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THE COSTS OF CONFORMING TO STANDARDS FOR NOISE FROM ROAD TRAFFIC

by

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CONTENTS

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ABSTRACT

This report describes a study of the costs of conforming to a range of noise standards by several different means. Three sites were studied where recent new road construction schemes were near concentrations of houses. The study indicated that there was no great difference in costs between a solution using double glazing only, and one that used a combination of double glazing and a barrier, the latter combination appearing slightly cheaper. If the standard were improved from 68 dB(A) to 64 dB(A) the marginal cost was found to be about 50 per cent.

1. INTRODUCTION

1.1 *Background*

As part of the programme of research into environmental assessment the costing of standards is being investigated: in the first instance noise standards. A discussion of standards and a description of United Kingdom practice is given in Pollution Paper No. 11[1].

This note gives the estimated costs for different methods of conforming to a range of noise standards at house facades for three different sites where there was a concentration of houses and at which new roads have been constructed. Plans and basic data were kindly provided by the County Surveyors of Berkshire, Hampshire and Surrey. The costings have been carried out for illustrative purposes and although they are considered to be sufficiently accurate for this, they might not agree in detail with any made by the County Surveyors which would be based on more detailed local knowledge.

1.2 *Methods of conforming to standards*

The main methods for conforming to the standards that were costed at each site were double glazing and sound barriers – fences or mounds. At one site estimates were made of the costs of putting the road into cuttings; these were several times as high as the other methods and were not calculated elsewhere. One site was used as the basis of an exercise using traffic management to achieve noise standards (see Section 3).

When comparing different methods of reducing noise it must be remembered that different methods will have different second order effects, which may be advantageous or disadvantageous, and that the costs may fall on different groups of people. For example double glazing affects the noise only within a house and has disadvantages related to its installation. It also brings thermal advantages. Noise barriers bring relief out of doors as well as indoors but may be very unsightly. For methods that intercept the noise, such as roads in cutting, barriers or double glazing, the costs fall on public authorities or householders. The costs of traffic management schemes that divert the noise source fall upon the road users – who probably incur no compensating benefit.

1.3 *Basis of calculations*

The predicted noise levels were obtained through the procedures laid down in 'Calculation of Road Traffic Noise'[2].

Noise levels were calculated at points chosen in an irregular grid pattern so placed that the possibility of interpolation was maximised consistent with keeping the number of points low. From this grid of predicted levels, noise contours were drawn; an example is shown in Figure 1. During the plotting of the contours their position was determined by a judicious balance of the predicted levels at the grid points, the expected drops across houses, allowance for partial shielding, and the assumption of constant noise level between rows of houses parallel to the noise source.

All calculations were for first floor level (4m high) and were assumed to be the same at ground floor level, with the exception of a few properties at sites B and C where allowance was made for differential shielding, by barriers, at different floor levels. Apart from a very few properties at site C, which were known to be three floors high, all were assumed to be two storey houses. The number of facades in each 4 dB(A) band were counted and these figures then aggregated to give numbers of facades above the levels of 56, 60, 64 and 68 dB(A).

1.4 *Description of sites*

At site A (see Figure 2) the road is about one kilometre long and consists of a twin 3-lane motorway with a modern housing development on either side with about 360 dwellings within 100 metres from the carriageway edge. The dwellings are mostly semi-detached or short terraces. The whole area was assumed to be substantially flat.

At site B (see Figure 3) the road is about one and a third kilometres of dual 2-lane carriageway all purpose road, part of which runs in a cutting. Most of the line of the road has been reserved for some years. There are about 320 dwellings within 100 metres of the road some of which are partly protected from traffic noise by an artificial earth mound. One area of houses is a very modern development, and the rest are partly pre-war and partly post-war. There is a mixture of terrace, semi-detached and detached houses; one of the terraces which is very long acts as a barrier to noise penetration to the rest of the development.

At site C (see Figure 4) the road is 'T' shaped with one arm of the 'T' being dual carriageway and the rest single carriageway; the total length is about one and a third kilometres. The line of this road has been reserved for many years. It by-passes a short twisting section of village road to the north east and a slightly longer section to the south. Most of the dwellings are pre-war and about two-thirds are semi-detached and terraced with the rest detached. There are about 340 dwellings within 100 metres of the road and the site is almost flat with one long terrace of houses being protected by an artificial earth mound.

The estimated traffic flows for fifteen years from the dates of the schemes were provided by the County Surveyors together with the estimated speeds and percentages of heavy goods vehicles. These data were used to estimate the basic noise level using the procedures in Calculation of Road Traffic Noise. The basic data are shown in Table 1.

TABLE 1

Estimated traffic flow and noise level at each site after fifteen years

Site	Traffic flow			Noise level 18 hr L_{10} (dB(A))
	Vehicles/18hr day	Percentage heavy goods vehicles	Speed (km/h)	
Site A	33,000	11	108	78
Site B	24,000	22	60	74.5
Site C-dual c/ways	38,000	5	60	74
single c/ways	19,000	5	50	70

1.5 *Cost assumptions*

Costs are given in terms of 1979 levels by extrapolating from costs for earlier years[3,4,5,6]. As the original cost data are several years old sensitivity tests have been carried out to see if relative price changes, eg between double-glazing and fences, could have invalidated the findings. Tests were made by assuming that different prices changed by ten per cent more and ten per cent less than the general level of changes. Whilst obviously making some alterations the different results did not invalidate the comparisons.

The cost of insulating one facade of a two storey house is taken to be about £1000 and of a single storey dwelling about £720; this agrees roughly with the estimate in Design Bulletin 26[3] and with calculations using the cost per square metre of double glazing plus the cost of sound proofed air ventilators. The cost of fences was estimated from actual figures quoted by a variety of sources. For a three metre high fence costs varied from £70 to £90 per metre run, so a figure of £80 per metre run was used in the calculations. A two metre high fence costs about £55 and a 2.5 metre fence about £70 per metre run.

The cost of earth mounds was again estimated using several sources plus calculations of earthmoving costs. A three metre high mound using soil found on the road construction site (ie no 'haul' distance) was thus estimated at about £40 per metre run, a two metre high mound about £27 per metre run, and using imported soil about £95 per metre run for a three metre high mound. These costs include an allowance for grassing but not the cost of the extra land required for a mound over that required for a fence; this would probably be 12 metres wide. Land costs appeared to vary in 1975 from £2,500 per hectare for agricultural land, through £130,000 per hectare for rural land to £250,000 per hectare for suburban land.

The costs of constructing roads in open and retained cuttings were estimated at £3.0 million and £10.5 million per kilometre respectively for a 2 x 11 metre motorway[4,5]. The cost at ground level would be about £2.7 million per kilometre[6].

2. COSTS

2.1 *Site A*

Costs at Site A were estimated for double glazing only, for fencing, mounds, a road in open cut and a road in retained cut, including in all cases any residual double glazing required. The costs to achieve noise standards of 68, 64, 60 and 56 dB(A) are given in Table 2.

TABLE 2

Costs at Site A

Noise standard (dB(A))	No. of facades above standard if no treatment	Costs (£000)				
		Double glazing only	3m Fence	3m Grassed mound*	Open cut (6m)	Retained cut (6m)
68	188	200	200	170	1570	12 300
64	319	340	290	260	1640	12 400
60	664	720	520	480	1800	12 600
56	1031	1110	1080	1090	2160	13 000

* Mean of costs for no imported soil and for all soil imported

Table 2 shows that for each standard there is very little to choose between double glazing, and a fence or a mound but that the costs of a road in cut are of quite a different order of magnitude. The most favourable comparison is for a standard of 56 dB(A), when building a road in open cut would be only about twice as expensive as the other methods.

2.2 *Site B*

For Site B costs were calculated for several possible combinations of fencing, mounds and double glazing; there were no great differences between them. The costs of double glazing only and of the cheapest scheme to achieve the standards are given in Table 3. The cheapest scheme entailed erecting a total of 685 metres of two metre fence and 230 metres of two metre earth mound.

TABLE 3

Costs at Site B

Noise standard (dB(A))	No. of facades above standard if no treatment	Costs (£000)	
		Double glazing only	Cheapest scheme
68	134	140	120
64	198	210	200
60	287	310	260
56	414	450	400

2.3 *Site C*

Similar calculations were made for Site C. The costs for double glazing only, for erecting 380 metres of two metre fence and 320 metres of earth mound 1.3 metres high (Scheme X), and for a third scheme which included a further 950 metres of fencing (Scheme Y) are given in Table 4.

TABLE 4

Costs at Site C

Noise standard (dB(A))	No. of facades above standard if no treatment	Costs (£000)		
		Double glazing only	'Scheme X'	'Scheme Y'
68	102	110	150	90
64	133	140	160	140
60	259	280	310	300
56	362	390	430	340

2.4 *Comparative costs*

There are two types of comparison that need to be made, between standards and between sites.

A comparison between sites is given in Table 5, where for each site the costs are expressed as a percentage of the costs at that site for attaining a standard of 68 dB(A).

TABLE 5

Comparisons between cheapest cost of different standards at the three sites
(68 dB(A) = 100)

Site	Cost for standard of 68 dB(A) (£000)	Standard dB(A)			
		68	64	60	56
A	170	100	150	290	645
B	120	100	160	210	330
C	90	100	150	300	370

Table 5 shows a considerable degree of uniformity between the three sites. In general it can be said that if the standard is raised from 68 dB(A) to 64 dB(A) then the cost is increased by a factor of one and a half, if raised from 68 dB(A) to 60 dB(A) by a factor of two to three and if raised from 68 dB(A) to 56 dB(A) by a factor of four to six.

To compare sites the costs have to be standardised. This has been done in two ways – the length of road and the number of houses within an arbitrary distance of 100 metres of the road.

The comparisons between the costs per kilometre of the cheapest scheme for each site are given in Table 6.

TABLE 6

Costs per kilometre for the cheapest scheme at each site
(£000)

Site	Length (km)	Standard – dB(A)			
		68	64	60	56
A	1.06	160	250	450	1020
B	1.30	90	150	200	310
C	1.30	70	110	210	260

The costs at sites B and C are very similar but those at site A are higher – over twice for the higher standards. This difference is reduced when the costs are standardised by the number of houses adjoining the road; this comparison is given in Table 7.

TABLE 7

Costs per 100 houses within 100 metres of road for the cheapest scheme at each site
(£000)

Site	No. of houses within 100 metres of the road	Standard – dB(A)			
		68	64	60	56
A	359	45	70	135	300
B	318	40	60	80	125
C	338	25	40	85	100

The main reason for site A being more expensive is that it is the noisiest: the basic noise level is 78 dB(A) as compared with 74 dB(A) at sites B and C (see Table 1). Therefore ceteris paribus the noise will spread further and more properties will need to be insulated.

3. TRAFFIC MANAGEMENT

All the schemes discussed so far reduce the traffic noise that people perceive by placing some form of barrier between them and the noise source. An alternative approach is to remove the noise source by diverting the traffic, either by traffic management schemes or by building new roads.

These alternatives were not part of the schemes discussed in this Report but the information available has been used to cost possible schemes.

If it is assumed that, after the new roads had been built, the traffic flow on the old road in the north east (X to Y in Figure 4) would be 9,200 vehicles per eighteen hour day then the 18 hour L_{10} noise level would be 68 dB(A). If this road were closed to through traffic, the vehicles would have to use the new road and would have to travel an extra 0.3 kilometres. Assuming an average speed of 40 kilometres per hour this would cost 1.4 pence per

vehicle journey (4.67p x 0.3km) at 1973 prices[7]. The total cost of the detour at 1979 prices would be approximately £120,000 per annum. This compares with a capital cost of £114,000 for double glazing 114 properties at £1000 each.

The flow that is actually forecast for this road in fifteen years time is 3,700 vehicles per day which would result in a noise level of 64 dB(A). The annual cost of diverting 3,700 vehicles would be £48,000. Thus on this section of road to achieve a noise standard below 64 dB(A) would cost £114,000 using double glazing and £48,000 via traffic management.

A further exercise is to assume that the north-south section of the new road was not built and that there are no houses there. Then the forecast noise level on the old road in fifteen years time would be 72 dB(A). The cost of building the north-south section would be about £160,000 compared with £114,000 for double glazing along the old road; in addition there would be some traffic costs to add to the £160,000 but the noise relief from road building would be more comprehensive than from double glazing.

4. DISCUSSION

This study has been concerned with costs and no attempt has been made to assess the benefits. As pointed out in the introduction, the costs may fall on different groups of people according to the measures used to obtain a standard.

Any conclusions that may be drawn from this study must be very tentative as they will be based on very few examples. These are for typical densities of development; at lower or higher densities these conclusions would not necessarily apply.

Tentative conclusions are:–

(i) Putting roads into cuttings will normally be an extremely expensive way of achieving noise standards.

(ii) The differences in costs between double glazing and some combination of double glazing and barriers are not very large.

(iii) For the three sites investigated the variation in the costs per kilometre appears to be dependent on the initial noise level.

(iv) If improved standards were being applied to the whole country, in addition to increased costs per site, more sites would need treatment. At the sites investigated, raising standards from 68 dB(A) to 64 dB(A) would increase costs by a factor of one and a half.

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Fig. 1 EXAMPLE OF TRAFFIC NOISE CONTOURS

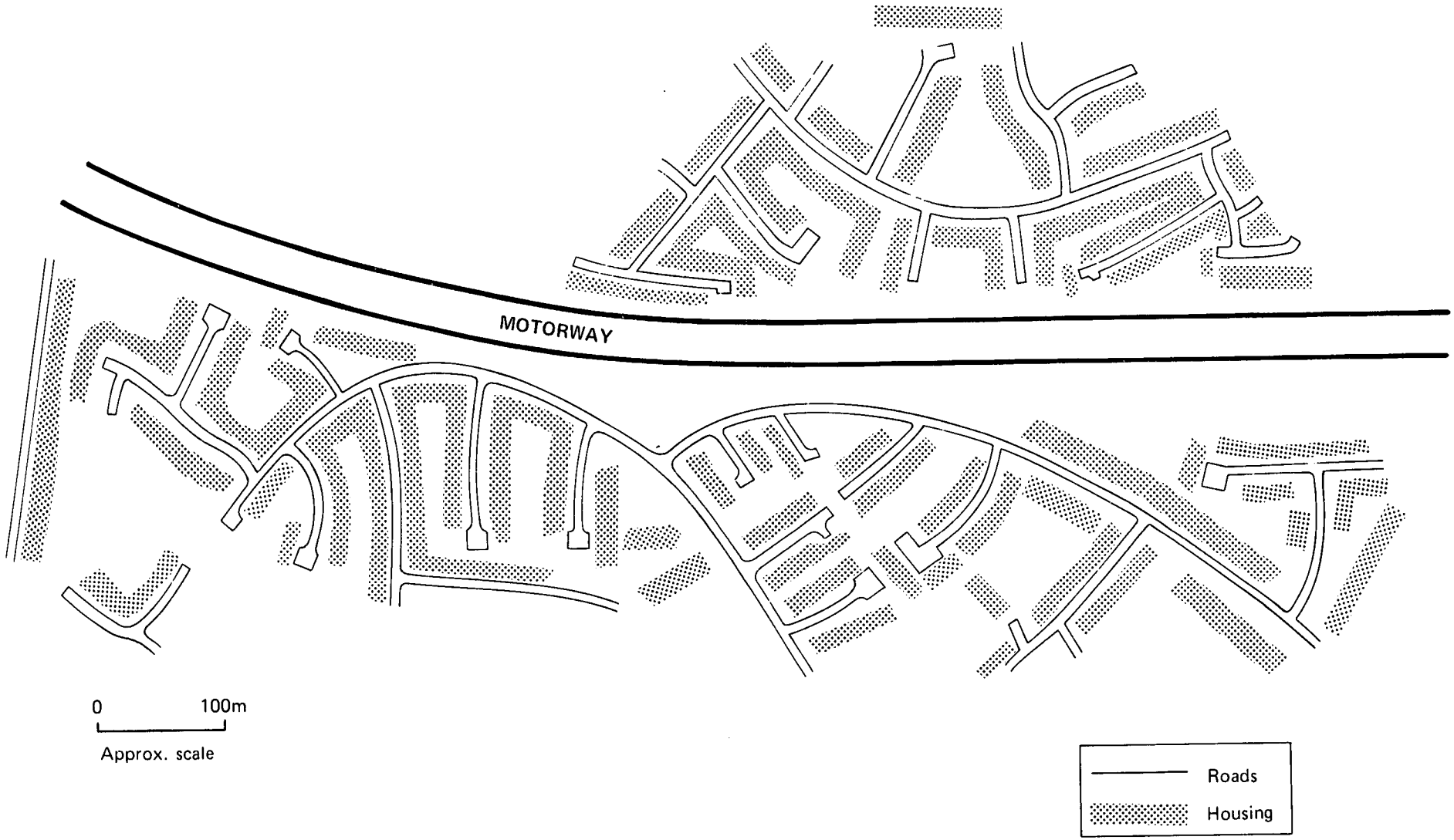

Fig. 2 PLAN OF SITE A

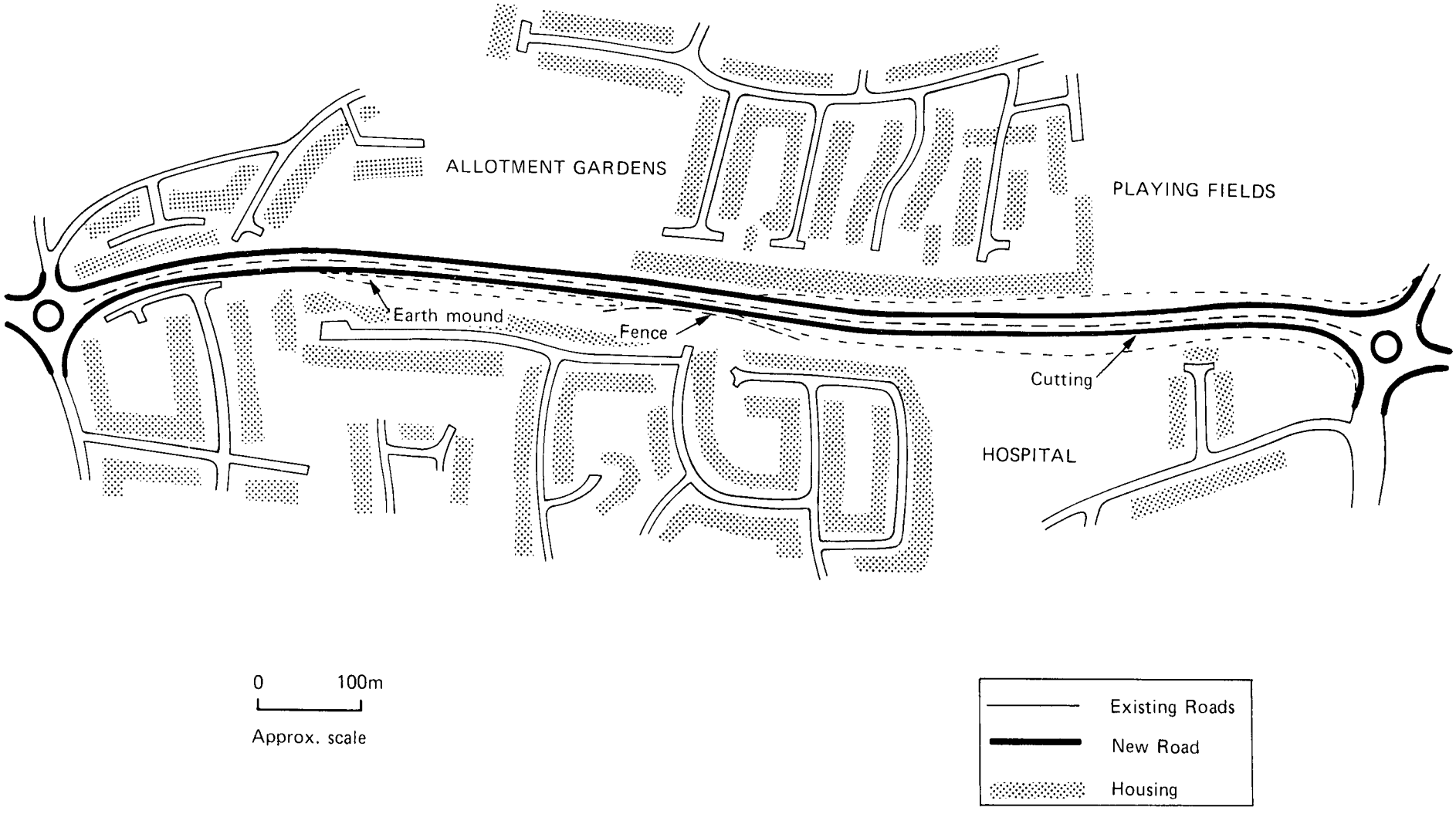

Fig. 3 PLAN OF SITE B

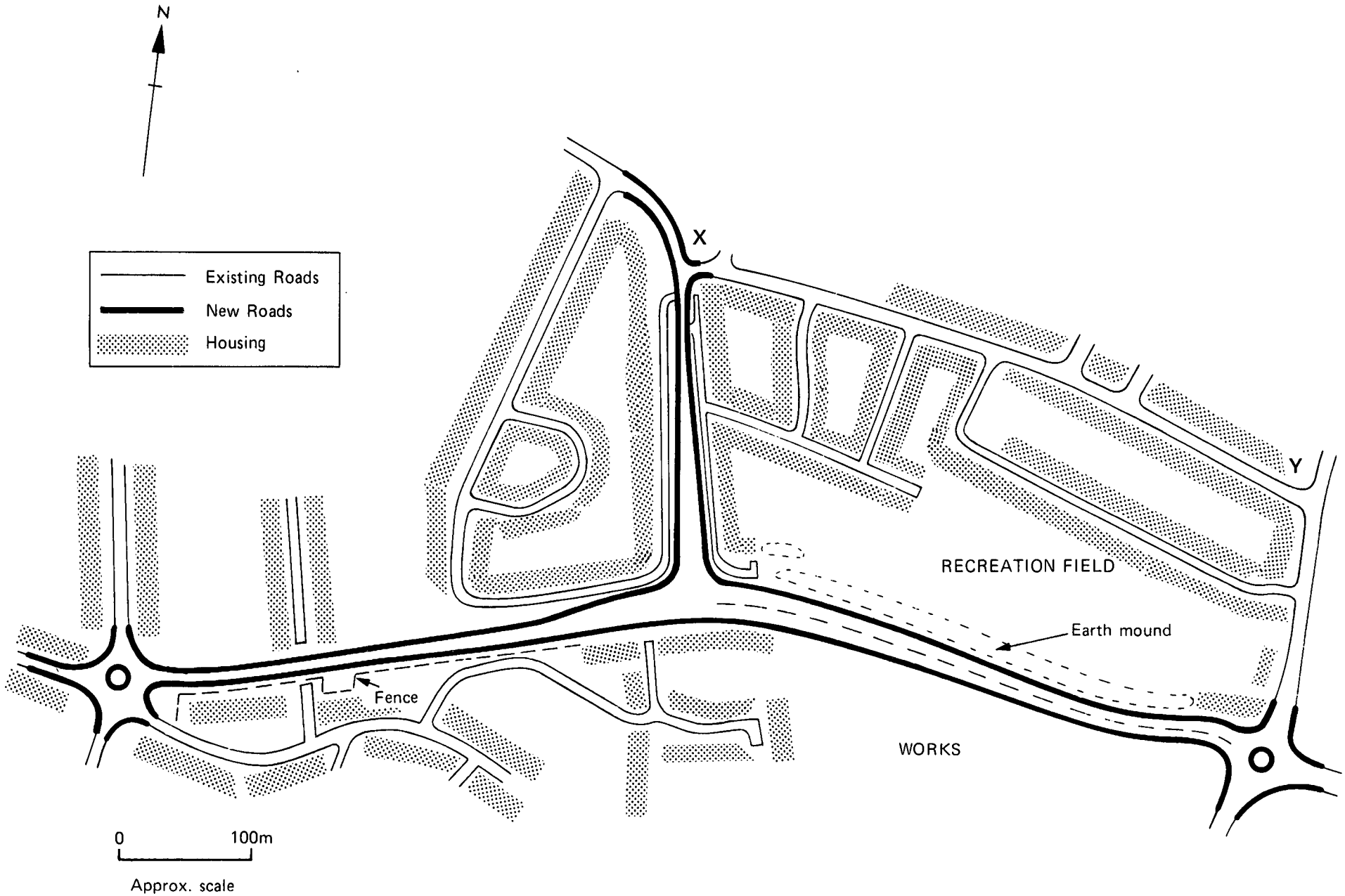

Fig. 4 PLAN OF SITE C

(603) Dd0536361 1,300 4/80 HPLtd So'ton G1915
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