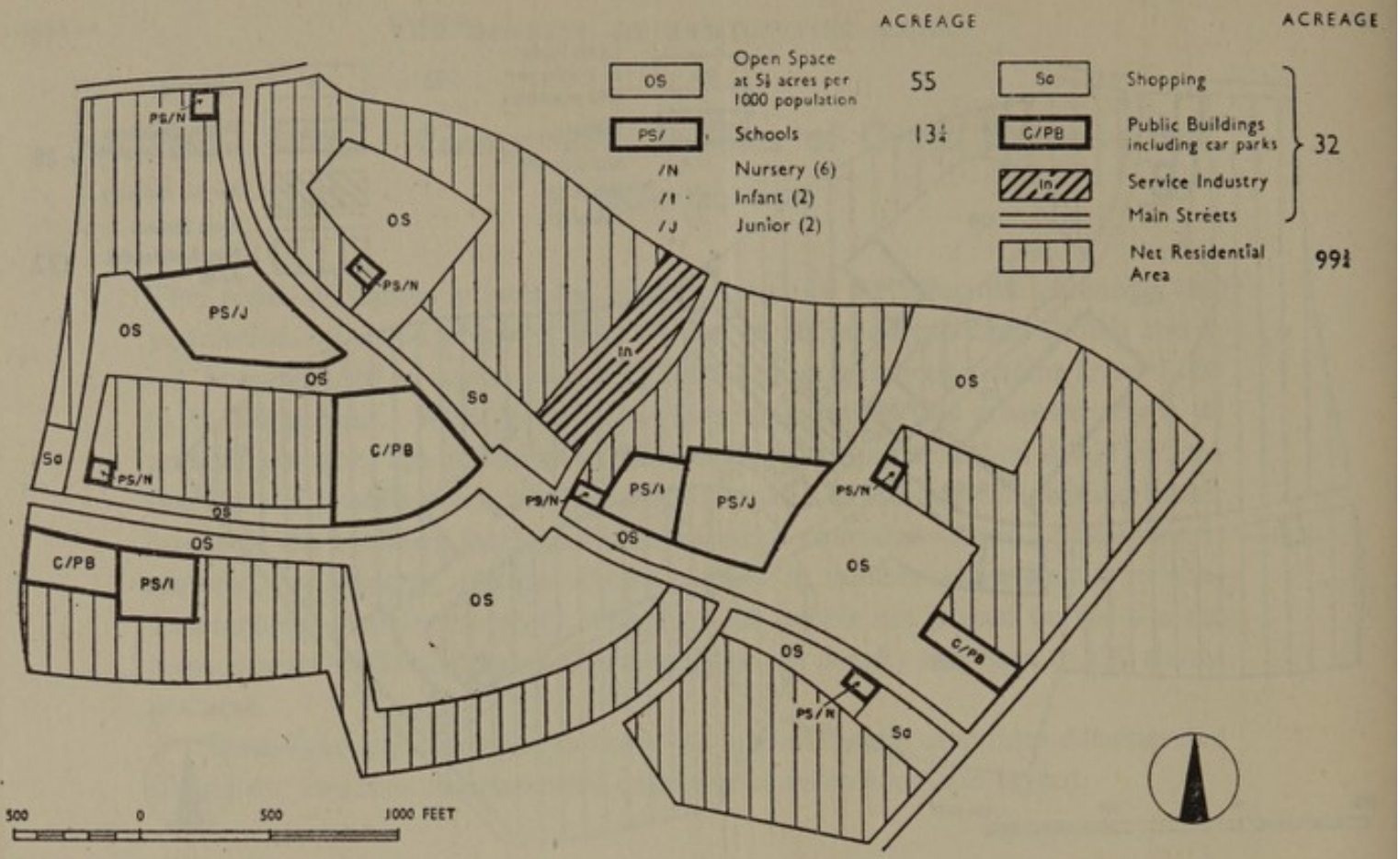

Fig. 21. GROSS DENSITY 50 PERSONS PER ACRE

10,000 people. Net density 112 rooms per acre (average)

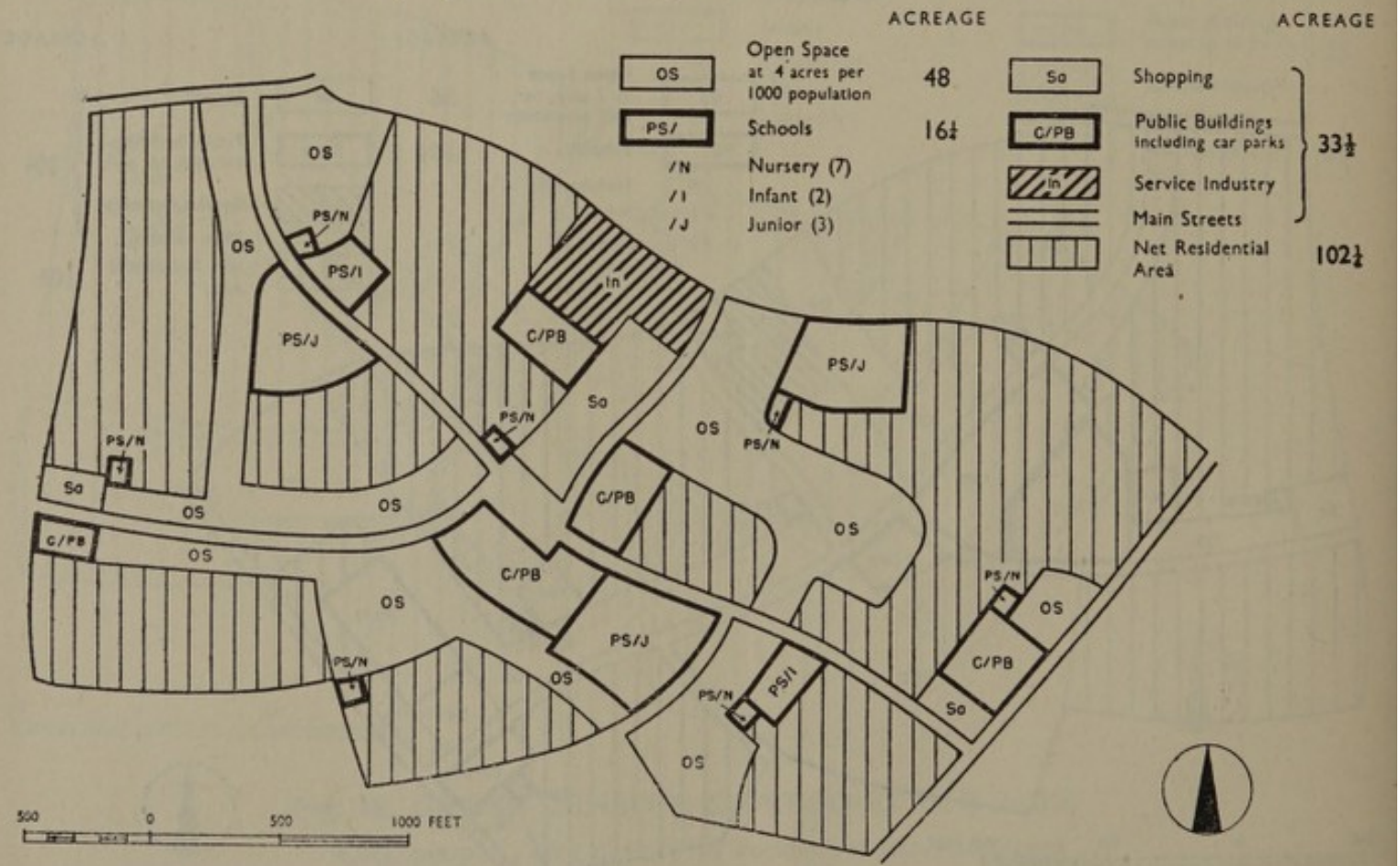

Fig. 22. GROSS DENSITY 60 PERSONS PER ACRE

12,000 people. Net density 130 rooms per acre (average)

TABLE 10

Area in Acres Occupied by each Main Use Group for a Number of Existing Towns, and for Certain New Towns.

Type of Town	Population	Developed Area (acres)	The Main Use Groups												Overall Town Density (persons per acre)
			1. Residential Area			2. Central Area		3. Industrial Area		4. Higher Education		5. Open Land		6. Large Establishments		
			acres	acres per 1,000 persons	equivalent in persons per acre	acres	acres per 1,000 persons	acres	acres per 1,000 persons	acres	acres per 1,000 persons	acres	acres per 1,000 persons	acres	acres per 1,000 persons	
EXISTING TOWNS															
Small market centre, residential for nearby large town	8,234	1,088	767	70·0	14·3	18	2·2	143	17·4	19	2·3	318	38·5	13	1·6	7·5
Minor county agricultural centre, with one important engineering industry	10,410	867	426	40·8	24·5	24	2·3	154	14·7	54	5·2	197	18·9	12	1·15	12·0
Minor county centre, some industry	16,520	1,388	634	38·5	26·0	34	2·1	219	13·2	51	3·1	439	26·5	11	0·66	11·9
Market and national racecourse	17,690	1,642	799	44·0	22·7	52	2·9	152	8·6	36	2·03	276	15·6	327	18·4	10·7
County market town, some industry	19,710	1,315	517	26·0	38·5	88	4·4	284	14·4	40	2·0	240	12·2	96	4·9	15·0
Dormitory and shopping centre	26,820	2,848	1,570	58·5	17·1	38	1·4	128	4·7	14	0·52	1,085	40·5	13	0·4	9·5
County town and cathedral city; rapid growth of war-time industry	64,170	3,198	1,828	28·5	36·0	76	1·18	433	6·8	77	1·2	588	9·2	194	3·0	20·0
University and market	86,000	7,030	5,424	63·0	16·0	84	0·98	300	3·5	403	4·7	659	7·7	160	1·9	12·3
University and industrial	105,800	7,327	4,196	40·0	25·0	93	0·88	626	5·9	332	3·14	1,824	17·3	256	2·4	14·4
County town market and industrial	114,500	4,421	2,886	25·1	40·0	132	1·15	491	4·3	70	0·61	748	6·5	94	0·82	26·0
Shipping and industrial and county centre ..	189,400	6,333	3,319	17·5	57·2	149	0·79	634	3·4	93	0·5	792	4·2	1,646	8·7	30·0
NEW TOWNS																
Reith Report	60,000	5,000	2,750	45·8	21·8	60	1·0	600	10·0	200	3·33	1,390	23·2	—	—	12·0
Stevenage (Master Plans as submitted)	60,000	4,593	2,674	44·3	22·6	100	1·6	711	11·8	200	3·33	822	13·7	86	1·44	13·1
Harlow (Master Plans as submitted) ..	60,000	4,539	1,688	28·0	36·0	100	1·6	565	9·4	325	5·4	1,861	31·0	—	—	13·2
Crawley (Master Plans as submitted)	50,000	4,000	2,048	40·9	24·4	104	2·0	476	9·9	256	5·1	1,085	21·7	30	0·60	12·5

on a simple classification, no less than 18 different land uses. To examine in detail the importance of all these uses as consumers of land and hence to judge the contribution that each makes to the overall density of the town would be a formidable task. In the examination of density over the neighbourhood it was possible to reduce the variables to four but even so the comparative analysis was somewhat complicated. The first need, therefore, is to re-define the uses into a manageable number of groups each having significance as a consumer of land. On this basis the least number of separate groups appears to be six, composed as shown in Table 9.

TABLE 9

Classification of Land Uses in a Town

Group	Constituent Uses
1. Residential Areas	All neighbourhood uses as defined in section IV of chapter I
2. Central Areas ..	The town's central shops, offices, public buildings and wholesale warehouses
3. Industrial Areas	Light industrial, industrial and special industrial uses; railways and goods yards; gas works and power stations
4. Educational Uses	Secondary schools; colleges and technical schools; large independent schools
5. Open Land ..	Large parks, private playing fields, unused land, etc. (not included in residential areas), allotments
6. Large Establishments	Hospitals, barracks, asylums

68. To give some idea of the relative importance as consumers of land of the groups of land uses shown in Table 9, an examination has been made of a number of existing towns, and the areas occupied by each use group have been measured. The results are shown in Table 10. In this Table there are shown, in addition to the separate areas of the use groups, the total population of the town, the total developed area, the area of each use group expressed as an acreage per 1,000 people, and finally the " overall density " of the town in persons per acre. In addition to the figures for existing towns there are also shown for comparison the figures for three New Towns which are being planned under the New Towns Act, 1946. It should be understood that " overall density " is the ratio of the total population of the town divided by the total *developed* area of the town as opposed to the area within the local government boundary — or in the case of a New Town the designated area.

69. The sample of towns shown in Table 10, though too small in itself to form the basis for wide generalizations, nevertheless illustrates clearly several points which more extensive studies have confirmed. The first point is the wide variations of overall density that existing towns display. There is no apparent correlation for instance between the densities of towns of the same character or having the same main industries. There is slight evidence that density does tend to increase as town size increases but there are many exceptions to this rule, if it can be called such. On the whole the figures of overall density are remarkable for their diversity and the real explanation may well lie as much in differences of topography and other physical characteristics of the site as in any other factors.

70. When the areas occupied by the main land use groups are examined, however, it is apparent that some groups are not only more important than others in respect of the proportion of the total town area that they occupy, but are also more subject to variation. Thus in most towns the central area is a relatively small part of the whole, whereas the residential areas may together constitute as much as 50-60 per cent. of the whole area. And again, the size of central areas depends broadly upon the number of people served, and variations as between town and town are mainly accounted for by this factor rather than by differences of design or layout; on the other hand the size of residential areas may differ markedly from town to town, and the differences may be as much due to variety in design and density as to differences in the number of people accommodated. Examined in this light the six land use groups sort

themselves very broadly into two categories — the major land users (residential areas, industrial areas, and open land, i.e. Groups 1, 3, and 5), and the less extensive land users (central areas, education, and large establishments, i.e. Groups 2, 4, and 6). It will be understood that these are wide generalizations. Their purpose is to give some idea of the range of overall density that existing towns display and an indication of the relative importance as consumers of land of the main land uses occurring in existing towns.

71. This brief study shows that in all towns the residential areas are the largest land consumers, but yet they show such variety of size and density from town to town that it is almost impossible to deduce any general rules helpful to planning. There is perhaps this general lesson to be learnt, that since none of these towns can be dismissed as utterly unsatisfactory places to live in, it follows that residential density is not the sole index of the standard of living conditions. Human beings are in fact adaptable and resourceful and can find their contentment in a very great variety of conditions, indeed variety of environment is probably the most important single need in town design.

72. There is one important feature common to the majority of our towns which the preceding Tables have not brought to light. It is that they nearly all display the same general density structure — a central congested core surrounded by residential development tending to decrease in density as it lies farther out from the centre. This widely-spread characteristic was doubtless the foundation for the general planning practice of the inter-war years of zoning residential areas in rings of decreasing density outwards from the town centre. The point of concern to the planner is that this characteristic density structure, which was largely the result of population growth and the working of certain economic circumstances, has not by any means been consistently identified with satisfactory town development. Low-density estates on the outskirts of towns, for instance, have given rise to many problems particularly in relation to journey to work, schools and shops; and in not a few cases the density has dropped so low that the development lacks all social cohesion, and there is waste of land as well. There has tended also to be a rigid separation of houses from flats (houses being built on the outskirts and flats towards the centre of the town) which may well lead in time to the undesirable separation of households with children from those without. The forces which produced the characteristic inter-war density structure are still, for the most part, at work, and the planner should therefore be particularly careful to ensure that the unsatisfactory features are not repeated.

VI. RESIDENTIAL DENSITY AND COST OF DEVELOPMENT

73. The fifth and last aspect of density requiring consideration is the relationship between density and cost of development. For a discussion of this to be profitable it is necessary to restrict the field fairly closely, for it is easy to see that factors without end could be brought into the discussion. Thus it might be claimed in argument against low-density, open-type development, that it takes more land, needs longer roads, involves longer runs of sewers and other services and results, in perpetuity, in longer and more costly circulation journeys of all kinds. Against high density it might be argued that the constructional costs of high buildings far exceed those of low ones, that operating and maintenance costs of buildings with lifts are excessive, and that a price has to be paid, and must therefore be brought into the account, for such intangible items as loss of seclusion, quiet, and play spaces for children. To make an analysis of all such items and to cost them in comparable terms would be a task of great complexity and quite outside the scope of this handbook. Nor would it necessarily be profitable in the long run as a basis for firm general guidance to planning authorities who are frequently bound in their decisions on density by other factors such as tradition, availability of land, and the physical characteristics of building sites.

74. Nevertheless recent experience has shown that there are two items in this matter of density

and cost of development that are of outstanding importance and no study of density would be complete without reference to them. The first item is concerned with the price that may have to be paid for urban expansion in the future in the form of losses of agricultural land, and clearly the density at which urban expansion takes place will have an important bearing upon the scale of these losses. The second item is concerned with the relative cost of accommodating people in houses and in flats. These two items are the more important for being to some extent interrelated, for if an appreciable amount of land is to be saved by increasing density it may involve the building of more flats.

75. Dealing first with the loss of agricultural land it will be necessary as a beginning to have some factual idea of the relative importance as consumers of land of the main urban uses, of the effect which town redevelopment of the kind in contemplation under the Town and Country Planning Act, 1947 is likely to have on these uses, and of the savings of land that could be effected by altering densities.

76. Some consideration has already been given in paras. 69 and 70 to the classification of the main land-use groups occurring in towns. Although there are great variations between towns, it is possible to distinguish two main categories—the major land users are the residential areas, industrial areas, and open land, and the lesser users are the central areas, higher education areas, and large establishments. The average figures for each group expressed in acres per 1,000 people for the eleven towns in Table 10 are shown in Table 11.

TABLE 11

Relative Importance of the Main Use Groups in a Number of Existing Towns

Use Group	Average Acreage per 1,000 population for eleven towns of sample in Table 10
Residential Areas ..	34·0
Central Areas	1·2
Industrial Areas	5·4
Higher Education ..	1·8
Open Land	10·9
Large Establishments ..	4·3

These figures are taken from a small sample and though they are probably a fair guide to the state of affairs in respect of the *relative* importance of land uses in other towns, they should be used with reserve for other purposes, and must on no account be taken as standards.

77. The best way of discovering how modern ideas of town planning are likely to affect the main land use groups is by the examination of development plans prepared under the Act of 1947. For the present purpose the object of these plans may be described as laying down the lines on which long-term rehabilitation is to take place. Nearly all our towns show in some degree six main defects — (i) congestion of space and building uses at the centre, (ii) congestion of traffic, including the passage of heavy motor traffic along unsuitable roads, (iii) areas of mixed uses (particularly of industry mixed with dwellings) which urgently require sorting out, (iv) large areas of obsolete and overcrowded dwellings (mainly legacies from the period of rapid growth), (v) insufficient open space, and (vi) inadequate schools (particularly in respect of playing fields). In the course of preparing their development plans local planning authorities examine their towns for these main defects, and the plan represents a programme for putting them right gradually in stages related to the resources available.

78. Some time must elapse before general inferences can be drawn from an examination of plans but it is possible to make a forecast of the extent to which remedies for these main defects will alter the areas devoted to the different land-use groups. Two groups are unlikely to be greatly affected. No action resulting from development plans is likely to increase very greatly the land occupied by central areas and large establishments; there will be changes of course but they are unlikely to have any significant effect on overall town density. Nor will the gradual carrying through of measures for the relief of traffic congestion require very much land in relation to the whole town area. On the other hand, the rehabilitation of obsolete residential areas and the reduction of overcrowding, the reorganization of industrial areas including the extrication of industries from areas of mixed use, the provision of more open space,

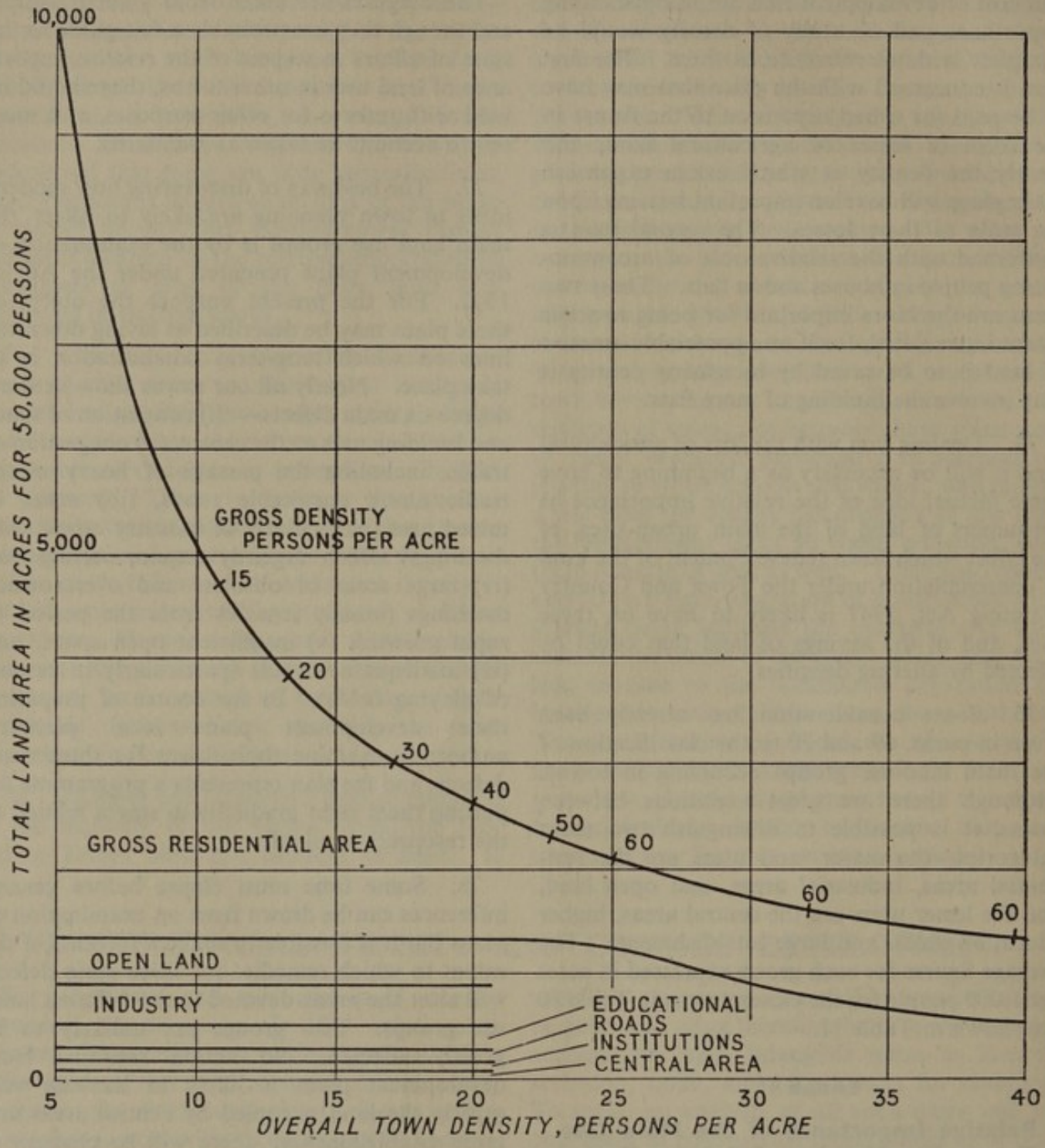

Fig. 23. RELATIVE IMPORTANCE OF THE MAIN LAND USES IN A TOWN OF 50,000 PERSONS

This figure shows the relative importance of the main land uses in a town of 50,000 persons at various overall town densities. Educational land is to Ministry of Education standards and open space is at 7 acres per 1,000. The figure also shows the relationship between overall town density and gross residential density. It will be seen that when the overall town density rises above about 20 persons per acre it becomes necessary to reduce the land area for the miscellaneous uses in order to leave sufficient land for the residential areas to prevent the gross density rising above 60 persons per acre.

and the reconstruction of schools, including the provision of new ones, together with the necessary playing fields, are all changes that may well require considerable areas of land. With the sole exception of schools, however, for which minimum standards have been prescribed, it is difficult to be specific about the effect which these changes may have. This is due partly to the great variety in the size of land-use areas which existing towns display, and partly to the wide range of suitable standards likely to be adopted in development plans. An idea of the relative importance of the main land uses in a town of 50,000 people as they might be after redevelopment to certain standards is given in Fig. 23. As was the case with Fig. 17, typical areas required for the main components have been plotted vertically above one another. Fixed standards of 100 acres for the central area, and of 50 acres for large establishments, have been assumed; educational land is to full Ministry of Education standards as described in paras. 53 and 54 and other uses are to reasonably generous standards until the gross residential density increases to 50 persons per acre at which figure the overall town density would be about 22 persons per acre. When overall density exceeds 22 persons per acre it will be seen from the graph that even to prevent the average gross density exceeding a figure as high as 60 persons per acre a marked reduction in standards for non-residential components would be necessary. These reductions are not shown in detail on the graph, because it would be a matter of choice which land uses should be cut and by how much.

79. The gross residential density of 60 persons per acre mentioned in the previous paragraph is a high figure. Reference to Fig. 17 will show that given a reasonable open space standard (though not as high as 7 acres per 1,000), a gross density of 60 persons per acre would result in an average net density of 130 rooms per acre and this would inevitably mean that a high proportion (about 80 per cent.) of people would be accommodated in flats. An examination of a sample of 63 towns showed that roughly half had overall densities over 20 persons per acre and may therefore require considerable areas of land to deal with problems of congestion and lack of space for various facilities. It would be dangerous to generalize too far from these figures but they do perhaps give some idea of the scale of density changes that may be required in the future.

80. Fig. 23 is not entirely fair in its representation of the comparative areas of the different land uses because it does not wholly succeed in grouping similar uses together. For instance, the areas shown for schools and open land do not in fact include all the open land and school areas of the town because a certain amount of each is included in the gross residential areas. Fig. 24 has accordingly been prepared. It is exactly the same curve but the area is split between similar uses regardless of locality. This again shows that the net housing areas are by far the most important users of land but emphasizes that open land (including all forms of open space) is also a user of some significance.

81. It is clear from Fig. 23 that by far the largest component is the gross residential area, and it is this that is most likely to yield a substantial saving by alteration of standards. The open land component is also a major user but it is fairly plain from the Figure that the other groups are unlikely to provide a source of spectacular savings.

82. Considering in more detail the savings of land that might be effected by altering the density of the residential areas, it must be emphasized that a neighbourhood does not consist simply of houses and flats. There are four distinct groups of land uses — (i) the land occupied by dwellings and their immediate surroundings, (ii) schools and their playing fields, (iii) open spaces, and (iv) the miscellaneous uses such as shops, public buildings, service industry and roads. In theory at any rate the land occupied by the last three of these four groups of uses is primarily dependent upon the number of people to be served, and it makes no difference to the amount of land required for these uses if the people are living in houses or flats. This is not entirely true in practice but it is certainly true enough for it to be said categorically that the overall saving of land in a neighbourhood resulting from the substitution of flats for houses is by no means in proportion to the net saving of land for the area occupied by the dwellings alone. This can be made clearer by an example.

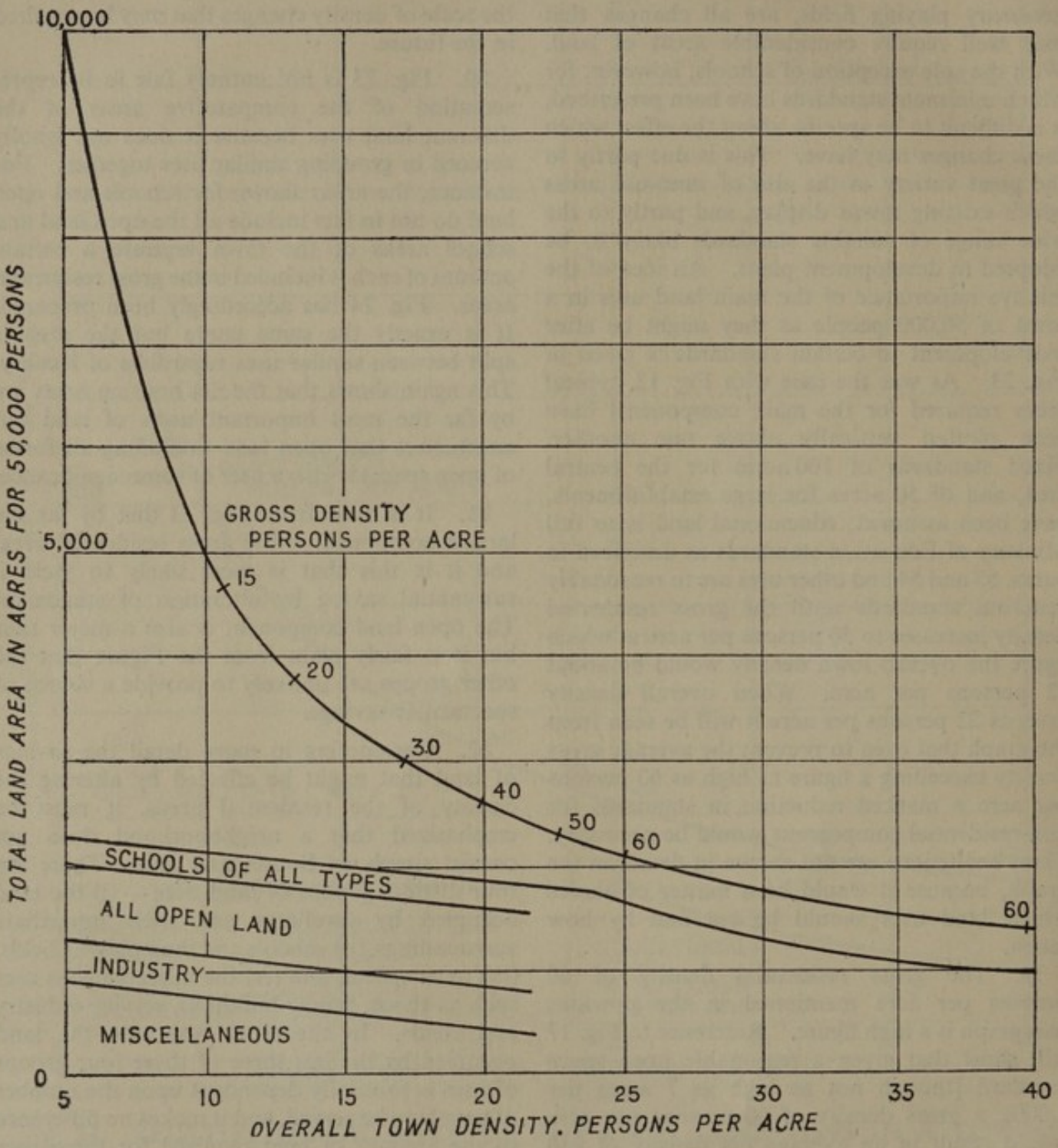

Fig. 24. RELATIVE IMPORTANCE OF THE MAIN LAND USES IN A TOWN OF 50,000 PERSONS (ALTERNATIVE PRESENTATION)

This diagram is similar to Fig. 23 except that the breakdown of the total land area is more strictly by functions in order to show how the main groups stand in relation to each other at various overall town densities. Thus all the land for education purposes has been grouped together and similarly all the open land of all kinds.

At a gross density of 30 persons per acre the total land required for accommodating 10,000 people would be 334 acres, which might be made up roughly as follows:—

	Acres
Housing area (at 56 rooms per acre net density and Occupancy Rate ·89 persons per room)	201
Schools 1·3 acres per 1,000	13
Open space (7·0 acres per 1,000) ..	70
Miscellaneous (shops, roads, etc.) ..	50
	334

The net housing area of 201 acres is about 60 per cent. of the total area. If it were now decided to save land by doubling the net housing density, the areas required would be as follows on the assumption that the school and open space standards are unaltered:—

	Acres
Housing area (at 112 rooms per net acre)	102
Schools (1·3 acres per 1,000) ..	13
Open space (7·0 acres per 1,000) ..	70
Miscellaneous	45
	230

The total saving of land resulting from doubling the net housing density is therefore about 104 acres or about 30 per cent. of the original total figure.

83. The proportionate savings of land that might be effected in various ways in the accommodation of 10,000 people is shown more clearly in Tables 12 and 13.

84. The general lesson of these Tables is that in the lower range of gross densities the most worthwhile saving of land is achieved by increasing the net housing density, but the consequences of doing this and the drastic effect that such action may have on the housing conditions should be clearly understood. In the higher range of gross densities the relative saving resulting from reducing the open space standard is more pronounced but on the other hand the total saving resulting from increasing the gross density itself becomes progressively less as the density increases. Moreover, it may well be that the greatest need for a generous open space rate will occur when the gross density is high, since there will be fewer private gardens.

85. This question of saving land by altering residential densities can be considered in another way by taking as an example the kind of development which most urban authorities are likely to be faced with in the future, that is to say the development of an outlying estate for the reception of overspill from the inner congested areas. It will be assumed, as an illustration: (*a*) that a large authority has acquired 1,000 acres of open land outside their city and desire to find out how many people could be

TABLE 12

Savings Attainable by Increasing Net Housing Density for 10,000 People

(Schools and open space fixed at 1·3 and 7 acres per 1,000 respectively: Occupancy Rate ·89 persons per room)

Net Density (rooms per acre)	Total neighbourhood Area (acres)	Gross Density (persons per acre)	Saving	
			Acres	% of Total
15	927	10·8	0	0·0
20	727	13·7	200	21·5
30	537	18·6	390	42·0
40	437	22·9	490	52·9
50	374	26·8	553	59·6
60	324	31·0	603	65·0
70	290	34·5	637	69·0
80	264	38·0	663	71·5
90	245	41·0	682	73·5
100	225	44·5	702	76·0

TABLE 13

Savings Attainable by Reducing Open Space for 10,000 People

(School area fixed at 1·3 acres per 1,000: Occupancy Rate ·89 persons per room)

Open Space (acres per 1,000)	Total neighbourhood Area (acres)	Gross Density (persons per acre)	Saving	
			Acres	% of Total
(*a*) Net density 40 rooms per acre.				
7	437	22·9	0	0
6	427	23·4	10	2·3
5	417	24·0	20	4·6
4	407	24·6	30	6·85
3	397	25·2	40	9·1
2	387	25·9	50	11·5
(*b*) Net density 60 rooms per acre.				
7	324	31·0	0	0
6	314	31·9	10	3·2
5	304	33·0	20	6·2
4	294	34·0	30	9·3
3	284	35·2	40	12·3
2	274	36·5	50	15·4
(*c*) Net density 100 rooms per acre.				
7	225	44·4	0	0
6	215	46·6	10	4·4
5	205	48·7	20	8·9
4	195	51·4	30	13·3
3	185	54·2	40	17·7
2	175	57·2	50	22·1

accommodated upon it at various standards of net housing density; (*b*) that primary schools are to be provided at full Ministry of Education standards as previously described in paras. 53 and 54; (*c*) that open space is required at 7·0 acres per 1,000 people, and (*d*) that other uses will be at the standards assumed in Fig. 17. It will also be assumed, to make the example realistic, that secondary schools have to be provided in accordance with Ministry of Education standards. (It will be remembered that secondary schools are not included in the definition of gross residential areas in this handbook).

86. The simplest method of approaching this problem is to assume various figures of population that might be accommodated on the site and then to work backwards and elucidate the resulting housing conditions as reflected in the figures of net density. This has been done with the help of Fig. 17 and Table 4 for populations varying from 20,000-50,000 and the results are tabulated in Table 14.

87. It will be seen from this Table that placing 25,000 people on the site gives a net accommodation density of about 49 rooms per acre. This might be said to correspond roughly to local authority practice between the wars when many estates were laid out at about 10 semi-detached houses to the acre. Taking this figure as a datum it will be seen that roughly another 5,000 people could be placed on the site by increasing the net density to 62 rooms per acre which would involve the use of terrace houses. 7,000 more people than the datum figure could be accommodated by introducing about 20 per cent. of the accommodation in the form of medium-height flats; 10,000 more than the datum by using about 40 per cent. five-storey flats; and 15,000 above the datum by using about 60 per cent. five-storey flats with fairly close terrace housing. It will be understood

TABLE 14

Housing Conditions Resulting from Placing Various Populations on a 1,000-acre site

Population	Area Required for Secondary Schools (acres)	Area Available for Gross Residential Area (acres)	Gross Density (persons per acre)	Corresponding Net Density (rooms per acre)	Remarks on Housing Conditions*
20,000	50	950	21·0	35·0	Could all be in houses
25,000	60	940	26·6	49·0	Could all be in houses, corresponding roughly to inter-war practice at old standard of 10 semi-detached houses per acre
30,000	73	927	32·3	62·0	Could all be in houses, given fairly free use of terrace form
32,000	77	923	34·7	75	80 per cent. of accommodation could be in terrace houses (two or three storeys), 20 per cent. in flats (three to five storeys)
35,000	87	913	38·4	83	60 per cent. in terrace housing, 40 per cent. in five-storey flats
40,000	100	900	44·4	100	40 per cent. in terrace housing, 60 per cent. in five-storey flats
50,000	121	879	56·9	125	20 per cent. in terrace housing, 80 per cent. in ten-storey flats

* For each case one possible way of arranging the accommodation is given, but of course there are many alternatives.

that these are very rough figures and it would be quite possible in each case to alter the proportions of houses and flats by simply varying the individual net densities of each. The figures are a guide however to what can be achieved in land economy compared with inter-war practice. The savings in acres are shown in Table 15, it being assumed in each case that the population accommodated above the datum will no longer need land elsewhere.

88. The significance of these figures becomes plain when it is recalled that out of a group of people as large as 20-30,000 there are bound to be some who will welcome the economy of terrace houses, and others who can appropriately be accommodated in flats. This variety of demand arising within a large group of people could, it is suggested, be exploited to enable residential areas to be planned at somewhat higher densities than were common between the wars. Granted that up to 25 per cent. of accommodation in flats might be appropriate in some cases, then it would appear, from Fig. 17 and Table 4, that gross densities up to about 40 persons per acre might well be possible without causing an undue proportion of families to be accommodated in flats. This does in fact correspond with the advice given in the Housing Manual (para. 26) that a full range of schools and communal facilities can be provided at gross densities ranging between 30-40 persons per acre. Table 15 shows that the saving of land that would result from these densities compared with inter-war practice might be of the order of 20-25 per cent. For more spectactular savings of land higher net densities would be necessary, and these would involve equally spectacular departures from most of the ideals that have been entertained about re-housing the population.

89. It is highly improbable that a total saving of as much as 25 per cent. could be achieved over the whole country in respect of development on new land by this method of increasing net densities. Estates as large as

TABLE 15

Percentage Savings of Land on a 1,000-acre Site for Various Forms of Housing

Method by which Saving might be Achieved	Gross Density	Population	Extra Population above Datum	Saving of Land*	
				acres	% of gross residential area
— —	26·6	25,000 (datum)	—	—	—
Use of terrace houses	32·3	30,000	5,000	154	16·6
Use of 20 per cent. medium flats, and terrace houses	34·7	32,000	7,000	202	21·9
Use of 40 per cent. medium height flats, and terrace houses	38·4	35,000	10,000	260	28·5
Use of 60 per cent. medium height flats, and terrace houses	44·4	40,000	15,000	338	37·5
Use of 80 per cent. high flats, and terrace houses	56·9	50,000	25,000	440	50·0

* i.e. The land that would have been required elsewhere at the same gross density for the extra population placed on the site.

1,000 acres will be the exception rather than the rule, and with smaller estates the chances of making effective savings are reduced. In many rural and small town areas, moreover, development will be appropriate at comparatively low net densities allowing for houses with fairly substantial gardens. Again, although it may be possible to achieve higher net densities than were general before the war, it does not follow that gross densities will be higher because much inter-war development was under-provided with schools and open space.

90. It is questionable whether, in order to save land, there is any scope for adopting higher *redevelopment* densities than have hitherto been used. In many towns gross densities of 50-60 persons per acre involving net densities of the order of 120 rooms per acre with the greater part of the accommodation in flats, are already being accepted. Few people would wish to see the densities increased beyond this, certainly not to the extent adopted in some American cities where multi-storey flat blocks are being built at densities up to 450 rooms per acre.

91. Figs. 17 and 23 throw an interesting light on the land requirements of New Towns which have been the subject of some criticism. The density of Stevenage as proposed in the Master Plan was about 13 persons per acre. Supposing it to be increased to 16 in the interests of land economy, the consequent saving of land would be about 880 acres. This saving might be of great local significance in relation to some particular farm or a patch of high quality land, but the fact remains that the figure even when multiplied by all the New Towns is not spectacularly large. Moreover the increase would mean that the average net density would have to be in the neighbourhood of 60 rooms per acre, which many planners would contend was too high for so important an undertaking as a New Town whose principal purpose is to provide all kinds of people with better living conditions than they had in the old town from which they came. Such experience as has so far been gained suggests, however, that an average of 50 rooms per acre over the whole town may be attainable.

92. The provision for open space in some current plans has been criticized on the score of lavishness. Reference to Fig. 17 shows that in neighbourhoods being developed on new land the provision of open space, even at 7·0 acres per 1,000 as shown in the diagram, does not consume much land compared with the total. Even so, small economies would be possible, though it would be necessary to consider whether

the yield really balanced the loss to the community. Some plans do seem to err, however, in the casual introduction of odd open spaces, meandering strips, and wide verges to roads. This should not be taken as saying anything against the most desirable movement of recent years towards greater variety of layout in housing schemes with a freer use of small open spaces, but is a caution against excessive openness which can so easily be a cloak for faulty planning.

93. It has been shown that some savings of land may be secured by the freer use of terrace houses and flats as compared with more stereotyped layouts of semi-detached houses. This possibility at once suggests the second aspect of density and cost, for it is well known that flats are considerably more expensive to build than houses.

94. The first need is to have some idea of the relative cost of housing in the semi-detached, terrace, and flat forms. In Table 16 are shown the approximate relative costs of building a dwelling of fixed size in various forms of structure.

TABLE 16

Cost Factors for a Dwelling of Fixed Size in Various Structure Forms

Type of Structure	Cost Factor
Houses, semi-detached	1·0
Houses, terrace, 2-storey ..	1·0
Houses, terrace, 3-storey ..	1·1
Flats, 3-storey	1·2
Flats, 5-6 storey, with load bearing walls	1·5
Flats, 6-10 storey, with framed structure	1·7

The factors in this Table relate *to the basic cost of the structure only* with an allowance for lifts. This has been taken as the fairest unit for comparison. In practice, the cost of laundries, playrooms, etc., and other items normally associated with flats but yet too variable to be included in a basic cost factor, would tend to increase the factors for flats, possibly in some instances raising the factor for high flats to as much as 2·5.

95. On the basis of the cost factors given in Table 16, a diagram has been constructed (Fig. 25) to illustrate the kind of relationship that exists between net density and cost of development. In this diagram there have been plotted vertically, for various net densities, first the cost of roads, services, and site preparation per habitable room, then the cost of structure per room, and then various costs of land per room. The general lessons of this diagram and of Table 16 are:—

(i) Total cost-per-room decreases, irrespective of land cost, with increase of density until it becomes necessary to start using flats. The increased cost of structure then causes the total cost-per-room to rise sharply. At still higher densities it starts to fall again, but unless land is very expensive the cost-per-room does not recover sufficiently to drop below the first minimum, even if the density is increased to 200 rooms per acre. In brief, high densities only pay, in the narrow sense, when land is very expensive, though this is not to say that the cost of high density in other circumstances may not on occasion be justified.

(ii) Where land is cheap two-storey open-type development is likely to continue to be more attractive financially than high-density development. Where land is expensive then it pays (in the narrow sense that the cost per habitable room is reduced) to increase the density.

(iii) There are grounds for contending that a modest increase of density compared with inter-war practice would not involve additional cost.

96. To summarize this matter of the relationship between residential density and the cost of development, it can be said that to achieve substantial savings of land in urban redevelopment it would be necessary to place a much greater proportion of the population in flats than has hitherto been thought desirable, and at a much greater capital cost. On the other hand it may be possible on large estates to attain a saving of perhaps 20 per cent. compared with inter-war practice and at no greater cost, by close attention to detail, avoidance of waste, and judicious use of terrace houses and low flats.

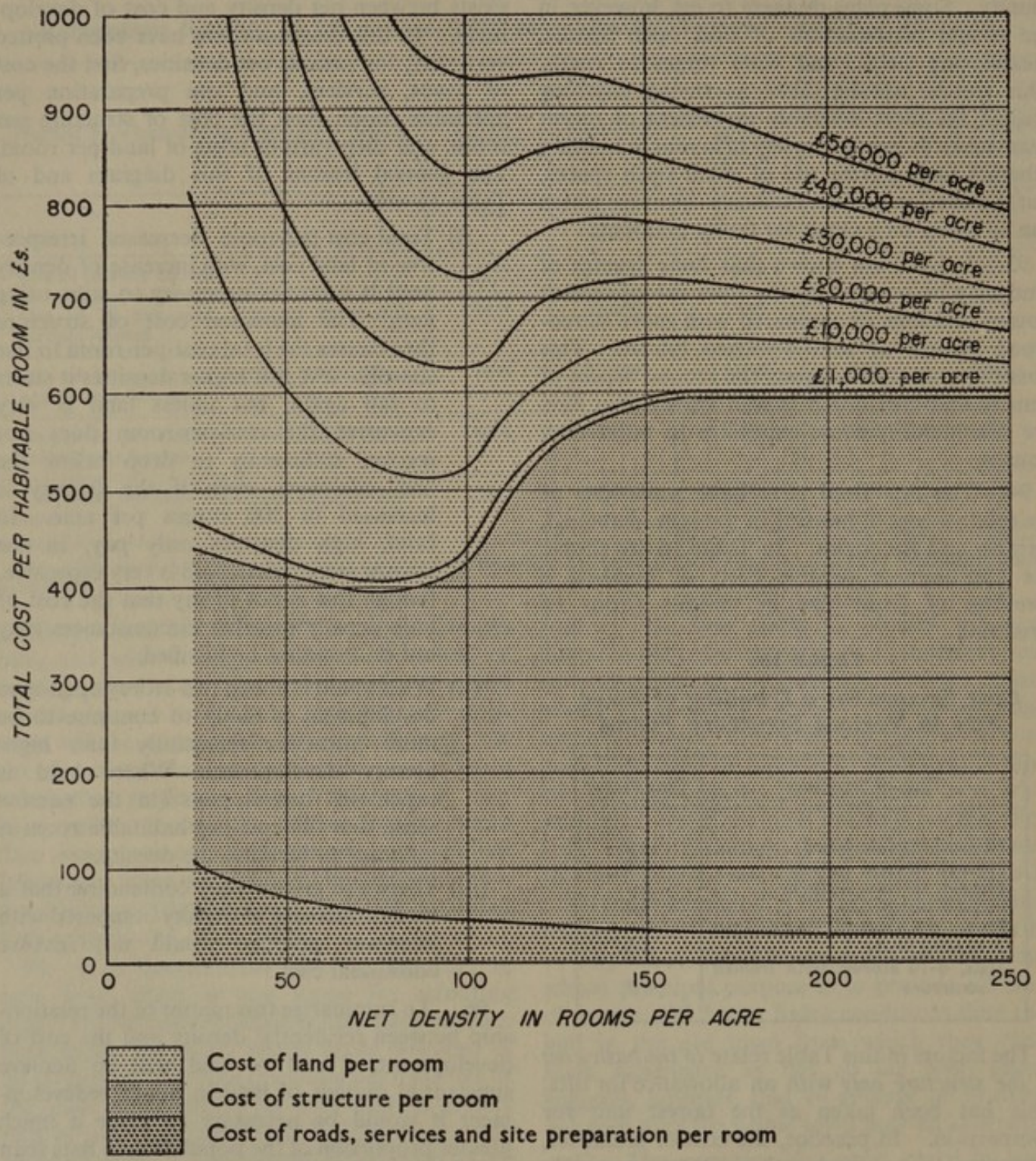

Fig. 25. RELATIONSHIP BETWEEN DENSITY AND COST OF DEVELOPMENT

This diagram shows the effect of increases of net density upon the cost of development. Broadly speaking, cost tends to fall with increase of density until it becomes necessary to use flats. The high structure-cost of flats then causes a sharp rise in total cost. The diagram is necessarily very general in character and should not be taken as indicating precise costs for any locality.

VII. CONCLUSION

97. In this chapter the attempt to explore the meaning of residential density will have made it plain enough that it is a complicated subject with many aspects and many variable factors. There is however one point which stands out quite clearly: it is that in many ways the most significant aspect is the density at which dwellings are grouped together, or the net accommodation density. It is important both because the area occupied by the dwellings is a large user of land, and because the density at which the dwellings are arranged has a vital bearing on the conditions under which the people live.

98. Net accommodation density has been investigated in section III, and the range of choice of building forms at various densities has been demonstrated by means of graphs and tables. It may nevertheless remain in the mind of the reader to ask whether any definite net densities can be recommended for general adoption. The answer to this question depends really upon the kind of towns that are wanted. If it is the general aim to economize land and to redevelop towns so that they are compact and urban, with a wide variety of accommodation in flats and houses to suit different tastes and with a rich and characterful variety of scene, then densities higher than those in general use between the wars for peripheral development will be both possible and desirable. The paradox of the inter-war development is that whereas it produced better dwellings it also produced, in many respects, worse towns, and low density lay close to the root of the trouble. It is significant too that the universally admired charm and character of so many old towns is frequently associated with medium or high densities.

99. Para. 88 repeats the advice given in the Housing Manual that full communal facilities can be provided within a gross density range of 30-40 persons per acre. The corresponding range of net accommodation density, allowing reasonable standards for other land use, is about 55-90 rooms per acre, and it is suggested that within this range there are densities applicable to large parts of most of our towns.

100. Two final points must be emphasized. First, the densities quoted above are based on exploiting the variety of demand that must arise from any large group of people, and putting into flats those people who can be so accommodated without discomfort or hardship. It is a common error to assume that the population consists entirely of married couples with children wanting houses and large gardens. Secondly, the price of higher density is better design. It is one thing to lay out houses at 6 or 8 to the acre, it is quite another to design houses and flats in mixed groups at medium or high densities, and ensuring all the time that all the dwellings have privacy, daylight, and good aspect, and that every square yard of land is used to the best advantage. This is a field of design requiring skill of a high order.

CHAPTER II

Residential Density and Development Plans

101. In the course of preparing their development plan as required by the Town and Country Planning Act, 1947, a local planning authority have the opportunity to take a broad look at all problems of land use and physical development, to set these problems in a rough order of priority, and then to tackle them according to the resources available in labour, money and materials. In some areas no very urgent changes will be required and the plan in consequence will be very simple; in others there may be an array of formidable problems whose ultimate solution lies further ahead than it is possible to see at the present time and the plan in consequence will provide for part solutions only.

102. In residential areas the main planning problems likely to arise are:—

(i) *The rehabilitation of the existing fully developed residential areas.*

Such areas may contain obsolete dwellings as well as being defective in one or more of the following ways all connected with density:—

(*a*) There may be a congestion of people in dwellings.

(*b*) There may be a congestion of dwellings on the ground.

(*c*) There may be large areas of dwellings insufficiently provided with various facilities.

To ascertain the extent of these defects in any area the local planning authority will have to make a survey (which should include consultation with the local housing authority) from which certain proposals should arise. If serious congestion in dwellings is found, accommodation elsewhere will almost certainly have to be provided. While higher density development on the site may go far to solve the problem, this may not be a practical possibility if it involves any large scale demolition of existing buildings, even if it were unobjectionable on grounds of density itself. From most seriously congested areas, therefore, there is likely to be an overspill of population requiring urgent re-housing. Population may also have to be moved because of a congestion of dwellings on the ground and/or because the provision of facilities such as schools is unsatisfactory. Removal of population for these reasons is likely to be a slow process dependent upon the degree of obsolescence of existing buildings and upon the resources available for rebuilding.

(ii) *Removal of residential accommodation from unsuitable areas*

People may be living in dwellings round which busy industrial areas have developed, or in tenements in noisy central areas. These are but two examples of many situations which are likely to arise in towns in which the local planning authority will feel as a result of their survey that residential accommodation must eventually be removed to more suitable localities. The process will again be a gradual one.

(iii) *Provision of new residential areas*

The need for these may arise from one or more of the following causes:—

(*a*) To accommodate overspill from congested areas (see (i) above).

(*b*) To accommodate overspill from areas being rebuilt (see (i) above).

(*c*) To accommodate people removed from areas unsuitable for dwellings (see (ii) above).

(*d*) To accommodate other people requiring dwellings but who do not appear in an overcrowding survey (e.g. people who may be living in hotels or in caravans or who share accommodation with others without overcrowding but need a separate dwelling).

(*e*) To accommodate the natural increase of the population, and any increase in the number of families.

(*f*) To accommodate increase of the population caused by immigration.

The new residential areas required for these purposes may be of two kinds—the infilling of existing partly-developed areas, and new areas. For the first kind a survey will be necessary to determine the amount of land available in these partly-developed areas.

103. The last paragraph outlines very briefly the planning problems to be dealt with in residential areas. The question of density arises in connection with:—

(i) *Survey.*

(*a*) Estimation of congestion of people in dwellings.

(*b*) Estimation of net and gross densities of existing fully and partly-developed areas, giving a broad idea of the extent of congestion of dwellings on the ground, the sufficiency of facilities, and the capacity of partly-developed areas to receive more population.

(ii) *Plan.*

Fixing of densities for redevelopment areas, areas to be filled in, and new residential areas.

104. This description of the planning process as related to density is closely reflected in the various surveys and plans which the Ministry recommend in connection with development plan submissions under the Town and Country Planning Act, 1947, and which are listed in the Ministry of Town and Country Planning's Circulars Nos. 40, 59, 63 and 97. Any town which has serious problems of redevelopment or expansion is at some stage likely to be the subject of a "Town Map", that is to say the map showing the main proposals for the next 20 years will be to 6 in. scale and it will be supported by a survey map showing the existing land uses to the same scale. If comprehensive development or redevelopment of any substantial part of the town or its environs is expected to take place in the near future then it will be open to the authority to treat the area as an "Area of Comprehensive Development" and planning proposals will be prepared in some detail at 25 in. scale. These detailed proposals need not, however, be submitted concurrently with the Town Map, and there may in fact be advantages in keeping them separate.

105. In order to explain in more detail the use of the various survey and plan maps, the following paragraph gives a brief description of the sequence of thought which, when the maps were being designed, it was expected a planning officer would need to adopt, wholly or in part, in the preparation of a development plan. This necessarily rests on the assumption that the planning officer would be working on a town new to him and hitherto unsurveyed; in practice of course, many planning officers will already have considerable information about their towns and the problems arising.

106. Dealing with survey first, the maps which the planning officer will find essential to the planning of the residential areas are shown in Table 17.

TABLE 17

Survey Summary Maps (Scale 6" = 1 mile) related to the Planning of Residential Areas

Map Reference in Circular No. 63	Title
1 (1)	Land Use
1 (2)	Age of Buildings
1 (4) (i)	Net Accommodation Density
1 (4) (ii)	Net Population Density

These maps are all *summary* maps of more detailed surveys made by the local planning authority. The form and scale of these detailed surveys are, of course, entirely a matter for local decision. Reference in this chapter to the use of such a map is intended to include also all the detailed information from which the summary was compiled.

107. The Land Use Map requires little explanation. From it the planning officer will get a broad impression of the layout of the town and the disposition of the main land uses. Even without other detailed surveys the Land Use Map will give the first ideas of the residential

areas that are obsolete or overcrowded, the areas that are irretrievably badly situated, the areas that lack facilities, the areas that are underdeveloped, and the vacant land upon which new housing might be placed. From the Land Use Map also the planning officer will begin to form his first ideas of the areas that stand together as homogeneous residential groups, and of other areas that might be drawn together.

108. The Age of Buildings Map shows primarily the buildings that were erected before 1875, those that were erected between 1875 and 1914, and those that have been erected since 1914. These dates have been selected because they correspond in general to significant changes in the conditions of urban development, but if a local planning authority consider other dates of more significance in any particular town then they can, of course, vary them, provided the change is clearly recorded on the map. This classification of buildings by age should give the planning officer some lead to the amount of redevelopment needed and the order in which it should take place. Although many dwellings erected before 1875 may still be sound and habitable or worthy of preservation for some reason or other, there will be a prima facie case for replacing dwellings so much extended beyond their normal life. Similarly there will be a prima facie case for retaining dwellings erected since 1914 on the grounds that their normal life is not yet run. The Age of Buildings Map also picks out other facts of importance to the planner, for example, it shows buildings which have already been condemned or those which ought to be preserved for architectural or historical reasons.

109. The clarification of the problems of redevelopment is carried a stage further by examination of the Net Accommodation Density and the Net Population Density Maps. The first defines and distinguishes the areas over which the residential development is broadly similar in character, and indicates for each such area the accommodation density in habitable rooms per acre according to the following classification:—

Under 30 rooms per acre
30 or over but under 60
60 or over but under 90
90 or over but under 120
Over 120

The Net Population Density Map shows the population density in persons per acre in the same classification as above but with " persons " instead of " habitable rooms ". These maps have two main uses. First, the Net Accommodation Density Map is a good guide to the degree of crowding of accommodation on the ground, especially when read in conjunction with the mapped data of the Ordnance Survey visible beneath the notation, and thus will be a further pointer to areas needing redevelopment. Secondly, if the accommodation density figure for any particular area is divided into the population housed within the same area (this being obtained of course from the basic data of which the Net Population Density Map is a summary) then the result will be the Occupancy Rate, or number of people accommodated per habitable room. This, as shown in chapter I, will be a guide to the degree of congestion of people in dwellings.

It is to be noted that existing Occupancy Rates are not required to be shown on the Net Accommodation Density Map. They are however almost certain to require study by a planning officer concerned with problems of overcrowding. It is difficult to give general advice about the Occupancy Rates to be adopted in particular cases, but it is suggested that much useful guidance can be obtained from a study of existing Occupancy Rates in other parts of the town. This will apply particularly where there is already in existence elsewhere in the town development of the type contemplated.

110. After completing his study of these surveys the planning officer should know a good deal about the residential conditions throughout the town. He will know the areas that are congested, either with people or with dwellings or both, and the degree of such congestion; he will know in general terms the condition of the dwellings and the amount and order of replacement required; at the same time he will have formed ideas about the areas which might be described as neighbourhoods. He may now turn aside to consider other housing matters not arising directly out of these surveys. It would be beyond the scope of this handbook to deal with the whole question of estimating housing needs including such difficult matters as judging the effects of migration of population. It is sufficient to say that no final decisions on density

in respect of areas to be redeveloped or new areas to be built over can be taken until the whole question of the town's future population has been investigated and a broad idea arrived at of the gross amount of extra accommodation likely to be needed during the period ahead for which plans can reasonably be laid, together with an idea of the rates at which the accommodation will be required and can be built.

111. On the assumption that this study of the housing position in relation to population has been made, together with the specific surveys described above, the planning officer will now be able to turn his attention to the plan. Before discussing this, however, it will be as well, even at the risk of repetition, to re-emphasize what the physical process is likely to be:—

(i) There may be, in the first instance, an immediate need to build new accommodation in order to cope with existing congestion and other urgent needs reflected in the housing lists. This new accommodation may form the nucleus of new neighbourhoods or it may be found a place in existing under-developed neighbourhoods. Sometimes it may be possible to cater for it by reconstruction on the site though if the district is densely developed there will be obvious difficulties about this. In so far as it is possible to generalize, it may well be that serious redevelopment of extensive obsolete and crowded areas cannot be started until the worst of the congestion has been dealt with by the provision of new accommodation elsewhere.

(ii) When extensive redevelopment does start, a further need for additional accommodation elsewhere is likely to arise, either because the net accommodation density is being reduced or because some of the land is wanted for some other purpose, perhaps an open space or a school.

(iii) At the same time that this redevelopment of obsolete areas is taking place a still further need for accommodation on undeveloped land may arise to meet such needs as natural increase of population.

(iv) The process throughout will be a gradual one which may or may not be finished at the end of the 20-year period of the development plan. If in any particular case the process is expected to be incomplete, the development plan should indicate the stage expected to be reached at the end of the period, and in such a case the densities shown on the plan would be those expected at the end of 20 years and not the ultimate densities.

112. The planning officer is therefore likely to find himself, as far as residential density is concerned, with three main matters for settlement:—

(i) The final densities of the redevelopment areas.

(ii) The final densities of the new or partly-new areas.

(iii) The extent to which these final densities are likely to have been achieved in 20 years' time.

It should be pointed out here that although development plans are expected to be based in the main on proposals which are likely to be carried through within 20 years, it is recognized that these 20-year plans are in reality the first instalments of much longer term plans and cannot in fact be prepared unless the planning authority have in the background a broad picture of the town as it will eventually be.

113. In most cases the redevelopment and new development areas will be linked by reason of the fact that population from the first will be moved to the second. It is therefore unlikely that density decisions on the one could be taken without reference to the other. The planning officer will probably find it best, having provisionally settled the boundaries for the redevelopment areas and having chosen suitable net accommodation densities and standards for open space and other facilities, to fix a provisional figure of ultimate gross density for each area. In choosing a figure he will be bound to have some regard to the existing density and the state of the development. Thus if the existing gross density was 100 persons per acre and he chose a final redevelopment density of 30 persons per acre it is clear that the task of redevelopment would be very formidable. From every acre 70 people would have to be

removed, and the resulting uprooting of associations and breaking of ties (as between home and workplace, for instance) might be so outrageous that it ought not to be done.

114. Having chosen provisional figures of density for the redevelopment areas the planning officer should next consider the implications of his choice. The proposed total population of each neighbourhood should be compared with the existing populations to obtain a provisional figure of overspill. This figure should then be added to the list of other increases of population likely to lead to demands for accommodation and an idea will then be gained of the total extra population for whom new accommodation will be required. The next step is to explore where these people might be accommodated and how much land appears to be needed.

115. Again a series of provisional proposals will have to be made both as regards location and density. Emphasis is placed on the word "provisional" because no final decisions can be taken until all the implications of any one proposal have been worked out. One site may seem capable of taking so-many people at such-and-such a density, but on closer consideration may be found to lead to acute difficulties over journey to work; another may prove incapable of carrying the number of people at first suggested owing to physical difficulties of relief and drainage; still another may be satisfactory in almost every respect except that the land happens to be of high agricultural value. Many difficulties of this kind will need to be sorted out and the process will involve constant cross-adjustments and variation of original assumptions. To give but one extreme example, it is conceivable that prolonged search for sites for overspill might prove completely abortive, in which case there would be no alternative but to go back to the redevelopment areas and reconsider their density from the beginning.

116. In attempting to arrive at a provisional figure of gross density for any particular area of new development, it is probably best to choose first a figure of average net accommodation density. Net density probably reflects environmental conditions more closely than any other index, and the figure chosen should be such as will meet the real demands of the people likely to come to the site. If a large group of people is involved (say 10,000 or more), it will be likely to display a demand for a considerable variety of housing conditions, both with regard to standards of spaciousness and size and type of dwelling. The two most important factors affecting this demand are the rents that can be afforded and the household structure. With regard to the second, a large group of people is bound to comprise a variety of households and the fact that some of these households will accept and even prefer accommodation in flats can, it is suggested, be exploited to enable residential areas to be planned at somewhat higher net densities than were common between the wars for areas of new development, at the same time giving better living conditions and more convenient accommodation

117. When a suitable average net density has been selected, the equivalent gross density should be calculated on the basis of assumptions relating to Occupancy Rate, school, open space and other use standards. For quick calculations the information given in Fig. 17 is useful. Once the gross densities have been calculated the neighbourhood populations can be worked out.

118. There is a pitfall to be avoided in connection with secondary schools. A common problem that arises is to decide how many people a given area of land on the outskirts of a town will contain. If it is clear that a large number of people is involved, say 10,000 or more, then it may not be satisfactory simply to multiply the total area by the provisionally selected gross density, because the gross density figure does not allow for secondary schools which may in fact have to be located within the site. In such a case the area required for secondary schools should be deducted from the total area and the provisional gross density then applied to the remainder of the site. If very large numbers are involved, say 30,000 or so, then the conditions approach that of a small new town and it may be necessary to allocate land for still other purposes than those contained in a normal neighbourhood, for example industry.

119. The process of proposal — check — counter proposal — re-check will be continued until all is in a reasonable state of balance. As far as possible redevelopment densities will have

been chosen that offer a genuine improvement on existing conditions without giving rise to large overspills of population that cannot be dealt with, and new-development densities will be such that avoid extravagant consumption of land but yet accord with the planning authority's responsibility to ensure that nothing in the way of mean or cramped living conditions is produced. Estimates must then be made of the progress likely to be made towards the final scheme within the 20 years and these must be expressed in terms of the densities likely to be achieved. The final outcome of all this work will be expressed in the 6 in. Town Map. This map will show the main land uses of the town as they are expected to be in about 20 years' time. The residential areas will be shown broadly subdivided according to differences in gross population density, such areas corresponding to what have been termed "neighbourhoods" in this handbook. Within each area only three sub-uses should normally be picked out individually — shopping centres, primary schools and open space. Shopping centres are shown, possibly only symbolically, because some early decision will be needed on the centre and focus of the neighbourhood, and primary schools because they are again an important use upon whose location other matters will depend and which may call for early acquisition of land. No other detail is called for, except that there should be shown against each area figures giving the total area in acres and the proposed gross density in persons per acre at the end of the 20-year period.

120. The Town Map is intended to relate, fairly strictly, to the 20-year period. In order, however, to give the Minister some idea of the final residential standards upon which the 20-year instalment is based, the planning authority are invited to set down in the written Analysis of the Survey* the following information in respect of each gross residential area shown on the Town Map:—

(i) The net accommodation densities at which development is expected to take place.

(ii) The standards of open space which it is hoped to achieve.

121. When the Town Map has been completed indicating the main lines on which the town should develop, attention will have to be given to the planning of those residential areas where development or redevelopment on a large scale or of considerable consequence is imminent and where it is essential to secure a more detailed allocation of future land use than a Town Map provides. It is emphasized that there is no advantage in undertaking detailed planning in advance of the actual need arising because adjustments in layout are bound to be called for with the passage of time through changes in policy or circumstances. One of the major difficulties that has had to be faced since the war is that the pressure for housing has forced a certain amount of detailed planning to be undertaken before some of the wider issues of policy have been fully considered and settled.

122. It is open to planning authorities to seek the Minister's approval of their proposals for the detailed planning of areas where development or redevelopment is imminent. Provided the purposes comply with those defined in Section 5 (3) of the Act they may submit plans to 25 in. scale known as Comprehensive Development Area Maps. In some cases these maps will be essential for they will be part of a process of compulsory acquisition provided in the Act, but they need not always be linked with compulsory acquisition, or be made the basis for a claim under the Ministry's Grants Scheme; they may be submitted where there are advantages in securing the Minister's approval to planning proposals somewhat more detailed than those shown on the basic maps.

123. Even on these 25 in. Comprehensive Development Area Maps there is a limit to the amount of detail that should be shown. The detail normally required is set out in Circular No. 59 and as far as density is concerned all that is specified is that the boundaries of residential zones of different net densities should be shown, with an indication for each zone of its area in acres and the proposed net density in habitable rooms per acre.

124. It should be noted that whereas the 6 in. Town Map shows proposed gross densities in

* *See* Ministry of Town and Country Planning, Circular No. 97. H.M.S.O., 1950.

persons per acre, the 25 in. Comprehensive Development Area Map shows net densities in habitable rooms per acre. This difference corresponds to two distinct stages in the working out of the Plan. At the Town Map stage the local planning authority are, in effect, saying " These are our broad proposals for the development of the town over the next 20 years. We propose that so-many people should be accommodated on this particular area, and so-many people on that area. We arrived at this figure of people by choosing an average net density which would give appropriate housing conditions, we applied a suitable Occupancy Rate, made allowance for other land uses, and by a process of adjustment discovered approximately how many people could conveniently be put on the site. We are interested in numbers of people at this stage because we have to provide shops, schools, water supply, drainage and other services whose sizes are all dependent upon the number of people to be served. Dividing the number of people by the site area gave us the gross density which is a useful figure for making comparisons and quick calculations and this in fact is the actual figure shown on the map, though multiplication of area by density will quickly give the total population ". At the Comprehensive Development Area Map stage the planning authority are in effect saying " We are now very near actual construction and this map shows our intentions. On this section of the area we wish to see built so-much accommodation, and so-much on that other section. The housing conditions within each section can be roughly judged by the net density shown on the map. Some of these are up and some are down on the net density we originally had in mind but the *average* is about the same and when the expected Occupancy Rate is applied the total population is approximately equal to the total upon which we have based all our schools, shopping centres, drainage and other facilities and services ".

125. Preparation of 25 in. scale maps will not, of course, provide the solutions to all the problems of density arising on residential development. An attempt is made in the next chapter, which deals with density control, to outline the considerations which should be borne in mind in dealing with proposals for development on sites not covered by 25 in. maps and in overcoming certain difficulties that may occur even where such maps have been prepared.

CHAPTER III

Residential Density and Planning Control

126. By planning control is meant the control of development, as it occurs, by the machinery of planning consent contained in the Act of 1947, in conformity with the broad intentions of the development plan. For the purpose of this discussion the term is assumed to include the control of all municipal housing; the procedure differs of course in the case of local authority development but there is no essential difference in the way in which proposals for development, whether by public or private enterprise, should be considered before permission is finally given.

127. In controlling residential development questions of density are bound to arise in almost every case. They are likely to be most difficult in areas where the planning proposals are in a very early stage of formulation, but experience has shown that problems of acute difficulty can arise even in areas where the long-term intentions have been clearly set down and agreed. The purpose of this chapter is to consider and to give advice on some of the problems that local planning authorities are likely to meet in the day-to-day control of development, for it is clear that density provides no rule-of-thumb for the decision of individual cases.

128. The various kinds of cases likely to arise can be roughly classified into:—

(i) Large housing schemes.

(ii) Small groups of dwellings (including single dwellings).

(iii) Conversions.

Within these groups, which will be considered in more detail below, different considerations may arise if the site is in a heavily built-up area or on new ground, and the amount of thought required to deal with a case will largely depend on whether it is within a Comprehensive Development Area where the redevelopment proposals have already been worked out fairly carefully, or whether the site is merely covered by a 6 in. Town Map indicating that only the broadest consideration has been given to future planning.

129. (i) *Large housing schemes.*

It is unlikely that any large scheme will go forward in future except in accordance with proposals worked out on a map to 25 in. scale — whether or not a Comprehensive Development Area Map has been formally approved. In such cases the average net density in habitable rooms per acre will already have been fixed, and in theory there should be no great difficulty in securing that the development complies with the plan. In practice, in schemes within heavily built-up areas, a difficulty may arise inasmuch as land is likely to be very costly and the demand for dwellings very urgent, and therefore there will be a temptation to step up the density in the first stages of development with the genuine intention of reducing it elsewhere in the later stages so that the desired overall average is maintained. There is, however, the danger that over-building in a redevelopment area in the early stages may start a process that is extremely difficult to reverse. The high density chosen at the start may all too easily become the average. To achieve genuine reductions of density in congested areas, and to refrain deliberately from rebuilding on certain parts in order to produce open space will undoubtedly require a good deal of courage on the part of the local authority. The great safeguard, of course, against a gradual whittling down of intentions is a thoroughly worked out programme.

130. This difficulty may arise in reverse when the site is on new land, say on the outskirts of a town, for in such cases there may be a temptation to step down the density in the early stages (when the urgent demand for accommodation is likely to be for houses for families with children) with the intention of raising it later on, perhaps by building a proportion of flats. The danger is that the estate will eventually consist of one type of dwelling only, at an unnecessarily low

overall density, instead of comprising, as would be desirable, a variety of families in a variety of dwellings.

131. (ii) *Small groups of dwellings* (*including single dwellings*).

In built-up areas, where early redevelopment is contemplated, a comprehensive redevelopment plan will have been prepared: and whether an individual application made in advance of the general redevelopment programme can be allowed to proceed will naturally depend on whether it conforms with the plan. Where redevelopment is less immediate or is not contemplated for many years the situation will be different. In the latter case, the character of the existing neighbourhood must clearly govern the decision: but the intermediate stage when redevelopment is in sight but not yet imminent may pose the planning authority with a difficult decision. Should the proposed development be encouraged to conform to the long-term development plan even if this would temporarily result in the development being out of character: or should the proposed development be allowed to continue the existing character of the area, even though on a long-term basis, this may not be entirely satisfactory? It is difficult to give general advice in these cases which can only be decided on their individual merits: but generally speaking, the longer the life of the area in its existing shape, the stronger the case for the proposed development conforming to its general character. This would not of course exclude an immediate reduction of density in the case of an area which was becoming congested: but it would probably operate in favour of a gradual rather than a steep reduction where rebuilding of only a limited part of the area was under consideration.

132. There is one further point worth mentioning. This concerns the extent to which individual applications should be required to conform to an *average* figure of density. When an authority fix a net density for an area they are in fact saying that on that area they consider a certain total amount of accommodation to be appropriate. They divide accommodation by area to produce a ratio of density, and they use this density for quick calculations and for making comparisons. They may even assume a density, in the first instance, to help them arrive at a suitable amount of accommodation for the site, *but the essence of their intention is to fix the total amount of accommodation, and any density resulting must be an average.* It is at this stage of determining the general future character of an area that the figure of density itself is most useful; thereafter the broad character and layout, which derive from the figure of density, will themselves become the principal factors in the settling of individual applications. The greater the extent to which character and layout have been fixed, the easier will the planning authority find this task of dealing with applications.

133. There is no gain in insisting that each proposal should conform to the *average* density desired; on the contrary, too great insistence on the average figure may tend to produce a dull and monotonous result. Though some individual plots may warrant development exactly at the average density, it is clear that there are dangers in attempting to enforce the average as though it were a maximum or a minimum. Once the broad character and layout desired are established, general considerations on the lines which follow will be more helpful to the planning authority in achieving a good result than adherence to any set figure:

(*a*) Would this development, if permitted, accord well with the physical characteristics of the site and represent an economical use of it?

(*b*) Would this development result in the site being overloaded with accommodation and hence with people, resulting in traffic congestion, noise, or undue pressure on services?

(*c*) Would this development result in satisfactory living conditions, particularly in respect of light, air, and minor open space?

(*d*) Would there be any serious interference with adjoining properties and the enjoyment of them?

The answering of some such questions will usually assist in the interpretation of average density for an individual site and the flexibility of this method is preferable to the rigidity of fixed requirements in respect of density and site coverage.

134. (iii) *Conversions.*

Over the last three or four decades, a great many families have found their accommodation in single houses that have been converted into flats or maisonettes, and this is a process that probably still has some way to run before its possibilities are exhausted. These conversions can, on occasion, give rise to difficult problems of density. It is difficult to give much general advice beyond saying that every individual case should receive close consideration rather on the lines just suggested for single plots. There is however one caution to be observed. Most conversions do not add greatly to the actual size of a building, what they do is to make fuller use of it. As a result, a long run of conversions may completely alter the population of a district, even to the extent of doubling or trebling it, and the planning authority need to be fully alert to what is happening so that they can properly assess the extent of the ultimate population and its needs, such as schools and open spaces. It is clear that the more knowledge the authority have of existing amounts of accommodation and Occupancy Rates the better will they be equipped to deal with the problem of conversions. Incidentally, conversions demonstrate more clearly perhaps than any other form of residential development the insufficiency of the old method of measuring density in houses per acre. The method has no significance when flats are involved, and an attempt to enforce a prescribed density of so-many houses per acre in the case of a conversion could well lead to serious hardship.

SUMMARY

This summary of the main conclusions and recommendations of the handbook should be read in conjunction with the paragraphs of the text to which references are given. Qualifications, etc., in the text have been omitted from the summary.

Introduction:

The Scope of the Handbook

The handbook attempts to analyse the subject of residential density into its constituent elements. It is primarily concerned with land-use planning and not with architectural design and layout.

[Paragraphs 1-3]

Chapter I: The Background

I. The Meaning of Residential Density

The relationship between people and the amount of land needed for their accommodation is a fundamental problem of physical planning. Calculations of density have two main purposes, to estimate the amount of land used and to indicate the standard of living conditions. In this country the need for land for urban purposes competes with the needs of agriculture, mineral extraction, etc., and a compromise between competing needs must be made. In view of this the general approach in the handbook is to ascertain the least amount of land required to satisfy essential needs in an urban residential area.

[Paragraphs 4-5]

There are four distinct aspects of density. (i) There must be enough living accommodation arranged in a suitable variety of dwellings. (ii) The dwellings must be arranged on the ground to give enough space for various amenities. (iii) The dwellings should be conveniently sited in relation to shops, schools and other facilities. (iv) The residential area as a whole should be properly related to the rest of the town. **[Paragraphs 6-7]**

The relationships between these aspects of density are by no means simple. With so many variables, there is little possibility of defining absolute desirable standards for all areas. **[Paragraphs 8-10]**

To these four aspects a fifth, the relationship between cost and density, must be added and taken into account. **[Paragraph 11]**

II. Density within Dwellings

In any area there must be enough variously-sized dwellings to meet the needs of all households. In most cases the planner cannot do more than state the accommodation requirements in some convenient bulk unit, with only a broad idea of what the eventual breakdown into dwellings will be.

[Paragraph 12]

Of several alternative units for the bulk measurement of accommodation the habitable room is most useful and has been recommended by the Ministry for use in the preparation of survey and development plan maps under the Act of 1947. **[Paragraphs 13-14]**

The Occupancy Rate — the ratio of occupants to the number of habitable rooms — is a measure of the intensity of occupation in a dwelling. A rate much in excess of 1·0 is usually evidence of shortage of accommodation. The average Rate for a residential area would in all probability stand at less than 1·0, although there are some areas where it is over 1·0. **[Paragraphs 15-16]**

There is no guide to the average Occupancy Rates suitable for various circumstances but as more information about existing rates becomes available it should be possible to make valid generalizations.

[Paragraphs 17-18]

III. Density of Dwellings on the Ground

This section deals with the arrangement and spacing of dwellings in the residential area. The density considerations applying to houses are likely to be somewhat different from those applying to flats, and the two are therefore considered separately.

Room sizes affect density. For municipal housing the ratio of net dwelling area to the number of habitable rooms is between 180 and 250 sq. ft. This range is followed generally in the handbook. If the figure is substantially increased, the possible effect on densities may be considerable.

[Paragraphs 19-21]

(i) *Areas developed with houses.* The principal factors affecting the arrangement of houses are the type of house, garden size, space for access, space to ensure adequate daylighting and sunlighting, space for privacy and space for incidental open space. The first two are linked; in fact, garden sizes are broadly controlled by the type of house to whic

the garden belongs. Figs. 2-4 illustrate densities for two-storey terrace houses of 105, 72 and 65 rooms per acre. Corresponding densities for three-storey terrace houses are 135, 95 and 85 rooms per acre. Below these densities there is a great range of possibilities if different house types and garden sizes are mixed and Table 1 shows the density range for various proportions of different types of house according to the size of garden. **[Paragraphs 22-31]**

(ii) *Areas developed with flats.* The densities appropriate for areas consisting solely of flats depend on the method of arrangement of flats in blocks, their spacing for daylight, sunlight, noise insulation, etc., and for access and outdoor living space. For simple rectangular-shaped blocks laid out in parallel rows the maximum densities possible vary from about 120 rooms per acre for low blocks up to about 180 rooms per acre for taller, longer blocks. Other layout arrangements, encouraged by the use of " permissible height indicators " (see Appendix 2) make higher maximum densities possible which, depending on a number of variables, might be from 200-300 rooms per acre.

The spacing of blocks to ensure adequate daylighting will in general result in sufficient space about the buildings to meet minimum needs of access, privacy, etc., and will also give outdoor living space roughly equivalent in area to the garden space of high-density terrace housing. Illustrations of developments of an area with flats only can be seen in Figs. 8-11. **[Paragraphs 32-45]**

(iii) *Areas developed with houses and flats.* In an area of mixed development, the average density will depend on the proportion of the total number of rooms that are contained in houses and flats respectively and upon the densities of each. Table 4 illustrates this relationship. A suitable average net density for an area can only be given by analysis of the three parts of the problem: the desired allocation of rooms to houses and flats, the desired density of houses and the desired density of flats. Distribution between houses and flats may be a matter to which a planning authority will give considerable weight even to the extent of varying the average density or the separate densities for houses and flats.

Provided that the planning authority do not commit themselves at the start to rigid ideas about the separate densities of houses and flats, there should be no difficulty in securing a useful proportion of houses and flats with an average net density up to about 70 rooms per acre. Above this figure the proportion of flats must generally increase. **[Paragraphs 46-49]**

IV. Density over the Neighbourhood

In a residential area there should be, in addition to dwellings, certain other facilities so that the area may have a fair measure of self-containment for everyday shopping, primary schools, etc. Such an area is defined as a neighbourhood. The density of persons over this area is defined as the gross residential density. Gross density is a guide to conditions existing in an area and useful in estimating the total amount of land a group of people will require. **[Paragraphs 50-52]**

Space standards for schools are set out in para. 54 and a figure of 1·3 acres per 1,000 is taken as a rough guide to primary school needs. The various recommendations for public open space rates are given in Table 5, while Tables 6 and 7 set out land needs for shops, public buildings, service industry and main streets and car parks. **[Paragraphs 53-58]**

The relation between gross and net density is such that if a gross density for an area is fixed together with definite standards for schools and open space, then the average net density for that area is largely predetermined. This is a tempting procedure for planning authorities to adopt but has dangers when land is limited. Careful consideration is needed to see whether it is best to maintain a net density which will allow a suitable distribution of rooms in houses and flats, while accepting some cut in open space standards and school areas; or alternatively whether the last two should stay at fixed figures and the cut be accepted in the net housing density. **[Paragraphs 59-60]**

Fig. 17 shows that increases in gross density are accompanied by rapid decreases in the land available for housing. Above a gross density of about 45 persons per acre it becomes necessary to reduce the standards of ancillary uses in order to maintain reasonable net accommodation densities. **[Paragraph 63]**

V. Density over the Town

A simplified classification of land uses in a town is given, with six categories, in Table 9. Existing towns show wide variation in overall town density. The major land users are the residential areas, industrial areas, and open land. **[Paragraphs 65-68]**

Existing towns show such variety that it is impossible to deduce general rules for desirable densities. Residential density is not the sole index of the standard of living conditions: variety of environment is probably the most important single

need in town design. Most towns have a characteristic density structure of a central congested core surrounded by rings of residential development of decreasing density as they become further from the centre. This form of development has certain unsatisfactory features which should be avoided. **[Paragraphs 69-72]**

VI. Residential Density and Cost of Development

The fifth aspect of density is the relationship between density and cost. The two main items are the losses of agricultural land resulting from urban expansion, and the relative cost of houses and flats. These two items are interrelated. **[Paragraphs 73-74]**

Loss of agricultural land may take place as a result of alterations in land use proportions, which may prove necessary if the main defects in towns are to be dealt with. The redevelopment of residential areas, provision of more open space and larger school areas, and the reorganization of industrial areas are changes which may require substantial areas of additional land. **[Paragraphs 75-81]**

Residential areas and open land are the most extensive single users of land and are the most likely to yield a substantial saving by alteration of standards. **[Paragraph 82]**

In the lower range of densities the most worthwhile saving of land is achieved by increasing the net density but the consequences of this should be understood. On the higher range of gross densities, savings resulting in reduced open space standards are more pronounced. With up to 25 per cent. of the accommodation in flats, it would appear that gross densities up to about 30-40 persons per acre are possible with a full range of schools and other facilities. **[Paragraphs 83-88]**

The savings that would result from these densities compared with inter-war practice might be of the order of 20-25 per cent. For more spectacular savings higher net densities would be necessary. In redevelopment areas where gross densities are around 60 persons per acre and net densities are of the order of 120 persons per acre, there is little possibility of appreciable savings of land by increasing redevelopment densities. **[Paragraphs 89-92]**

Some savings in land may be achievable by means of the freer use of terraces and flats. This brings up the second aspect of density and cost. Cost of development per habitable room decreases, irrespective of land cost, with increases of density until it becomes necessary to introduce flats. The increased cost of structure of the flats then causes the cost per room to rise sharply with increased density. At still higher densities it starts to fall again, but unless land costs are very high the cost per room does not recover below the first minimum even if density is increased to 200 rooms per acre. (See Fig. 25.) **[Paragraphs 93-95]**

To achieve substantial savings of land in urban redevelopment it would be necessary to place a much greater part of the population in flats than has hitherto been thought desirable and at a much greater capital cost. On the other hand it may be possible to attain a saving of about 20 per cent. compared with inter-war practice at no greater cost by a modest increase in net density involving freer use of terraces and low flats. **[Paragraph 96]**

VII. Conclusion

The most important constituent of residential density is the density at which the dwellings are arranged or the net accommodation density, for dwellings are a large user of land and their density has a vital bearing on living conditions. For compact towns densities higher than those prevailing in new development in the inter-war years are desirable. Full communal facilities can be provided within a gross density range of 30-40 persons per acre. The corresponding net density is 55-90 rooms per acre. These densities should be capable of achievement provided there is designing skill of a high order and provided advantage is taken of the demand for a variety of accommodation in order to introduce a proportion of terrace houses and flats. **[Paragraphs 97-100]**

Chapter II: Residential Density and Development Plans

As far as residential areas are concerned the main problems with which development plans are concerned are:—

(i) rehabilitation of the existing fully developed residential areas;
(ii) removal of residential accommodation from unsuitable areas;
(iii) provision of new residential areas.

[Paragraphs 101-102]

The question of density arises at both the survey and plan stages of the preparation of a development plan. The Ministry's requirements are set out in Circulars Nos. 40, 59, 63 and 97. **[Paragraphs 103-104]**

The 6 in. survey maps essential to the planning of residential areas are Land Use, Age of Buildings, Net Accommodation Density and Net Population Density. The uses of these maps are explained. The Net Accommodation Map distinguishes areas over which the residential development is uniform in character and indicates the accommodation density in habitable rooms per acre. The Net Population Density Map shows the density in persons per acre. These two are a useful guide to residential conditions. **[Paragraphs 105-110]**

The planning officer is likely to find that the main decisions to be taken are:—

(i) the final densities of the redevelopment areas;

(ii) the final densities of the new or partly new areas;

(iii) the extent to which these final densities are likely to have been achieved in 20 years' time.

[Paragraphs 111-112]

Having provisionally decided the boundaries of the redevelopment areas, the planning officer should fix a provisional figure of ultimate gross density for each residential area. It will normally be difficult to change drastically the density of an area so long as redevelopment proceeds, as is likely, in slow stages. The implications of the provisional figures should be considered. **[Paragraphs 113-115]**

In attempting to arrive at a figure of gross density for areas of new development, it is best to choose first a figure of average net accommodation density. This should be based on consideration of the housing needs of the population to be dealt with. Gross densities can then be calculated, after assumptions for Occupancy Rates, areas for schools, open spaces, etc., have been made. **[Paragraphs 116-118]**

When a reasonable balance has been struck between redevelopment densities and the resulting figures of overspill of population, estimates should be made of the likely progress in the 20-year period of the development plan. The summation of all this work will be expressed in that part of the development plan known as the 6 in. Town Map. **[Paragraphs 119-120]**

After completion of the Town Map attention may be turned to the more detailed planning of areas where comprehensive development or redevelopment is expected to take place in the near future. It is open to planning authorities to seek the Minister's approval to such detailed plans under Section 5 (3) of the Act. **[Paragraphs 121-125]**

Chapter III. Residential Density and Planning Control

By planning control is meant control of development by the machinery of planning consent contained in the 1947 Act. In controlling residential development questions of density arise in almost every case. The main types of case are large housing schemes, small groups of dwellings including the single dwelling, and conversions. A common danger is the temptation to apply *average densities* to individual sites. **[Paragraphs 126-134]**

APPENDIX 1

Suggested Minimum Street Widths in Residential Areas

(These notes and tables are extracts from the Schedule of Suggested Minimum Street Widths, accompanying the Ministry of Local Government and Planning Circular No. 19, 1951.)

" Main street " means a street which is part of the main framework of streets for a residential area, a principal business area or an industrial area.

" Minor street " means a street other than a main street which is required only to give access to buildings or other land; and includes a " principal shopping street."

A Residential Area includes land used for purposes ancillary to residential use such as schools, local shops and offices, churches, cinemas, public houses, public buildings, local service industries and workshops and open spaces.

Type	Purpose	Minimum width of carriageway	Minimum number of footways	Minimum width of each footway	Conditions
		MAIN STREETS			
A	—	22 ft.	2	9 ft. (12 ft. along shop frontage)	Waiting bays or lanes not less than 8 ft. wide, or 9 ft. if intended for public service vehicles, to be provided by the developer where required by the local planning authority
		MINOR STREETS			
B	Principal shopping street	22 ft.	2	12 ft.	Waiting bays or lanes not less than 8 ft. wide or 9 ft. if intended for public service vehicles, to be provided by the developer where required by the local planning authority
C	—	16 ft.	2 (1 if access to property only on one side of street)	6 ft. (12 ft. along shop frontage)	Waiting bays or lanes not less than 8 ft. wide to be provided by the developer where required by the local planning authority
D	Cul-de-sac	13 ft.	2 (1 if access to property only on one side of street)	6 ft. (4 ft. 6 ins. if a verge is provided additional to the foorway)	The closed end of the street shall not be more than 600 ft. measured along the carriageway, from a street open at both ends
E	Cul-de-sac	13 ft. (9 ft. in any part where there is no access to property)	1	4 ft. 6 ins.	No part of the carriageway shall be more than 200 ft. measured along the carriageway, from a street open at both ends.

Type	Purpose	Minimum width of carriageway	Minimum number of footways	Minimum width of each footway	Conditions
		MINOR STREETS—*continued*			
F	Street bordering on an open space, (namely, a street not more than 1,000 ft. long and intended to give access solely to buildings in a quadrangle or arranged in some similar manner so as to front on an open space)	13 ft.	1	6 ft. (12 ft. along shop frontage)	Waiting bays or lanes not less than 8 ft. wide to be provided by the developer where required by the local planning authority
G	Street to give secondary means of access to residential property	13 ft. (9 ft. if the street is less than 200 ft. long)	—	—	See note (e)
H	Street (including a cul-de-sac) to give access to back of business premises for loading and unloading	20 ft.	—	—	See note (e)
		FOOTWAYS			
R	Footway	—	—	6 ft.	The footway shall not be used as the only means of access to a building which is more than 150 ft. from a carriageway measured along the footway. Where the footway joins a carriageway a waiting bay should be provided as required
S	Pedestrian way lined with shops	—	—	20 ft.	

NOTES

(*a*) No part of any street shall be more than the following distance (measured along the carriageway) from a street which is part of the main framework of streets for a residential area, a principal business area, or an industrial area; namely, in the case of a street in a residential area, ½ mile, . . .

(*b*) No new minor street shall be laid out so as to lead directly into a principal traffic road, except where the whole area of land to be developed is so small that it can be conveniently developed by means of one street.

(*c*) Every street, except a street referred to in the Table as a cul-de-sac, shall have a carriageway open at both ends.

(*d*) Every cul-de-sac shall have an adequate turning space at the closed end.

(*e*) On the side of a street where there is no footway a margin shall be provided with a minimum width of 3 feet except for streets type G where the width of the margin may be reduced to 1 foot 6 inches.

APPENDIX 2

Daylighting

1. The principles behind the design and use of the daylight indicators described in Appendix 3 of the Advisory Handbook on the Redevelopment of Central Areas can be applied to residential areas. The basis for and use of the indicators has already been published in " Planning for Daylight," by G. T. Pound (Journal of the Town Planning Institute, Vol. XXXIII, No. 4, May-June 1947).

2. The indicators for use in residential areas are set out in Fig. 26. There is a marked difference between these indicators and those recommended for non-residential areas. There are two reasons for this. One is that the daylight standards for residential buildings recommended in the British Standard Code of Practice* are somewhat different from those taken for office buildings. The other is that the floor-to-floor dimensions and window sizes are generally smaller in the case of residential buildings and therefore rather lower angles of obstruction are needed to safeguard the daylight standards.

* British Standards Institution. Interim code of functional requirements for dwellings and schools (classification code), chapter 1 (A); daylight (draft). (British Standard Code of Practice, C.P. 1944, C.P. (B), 327. Codes of Practice Committee, Ministry of Works). British Standards Institution, 1944.

APPENDIX 3

Definitions

1. A Habitable Room is a room which is normally used for living or sleeping in. A kitchen should only be regarded as a habitable room when it is also used as a living room.

2. Occupancy Rate: The ratio of occupants to the number of habitable rooms in a dwelling or a group of dwellings.

3. Net Dwelling Area: The total floor area of a dwelling measured inside the main external walls including the thickness of internal walls. It includes habitable rooms, stairways, bathrooms, corridors, and outbuildings.

4. Net Residential Area: The area of land actually developed or to be developed as dwellings, and including:—
   (i) the sites of the houses and other residential buildings and their curtilages;
   (ii) any small public or private open spaces included in the layout;
   (iii) half the width of any street on which land mentioned in (i) or (ii) above abuts except that where a curtilage abuts upon a principal traffic road only twenty feet of the width of that road is included.

5. Net Accommodation Density: The number of habitable rooms contained in the dwelling houses and other residential buildings on the land divided by the net residential area of the land in acres. It is expressed as habitable rooms per acre.

6. Net Population Density: The total number of persons divided by the net residential area in acres. It is expressed as persons per net residential acre.

7. Gross Residential Area: The area includes the net residential area and
   (i) the sites and curtilages of primary schools, local shops, offices and business premises, cinemas, public houses, local service industries and workshops, churches and public buildings;
   (ii) open spaces not included in the net area;
   (iii) half the width of any street on which land mentioned in (i) or (ii) above abuts excepting that — in survey — where the land abuts upon a Trunk or Class I or Class II road only twenty feet of the width of such a road is to be included.

8. Gross Density: The total number of persons in an area divided by the gross residential area.

9. Overall Density: The total number of residents in a town divided by the total developed area of the town.

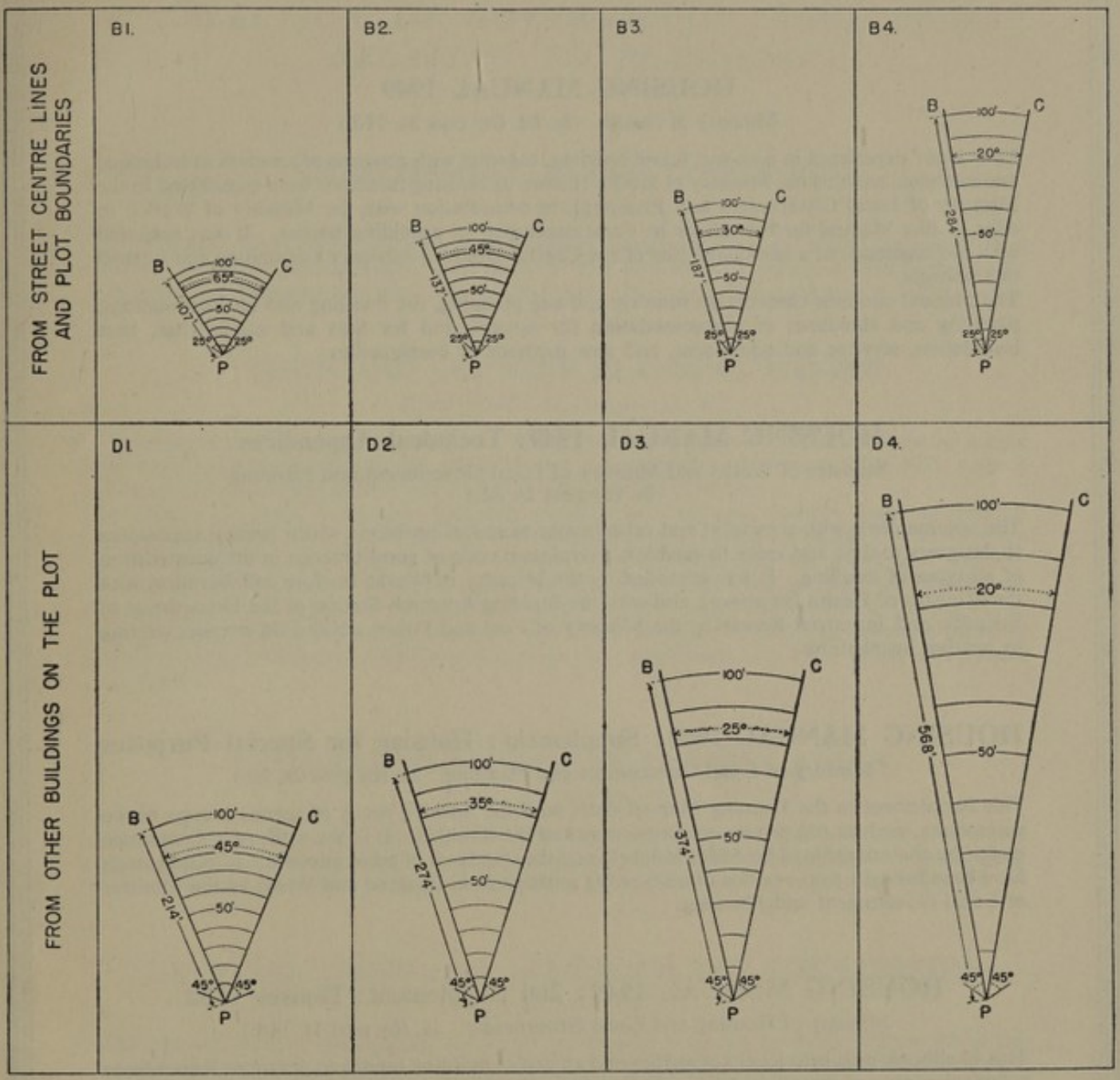

Fig. 26. PERMISSIBLE HEIGHT INDICATORS FOR RESIDENTIAL BUILDINGS SPACED FOR DAYLIGHTING

The figures on the line P B denote permissible height above point P. The distance P B is the horizontal distance from P to the point where the permissible height is 100 ft. and is given to enable the indicator to be constructed.

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