THE DEPARTMENT OF TRANSPORT

THE A406 TRUNK ROAD
(GUNNERSBURY AVENUE IMPROVEMENT)

ENVIRONMENTAL STATEMENT
(VOLUME II)

Department of Transport
London Regional Office
2 Marsham Street
London SW1P 3EB

Ref. 83.852.0
February 1992

Howard Humphreys & Partners Ltd.
Consulting Engineers
Thorncroft Manor
Dorking Road
Leatherhead
Surrey
KT22 8JB

A406 TRUNK ROAD

GUNNERSBURY AVENUE IMPROVEMENT

ENVIRONMENTAL STATEMENT

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DEPARTMENT OF TRANSPORT
LONDON REGIONAL OFFICE

A406
NORTH CIRCULAR ROAD

(Gunnersbury Avenue Improvement)

PROOF OF EVIDENCE TO BE GIVEN BY DEPARTMENT OF TRANSPORT WITNESS

Department of Transport,
London Regional Office,
2 Marsham Street,
London SW1P 3EB

Ref. 62372.0
June 1990

5.9 CONSTRUCTION

5.9.1 Timing, Duration and Cost

5.9.1.1 These proposals form part of the larger scheme to improve the North Circular Road between Popes Lane and Western Avenue. It is not therefore the Department's intention that their construction should be undertaken separately from the remainder of the scheme. Subject to the satisfactory completion of Statutory Procedures and the availability of funds, it is anticipated that construction of the scheme, including these proposals, should commence in early 1993.* Construction of the main works would last approximately 2½ years. Due to the complexities associated with the innumerable sets of Statutory Undertakers' equipment in the Uxbridge Road Junction area, diversion of some of these would commence before the main works. Consideration is being given to constructing part of the tunnel as an advance contract in association with the diversion of Statutory Undertakers' plant.

5.9.2 Traffic Diversions

5.9.2.1 Construction work would be phased to minimise delays to traffic and disturbance of local residents. Throughout the construction period traffic capacity in the vicinity of the sensitive Uxbridge Road area at least matching that available now on the North Circular would be provided for traffic in both directions. Through traffic would be discouraged from using the side roads and although no formal diversions would be in force, advance warnings to motorists would be posted over a wide area.

5.9.2.2 Construction vehicles and the delivery of plant and materials would be restricted to the North Circular Road and, where unavoidable, other major local roads such as Uxbridge Road. Clauses stipulating these requirements would be placed in the Contract Documents.

5.9.2.3 The capital cost of constructing the Southern Section of the Popes Lane to Western Avenue Improvement excluding design and supervision costs is estimated at £60m in 1989 prices. This sum includes the cost of diverting Statutory Undertakers' Plant and the acquisition of all necessary land and property.

5.9.3 Property and Land Required

5.9.3.1 The total additional area of permanent land acquisition scheduled in the published draft CPO is approximately 3.3 hectares. In addition some 2.2 hectares would be required temporarily during the construction phase.

5.9.3.2 Construction of the proposals would require the demolition of 20 properties of which 18 are residential and two recreational. The latter two consist of a riding school and sports pavilion. Out of the total, 14 plus the riding school are owned by the Department. Several of the larger residential properties have been converted for use in multiple occupation. Examples include 18 to 19 Hanger Lane, known as Kolbe House and used as a home for

* The revised start of construction is 1995

Public Inquiry Document No. 2/4

Section 5.4, Volume 1 of the Proof of Evidence on Design and Construction elderly displaced Poles and No.1 Elm Avenue, a hostel run by the London Borough of Ealing for homeless families. By considering each individual unit within a building then the demolition of 18 residential properties would affect 93 households.

5.9.4 Construction Noise

5.9.4.1 During construction, it is the Department's policy to observe the same standards of noise control as would be imposed by the statutory requirements of the Control of Pollution Act 1974. To this end conditions would be included in the contracts for the works which would restrict the noise levels emanating from the sites. In addition, the Department would consider providing insulation for those properties which would be seriously affected for a substantial period of time during construction, but which did not qualify through the provision described at paragraph 5.6.2.2.

DEPARTMENT OF TRANSPORT
LONDON REGIONAL OFFICE

A406
NORTH CIRCULAR ROAD

(Gunnersbury Avenue Improvement)

PROOF OF EVIDENCE ON DESIGN & CONSTRUCTION

Volume 1

Department of Transport,
London Regional Office,
2 Marsham Street,
London SW1P 3EB

Ref. 62372.0
June 1990

HOWARD HUMPHREYS & PARTNERS
Consulting Engineers,
Thorncroft Manor,
Dorking Road,
Leatherhead,
Surrey KT22 8JB

5.4 Associated Contractual Matters

5.4.1 The Conditions of Contract used by the Department of Transport for its highway contracts enable conditions to be imposed upon the contractor to minimise adverse effects of the work on the surrounding area. In view of the residential nature of the area in the vicinity of the proposals it is intended that some restrictions would be placed upon the contractor and these are described below.

5.4.2 Restrictions of working hours would ensure that disturbances and nuisance caused by work outside normal working hours would be minimised. A total prohibition of night time work would not be possible because some activities are only possible at this time. In particular, for safety reasons, certain operations over and adjacent to the railway lines can only be carried out at night when no trains are running. There would be specific requirements set out in the Contract for the performance of such unavoidable night time tasks and to limit the extent of these.

5.4.3 Access to the site would only be permitted by means of the existing trunk road and, where unavoidable, other major local roads such as Uxbridge Road. Prohibition of Contractors vehicles and the delivery of both plant and materials along residential roads would be signed and strictly enforced by the Department's representatives on site.

5.4.4 During the detailed design of the proposals, construction noise levels would be discussed with the Environmental Health Officer from the London Borough of Ealing. The periods during which specific items of plant such as piling equipment, could be used would be controlled and maximum noise levels specified.

5.4.5 Access to private driveways and to businesses would be maintained at all times. Where accesses need to be regraded to match the new highway levels, some short term inconvenience may be unavoidable with temporary ramps providing a running surface.

5.4.6 Space for the contractor's offices, stores and equipment is severely restricted. However, where property has been demolished, there would be a few areas where it would be possible to use the remaining rear gardens of numbers 21-24 Hanger Lane (already owned by the Department) and number 13 Hanger Lane and the access to Popefields from Gunnersbury Avenue, which is cut off from the playing fields by the new road.

Public Inquiry Document No. 2/7

Proof of Evidence on Landscape including Document 8/5. Errata on Visual Intrusion and Visual Obstruction

DEPARTMENT OF TRANSPORT
LONDON REGIONAL OFFICE

A406
NORTH CIRCULAR ROAD

(Gunnersbury Avenue Improvement)

PROOF OF EVIDENCE ON LANDSCAPE

Department of Transport,
London Regional Office,
2 Marsham Street,
London SW1P 3EB

Ref. 62372.0

June 1990

LAND USE CONSULTANTS
Environmental Planners & Designers
43 Chalton Street,
London,NW1 1JB

NORTH CIRCULAR ROAD, EALING:

Proof of Evidence: Landscape and Visual Effects

1.0 Introduction

1.1 My name is Richard George Flenley and I am Principal in the practice Land Use Consultants (LUC). LUC is a multi-disciplinary practice which undertakes a wide range of consultancy work in the fields of environmental planning and landscape design. LUC has been appointed to advise the Department of Transport on landscape impacts of the proposed NCR improvements at Ealing and to develop landscape proposals for the scheme.

1.2 My qualifications include Bachelor of Arts in Geography and a Diploma of Landscape Design. I have been an Associate of the Landscape Institute since 1973. I have been in practice for some 19 years and have undertaken a wide variety of studies and projects involving landscape appraisal and landscape design.

1.3 My involvement in the formulation of landscape proposals for the scheme began early in 1988. Prior to that time, landscape appraisal had been undertaken by the landscape team within the Department of Transport, including the preparation for and submissions to the 1983-84 Inquiry.

1.4 As part of my work for the Department on this scheme I prepared display material on landscape impacts and proposals for public exhibition (held at Ealing in January 1989). I also attended the exhibition to provide further explanation where required.

1.5 I should here declare a local interest in the scheme. I am a resident of Ealing and have lived in the Borough for some 15 years. I know this section of the NCR well and frequently travel along it or across it. I have been a casual observer of Ealing Common and have also enjoyed its amenity as a user. Such experience has contributed to my professional understanding and interpretation of the landscape fabric of the NCR corridor.

1.6 The scope of my evidence covers:

(i) a description of the landscape/townscape in the existing and proposed road corridors. A summary of the main changes which will take place as a result of building the new road;

(ii) a review of the planning policy context affecting landscape/townscape issues;

(iii) an analysis of the tree survey undertaken by LUC to examine the impacts of the new road on the existing population of trees;

(iv) an explanation of the visual impacts of the road proposals,

(v) a description of the landscape proposals formulated in consultation with the Consulting Engineers and the Department of Transport.

2.0 LANDSCAPE/TOWNSCAPE CONTEXT OF THE EXISTING AND PROPOSED ROUTES

2.1 I shall describe the route from north to south, concentrating on the landscape/townscape context and the main components which frame the existing and proposed corridors. I use the term townscape here to describe the built physical environment - buildings, property boundaries of walls and fences, structures, roads and other hard surfaces. Soft landscape features of trees, verges, shrub groups, and more extensive open space also form part of this townscape structure. These ingredients combine in different proportions, grain, and style to form the landscape context of the road corridor, which changes in character over the 1.8 km length from B.R. Western Region railway bridge (ES.34) in Hanger Lane to Gunnersbury Avenue alongside Gunnersbury Park.

2.2 I have recognised these changes in character along the route and subdivided the corridor into a number of "character areas" as shown on Fig. RF1. The purpose of defining such subdivisions is to assist in understanding the present fabric, to assess the significance of the changes to the townscape, and to inform landscape proposals.

2.3 For the existing corridor I have recognised the following character areas:

Area 1. **Hanger Lane:** from railway bridge ES.34 to the Uxbridge Road.

Area 2. **Ealing Common:** from the Uxbridge Road to Elm Avenue.

Area 3. **Gunnersbury Avenue (north):** from Elm Avenue to Baronsmede.

Area 4. **Gunnersbury Avenue (south):** from Baronsmede to Park Parade.

Area 5. **Pope's Lane Junction**

Area 6. **Gunnersbury Park:** i.e. Gunnersbury Avenue south of Pope's Lane Junction.

2.4 These same character areas also encompass the proposed route except where it would by-pass Area 3 (Gunnersbury Avenue north) and take a new corridor to the west of the present alignment through:

Area 3a the stables at St. Paul's Field;

Area 3b Popefield Playing Field;

Area 3c gardens and houses on the east side of Gunnersbury Avenue.

2.5 Taking each of these in turn I shall describe in broad terms the existing landscape/townscape and the main physical impacts that would result from the road proposals.

Area 1: Hanger Lane

2.6 This 340m length of road from the railway bridge (ES34) to the Uxbridge Road, lies within the Ealing Common Conservation Area (designated 1982) and is framed on its western side by a double avenue of mature horse chestnut trees, interplanted with limes, and dating from the latter part of the nineteenth century. The avenue, and verge upon which it stands, form part of the registered Common. The character of this area is established and defined by this avenue and the facing houses which frame the eastern side of the road. The junctions of well treed side roads - Inglis Road and Hamilton Road, together with a number of large trees around the junction with Freeland Road and in front of the Dairy (formerly Hanger Hill Farm), reinforce the character of a leafy late Victorian suburb, juxtaposed with the existing detrimental effects of traffic on the NCR.

2.7 The road proposals would, in providing the increased width from existing single carriageway to dual carriageway, with slip roads for the grade separated junction at Uxbridge Road, cause major changes in this setting. Eight large houses on the eastern side of Hanger Lane would be demolished together with a number of adjacent trees and most of the chestnut/lime avenue on the western side of the road. In effect much of the containing framework of the existing road would be lost; and houses and gardens of side roads particularly to the east of the NCR would become more exposed to the road corridor. Some of the trees in the outer line of the avenue to the north of North Common Lodge would remain. The proposals include the new feature of a pedestrian/cyclist underpass connecting Inglis Road and Hamilton Road.

Area 2: The Common

2.8 Ealing Common extends to some 16ha (40 acres) and is predominantly maintained flat grassland, bordered and partially subdivided by lines of trees of mainly late nineteenth century origin. It is an historic open space which has been under the direct control of the local authority since 1878. The Common's broad open character and mature trees framed by mainly late nineteenth century houses have made it a fine and much valued landscape resource which also symbolises the Borough to a wider audience.

The origins of human activity on the Common go far back into history. Plan evidence from the eighteenth century shows that some of the present road alignments (Gunnersbury Avenue, Uxbridge Road, Warwick Road) already existed at least as tracks at that time. (eg. John Rocque's survey of Middlesex 1754). During the nineteenth century, tree planting was undertaken in various separate phases of activity, roads were widened and formalised, and in 1883 there is reference to the Common "now being planted round the edges and made level, in order to fit it for a recreation ground" (Greater London; edited by Edward Walford, 1883).

Some extraction of brick earths (which lie over the gravels) appears to have taken place in the southern part of the Common (South of Warwick Road) before the end of the nineteenth century, with subsequent infilling in the present century, leaving the recessed trough alongside Gunnersbury Avenue and the hollows in the south-east corner of the Common.

The Common is sub-divided by roads and paths, the most significant of which are the NCR itself (Hanger Lane/Gunnersbury Avenue), the east-west Uxbridge Road, and the two south-west/north-east diagonal roads of The Grange and Warwick Road, all of which are also tree lined. The majority of the Common is open, regularly maintained grassland; the area to the east of Gunnersbury Avenue is more densely planted with a variety of trees reinforcing a parkland quality. At the junction with Uxbridge Road, two small triangles of land have been isolated by slip roads. However the visual continuity of the Common is extended across these separated areas by several mature trees which contribute to the overall pattern. The levels in the southernmost part of the Common (Warwick Road to Elm Avenue) appear to have been excavated then raised by landfilling some years ago, leaving a slightly irregular field surface and the hollows of original ground, mainly alongside Gunnersbury Avenue. There are records of palaeolithic implements and neolithic flints associated with the Common including finds in this south-eastern corner, indicating different phases of prehistoric activity in the area. Further finds in this area are always possible despite the considerable surface disturbance which has already taken place. Excavation of the tunnel would disturb and thereby destroy such evidence which may exist in the brickearth and gravel strata. However, the proposed timescale would allow for archaeological review and investigation and there would be the opportunity for proper recording during excavation.

2.9 The proposals for the 520m long tunnel would necessarily cause major constructional disturbance across part of the Common with excavation to some 9m depth. Subsequently much of the traffic which at present passes along Gunnersbury Avenue would pass under Uxbridge Road and under the Common. Gunnersbury Avenue would remain as a connector to the slip roads at the southern end of the tunnel using a short section of Elm Avenue. The construction of the tunnel would take in some 3.5 ha. of land causing significant loss of existing trees at Warwick Road, Elm Avenue and particularly at Uxbridge Road junction. Temporary diversions during construction of the tunnel would widen the extent of itself, also displacing the commemorative drinking fountain (1878) which would need to be recovered and subsequently reinstated. The line of the tunnel would also be clearly visible at the southern boundary of the Common where it would break through the existing line of houses on Elm Avenue.

Area 3: Gunnersbury Avenue (Elm Avenue to Baronsmede)

2.10 This section of existing road (390m length) is single two lane carriageway. The road is framed by 2 and 3 storey houses facing directly onto the road, forming a 14m wide corridor between garden frontages. Two side roads (Evelyn Grove and Kingsbridge Avenue) meet the east side of the NCR in this section. The road is bordered by narrow verges with a now incomplete avenue of horse chestnuts. This was formerly part of a grand avenue approach to Gunnersbury House and the avenue continues the axis southwards past Baronsmede junction along Gunnersbury Drive to Gunnersbury House gates. The grass verges are badly rutted and worn throughout this section, probably caused by difficult access to driveways or parking along the verges, and there are now only 15 of the original 86 trees surviving in this section. The poor condition of the verges also means that replacement planting during recent years has been of limited success although some further replanting has taken place here during the early months of 1990.

2.11 Under the proposals this section of Gunnersbury Avenue would be closed-off at its southern end, with the new road by-passing it through the reserved corridor to the west. The subsequent reduction of traffic would enable the verges to be more fully reinstated and allow the tree planting to re-establish.

Area 3a: St.Paul's Field

2.12 This area of reserved road corridor from Elm Avenue to the Piccadilly Line bridge (D57) is 230m in length and some 34m wide, between rear garden boundaries of St. Paul's Close and Gunnersbury Avenue (west side). At its northerly end it is enclosed by two houses, which face onto Elm Avenue and the Common, with well planted and mature garden vegetation to front and rear. Beyond the gardens, southwards, the corridor follows the edge of the former St. Paul's Field playing field. This area is currently occupied by a riding stables which makes use of the former pavilion and provides fenced riding and paddock areas, with the main extent of the space given over to grazing and exercising for a number of ponies. The well vegetated rear gardens of Gunnersbury Avenue (west side) form the eastern boundary of the corridor. Mature garden trees and shrubs partially screen the houses from the corridor and the boundary is formed by a variety of fencing types.

The western boundary of the corridor is defined by a 1.5 to 1.8m high brick wall forming the garden wall for houses in St. Paul's Close. These gardens are small (6 to 8m depth). There is limited tree planting on the eastern side of the wall in some gardens and in one of the small public courtyards against the wall. Such planting already provides visual variation along the length of the wall.

2.13 The new road proposals would necessarily require demolition of the two properties on Elm Avenue (nos 1 and 3) in completing the southern end of the tunnel, with the carriageways rising from the tunnel to existing field level some 150m southwards along the corridor. The tunnel ramps would be flanked by slip roads, which would link to Elm Avenue. As the slip roads feather into the main carriageway which itself starts to rise slightly to the south to gain clearance over the railway line, there would be broader margins with room for more consolidated planting treatment.

Area 3b: Popefield Playing Fields

2.14 At Bridge D57 the new road would be up to 1 metre above the existing field level of St. Paul's Field and the Popefield Playing Fields. Residential property on 3 sides partly looks over the open space although the boundaries of these rear gardens are, in the main, thickly planted. The playing fields are maintained by the London Borough of Ealing for schools' use and contain 2 football pitches (1 full size, 1 junior) and a hockey pitch for winter use, with a centrally located cricket-table. The layout of the pitches runs very tight to the garden boundaries on the east side, but keeps well away from the railway boundary on the north side. In summer, an athletics track and field events areas are marked out without affecting the cricket-table.

2.15 The new road would continue obliquely across the north east corner of the playing field so displacing the changing pavilion and the adjacent car park area, and severing the present access road from Gunnersbury Avenue. The proposals here include forming a screening mound, up to 2.5m high, on the western side of the road, and planted throughout with native trees and shrubs to contain the road. The mound would have an important screening function for properties on the southern and western sides of the playing field (Baronsmede north side, and Aspen Close) and with its planting for reducing the visual impact of ball game fencing which would be necessary on the playing fields side. Overall the road and mound would take 0.269 ha. from the playing field and this would necessitate some adjustment to the present layout of pitches and cricket square. All the present pitches could be accommodated in a modified layout. A new access to the playing fields would be provided off Baronsmede (through the rear gardens of properties on the west side of Gunnersbury Avenue) and a replacement car park and pavilion could be sited nearby to suit the managing authorities.

Area 3c: Gunnersbury Avenue: West side gardens and houses

2.16 Almost immediately south of Bridge D57, the new road alignment would cut across the rear gardens of houses on the west side of Gunnersbury Avenue, running obliquely through the gardens of numbers 41 to 73 and requiring the demolition of 8 houses before regaining the existing alignment of Gunnersbury Avenue close to the junction with Baronsmede and Gunnersbury Drive. The construction of the Baronsmede subway with pedestrian and cycle approach ramps, and the new Popefield access would also affect these properties and adjacent verges. At present the gardens affected by the scheme are well stocked with trees and shrubs.

Area 4: Gunnersbury Avenue - Baronsmede to Park Parade

2.17 This 250m section of existing road has garden frontages with broad grass verges. Locally, on the east side of the road, a number of properties have planted and now maintain respective sections of verge under licence. In the main, garden frontages are defined by walls with mature shrubs and garden trees in front gardens. Some of these properties have garages; a few have front courtyard parking. All are served directly off the NCR with driveways across the broad verges. Recently a few standard trees have been planted on the roadside footway.

2.18 The proposed road widening together with service bays (to allow safe turning into driveways and servicing) and footways would take up all the existing verges. Towards Pope's Lane, where additional road width is needed to provide for the junction, the proposals would also remove a narrow portion of garden frontages south of Tudor Way from 96 to 106 (east side) and 97 to 111 (west side). The widening would affect the character of the present corridor by removing the grass verges, some garden walls and much of the mature vegetation of garden trees and shrubs where this exists immediately behind front garden walls.

Area 5: Pope's Lane Junction

2.19 The townscape of the existing Pope's Lane/NCR junction is formed by four contrasting land uses. To the south west, the park railings and mature trees of Gunnersbury Park form an impressive facade which extends along Pope's Lane, and, as a high brick wall, down Gunnersbury Avenue; (Gunnesbury Park is listed as Grade II in English Heritage's Register of Parks and Gardens of special historic interest in England); the north west corner is occupied by a petrol filling station accessed from both Pope's Lane and the NCR; the north east corner is framed by Park Parade - a row of shops and commercial properties with residential above and with a small service road in front; and the south eastern corner has semi-detached residential property facing directly onto the junction, partially screened at street level behind hedging.

2.20 The modifications to provide additional traffic lanes would affect the whole area except for Gunnersbury Park. A small area of forecourt would be lost from the filling station, as would the service road in front of the shops; and the front gardens of the semi-detached pair of houses on the south-east corner would be reduced including the loss of front hedgerows. Additionally, realignment of Gunnersbury Lane into this south eastern corner of the junction would cause some reduction of garden frontages for 7 properties on the south side of Gunnersbury Lane, (house nos. 193-205) with a new retaining wall displacing existing garden walls and some garden vegetation to form the step down between footway and garden levels. To the west, along Pope's Lane, adjustments to the eastbound carriageway would affect garden frontages of No. 21 Pope's Lane, of Gunnersbury Park Mansions and a small area of the hard surfaced garage forecourt.

Area 6: Gunnersbury Park

2.21 To the south of Pope's Lane junction the existing NCR continues as dual carriageway with narrow grass verges, and a 7m wide central reserve supporting a line of mature horse-chestnut trees. Minor adjustments would be made to the southbound carriageway, marginally affecting the verge. The central reserve would be modified over some 180m to form a northbound right turn lane to the junction. This would reduce the northernmost 120m to a narrow hard surfaced strip, accommodating a central barrier and would also mean that several of the chestnut trees would be removed.

3.0 **Planning Policy Context**

3.1 The Ealing Borough Plan (Nov. 85) sets the local planning policy context for the area through which the existing and proposed road corridors run. I shall here confine myself to aspects which relate directly to landscape and townscape.

3.2 In relation to the proposals here under consideration, I note the significance of policies GS16 and GS17.

"GS16: Generally the Council will seek to reduce the adverse effect of road traffic on the local environment."

"GS17: The Council will consider landscape features, both in the built-up area and open land, which are affected by development and will promote conservation of important features of the natural environment such as ancient habitats; and will have regard to the preservation and creation of wildlife habitats in considering landscape schemes."

3.3 Together these policies show the current dilemma of the North Circular Road in Ealing. On the one hand its improvement, in an appropriate manner, could resolve many of the problems of "through-flow" traffic and take pressure off rat-runs, thereby reducing adverse effects of road traffic on both the immediate and the wider environment. On the other hand the process of making such improvements would cause and create some adverse effects in the immediate corridor including demolition of property, loss of prominent tree groups, and physical and visual intrusion into areas of open space also affecting residential property.

3.4 This dilemma is particularly pronounced at Ealing Common which is a unique environment and which has been designated as a Conservation Area since 1982.

3.5 Such status recognises the "special architectural or historical interest, the character or appearance of which it is desirable to preserve or enhance" (LBE Borough Plan Glossary). Policy U10 states that "The Council will protect and enhance the environment of the area designated on the Proposals Map and in the Schedule para. 9.16 as Conservation Areas and other areas which may be so defined...."

3.6 Policy OL3 specifically identifies landscape schemes in relation to certain routes including the North Circular Road:

"OL3: The Council has defined on the Proposals Map certain routes which form links between Major Open Areas as Environmental Corridors in which visual continuity between the open areas is to be provided by planting and landscape schemes incorporating as appropriate footpaths and cycleways and enhanced by such open space that is available. New development in or adjoining the corridor will be expected to enhance this continuity, contribute to the landscaping and improve amenity:"

With the further note:

"North Circular Road where it links Major Open Areas between Twyford Abbey, Hanger Hill Park, Ealing Common and Gunnersbury Park. The road and footway will be separated by landscaping where possible."

3.7 There are several areas where such an opportunity can be taken through the proposals, including of course the major effect of the road in tunnel under the Common, and the considerable reduction of traffic in Gunnersbury Avenue, north of Baronsmede, which would thereby make this a much more pleasant pedestrian and cycling route. Elsewhere, north of Uxbridge Road and south of Baronsmede the geometry of the road and the width of the corridor limit opportunities for footways separated by landscaping.

3.8 Policy U17 states:

"The Council will encourage the protection of ancient monuments and areas of archaeological importance. In the event of the discovery of new sites of archaeological importance, or of development being proposed which would affect such sites, the Council will encourage developers to enter into agreements with archaeological bodies requiring access to the site prior to or during development, and ensure that development does not unreasonably impair archaeological features which need to be retained on the site, or cause them to be destroyed without proper record."

This policy is of relevance here since there have in the past been finds of archaeological interest on and close to the Common and major excavation for the tunnel could destroy such evidence. It would be important to undertake desk study and initial investigation to ascertain the extent of interest prior to works being undertaken and, in the light of such research, to target record survey work during the construction period.

3.9 Finally Policies U13, U14 and U19 have relevance to the scheme:

"U13: The Council will encourage the retention of those incidental features in the urban environment which give an area its special character, particularly at locations serving as focal points for the community....."

"U14: The Council will continue to encourage new tree planting and seek to preserve individual trees and groups of trees which contribute to the quality of the urban environment...."

"U19: The Council will expect development to reflect the best elements of the character of the surrounding area, or have sufficient and distinctive merit which adds to the character and appearance of the area."

3.10 It is recognised that the road proposals themselves are not directly consistent with these policies since the scale of the new road and its constructional impacts would remove some features, tree groups and positive fabric of the urban environment. However, the intention within the proposals is clearly to repair and reinstate to a high standard and in appropriate manner where such changes take place, and the reduction in adverse effects of traffic could enable the policies to have greater application in the wider area. The policies underline the importance of recognising local identity and of achieving positive treatments in both hard and softworks. The landscape proposals for the scheme have followed such an approach and incorporate positive treatments.

4.0 **The Tree Survey**

4.1 The existing NCR through Ealing is physically constrained by and to a large extent characterised by mature trees which line the route. It is inevitable, though regrettable, that road widening/realignment proposals would cause the removal of significant numbers of trees. A tree survey was undertaken in 1988 (with additional inspections in June 1989 and March 1990) to record the existing populations of trees along the route and to assess the effects of the proposals on this population.

4.2 The survey concentrated on trees within the existing and proposed road corridors. It was extended to include those trees which would be immediately adjacent to construction or accommodation works, where appropriate, taking existing physical boundaries, such as fences or walls, which effectively define the road corridor.

4.3 The survey distinguished between:

(i) individual street trees, mainly in verges/footways and alongside the Common, but also including a few large trees in gardens which by their location and size are significant individuals along the road corridor;

(ii) garden trees and shrubs forming consolidated groups in front and rear gardens and including those groups on the Piccadilly line railway embankment. (In so far as access allowed, the numbers in such groups were estimated).

4.4 For street trees, the survey schedule recorded the following data:

(i) reference number;

(ii) species;

(iii) girth (at 1.4m above ground level);

(iv) height (directly affected trees);

(v) age group (juvenile/young/mature/over-mature);

(vi) condition (good/reasonable/poor/serious);

4.5 For groups of garden trees and shrubs, a general description of size and content was entered in the schedule.

4.6 Because of the nature and root spread of mature trees it is possible that individual trees on the margins of construction activity could be affected by root severance or compaction or crown damage to such an extent that the tree could become hazardous and might then need to be removed. The analysis therefore identified such trees which could be put at risk but which, with appropriate protective measures and contractural constraints, could be conserved.

Accordingly analysis of the survey data in relation to the engineering proposals makes the distinction between:

(a) trees which would be necessarily removed as a direct result of works i.e being directly on line;

(b) trees close to the works with some root/crown spread within the construction area and which would need protection or remedial work in order to conserve them;

(c) trees which would not be directly affected by works.

4.7 Within the proposed road corridor the survey recorded 347 street trees and approximately 300 trees/large shrubs mainly in gardens. In total there is a wide variety of species although the street trees account for only 10 species. Horse

Chestnut (169 No. - 49% of population) and lime (76 No. - 22% of population) are the dominant species among street trees along this section of the NCR.

4.8 It is useful to recall that the main avenues of the Common, Uxbridge Road, Hanger Lane and Gunnersbury Avenue were planted predominantly in the latter part of the nineteenth century. There is some variation in age range among the mature trees in these constituent avenues, probably reflecting different periods of planting activity. Their spacing and shape, as mature trees with generally well formed open crowns, convey the image of leafy Ealing as perceived in the approaches to and passage across the Common. However, many of these trees are probably in the last third of their life span and indeed some show signs of decay and damage which may warrant earlier removal. Gaps have occurred in recent years, including the 1987 storm which caused particular losses on Elm Avenue. Partly in response to these changing circumstances, new planting has ben undertaken by the Borough not only to fill gaps (as most recently on Elm Avenue and lower Gunnersbury Avenue) but also in forming new patterns, for example at the south-west corner of the Common and near Warwick Deane.

4.9 In all, 150 street trees of various sizes would be removed as a direct result of the road proposals together with some 200 mainly small trees and large shrubs in groups and gardens. The predicted losses are shown in fig. RF2 and Table RF4. Of the 150 trees categorised as losses, the majority (111No.) are fully mature trees of which 19 were recorded as being in poor condition. A further 28 in the losses total are young trees less than 5m height (ie. planted during the last 5 years) and about half of these could still be in suitable condition and size to transplant. The figure of 150 trees includes 9 trees which would certainly be at risk through proximity of workings but which with appropriate protection, might still be retained. Such provisions would be made to protect them but they are included here as losses since their future cannot be guaranteed.

4.10 The main losses of street trees would be in the area of the Common, including those around the Uxbridge Road junction and northwards along Hanger Lane, where most (51 out of 68 trees) in the chestnut/lime avenue on the western side would be removed. A large proportion of these trees are mature, and in the present situation, they are visually dominant in the road scene. The impacts around the Uxbridge Road junction would remove trees in the intersecting north/south and east-west avenues, including 8 mature trees removed for temporary traffic diversions. These losses would be widely perceived from areas around the Common.

4.11 On the Common itself, tunnel construction at Warwick Road and at Elm Avenue would remove some 27 trees of which 19 are mature. There were already significant losses around the south and west sides of the Common in the 1987 storm and although considerable replacement planting has since been undertaken, there are now few mature trees along Elm Avenue. More recently in the early months of 1990 two more trees have been lost in the south eastern corner of the Common.

4.12 The roadworks/tunnel construction would remove the trees, shown coloured in RF2, leaving the residual pattern shown in fig. RF3. In visual terms the losses would be particularly severe at the Uxbridge Road junction and in Hanger Lane with obvious gaps in the avenue structure of Warwick Road and, to a lesser extent, Elm Avenue.

4.13 To the south of the Common, the 250m section of existing road in Gunnersbury Avenue down to Baronsmede would be by-passed by the new alignment of the NCR to the west, and accordingly its trees would be unaffected by works except at the southern end where the new alignment would rejoin the existing road at Baronsmede. The tree survey reveals the incomplete pattern which has evolved as a result of age and difficult environmental conditions in this section of the road. Of some 86 trees originally forming the avenue between Elm Avenue and Baronsmede only 15 now survive as mature trees, with more recent replacements on the partially trafficked verges. Some further planting of red flowering horse chestnuts has taken place on these verges in February 1990.

4.14 By contrast, in the reserved corridor of St. Paul's Field there are few existing trees although the gardens along the east side form a strong vegetational framework varying in height from 4m to 8m. The gardens on the west side, framed by a brick wall, contain a few trees which are now establishing well and would remain unaffected by the proposals. Standard trees in the public areas adjacent to the wall on the east side have yet to become properly established and could indeed be supplemented. The proposed road would remove some ornamental garden tree groups at the north end of the enclosed corridor in the gardens of nos. 1 and 3 Elm Avenue to the north as well as some naturally regenerated thorn, bramble, snowberry and cherry on the railway embankment to the south.

4.15 South of the Popefield, where the new road would cut obliquely through the properties on the west side of Gunnersbury Avenue there would be significant loss of garden tree and shrub groups, including 10 large trees (up to 14m tall) and some 100 smaller garden trees and large shrubs. Similarly front garden vegetation would be lost from house nos. 55 to 73 and 6 street trees (3 mature) would be removed in

Gunnersbury Avenue near Baronsmede where the new road would rejoin its current alignment.

4.16 In the section of Baronsmede to Pope's Lane, 6 recently planted standard trees in the verges and outside Park Parade, would be lost to the road improvements as would a narrow but significant band of front garden vegetation in the section south of Tudor Way on both sides of the road.

4.17 To the south of Pope's Lane, where the central reserve would be reduced in width to form a right turn lane (northbound) - 14 trees (including 5 mature) would be removed, 3 of which might be retainable with full protective measures.

4.18 Overall the effects of tree loss caused by the road improvements would be widely perceived by those who use or live close to this section of the North Circular. The avenues of Gunnersbury Avenue, Hanger Lane and on the Common itself contribute greatly to the character of Ealing as perceived from the NCR and from surrounding roads, and provide some visual containment for the road and its traffic. The road improvements would create obvious gaps in the landscape framework particularly at the Uxbridge Road junction and in Hanger Lane. Such gaps cannot be lightly disguised in the short term although, as described below, careful replacement is proposed taking account of the modified dimensions of the corridor and technical constraints of the tunnel itself.

4.19 As well as impacts on the existing tree pattern there would also be disturbance of the grassed surface of the Common itself during tunnel construction. The Draft Orders define a construction corridor of some 3.5ha between Uxbridge Road and Elm Avenue, varying in width from 45 to 85m. This area would be fenced off during the construction period. The topsoil and subsoil would be stripped and stored for re-use and would be subsequently replaced at existing field levels and re-seeded. In effect the land would be borrowed and fully reinstated following completion of construction works. In the area south of Warwick Road where the ground shows irregular undulations of former land filling operations, the reinstatement would produce a smoother ground profile, but still retaining the main trough alongside Gunnersbury Avenue and the hollow in the south-east corner of the Common.

5.0 The Landscape Proposals

5.1 The landscape proposals have evolved through analysis of the present landscape fabric and features, review of engineering proposals and assessment of impacts which would be caused by road construction. Consideration has been given to measures for avoiding or minimising impacts and for protecting the existing fabric. Opportunities for landscape treatments which would repair, reinstate or replace lost fabric in accord with the character of the area have been taken. The landscape proposals are prepared in plan form on drawing RF6. They do not attempt to show the exact locations of individual trees and shrubs nor the exact detail of individual hard surfaces.

5.2 Before explaining the layout of the landscape proposals, I will briefly describe the main components. These include trees, shrubs, grass in verges and on the Common, and hard landscape elements such as boundary walls, fencing, footway and cycle surfaces.

5.3 Tree planting is a major component of the landscape proposals, recognising the need to replace particular features or to replant gaps in existing lines or groups. Where possible, taking account of good arboricultural practice, street trees and those on the Common would be planted as advanced nursery stock in the height range 3.5m to 6m depending on specific locations. The advantage of planting trees of larger size is the more significant visual effect achieved in the initial years of the scheme. Trees of this size are also less prone to vandalism due to the greater stem height and girth. However where trees are to be planted in tight groups (for example on the Popefield mound) whips and feathered trees (0.5 to 1.6m height) would be used to achieve appropriate massing.

5.4 Shrub planting is proposed in combination with some of the areas identified for tree planting, where it is appropriate to the local character, and for those situations where tree planting is not possible due to the need to maintain sight lines for traffic movement, or where space is limited. Shrub planting on traffic islands would be confined to the use of ground cover plants whose eventual height may only be 300 to 500 millimetres. Similarly, ground cover shrubs would be used in preference on the planted shoulders and embankments alongside underpass ramps and footway approaches where there is public concern about security and visibility. The planting of shrubs would be carried out at a high density so enabling a carpet of foliage to be established quickly. Shrub planting would include a range of evergreen and deciduous species, using native species in informal locations, and mixed amenity groupings in street situations and garden frontages. The density of the planting adopted would relate to the size of the plants, the rate of growth and the ultimate height of the plant species chosen.

5.5 The details of the plant species to be used have yet to be resolved. It is the Department's practice to use species which are common to the area and to ensure that a consistency of plant types is maintained. This is of particular importance where there is reinstatement of vegetation lost as a result of the scheme, for example on the Common, where the continuity of horse chestnut and lime would reflect the existing situations. Planting contracts would include a three year maintenance period which would be supervised by the Department's agent. It is the Department's experience that over this timescale the planting can be monitored to ensure that there is successful establishment of the new landscape fabric. Any problems that arise due to vandalism or poor growth could then be corrected as part of the planting contract works. Beyond this period, maintenance would continue to be supervised by the Department's agent.

5.6 Attention to the detailed design of the hard landscape proposals for the scheme would be considered to ensure that materials, fittings and fixtures are robust and visually appropriate. For example paving and other surfacing materials would be selected and used in a limited range of colours and textures to define pedestrian routes, the central reserve, cycle tracks and other areas closely related to the road.

5.7 In particular situations, for example in the construction of the subways at Hamilton/Inglis and at Baronsmede, it is intended to incorporate some of the architectural vernacular and detailing which is typical of the locality. Indeed it may be possible to incorporate particular features and details from architectural salvage of properties which would be demolished. This would help to integrate the new structures and to reinforce local identity and quality for pedestrians and cyclists. Such treatments could give continuity of style with the surrounding townscape whilst incorporating the overspanned design of the subway construction. This might also be reflected on highway boundaries (for example at the redefined Kolbe House boundary), although final choice of materials in such cases will rest with respective owners.

5.8 The selection of hard landscape materials including the choice and positioning of items of street furniture, such as railings and street lighting, would be subject to further analysis at the detail design stage of the project.

5.9 The landscape proposals recognise the differences in landscape character along the proposed corridor. In particular they take account of the predicted losses in tree pattern, the increased dimensions of road surface, the loss of existing buildings which thereby open up new views to and from the road, and the residual pattern of tree planting which would be exposed by, and can be realistically protected through, the construction stages. These factors have been informed by the landscape appraisal (RF1) which I will now relate to the landscape proposals (drawing RF6) for each character area.

Area 1: Hanger Lane

5.10 At present the area is strongly framed by the local landmark of the chestnut/lime avenue (west side) and buildings which face onto the east side of the road. The landscape proposals recognise that in this area the essential geometry of widening the road from 2 lanes (8m) to 4 lanes with slip roads (19m widening to 38m at Uxbridge Road junction) would remove most of this containment. They would also seek to protect the residual components of the avenue and, where possible, to reform some of the visual containment of the road, (diagrammatic cross section RF5).

5.11 On the western side of the road, 15 trees of the existing avenue would be conserved. They would be protected during the construction works by fencing and by careful control of essential operations which might affect their root spread or canopy. Some tree surgery would be essential. Additional tree planting would be undertaken on completion of the roadworks to consolidate the remaining formation.

5.12 The proposals include planting a double staggered row of trees on the eastern side of the road. This would still leave space for redevelopment of the garden plots of nos. 14 to 20 Hanger Lane (Kolbe House; Cecilia House etc.). Although a broader landscape band could be provided at the expense of the redevelopable land here, on balance, given the particular circumstances of these properties with the opportunity for redevelopment, the constrained landscape solution is proposed. Appropriate development here would reinforce the containment of the road corridor behind the new avenue and would partially enclose the properties and gardens of

Inglis Road and Freeland Road from the widened NCR. Such redevelopment, while being outside the Department's powers and interests, would be subject to normal planning procedures through the local authority.

5.13 Replanting around the Inglis/Hamilton subway would include a number of trees and low shrub planting against the redefined property boundary of no. 23 Hanger Lane, with ground cover vegetation used immediately around the subway ramps, steps and shoulders. The latter is particularly important in maintaining light, airy approaches for pedestrian visibility and security. The subway itself would be of the overspanned design incorporating the architectural flavour and details of the locality and possibly including themes of culture or local heritage interest. Such treatment is shown diagrammatically in fig. RF7

Area 2: Ealing Common

5.14 The landscape strategy for the Common is to limit the impacts of cut-and-cover operations on the Common, to protect particular trees which can be kept within and adjacent to the CPO area, and subsequently to reinstate the Common, with its complete pattern of trees, by soiling, seeding and planting.

5.15 The landscape proposals include replacement planting of trees on the edges of Uxbridge Road, Gunnersbury Avenue and on the north eastern triangle in front of Creffield Road where a small area of existing highway would also be reinstated as grass verge. The corresponding south eastern triangle of the Uxbridge Road junction would also gain reinstated grass from the existing highway on its western side, with additional tree planting to reform part of the missing avenue. On the south western side of the junction and again at Warwick Road and Elm Avenue reinstatement would include tree planting over the tunnel to continue the lines of the avenues. (RF.8). It is desirable to achieve at least 2m cover of soil above the tunnel for tree growth and the sections at Warwick Road and Elm Avenue would achieve more than this for the trees which would be planted directly over the tunnel. In the case of the Uxbridge Road corner, the ground levels would be lifted locally over the tunnel by up to 1m to provide sufficient soil depth for tree planting. The field levels in this area are slightly lower than the adjacent pavement, so the lifting of levels could be married in without appearing as an obtrusive "bump". The commemorative drinking fountain which would be displaced by temporary traffic diversions could be reinstated on its existing site. On the north side of Uxbridge Road, the area over the tunnel portal would limit planting depths for trees so this area would be restored to grass and paving, with trees and shrubs in large containers.

5.16 At the southern end of the Common the hollow which would have been marginally affected by tunnel construction would be reinstated to its original shape with a suitable group of trees planted. Where the existing framework of houses along Elm Avenue would be breeched by the tunnel, a new service building would be constructed over the tunnel portal. This area, framed by the slip roads, the portal and the roundabout on Elm Avenue, would in keeping with adjacent gardens be enclosed with shrub planting and trees in containers, with due allowance for sight-lines on the slip roads. (RF9)

Area 3: Gunnesbury Avenue (north), St. Pauls to Baronsmede

5.17 Here the new road would run through a reserved corridor between rear gardens and across the edge of the Popefield Playing Fields. Unlike other sections of the scheme this is not an existing street frontage. There is no pedestrian access, no service access to properties and no road junctions along this section of the road.

Accordingly there is the scope to provide a different landscape treatment which reflects this rear-of-property context in contrast to the streetscape of serviced frontages further south and of the Common/tunnel to the north. Landscape proposals seek to reinforce the enclosed boundaries of existing properties with planting of mainly indigenous species on residual verges, planted as a combination of whips, feathers and standard trees. (Cross-sections Fig. RF10 and RF11).

5.18 The landscape proposals take account of acoustic barriers which are recommended for much of this section. On the western side, the existing 1.8m wall forming garden boundaries for St. Paul's Close would be supplemented by additional solid fencing to raise the effective height to 3m without dismantling the existing wall (which would otherwise cause further disturbance of gardens and trees). On the eastern side, similar noise barriers would be provided along the garden boundaries, tying into the parapets of the Piccadilly Line bridge and continuing along the modified rear garden boundaries of Gunnersbury Avenue (west side).

5.19 Along the Popefield boundary an earth mound up to 2.5m high would be formed to contain the road, affording visual and acoustic protection for the playing fields and properties beyond. (Rear of Baronsmede north side and of Aspen Close). (RF12)

5.20 The landscape proposals include substantial planting of these verges and the mound with a matrix of indigenous tree and shrub species. This would marry into the similar vegetation which is already well established along the Piccadilly Line railway embankment and would also incorporate some conserved garden trees towards the southern end of the mound.

5.21 At the southern end of the earth mound, the Baronsmede subway would provide a pedestrian and a cycleway link from Baronsmede to the closed off section of

Gunnersbury Avenue. Here the landscape proposals would form the transition from the predominantly native species of the enclosed Popefield/St. Paul's section to the modified road frontages of Gunnersbury Avenue. The proposals include tree and shrub planting, using ground covers on the embankments next to subway ramps in order to minimise security risks in the subway approaches. The subway itself would be of a similar overspanned design to that at Hamilton/Inglis, but could adopt different materials to reflect the local architectural character, possibly picking up some of the mock Tudor detailing and incorporating local themes associated with Gunnersbury Park or the Baron's Pond. (Fig. RF13)

Gunnersbury Avenue (North)

5.22 In removing through traffic from the length of Gunnersbury Avenue between Elm Avenue and Baronsmede, the scheme would provide opportunity for repairing damaged verges and replanting trees.

Area 4: Baronsmede to Park Parade

5.23 The widening of the existing road would remove grass verges and, towards the southern end, would cause realignment of front garden boundaries with consequent loss of some garden vegetation. The landscape opportunities are clearly restricted by lack of space, but the intention is to reinforce the residual garden vegetation and, where possible, re-establish roadside trees within footways or on verges. The dimensions of corridor severely limit such opportunities except for a number of trees in the footway north of Tudor Way and a narrow band of shrub planting in the central reserve between Tudor Way and Pope's Lane junction. (RF14). Planting by agreement would be offered by the Department for reinstating or reinforcing the garden frontages of these properties in Gunnersbury Avenue. At

Baronsmede junction, the existing wide expanse of tarmac would be reduced with the formation of a traffic island which could be planted with trees and ground covers using similar species to those proposed for the nearby Baronsmede subway embankments. Towards the Pope's Lane junction there would be a limited opportunity over about 100m to incorporate some vegetation within the central reserve, using the concrete barriers to contain the planting above the carriageway level.

Area 5: Pope's Lane Junction

5.24 The existing layouts at the junction of Pope's Lane and the NCR is of entirely hard surfaces with various barriers guiding pedestrian movements. The dimensions of the proposed layout are constrained and do not allow space for soft landscape treatment. On the south eastern corner and for some 90m eastwards along Gunnersbury Lane, carriageway re- alignment would affect garden frontages. Properties so affected would be offered planting by agreement to reinstate front gardens. Similarly realignment of some 120m of the eastbound kerbline in Pope's Lane would affect garden frontages of Parkview, Gunnesbury Park Mansions and the garage area, with similar possibilities of planting by agreement where appropriate within garden areas.

Area 6: Gunnersbury Parkway

5.25 The tie in for roadworks improvements would cause minor re-alignment of the southbound carriageway and removal of part of the grassed central reserve, including a number of horse chestnut trees, to form a right turn northbound lane. The landscape proposals include reinstatement of the grass verge where this still exceeds 3m and replanting of trees where the verge is more than 4 metres wide.

6.0 The Assessment of Visual Impact

6.1 The visual impact of the proposed road improvements has been assessed in accordance with the guidelines given in the Department's Manual of Environmental Appraisal (MEA) - 1983.

6.2 The MEA describes the methods by which visual impact can be assessed in terms of both visual obstruction and visual intrusion. Obstruction occurs when some part of a view is appreciably blocked off by the proposed road or associated structure or traffic on the road. This is an objective effect and can be quantified in terms of the solid angle of obstruction from a given viewpoint. Intrusion is a more subjective concept, describing the aesthetic impact of the highway on the surrounding environment. The appraisal of intrusion requires skills of appreciation which need to be applied consistently along the route in order to determine the likely effect of the new road improvements.

6.3 Both techniques of assessing visual impact are concerned with comparison between the existing and the proposed situation as perceived from individual properties which have views of either the existing or the proposed road. The visual envelope map defines the areas of land from which there is a view of any part of the road, its structures or the traffic which uses it. It follows that all visual obstruction and visual intrusion would lie within the areas defined on the visual envelope map.

6.4 In accordance with the outline methodology described in MEA, the initial exercise was to define the visual envelope by field inspection and survey.

6.5 The methodology for both assessments is based on the existing situation as observed and the proposed situation as predicted at the opening of the scheme.

Accordingly the proposed situation takes account of all structures, including service buildings, parapets, walls, noise barriers, embankments as well as the road surface itself and the visual impacts occasioned by traffic on the road. A height of 4 metres above the carriageway has been taken to represent the top of commercial vehicles using the road. For the proposed situation it is also necessary to take due consideration of the losses in landscape and townscape structure which would thereby open the views of properties previously screened from the road. In this case, the assessment is based on vegetation in its winter condition when there is maximum visibility. The effect of new planting identified in the proposed scheme is not considered to have any screening effect on day 1 although in many cases it would have an increasingly significant partial screening and foiling effect within a few seasons.

Visual Obstruction

6.6 Visual obstruction implies the blocking or partial blocking of a view seen by an observer. The measure of visual obstruction is the extent of the observer's field of view taken up by the obstruction. Field of view is measured in terms of the solid angle subtended at the centre of a sphere of unit radius by a unit area on its surface.

6.7 In accordance with the methodology, visual obstruction assumes an observation point at 1.8m above ground level at the facade of each property with a direct view line to the road. The quantified results are expressed as High, Moderate, or Slight.

6.8 Many of the houses and buildings in this area have multi-occupancy. In order to estimate the number of households affected, as opposed to the number of buildings, it was necessary to carry out a detailed occupancy survey of the appropriate buildings both by bellcount and by checking the electoral roll.

6.9 The next stage of the assessment was to produce a visual obstruction map for both existing and proposed situations respectively, (RF15 and RF16) showing the properties subjected to High, Moderate or Slight visual obstruction. A comparative map (RF17) shows those properties which would experience a change in the degree of visual obstruction. Fig.18 presents the quantified results by household in the form of a framework table.

6.10 I shall now describe the changes in the pattern of visual obstruction when comparing the existing situation and with the proposed scheme. (RF17)

6.11 At the northern end of the scheme some properties around the head of Hamilton Road, Inglis Road, Freeland Road and Hamilton Court would experience increases in visual obstruction. This is partly due to the removal of buildings on the east side (Kolbe House, Cecilia House etc.) which would expose some properties more directly to the road but is also increased by the raising of the road level to gain clearance over the new railway bridge (which itself lies outside the scope of this assessment).

6.12 The assessment shows some increase in visual obstruction for the most easterly properties on North Common Road which would be affected by the enlarged surface area of the Uxbridge Road junction in combination with the north portal of the tunnel.

6.13 At the south end of the Common there would be significant changes due to the proposed new alignment through St. Paul's Field. This would cause increases in visual obstruction for some properties in St. Paul's Close, Elm Avenue, and for part of Gunnersbury Manor, as well as at the rear of houses on the west side of Gunnersbury Avenue. Conversely the fronts of these same properties in Gunnersbury Avenue and properties on the east side of Gunnersbury Avenue would show reductions in degree of visual obstruction.

6.14 At Baronsmede two properties would show an increase in degree of visual obstruction as would no. 85 Gunnersbury Avenue; but southwards beyond this point although the area of road surface would be increased and brought closer to properties on both sides, the degree of visual obstruction recorded by the assessment would remain as at present.

6.15 Overall the framework table A (Fig.RF18) shows that 413 households would be affected by visual obstruction under the proposed scheme compared with 422 households similarly affected under the present situation. The distribution of households affected is clearly different in the two situations as a result of the proposed road following a new corridor along part of its route. Table A shows a significant reduction of households which would be subject to High Visual obstruction (314 to 177) but increases in the Moderate group (57 to 126) and Slight (51 to 110). Table B is a matrix showing how these changes occur and the comparative plan RF.17.

RF18 **VISUAL OBSTRUCTION**

TABLE A

Visual Obstruction	Number of households within the visual envelope subject to:	Proposed Scheme	Existing Situation
	High	177	314
	Moderate	126	57
	Slight	110	51

RF18 **VISUAL OBSTRUCTION**

TABLE B

From	High	Moderate	Slight	Zero
to				
High	156	20	1	-
Moderate	46	28	17	35
Slight	8	-	14	88
Zero	25	9	5	831
Demolished	79	-	15	-

Visual Intrusion

6.16 The assessment of visual intrusion is partly dependent on the quality and type of landscape and townscape through which the road runs. The Manual of Environmental Assessment sets out the definitions for assessing the changes in visual intrusion. Three degrees of visual intrusion are to be assessed - High, Medium and Low based on the following definitions:

HIGH VI - where the road would be considered to be the dominant intrusive element in the view.

MEDIUM VI - where the road would be considered to be an important intrusive element in the view.

LOW VI - where the road would be considered to be an intrusive element in the view.

As defined by MEA the term 'intrusive' refers to elements in the view which by their shape, size, colour, reflective surface, emitted light or movement are consciously or sub-consciously felt to be discordant or out of harmony with the general scene. 'Important' is used to describe an element in the view which is perceived to be high in the hierarchy of intrusiveness without being the dominant element. 'Dominant' is used to describe the element in the view which clearly attracts most attention.

6.17 The technique of assessing visual intrusion relies on subjective evaluation and judgement gained through experience and applied consistently through the survey area. The assessment is concerned with the changes in intrusion and relies on assessing the quality of both the existing scene and of the proposed road superimposed on that scene. The extent to which the view is down graded by the presence of the road determines the degree of visual intrusion to be recorded in both existing and proposed situations. The appraisal is, therefore, a qualitative comparison with assessment of the 'before and after' situation. The 'before' scene can be observed but the 'after' situation can only be interpreted. The process is essentially site-based and has been achieved by walking along the existing trunk road, side roads, footpaths and open spaces, the proposed road corridor and its immediate surroundings. The change has been judged by assessing the impact which the road would have when first opened to traffic. Screening mounds, walls and fences have been taken into account as well as traffic on the road; but screen planting has not been included as this takes time to become effective. The winter condition, when trees and shrubs are least effective in screening views, has been used for the assessment in both cases.

6.18 I draw attention here to the problem of street lighting in such an assessment. I have not included individual lamp columns and street lights in the appraisal although it clearly could have a perceived impact, particularly in the previously unlit corridor of St. Paul's/Popefield. For Hanger Lane, the Common and Gunnersbury Avenue south of Baronsmede the proposed situation would be generally comparable with the present, although the detailed disposition of lighting columns would be adjusted to central reserve locations where appropriate. However in the reserved corridor between Elm Avenue and Baronsmede, the lighting effects of 12m high columns in the central reserve, and 10m columns on the sides of the slip roads, would be perceived by the surrounding communities in Elm Avenue, St. Paul's Close Gunnersbury Avenue west side, Baronsmede, and Aspen Close. These considerations are therefore reflected in the assessments for visual intrusion.

6.19 The assessment of the number of properties affected by the visual intrusion of the existing and proposed schemes is shown on Fig. RF19 (existing situation) and RF20 (proposed situation) under the categories of High, Medium and Low, as outlined above.

6.20 Under the existing situation a large number of properties are directly exposed to the road and incur varying degrees of intrusion with many (183 out of 440 properties on the assessment) falling into the "High" category. The proposals, in widening existing sections of roadway (Hanger Lane and the lower part of Gunnersbury Avenue) may bring the road closer to properties but do not necessarily, in terms of the assessment, cause a change in the degree of visual intrusion recorded. On the other hand, where property is demolished or the road takes a new elevation, and certainly in cases where the road take a new alignment, there would be changes in the extent and degree of visual intrusion to be assessed and recorded. The main changes can be related to individual properties for which the assessment has been undertaken, and thereby to the number of households affected. Drawings RF19 and RF20 show respectively the properties falling within the assessment for existing and proposed situations. Drawing RF21 shows the distribution the changes (improvement and worsening in degree of visual intrusion) which the proposed situation incurs compared with the existing. These changes are also summarised, in terms of households affected, in Table RF22. I shall briefly describe the effects as follows:

6.21 In Hanger Lane, all properties which face onto the NCR already suffer a "High" degree of visual intrusion. The significant changes in visual intrusion caused by the road improvements would be predominantly related to the demolition of existing property on the east side of the road. This would expose properties and rear gardens in Inglis Road and Freeland Road to the widened NCR taking account of its increased levels where it would rise northwards to the railway bridge. The assessment shows that 24 properties in these locations, many of which are in multi-occupancy, would suffer a worsening effect in different degrees. It should be noted that were redevelopment of the residual Hanger Lane plots (Kolbe House, Cecilia House etc.) to take place, the screening effect of a new building in this location would thereby reduce much of the visual intrusion experienced from Inglis Road and Freeland Road properties. However, as noted previously, the Department has no powers to instigate or promote such development which would, in any case, be subject to normal planning procedures.

6.22 On the western side of the road, the assessment indicates an increase in degree of visual intrusion for some properties in Hamilton Court and at 36 Hamilton Road and 18 North Common Road.

6.23 Around the Common itself there is no shift in the pattern of visual intrusion occasioned by the completed scheme as recorded in the assessment except at the southern side where two properties on Elm Avenue would be demolished and 4 other properties immediately to the west would suffer an increase in degree of visual intrusion as a result of the slip road link using the eastern end of Elm Avenue. This might be considered surprising, given that a very large proportion of the existing through traffic would, in the proposed situation, be in the tunnel. However in accordance with the methodology, even this reduced flow on the Gunnersbury Avenue/Elm Avenue access to and from the south portal slip roads, as part of the NCR, has to be considered within the assessment. Although the reduced flow on these roads would be perceived as a considerable improvement both for properties around the Common and particularly for users of the Common, the degree of visual intrusion recorded against individual properties in the assessment does not necessarily change. By contrast, during the construction stages, many properties around the boundaries of the Common would suffer a temporary increase in visual intrusion, as part of the Common would be enclosed and excavated. Conversely, once the new road became operational, there would be considerably less traffic passing along Gunnersbury Avenue between Uxbridge Road and the new slip roads at Elm Avenue.

6.24 To the south of the Common, as a result of the new alignment, some 113 households in St. Paul's Close would suffer visual intrusion of which 40 would be in the "High" category. These properties currently suffer no visual intrusion from the NCR but its proximity in a hitherto quiet and unlit corridor would be intrusive to some degree even for properties which would have relatively narrow and contained views into the corridor.

6.25 The properties on the west side of Gunnersbury Avenue, to the east side of the new corridor, do not register on the assessment as showing a change in degree of intrusion, although in practice the area of such intrusion is transferred from the front (east side) of the houses to the rear (west side).

6.26 Conversely houses on the east side of Gunnersbury Avenue would benefit from the realignment with reductions in degree of visual intrusion. These include house numbers 11, and 12 to 54 (even numbers) and some properties in the side roads of Evelyn Grove and Kingsbridge Avenue.

6.27 Properties on the west and southern sides of Popefield Playing Fields (Aspen Close and Baronsmede, north side) would suffer some increases in degree of visual intrusion although the effect of planting on the proposed Popefield mound would subsequently foil and screen such intrusion of the road from these locations. Three houses on the south side of Baronsmede would also experience such increases as a result of demolitions on Gunnersbury Avenue and the construction of the subway.

6.28 In the section of road south of Baronsmede the properties facing onto the road are already assessed as suffering a "High" degree of visual intrusion. Although the widening of the road would bring traffic closer to these properties and the scale of the road would be greater, the degree of visual intrusion as recorded in the assessment would remain the same.

6.29 Overall the table (RF22) shows that for the proposal as a whole there would be a net increase in the number of households suffering visual intrusion (999 to 1021) although there would be a reduction in the number of households suffering a High degree of visual intrusion (372 to 312). The latter is partly explained by demolitions of property which would reduce the number of households in the "High" group by 79. Table RF22 shows how such shifts in the degree of intrusion would occur. It can be seen that 45 households previously suffering Medium, Low, or Zero visual intrusion (column 1) would, as a result of the scheme, be exposed to High visual intrusion whereas 62 households (line 1) would shift from High to Lower degrees of visual intrusion.

RF22 **VISUAL INTRUSION**

TABLE C

Visual Intrusion	Number of households within the visual envelope subject to:	Proposed Scheme	Existing Situation
	High	312	372
	Moderate	230	113
	Slight	479	514

RF22 **VISUAL INTRUSION**

TABLE D

From	High	Moderate	Slight	Zero
to				
High	250	17	4	41
Moderate	27	78	65	60
Slight	7	1	411	60
Zero	9	2	34	267
Demolished	79	15	0	0

6.30 The situation at Ealing Common deserves further mention here. The visual impact of excavating and constructing the tunnel would be widely seen by many of the properties which face directly onto the Common as well as some narrow and oblique views from side streets running off the Common. The construction works would be prominent even when seen over longer distances from the north west corner of the Common and they would certainly be intrusive to users of the Common. As the works would occupy the middle ground of a familiar and attractive open space, the degree of visual intrusion incurred in this construction phase would be recorded as High for most properties. As much of the working would be below ground level, these impacts could be considerably mitigated by placing appropriate screen fencing around the working areas. This would visually contain much of the surface disturbance and surface plant which would otherwise be a jarring element in the continuing amenity of the Common during this period. The Department would make provision for 2m high close boarded or solid panel fencing around the construction works on the Common. While recognising that the fencing itself could be intrusive, with appropriate dark colouring, it could provide a defined backdrop which would visually contain most of the works elements, allowing the main areas of the Common to continue to be used for active and passive recreational uses. Provision could also be made for a limited number of "observation windows" at selected points so that members of the public could see the nature and progress of the works. In the longer term, with full reinstatement of the surface over the tunnel, there would be very considerable benefits for users of the Common with the substantial reduction in traffic movements along Gunnersbury Avenue, the reduced severance to east-west movements across the Common, and the reduction in noise and pollution experienced on the Common.

7.0 **Summary**

7.1 In overall terms the proposals for the North Circular Road improvements at Ealing would bring substantial environmental benefits to the area. The amenity of the Common would be safeguarded as a historic open space. Adverse effects of traffic would be reduced both on the Common and in the wider area and throughout the route, pedestrian and cycling facilities would be improved.

7.2 Landscape appraisal recognises the initial impacts which the scheme would cause in construction and the need to respond actively to such impacts. The proposals take account of the importance of conserving trees wherever practically possible with appropriate protective measures in order to minimise the extent of such losses.

7.3 The scheme includes positive landscape proposals to replace such losses, maintaining insofar as the road geometry allows, the established structure and pattern of trees on the Common and ensuring that gaps in that structure are replanted and reinstated. In addition the proposals provide landscape treatments which would contain the road in the reserved corridor of St. Paul's Field and form a significant visual and vegetational link from the southern edge of the Common, through Popefield Playing Fields to Baronsmede.

NCR (Gunnersbury Avenue Improvement)

Errata : Supporting graphics on
Visual obstruction / Visual intrusion,
RF 15, 16, 17, 18, 19, 20, and 21.
Sheets marked with suffix - a - are
changes.

LUC June 1990

VISUAL OBSTRUCTION

1. Whilst preparing the clarification on Visual Obstruction at Hamilton/Inglis it has come to our attention that there are various graphical errors and omissions on the series RF-15, RF-16 and RF-17. We have now rechecked the graphics against the computer figures and have noted the corrections required on the enclosed list RF-23.

2. We have amended RF16A and 17A and will provide revised RF-15A.

3. In essence the changes are:

On RF-15: (Existing situation)
i) the North side of the Carnavon Hotel, South side of no. 9 Hanger Lane and 1a Creffield Road should be shown as moderate and slight (ie. the same as on RF-16)

On RF-16: (Proposed situation)
(i) a number of properties which should have been coloured have been left white

(ii) two properties were incorrectly coloured (Gunnersbury Lodge, and no. 2 Creffield Road,)

on RF-17: (Comparison between Existing and Proposed)
(i) a number of properties (11 no) which were shown white should be coloured pink

(ii) the fronts of 8 properties in Gunnersbury Avenue which were shown white should be coloured blue

(iii) 3 properties at western end of Creffield Road, which experience no change in V.O., and were shown pink should be shown white

4. We have also re-examined the collation of data and have identified minor changes in the totals. A revised framework RF-18A is herewith submitted.

5. These changes do not affect the substance of Mr Flenley's evidence except for paragraph 6.15 in which the numbers relating to the framework are amended.

RF18A VISUAL OBSTRUCTION - REVISED FRAMEWORK TABLE

TABLE A

Visual Obstruction	Number of households within the visual envelope subject to:	Proposed Scheme	Existing Situation
	High	192	323
	Moderate	135	65
	Slight	99	48

RF18A VISUAL OBSTRUCTION - REVISED FRAMEWORK TABLE

TABLE B

From	High	Moderate	Slight	Zero
to				
High	156	29	1	6
Moderate	55	28	17	35
Slight	8	-	15	76
Zero	25	8	0	828
Demolished	79	-	15	-

RF 23

VISUAL OBSTRUCTION

Corrections to RF 15, RF 16 & RF 17

OMISSION ON RF 15	WAS	NOW
South side of No. 9 Hanger Lane	white	brown
North side of Carnarvon Hotel	white	brown/yellow
1a Creffield Road	"	yellow
OMISSIONS ON RF 16	**WAS (RF 16)**	**NOW (RF 16a)**
38 Hamilton Road (front)	white	red
51-53 Hamilton Road	white	red
32-37 Hamilton Court	white	red
North Common Lodge	white	red
20 North Common Road	white	red
Dairy	white	red
9-12 Hanger lane	white	red
Carnarvon Hotel (west side)	white	red
10-11 Gunnersbury Avenue	white	brown
68 Gunnersbury Avenue	white	brown
120-122 St. Paul's Close	white	yellow
53-55 St. Paul's Close	white	yellow
19 Ridgeway	white	yellow
6-8 Ridgeway	white	brown
CORRECTION ON RF 16a		
Gunnersbury Lodge (no building)	red	white
2 Creffield Road	yellow	blue cross
OMISSIONS ON RF 17	**WAS (RF 17)**	**NOW (RF 17a)**
1-6 Hamilton Court	white	pink
Dairy (north side)	white	pink
13-27 Gunnersbury Avenue (fronts)	white	blue
120-122 and 53-55 St. Paul's Close	white	pink
56 & 67 Baronsmede (previously notified)	white	pink
174 & 201 Gunnersbury Lane	white	pink
3 Ridgeway	white	pink
CORRECTIONS ON 17a		
South side No. 9 Hanger Lane	pink	white
North side Carnarvon Hotel	pink	white
Kilbrin (Creffield Road)	pink	white

FRAMEWORK

THE A406

(GUINNERSBURY AVENUE IMPROVEMENTS)

GROUP 2: OCCUPIERS (continued)

SUB-GROUP	EFFECTS	UNITS	PROPOSED SCHEME	NO NOTHING	COMMENTS
Industrial and Commercial Properties;		Number of buildings within the visual envelope subject to:			
(a) Offices:	Visual Obstruction	High Moderate Slight	3 0 0	3 0 0	
(c) Other Business:	Visual Obstruction	Number of buildings within the visual envelope subject to:			
		High Moderate Slight	5 2 0	6 0 1	

RF 24

VISUAL INTRUSION (RF19, 20, 21)

OMISSIONS RF 19	WAS (RF 19)	NOW (RF 19a)
23-24 Hanger Lane	White	Pink
Hawthorne Court (The Common)	"	Yellow
No.1 St. Matthews Road	"	"
Fircroft and nos. 1, 2a, 4, 6 Evelyn Grove		
16, 18 and 20 Inglis Road	"	"
193 Gunnersbury Lane	"	"
The Grange	"	"

OMISSIONS ON RF 20	RF 20	RF20a
Nos. 83-117 (odds)	White	Pink
10 The Common	White	Yellow
31-41 Ridgeway	White	Yellow

CORRECTIONS ON RF 21	RF21	RF21a
18 North Comon Road	White	Pink
9 North Common Road	Pink	White

These graphical omissions do not affect the framework tables on RF 22.

Public Inquiry Document No. 2/7A

Proof of Evidence on Landscape
Supporting Graphics

DEPARTMENT OF TRANSPORT
LONDON REGIONAL OFFICE

A406
NORTH CIRCULAR ROAD

(Gunnersbury Avenue Improvement)

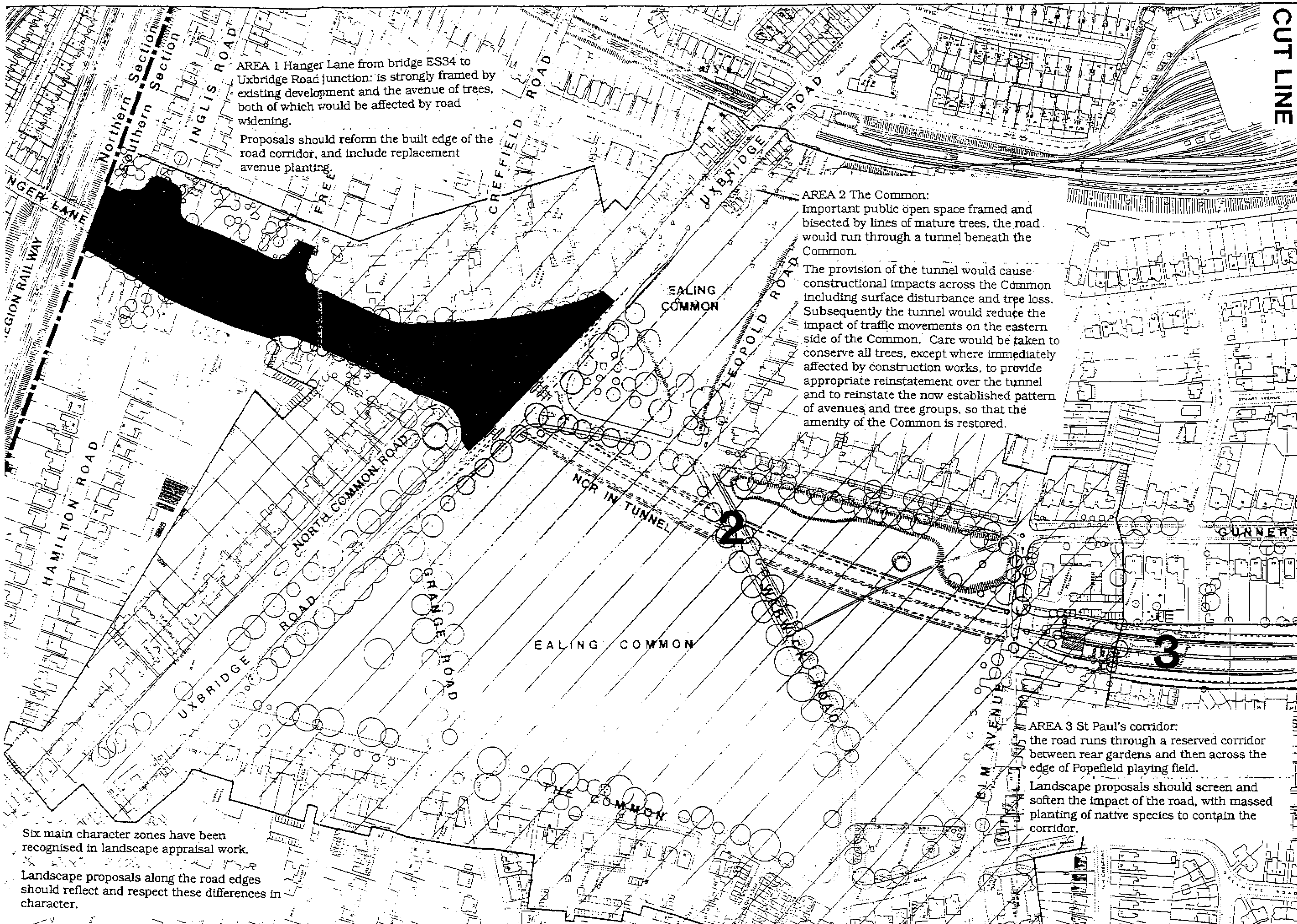
PROOF OF EVIDENCE ON LANDSCAPE

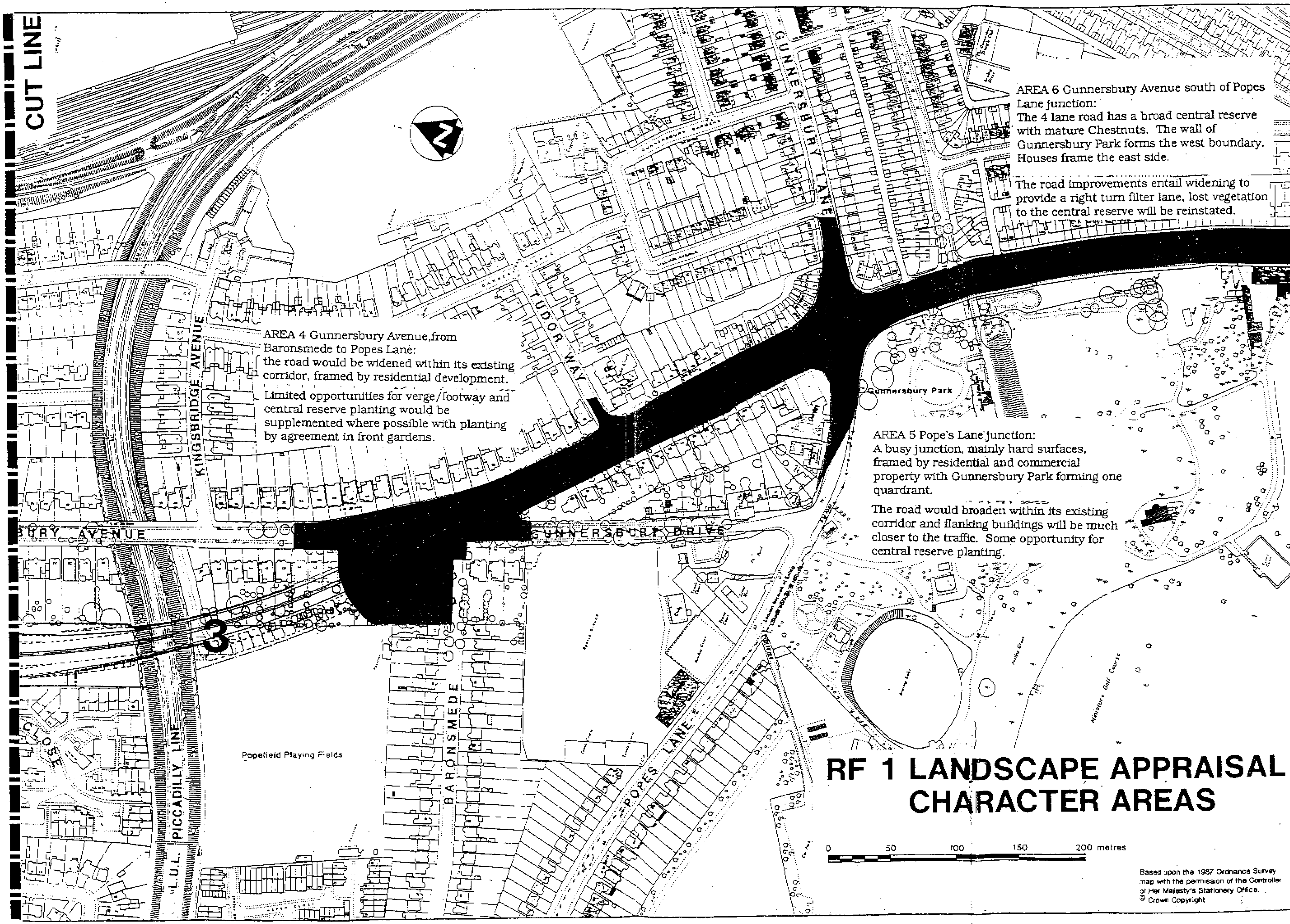
Supporting Graphics

Department of Transport
London Regional Office,
2 Marsham Street,
London SW1P 3EB

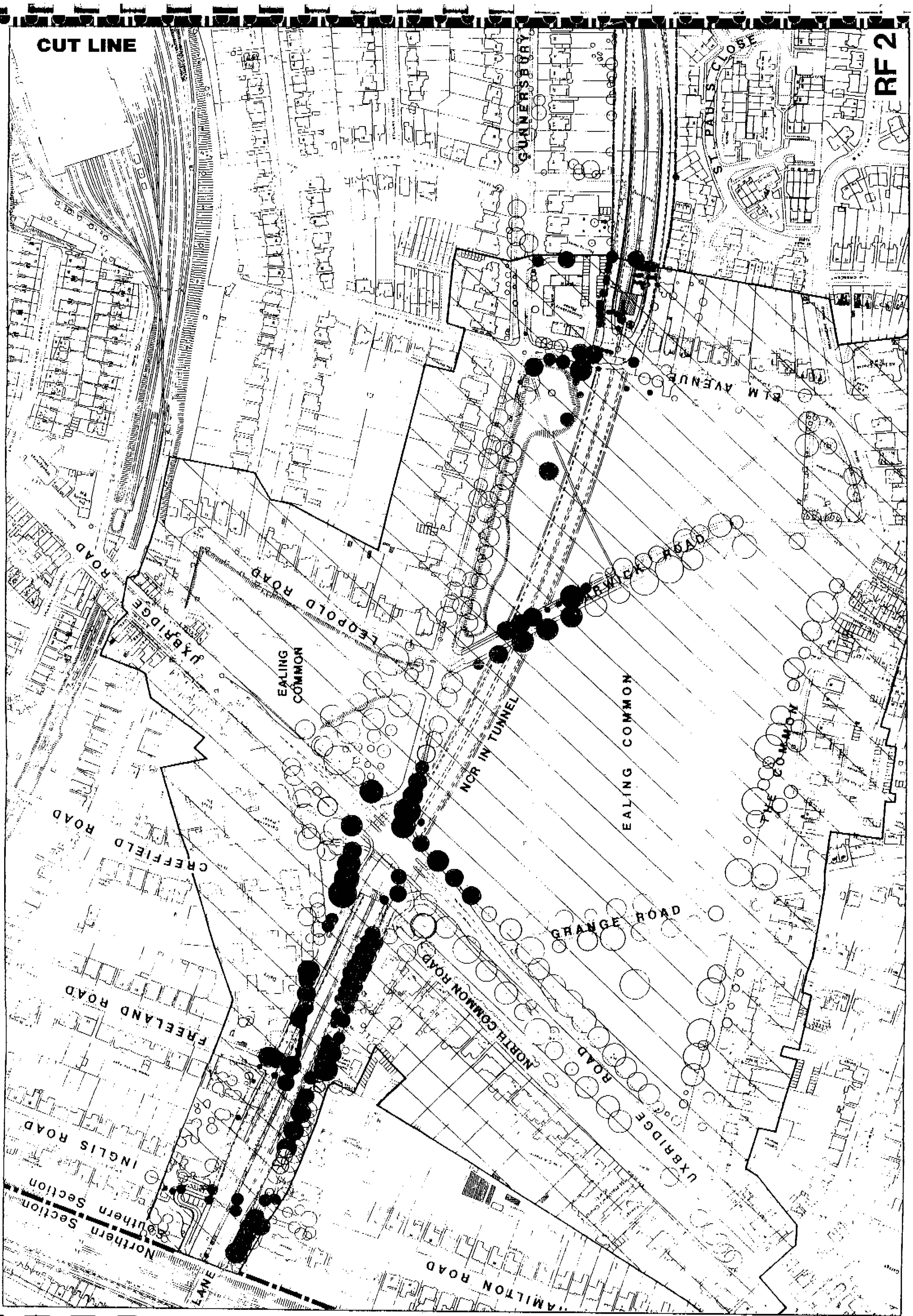
Ref. 62372.0
June 1990

LAND USE CONSULTANTS
Enviromental Planners & Designers
43 Chalton Street,
London, NW1 1JB


AREA 1 Hanger Lane from bridge ES34 to Uxbridge Road junction: is strongly framed by existing development and the avenue of trees, both of which would be affected by road widening.
Proposals should reform the built edge of the road corridor, and include replacement avenue planting.
AREA 2 The Common:
Important public open space framed and bisected by lines of mature trees, the road would run through a tunnel beneath the Common.
The provision of the tunnel would cause constructional impacts across the Common including surface disturbance and tree loss. Subsequently the tunnel would reduce the impact of traffic movements on the eastern side of the Common. Care would be taken to conserve all trees, except where immediately affected by construction works, to provide appropriate reinstatement over the tunnel and to reinstate the now established pattern of avenues and tree groups, so that the amenity of the Common is restored.
AREA 3 St Paul's corridor:
the road runs through a reserved corridor between rear gardens and then across the edge of Popefield playing field.
Landscape proposals should screen and soften the impact of the road, with massed planting of native species to contain the corridor.
Six main character zones have been recognised in landscape appraisal work.
Landscape proposals along the road edges should reflect and respect these differences in character.
CUT LINE
Northern Section
Southern Section
INGLIS ROAD
CREFFIELD ROAD
UXBRIDGE ROAD
EALING COMMON
LEOPOLD ROAD
NCR IN TUNNEL
NORTH COMMON ROAD
HAMILTON ROAD
GRANGE ROAD
WARWICK ROAD
EALING COMMON
THE COMMON
ELM AVENUE
2
3

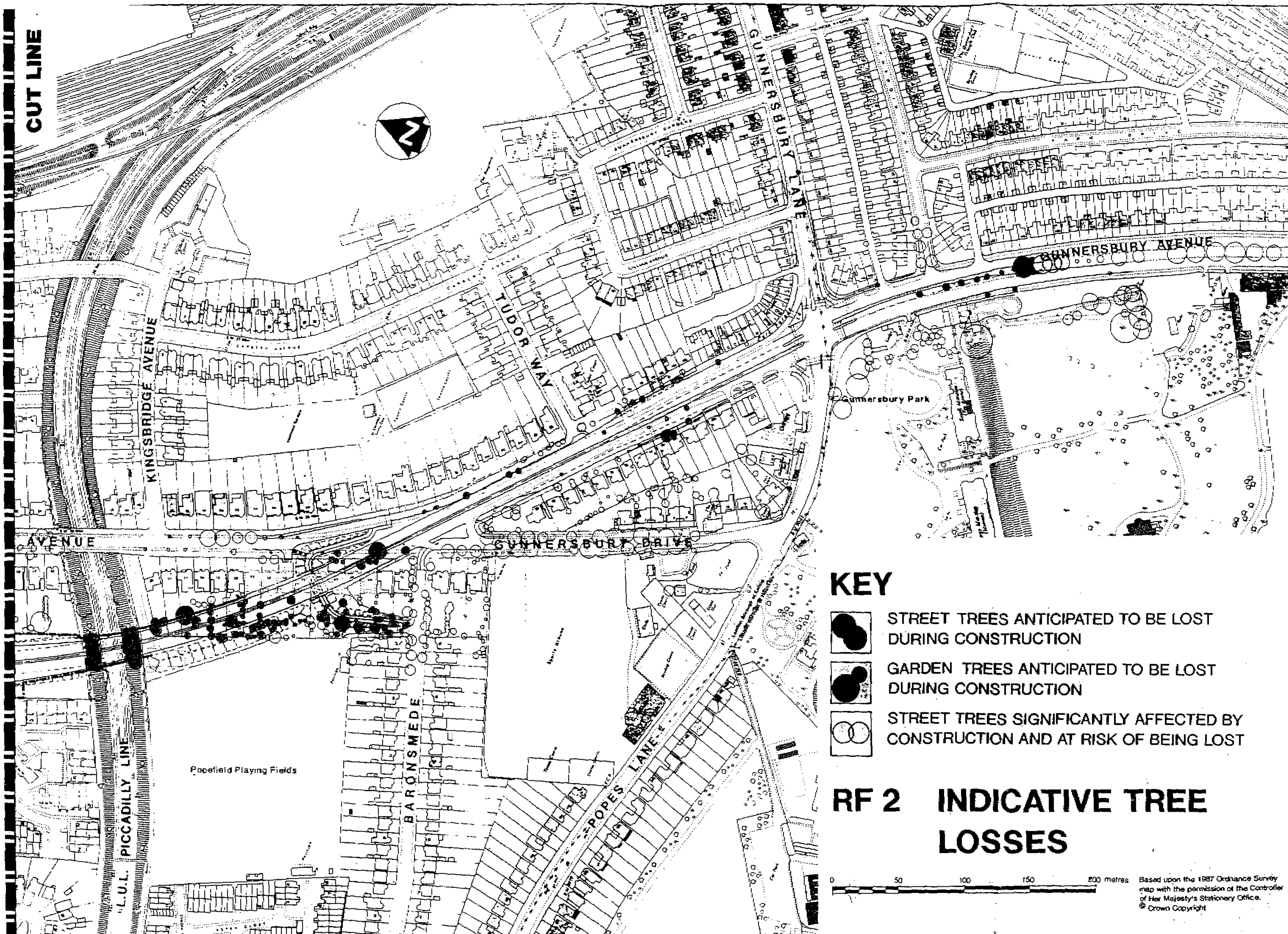


RF 1 LANDSCAPE APPRAISAL CHARACTER AREAS

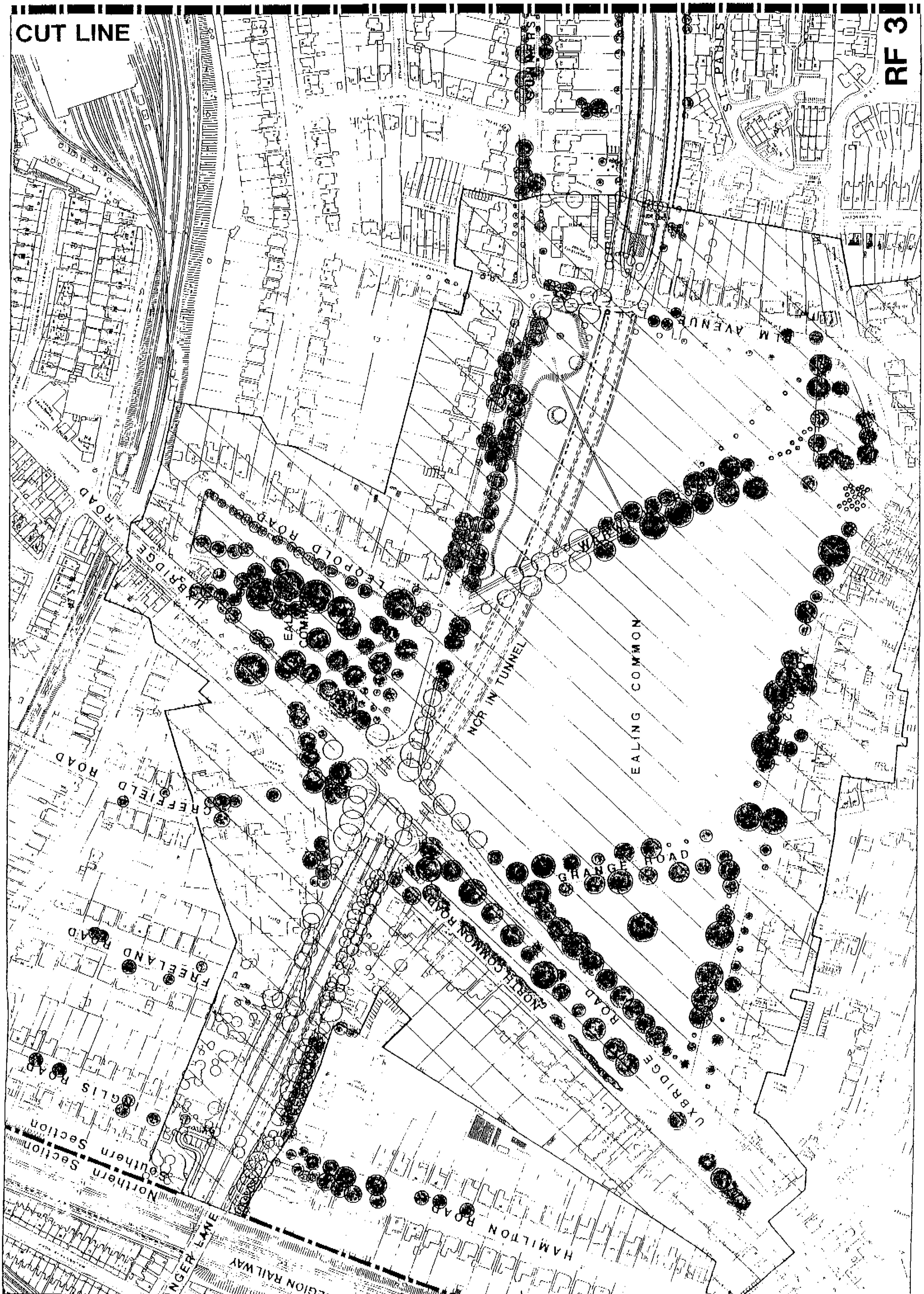


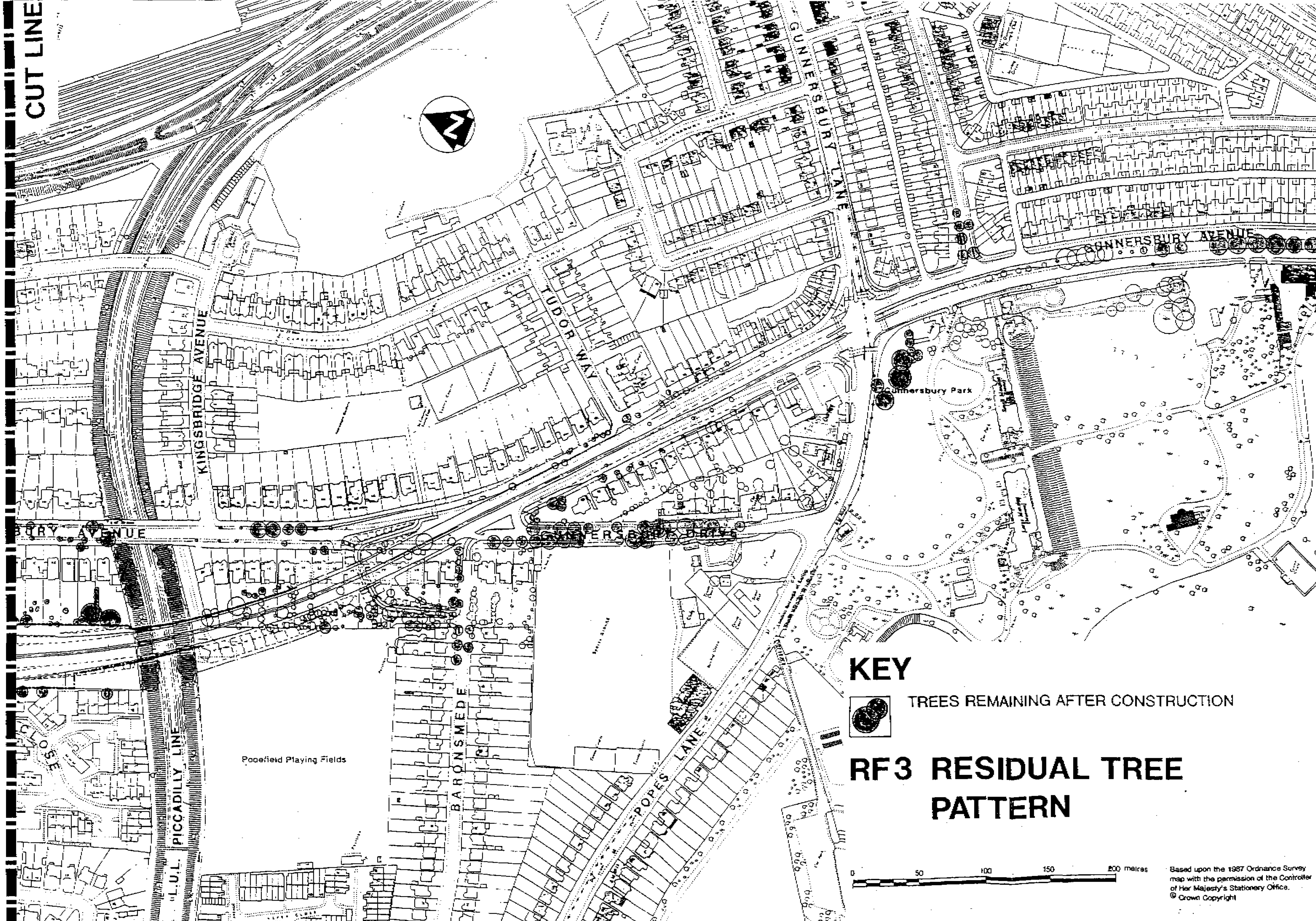
CUT LINE
RF 2
GUNNERSBURY
ST PAULS CLOSE
ELM AVENUE
RWICK ROAD
LEOPOLD ROAD
UXBRIDGE ROAD
EALING COMMON
NCR IN TUNNEL
EALING COMMON
THE COMMON
CREFFIELD ROAD
GRANGE ROAD
NORTH COMMON ROAD
FREELAND ROAD
UXBRIDGE ROAD
INGLIS ROAD
Southern Section
Northern Section
LANE
AMILTON ROAD

CUT LINE



RF 2 INDICATIVE TREE LOSSES


CUT LINE
RF 3
ST PAULS
ELM AVENUE
LEOPOLD ROAD
UXBRIDGE ROAD
EALING COMMON
NCR IN TUNNEL
CREFFIELD ROAD
GRANGE ROAD
NORTH COMMON ROAD
FREELAND ROAD
INGLIS ROAD
Southern Section
Northern Section
HAMILTON ROAD
UXBRIDGE ROAD



KEY

TREES REMAINING AFTER CONSTRUCTION

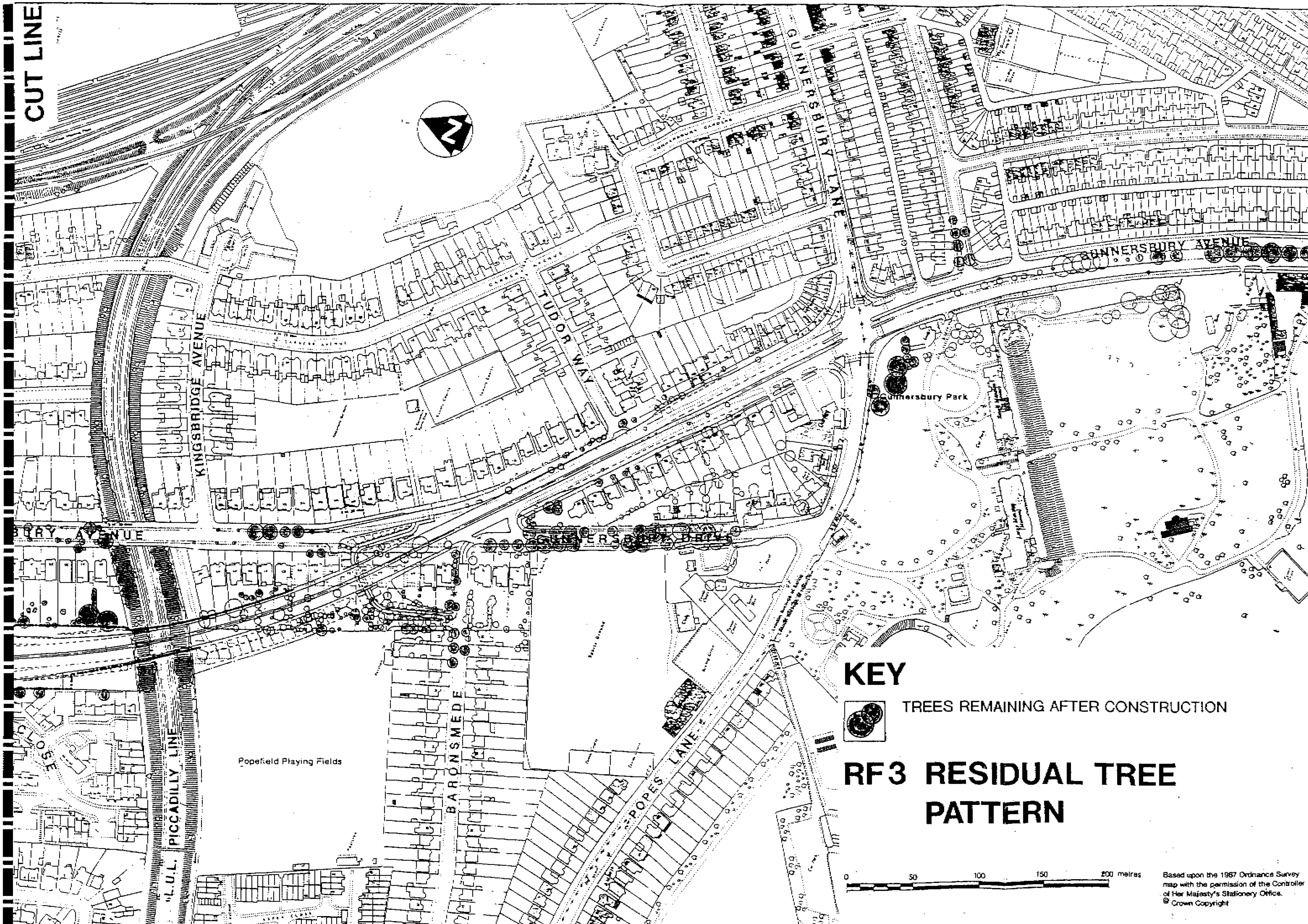
RF3 RESIDUAL TREE PATTERN

Based upon the 1987 Ordnance Survey map with the permission of the Controller of Her Majesty's Stationery Office.

RF4: PREDICTED LOSSES: STREET TREES

Table **RF4**

Assembly	Total Trees in Survey	Trees to be felled (IV) (certain losses)	Trees seriously affected (III) (possible losses)	**Total Losses**	Summary of 150 Losses		
					Mature Trees (Age Groups C & D)	Trees in Poor Condition	Trees which could be transplanted
Hanger Lane Avenue	68	47	4	**51**	51		5
Hanger Lane East	19	9	-	**9**	9	1	-
Inglis Road	6	5	-	**5**	3	-	-
Freeland Road	6	4	-	**4**	2	1	-
Hamilton Road	4	-	-	-	-	-	-
Uxbridge Road North	15	3	-	**3**	2	-	-
Uxbridge Triangle	30	8	1	**9**	9	-	-
Uxbridge Road/ Gunnersbury Avenue	19	10	1	**11**	10	1	1
Warwick Road	17	12	-	**12**	10	1	-
Elm Avenue	24	15	-	**15**	9	1	6
Gunnersbury Avenue/ Ealing Common	42	-	-	-	-	-	-
Gunnersbury Avenue Central	55	8	-	**8**	1	5	2
Baronsmede	3	-	-	-	-	-	-
Gunnersbury Drive	7	-	-	-	-	-	-
Gunnersbury Avenue South of Baronsmede	10	7	-	**7**	-	3	1
Gunnersbury Lane	2	2	-	**2**	-	-	-
Gunersbury Park	20	11	3	**14**	5	1	3
TOTAL	**347**	**141**	**9**	**150**	**111**	**19**	**13**



CUT LINE
GUNNERSBURY LANE
GUNNERSBURY AVENUE
Gunnersbury Park
TUDOR WAY
KINGSBRIDGE AVENUE
GUNNERSBURY DRIVE
BARONSMEDE
POPES LANE
Popefield Playing Fields
"L.U.L." PICCADILLY LINE
CLOSE
KEY
TREES REMAINING AFTER CONSTRUCTION
RF3 RESIDUAL TREE PATTERN
0 50 100 150 200 metres
Based upon the 1987 Ordnance Survey map with the permission of the Controller of Her Majesty's Stationery Office.
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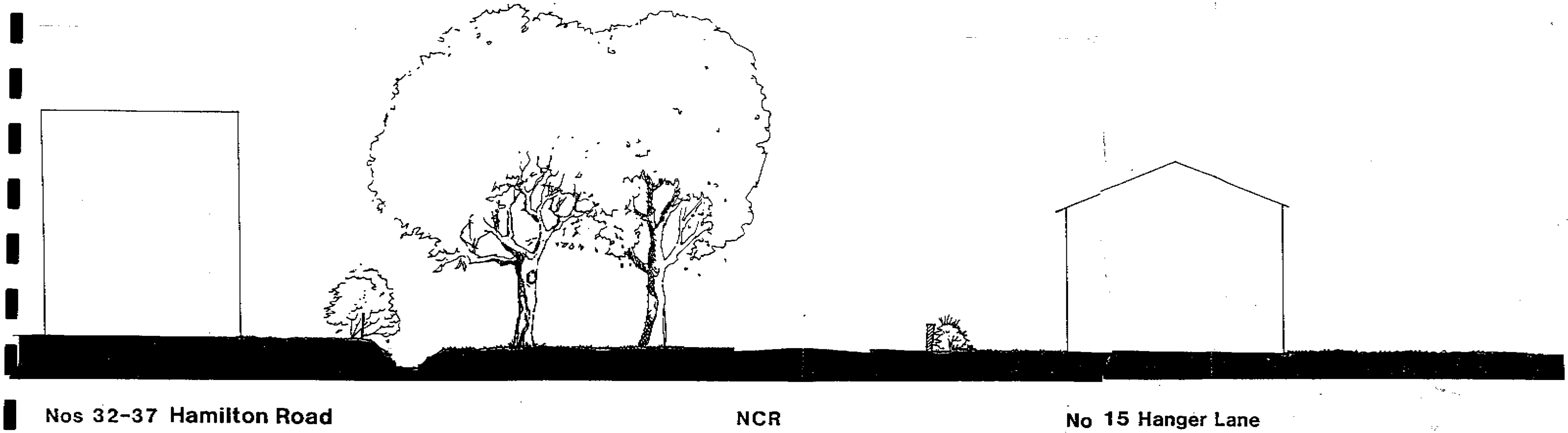

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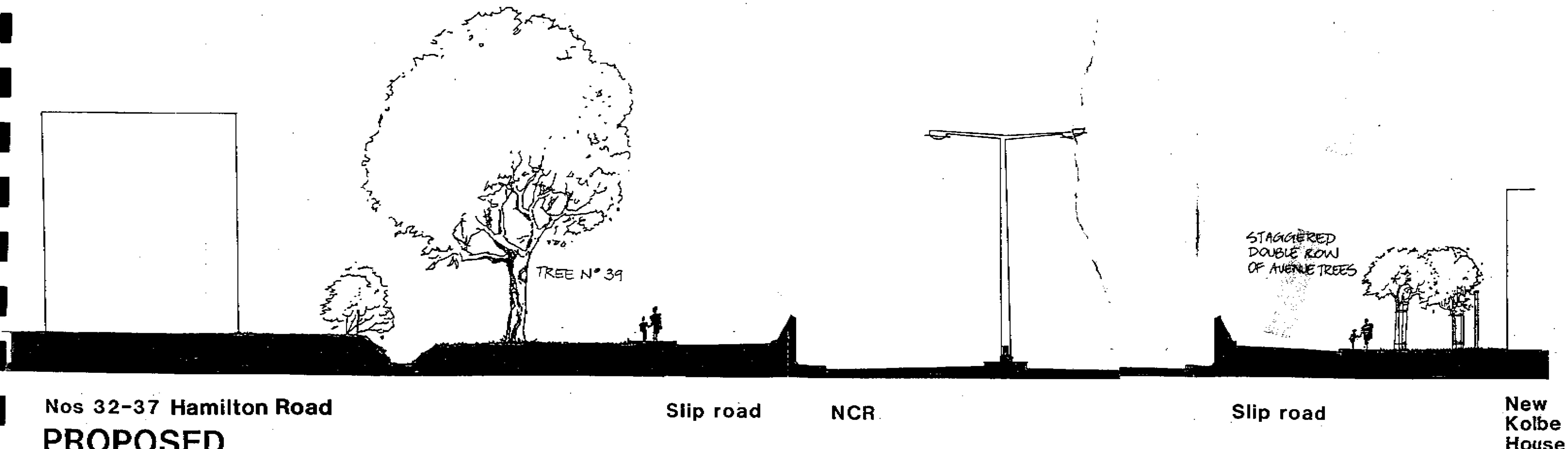
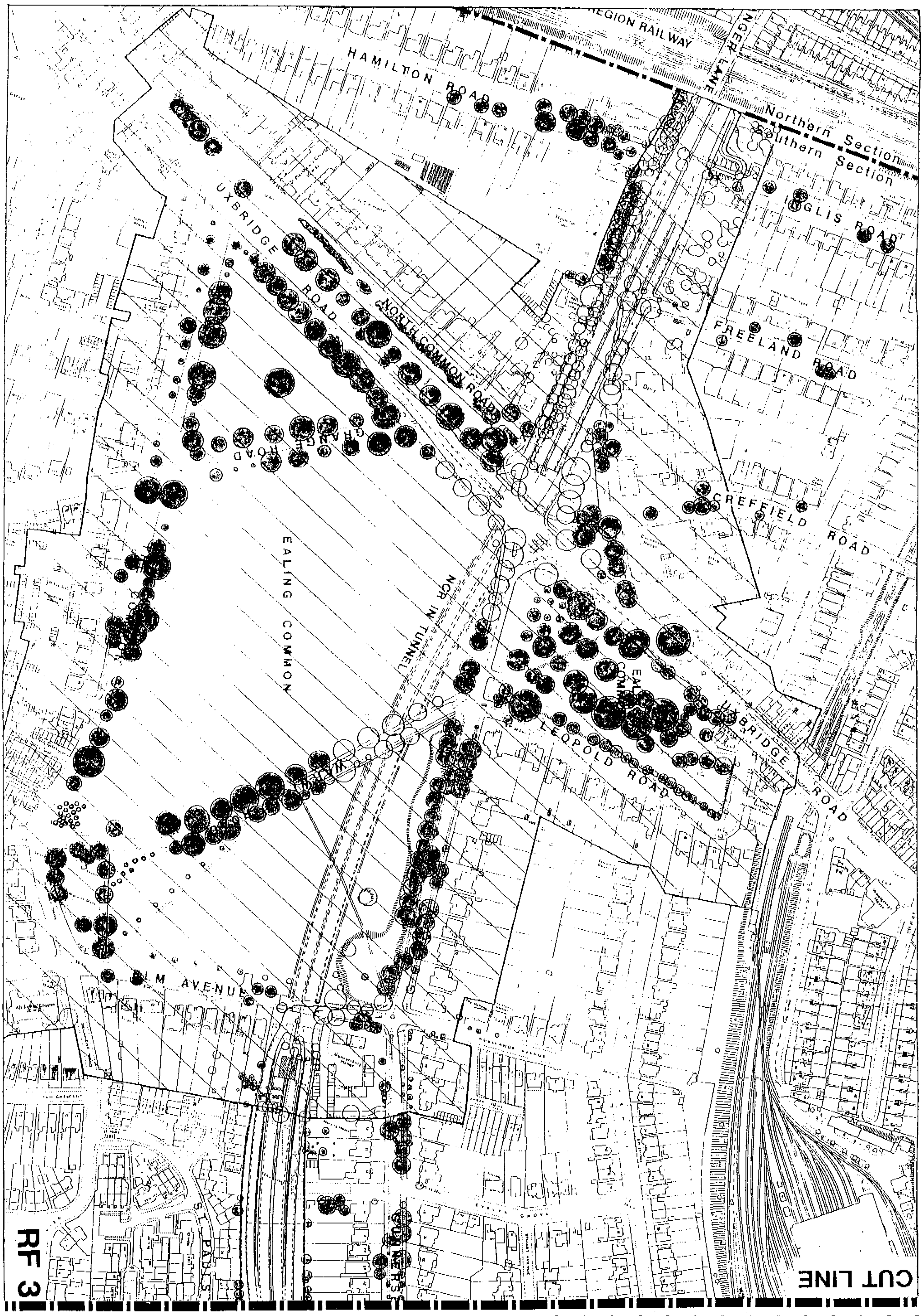


PROPOSED

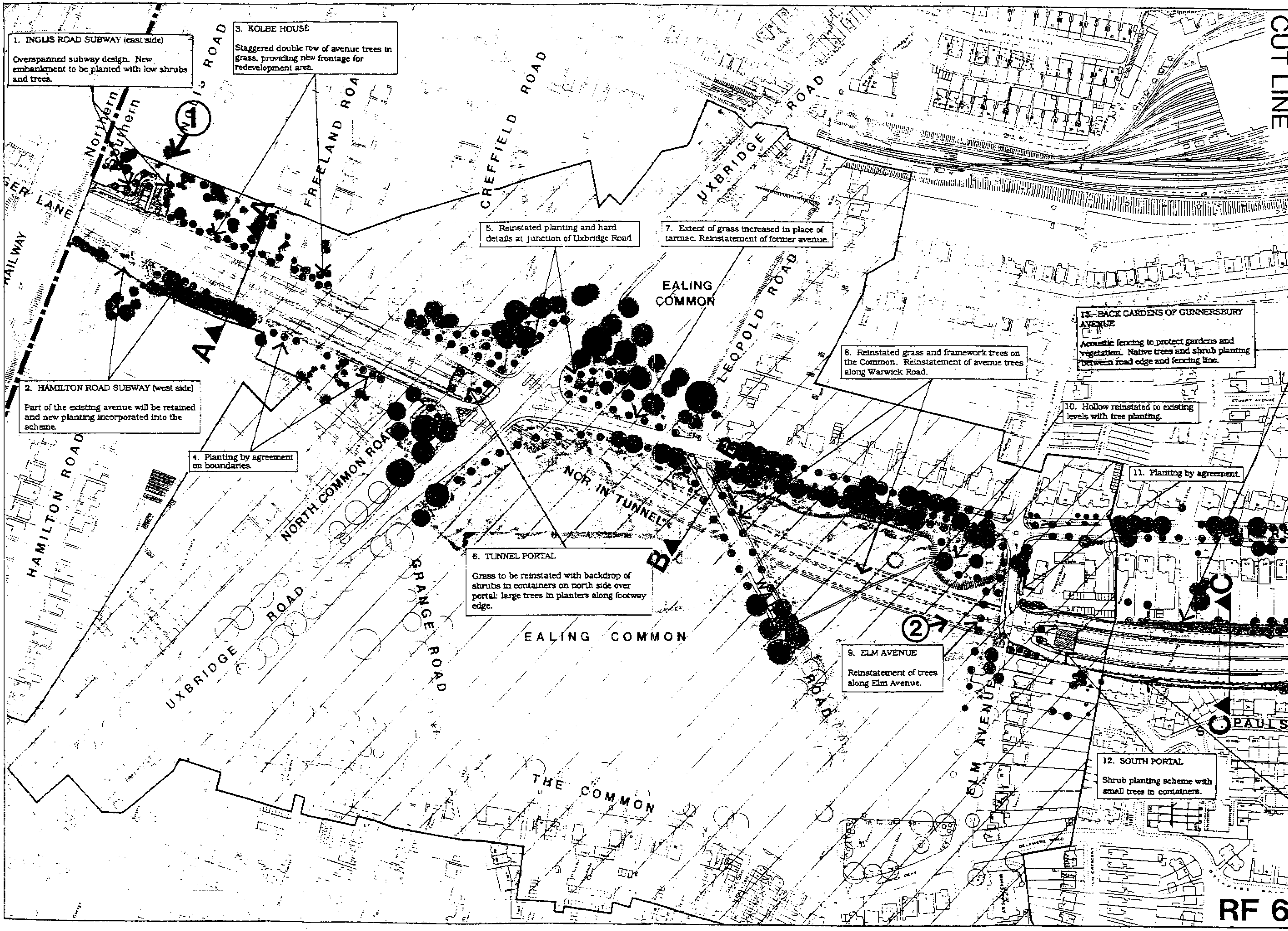
SECTION AA

LOOKING NORTH THROUGH NOS 32-37
AND NUMBER 15 HANGER LANE SCALE 1:200

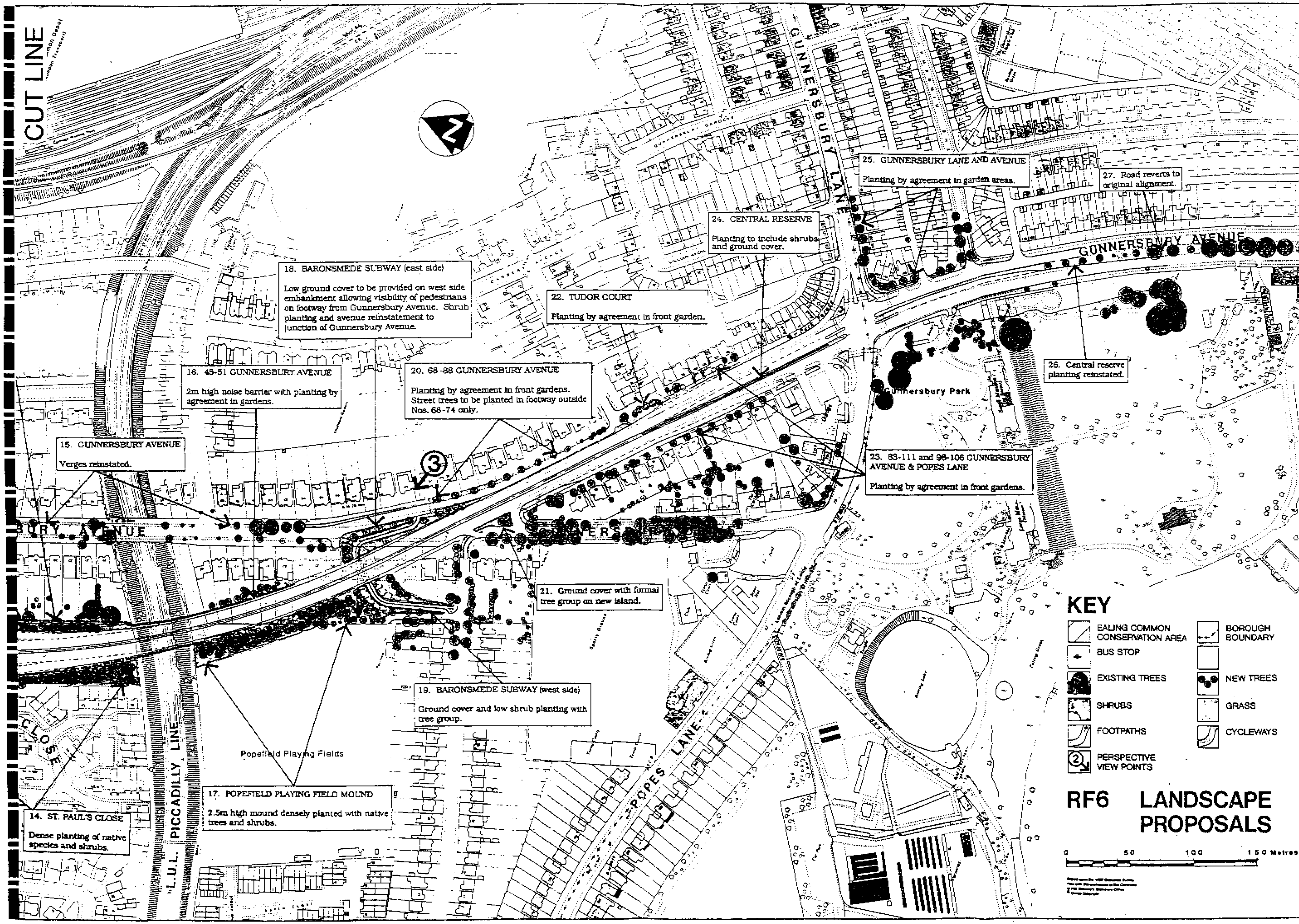
RF 5

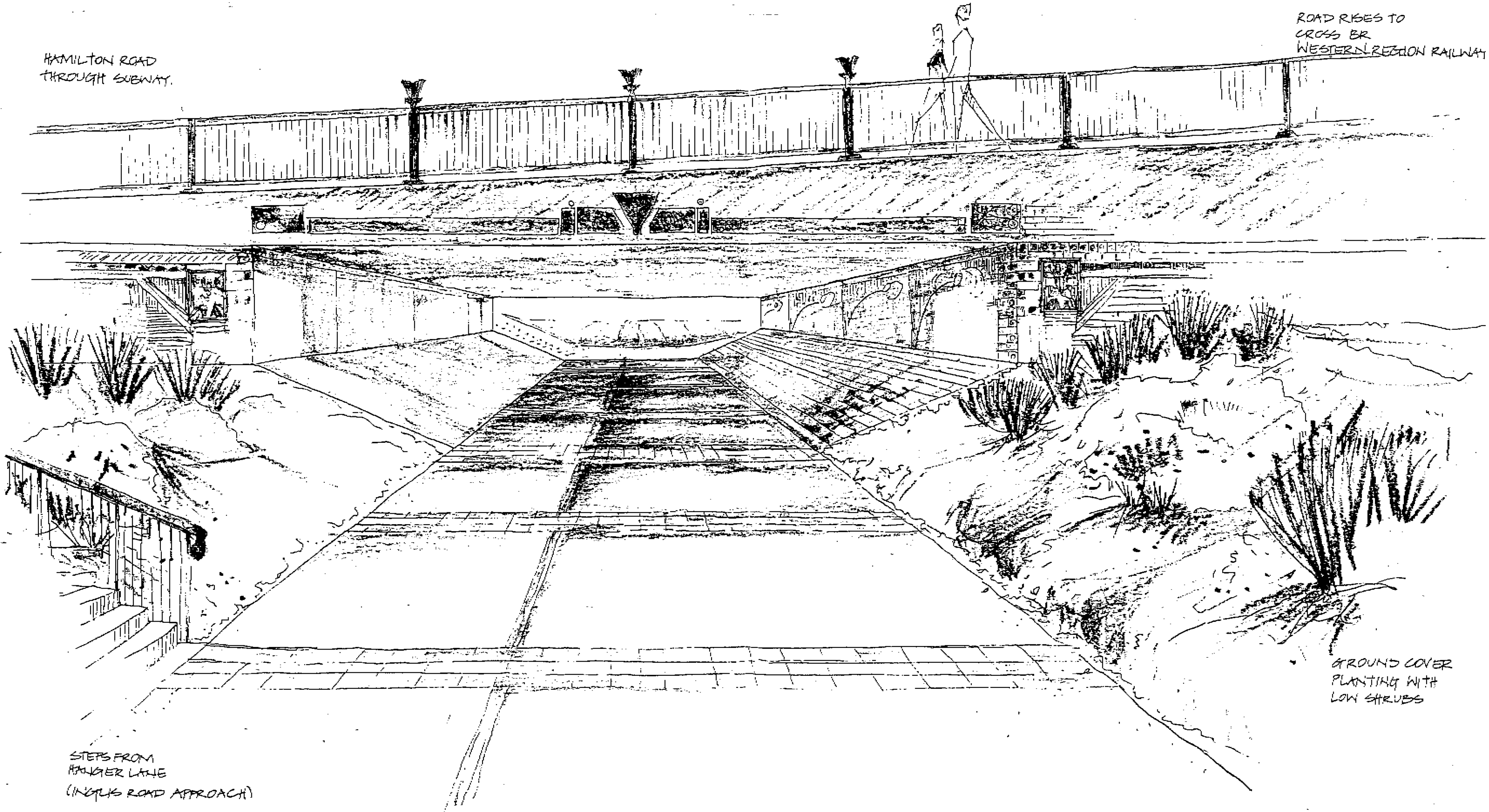


EGION RAILWAY
HAMILTON ROAD
Northern Section
Southern Section
INGLIS ROAD
UXBRIDGE ROAD
NORTH COMMON ROAD
GRANGE ROAD
FREELAND ROAD
CREFFIELD ROAD
EALING COMMON
NCR IN TUNNEL
LEOPOLD ROAD
UXBRIDGE ROAD
ELM AVENUE
RF 3
CUT LINE



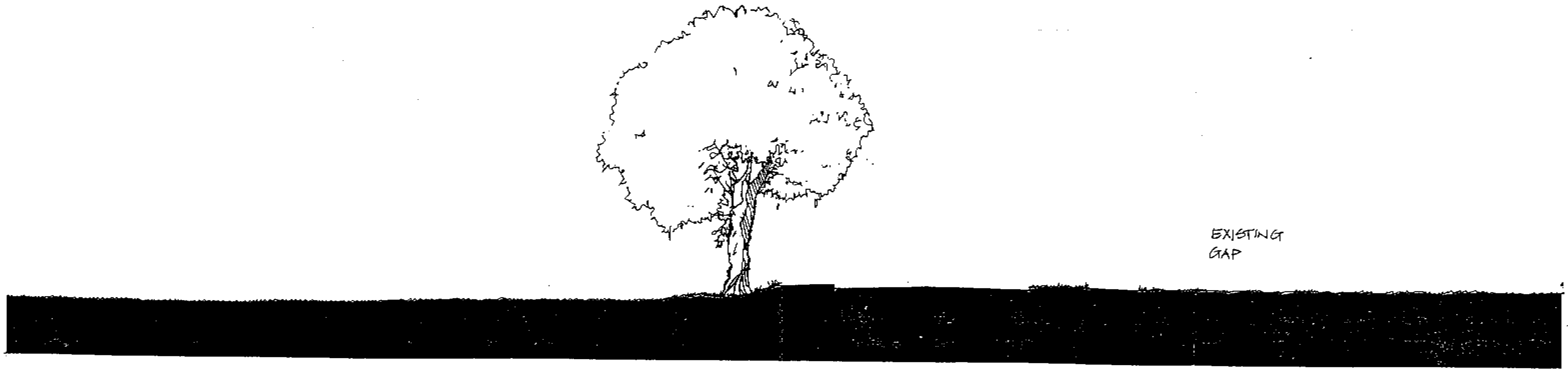
1. INGLIS ROAD SUBWAY (east side)
Overspanned subway design. New embankment to be planted with low shrubs and trees.
2. HAMILTON ROAD SUBWAY (west side)
Part of the existing avenue will be retained and new planting incorporated into the scheme.
3. KOLBE HOUSE
Staggered double row of avenue trees in grass, providing new frontage for redevelopment area.
4. Planting by agreement on boundaries.
5. Reinstated planting and hard details at junction of Uxbridge Road
6. TUNNEL PORTAL
Grass to be reinstated with backdrop of shrubs in containers on north side over portal; large trees in planters along footway edge.
7. Extent of grass increased in place of tarmac. Reinstatement of former avenue.
8. Reinstated grass and framework trees on the Common. Reinstatement of avenue trees along Warwick Road.
9. ELM AVENUE
Reinstatement of trees along Elm Avenue.
10. Hollow reinstated to existing levels with tree planting.
11. Planting by agreement.
12. SOUTH PORTAL
Shrub planting scheme with small trees in containers.
13. BACK GARDENS OF GUNNERSBURY AVENUE
Acoustic fencing to protect gardens and vegetation. Native trees and shrub planting between road edge and fencing line.
RAILWAY
Northern
Southern
HAMILTON ROAD
FREELAND ROA
CREFFIELD ROAD
UXBRIDGE ROAD
NORTH COMMON ROAD
GRANGE ROAD
EALING COMMON
LEOPOLD ROAD
NCR IN TUNNEL
ELM AVENUE
THE COMMON
PAULS
CUT LINE
RF 6


CUT LINE
L.U.L. PICCADILLY LINE
14. ST. PAUL'S CLOSE
Dense planting of native species and shrubs.
15. GUNNERSBURY AVENUE
Verges reinstated.
16. 45-51 GUNNERSBURY AVENUE
2m high noise barrier with planting by agreement in gardens.
17. POPEFIELD PLAYING FIELD MOUND
2.5m high mound densely planted with native trees and shrubs.
Popefield Playing Fields
18. BARONSMEDE SUBWAY (east side)
Low ground cover to be provided on west side embankment allowing visibility of pedestrians on footway from Gunnersbury Avenue. Shrub planting and avenue reinstatement to junction of Gunnersbury Avenue.
19. BARONSMEDE SUBWAY (west side)
Ground cover and low shrub planting with tree group.
20. 68-88 GUNNERSBURY AVENUE
Planting by agreement in front gardens. Street trees to be planted in footway outside Nos. 68-74 only.
21. Ground cover with formal tree group on new island.
22. TUDOR COURT
Planting by agreement in front garden.
23. 83-111 and 96-106 GUNNERSBURY AVENUE & POPES LANE
Planting by agreement in front gardens.
24. CENTRAL RESERVE
Planting to include shrubs and ground cover.
25. GUNNERSBURY LANE AND AVENUE
Planting by agreement in garden areas.
26. Central reserve planting reinstated.
27. Road reverts to original alignment.
GUNNERSBURY LANE
GUNNERSBURY AVENUE
POPES LANE
Gunnersbury Park
KEY
EALING COMMON CONSERVATION AREA
BOROUGH BOUNDARY
BUS STOP
EXISTING TREES
NEW TREES
SHRUBS
GRASS
FOOTPATHS
CYCLEWAYS
PERSPECTIVE VIEW POINTS
RF6 LANDSCAPE PROPOSALS
0
50
100
150 Metres



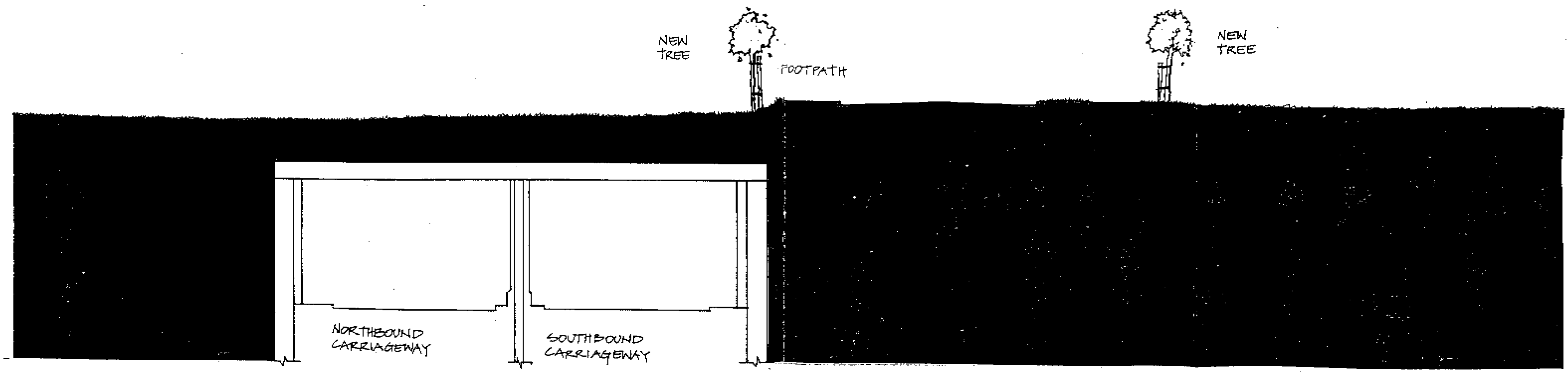
PERSPECTIVE SKETCH INGLIS/HAMILTON SUBWAY

RF 7



Ealing Common   Warwick Road

EXISTING



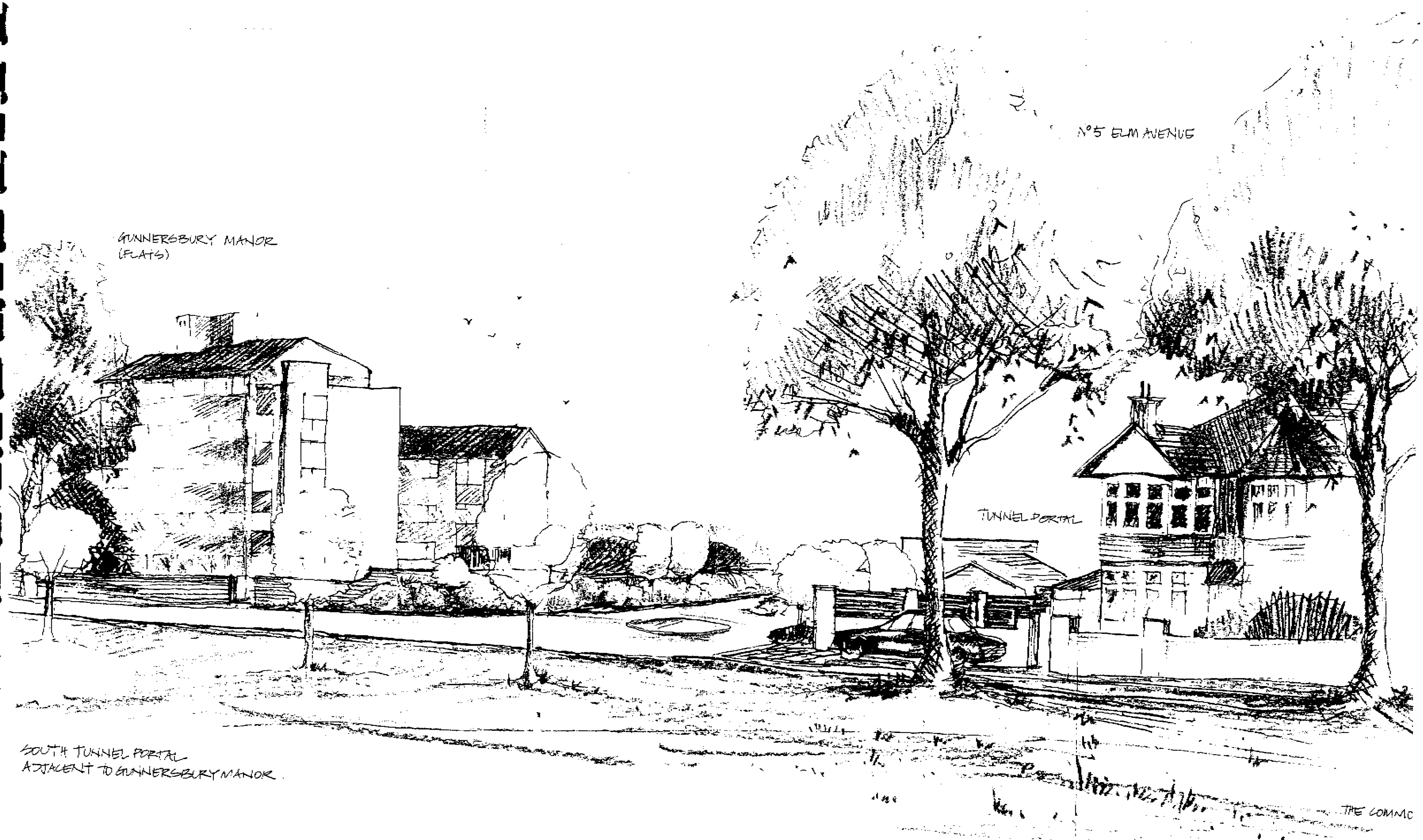
Ealing Common   NCR in tunnel   Warwick Road

PROPOSED

SECTION BB

LOOKING NORTH THROUGH THE TUNNEL AT WARWICK ROAD SCALE 1:200

RF 8



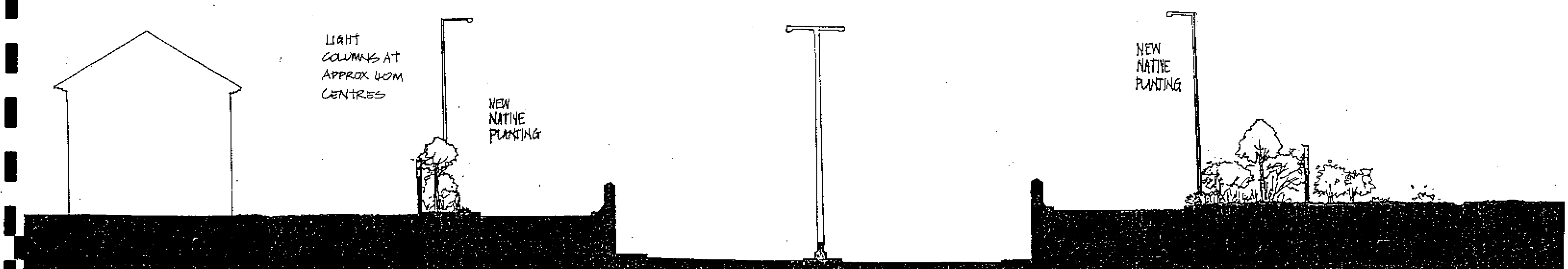
PERSPECTIVE SKETCH ELM AVENUE

RF 9

34 St Pauls Close

EXISTING

Garden of No 21
Gunnersbury Avenue



34 St Pauls Close

Slip road

NCR

Slip road

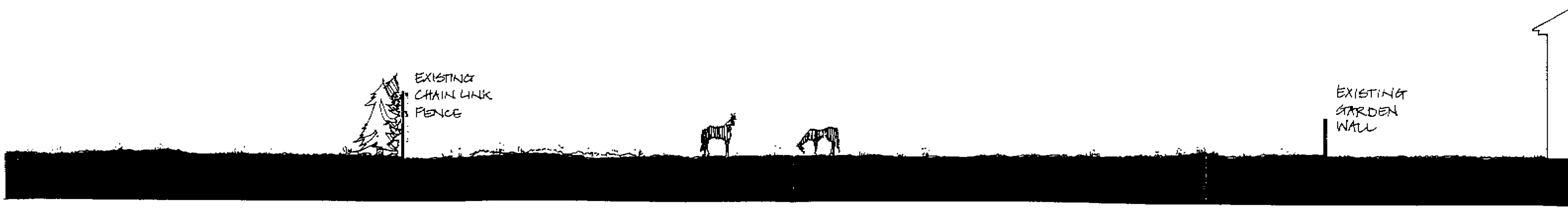
Garden of No 21
Gunnersbury Avenue

PROPOSED

SECTION CC

LOOKING NORTH THROUGH ST PAULS CLOSE
AND GUNNERSBURY AVENUE SCALE 1:200

RF 10

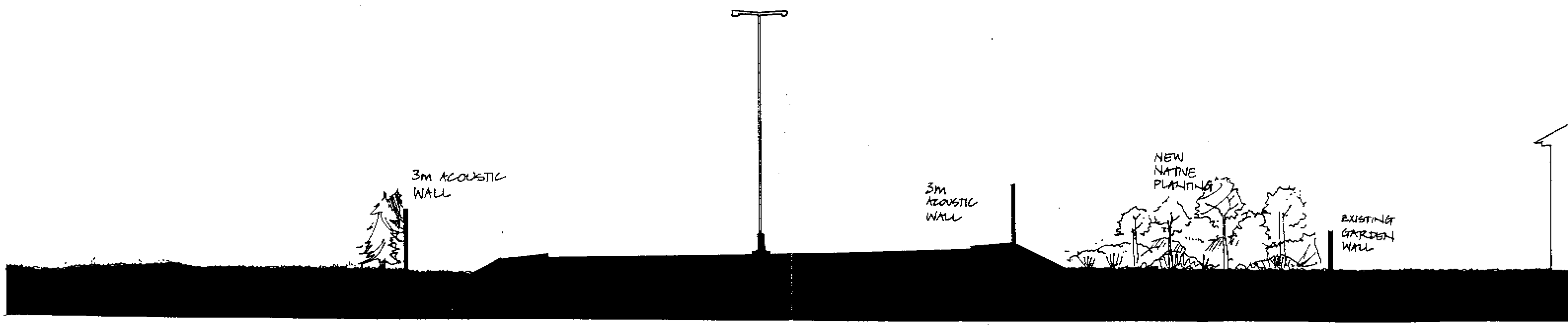


Garden of No 39
Gunnersbury Avenue

St Pauls Field

No 46 St Pauls Close

EXISTING



Garden of No 39
Gunnersbury Avenue

NCR

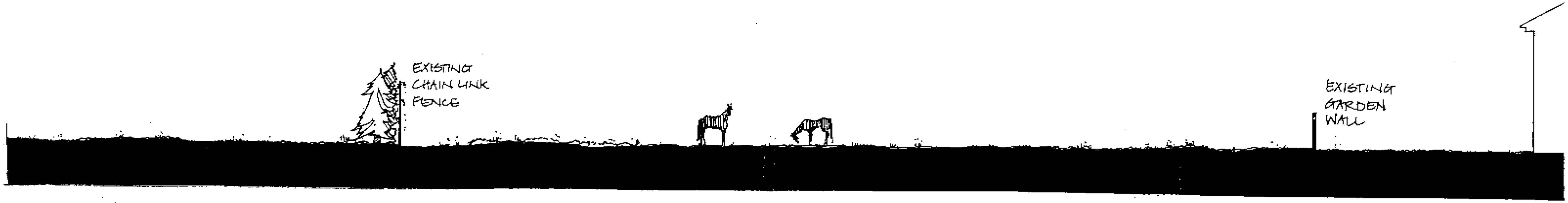
No 46 St Pauls Close

PROPOSED

SECTION DD

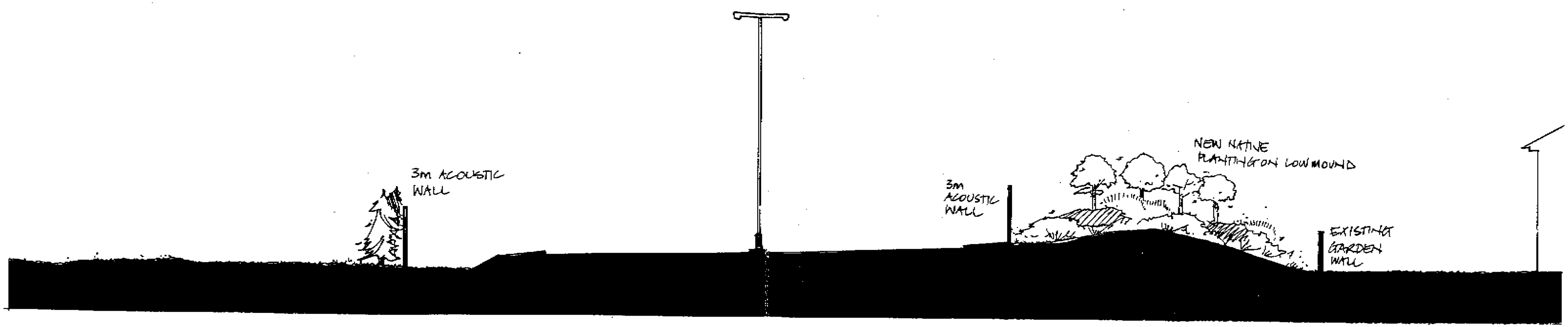
LOOKING SOUTH THROUGH No 39 GUNNERSBURY AVE AND No 46 ST PAULS CLOSE SCALE 1:200

RF 11



Garden of No 39 Gunnersbury Avenue | St Pauls Field | No 46 St Pauls Close

EXISTING



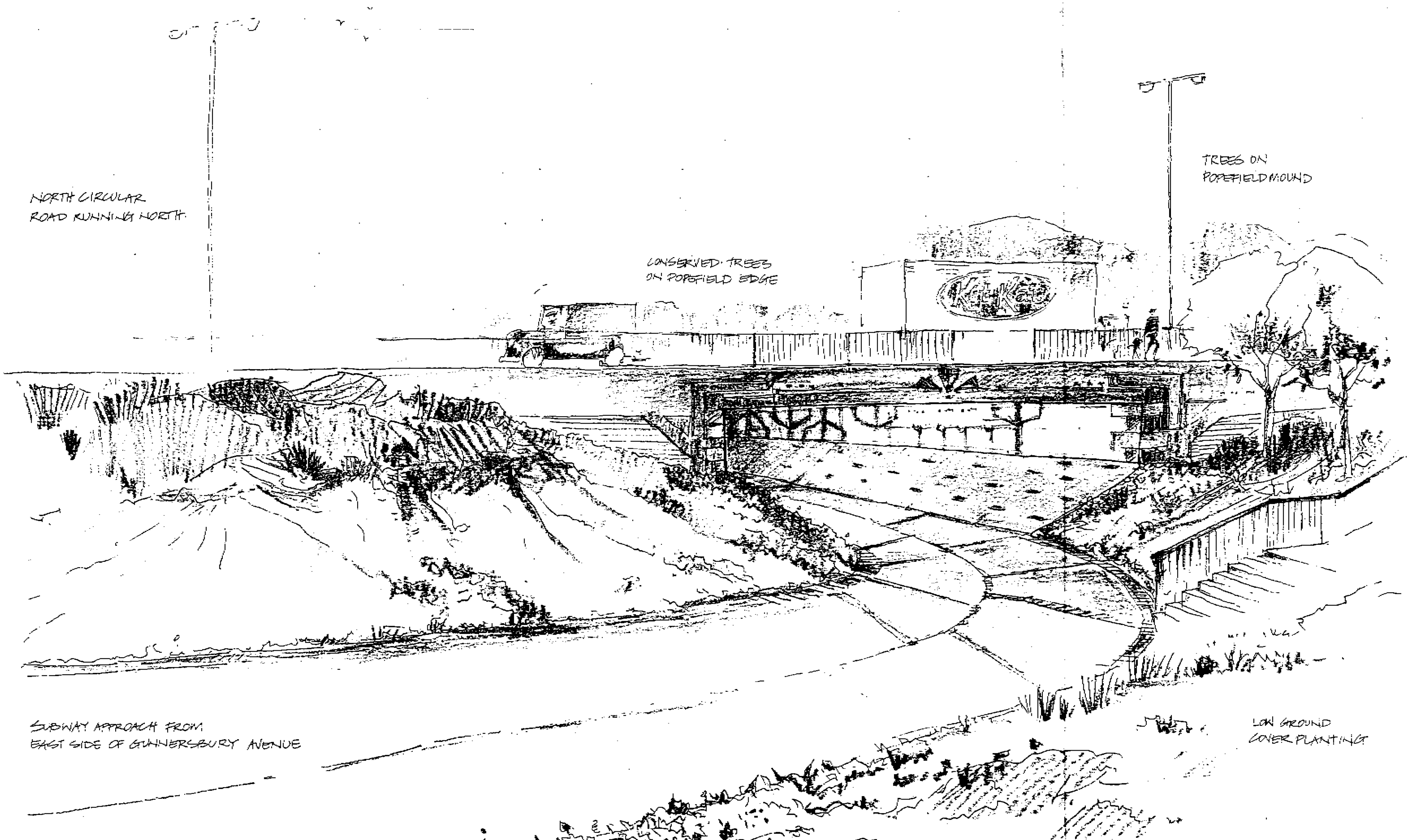
Garden of No 39 Gunnersbury Avenue | NCR | No 46 St Pauls Close

PROPOSED

SECTION DD

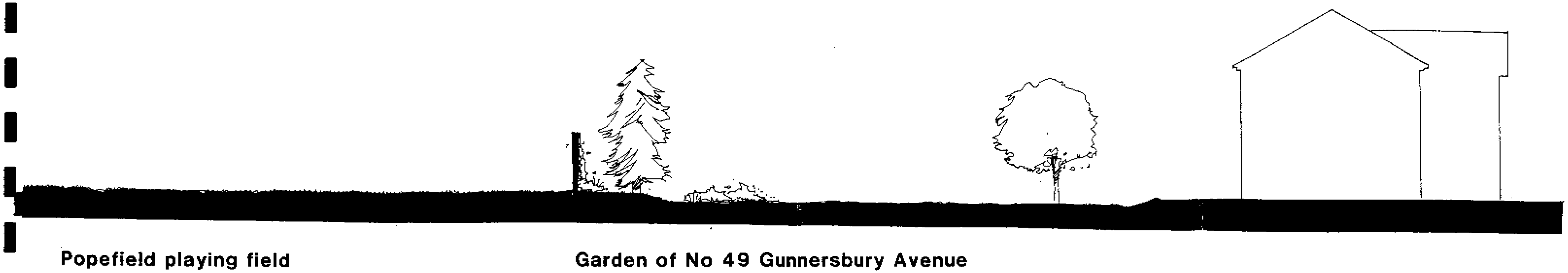
LOOKING SOUTH THROUGH No 39 GUNNERSBURY AVE AND No 46 ST PAULS CLOSE SCALE 1:200

RF 11a



PERSPECTIVE SKETCH BARONSMEDE SUBWAY

RF 13



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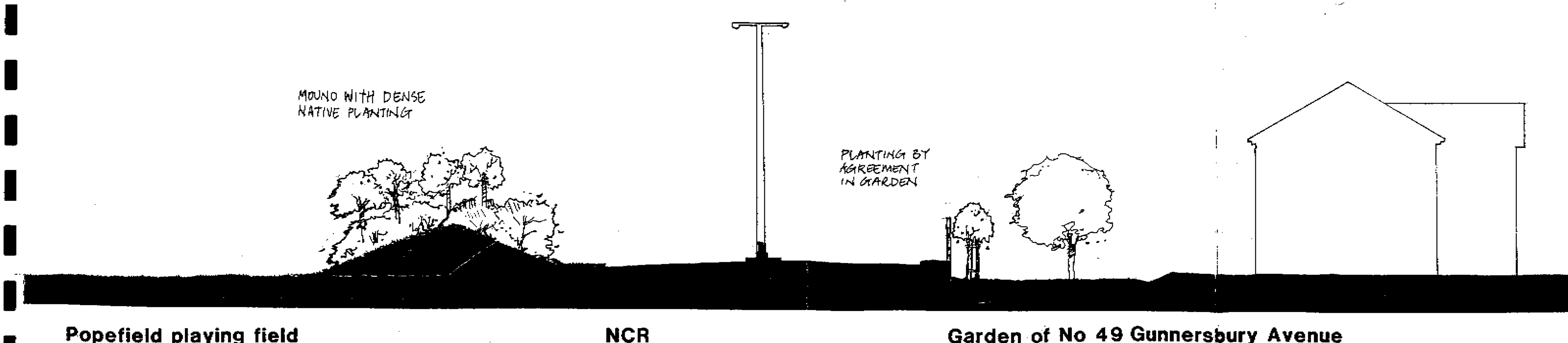
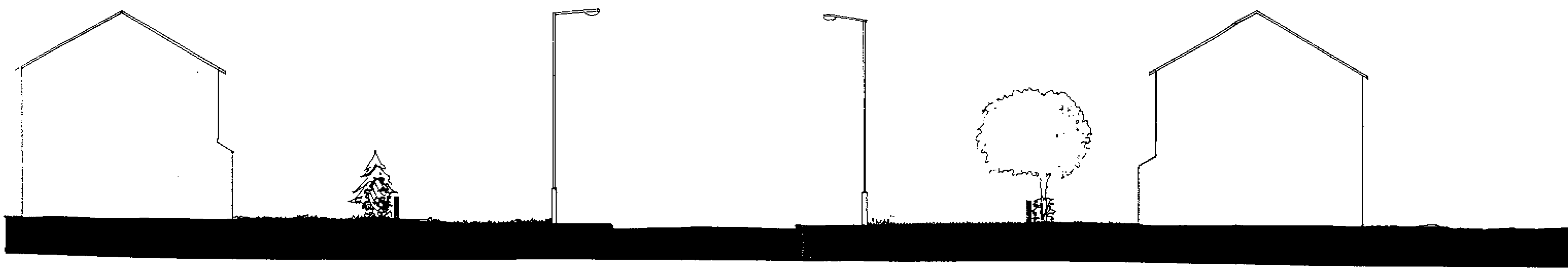


PROPOSED

SECTION EE

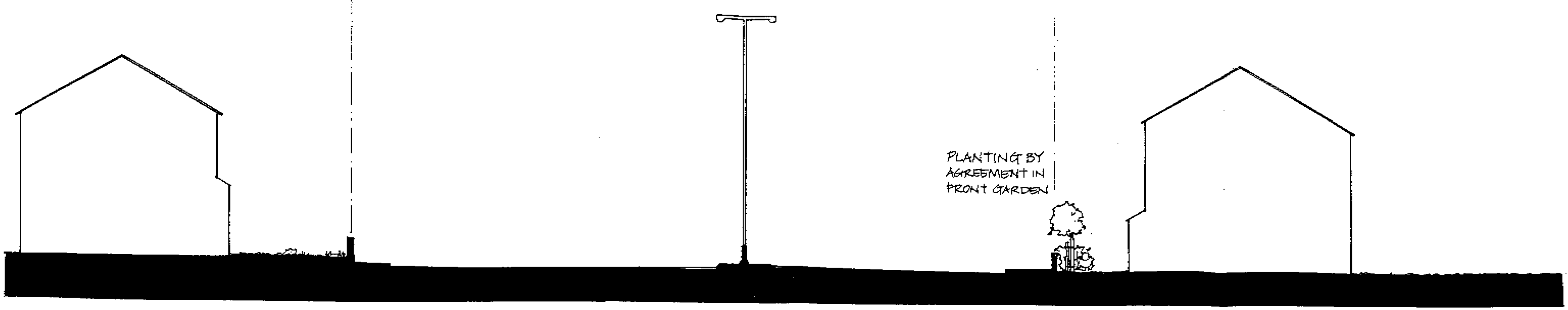
LOOKING NORTH THROUGH POPEFIELD PLAYING FIELD AND GUNNERSBURY AVENUE SCALE 1:200

RF 12



No 102 Gunnersbury Ave — NCR — No 105 Gunnersbury Ave

EXISTING



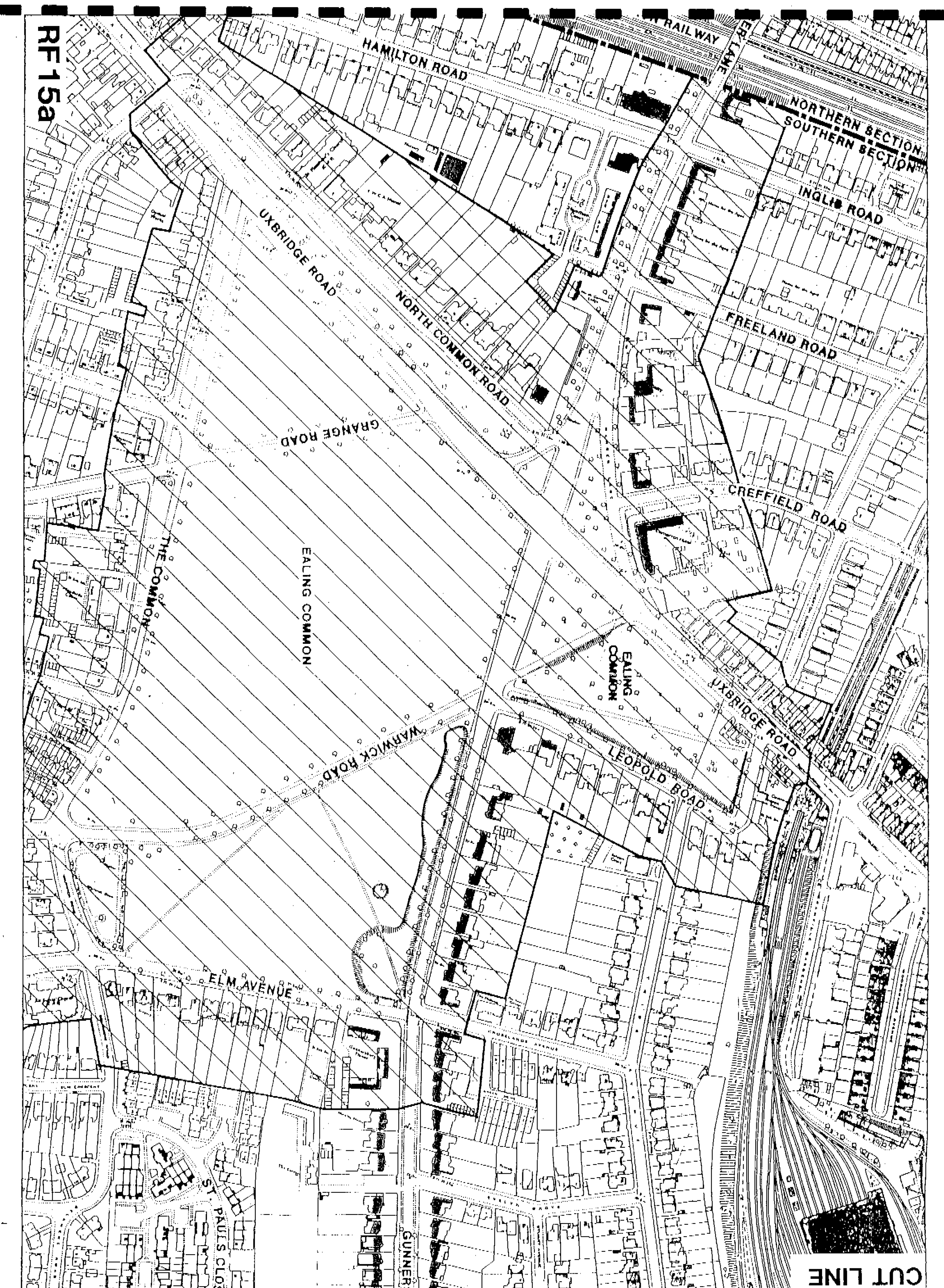
No 102 Gunnersbury Ave — NCR — No 105 Gunnersbury Ave

PROPOSED

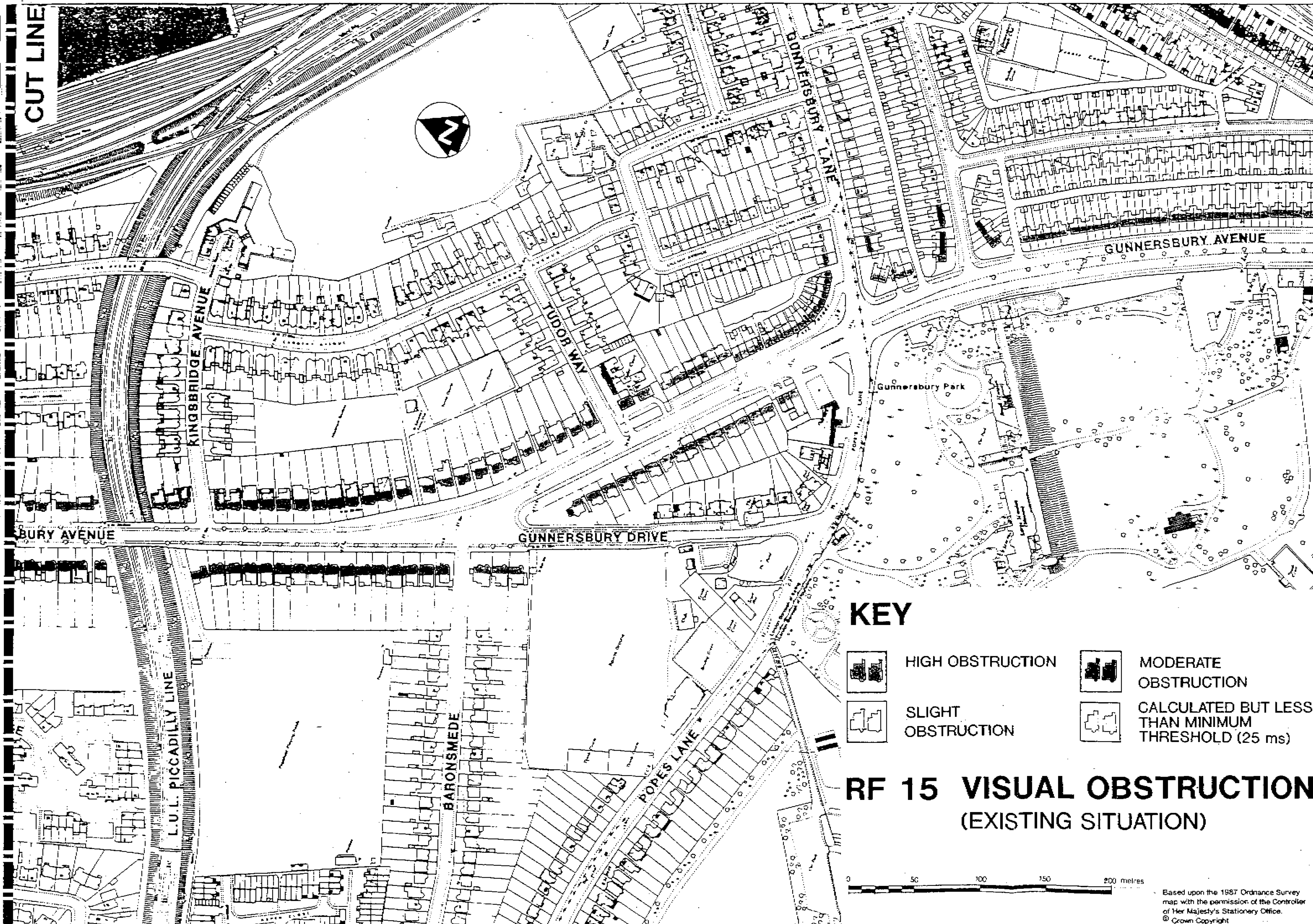
SECTION FF

LOOKING SOUTH THROUGH Nos 102 & 105 GUNNERSBURY AVENUE SCALE 1:200

RF 14



RF 15a
RAILWAY
HAMILTON ROAD
NORTHERN SECTION
SOUTHERN SECTION
INGLIS ROAD
UXBRIDGE ROAD
NORTH COMMON ROAD
FREELAND ROAD
GRANGE ROAD
CREFFIELD ROAD
THE COMMON
EALING COMMON
EALING COMMON
UXBRIDGE ROAD
WARWICK ROAD
LEOPOLD ROAD
ELM AVENUE
CUT LINE

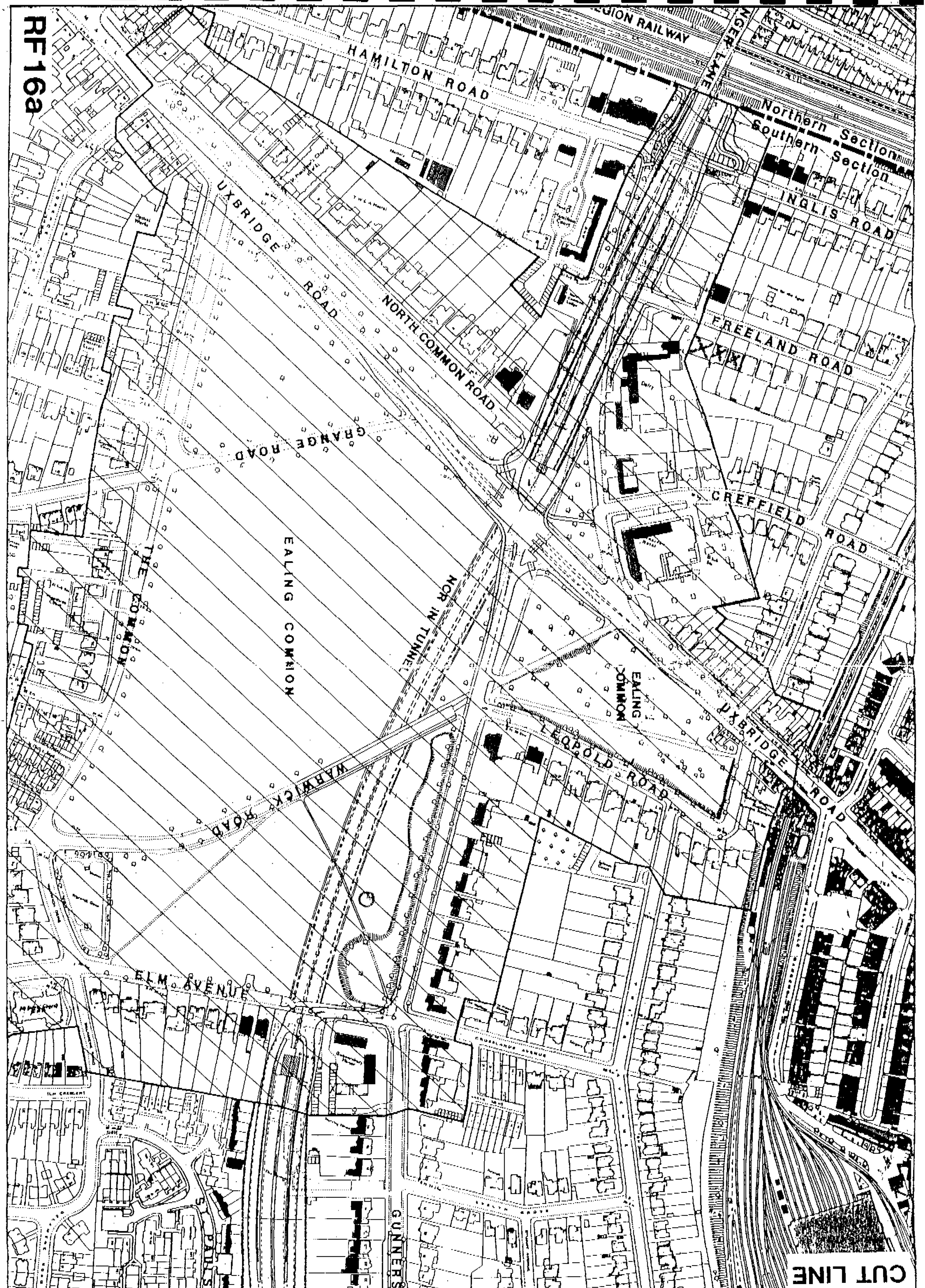


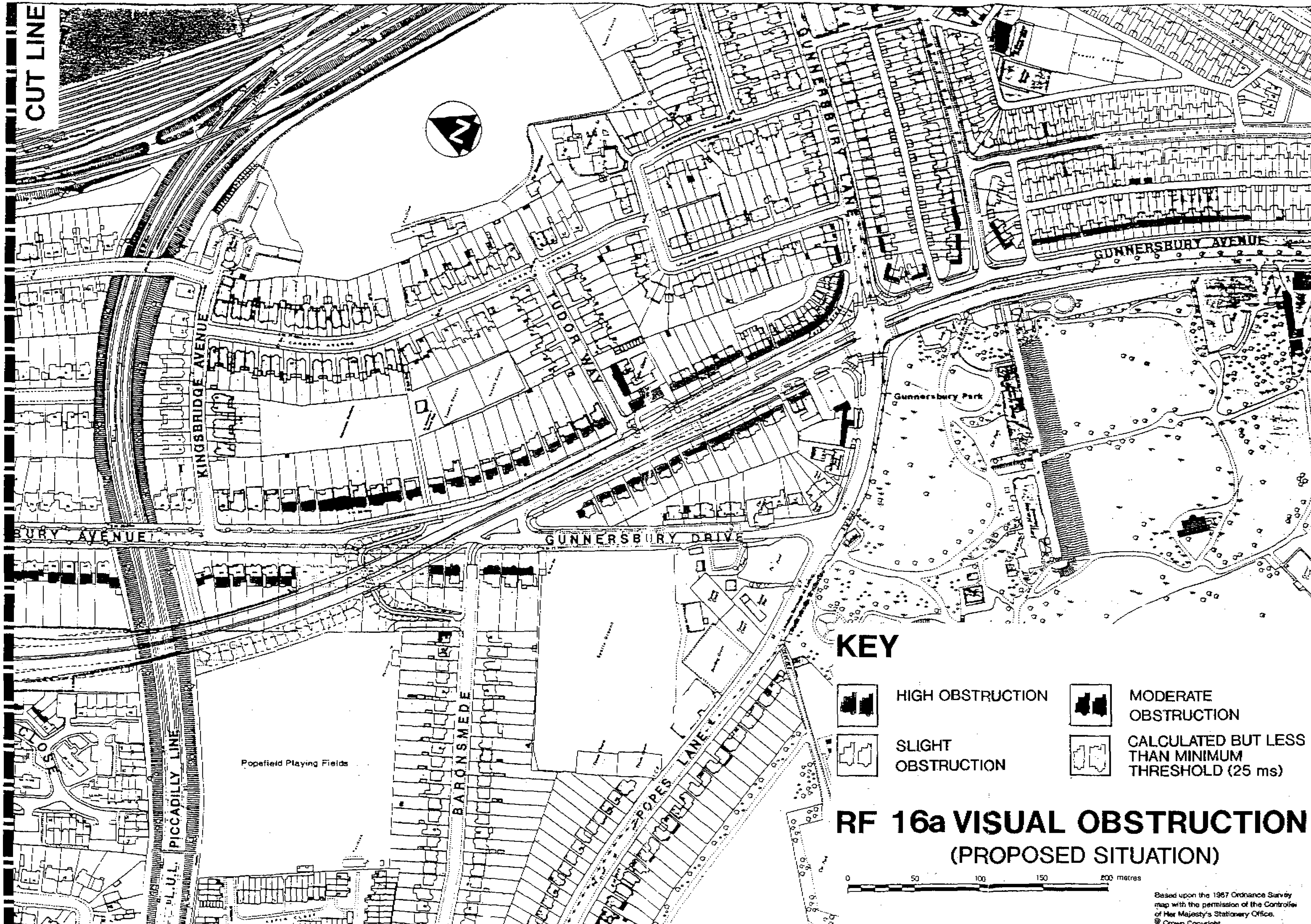
KEY

HIGH OBSTRUCTION	MODERATE OBSTRUCTION
SLIGHT OBSTRUCTION	CALCULATED BUT LESS THAN MINIMUM THRESHOLD (25 ms)

RF 15 VISUAL OBSTRUCTION

(EXISTING SITUATION)

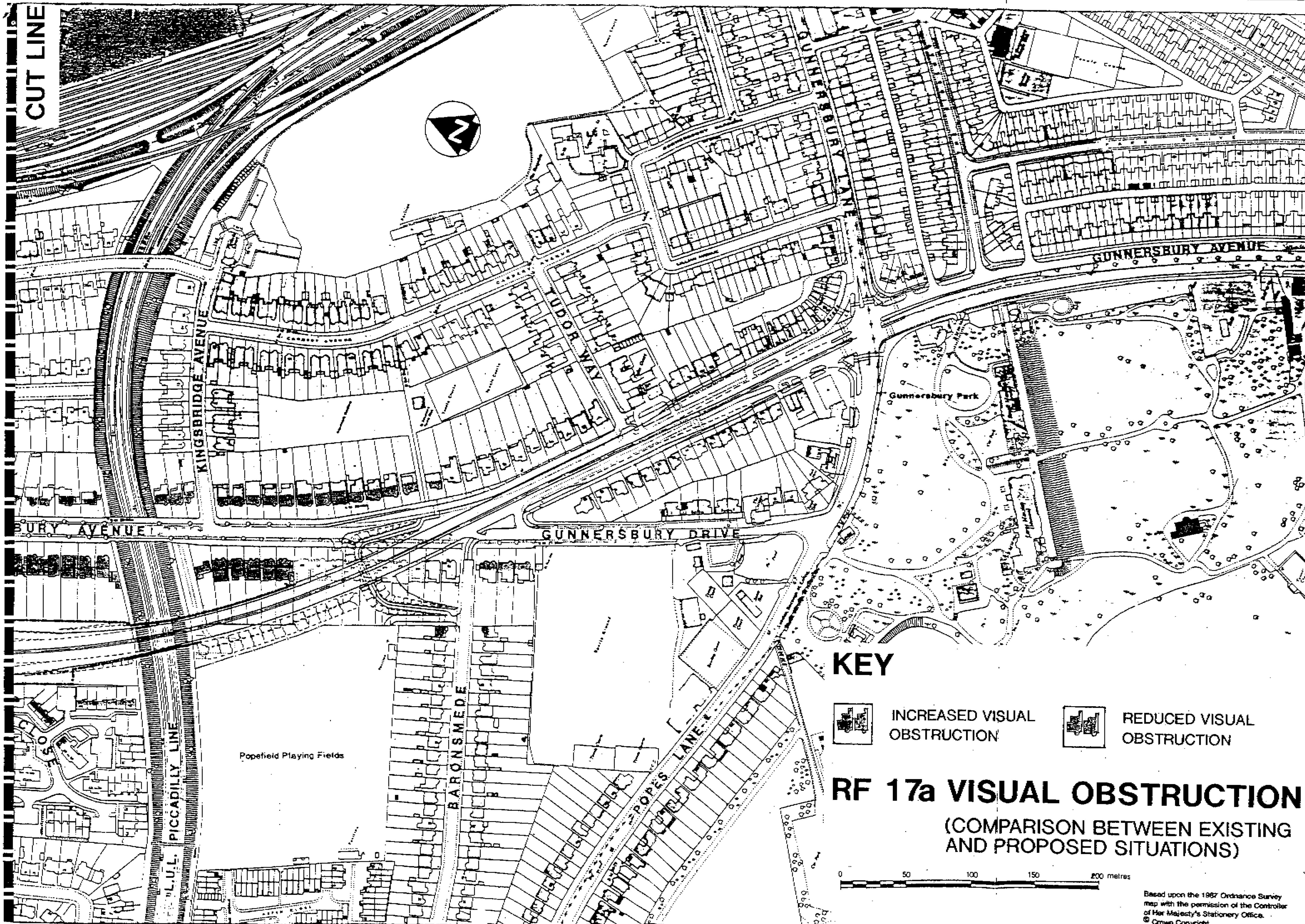

RF 16a
HAMILTON ROAD
Northern Section
Southern Section
INGLIS ROAD
UXBRIDGE ROAD
NORTH COMMON ROAD
FREELAND ROAD
GRANGE ROAD
CREFFIELD ROAD
EALING COMMON
THE COMMON
WARWICK ROAD
EALING COMMON
LEOPOLD ROAD
UXBRIDGE ROAD
ELM AVENUE
CUT LINE



RF 16a VISUAL OBSTRUCTION

(PROPOSED SITUATION)


RF 17a
REGION RAILWAY
HAMILTON ROAD
Northern Section
Southern Section
INGLIS ROAD
UXBRIDGE ROAD
NORTH COMMON ROAD
FREELAND ROAD
GRANGE ROAD
CREFFIELD ROAD
THE COMMON
EALING COMMON
NCR IN TUNNEL
EALING COMMON
LEOPOLD ROAD
UXBRIDGE ROAD
WARWICK ROAD
ELM AVENUE
GUNNERSBURY
CUT LINE

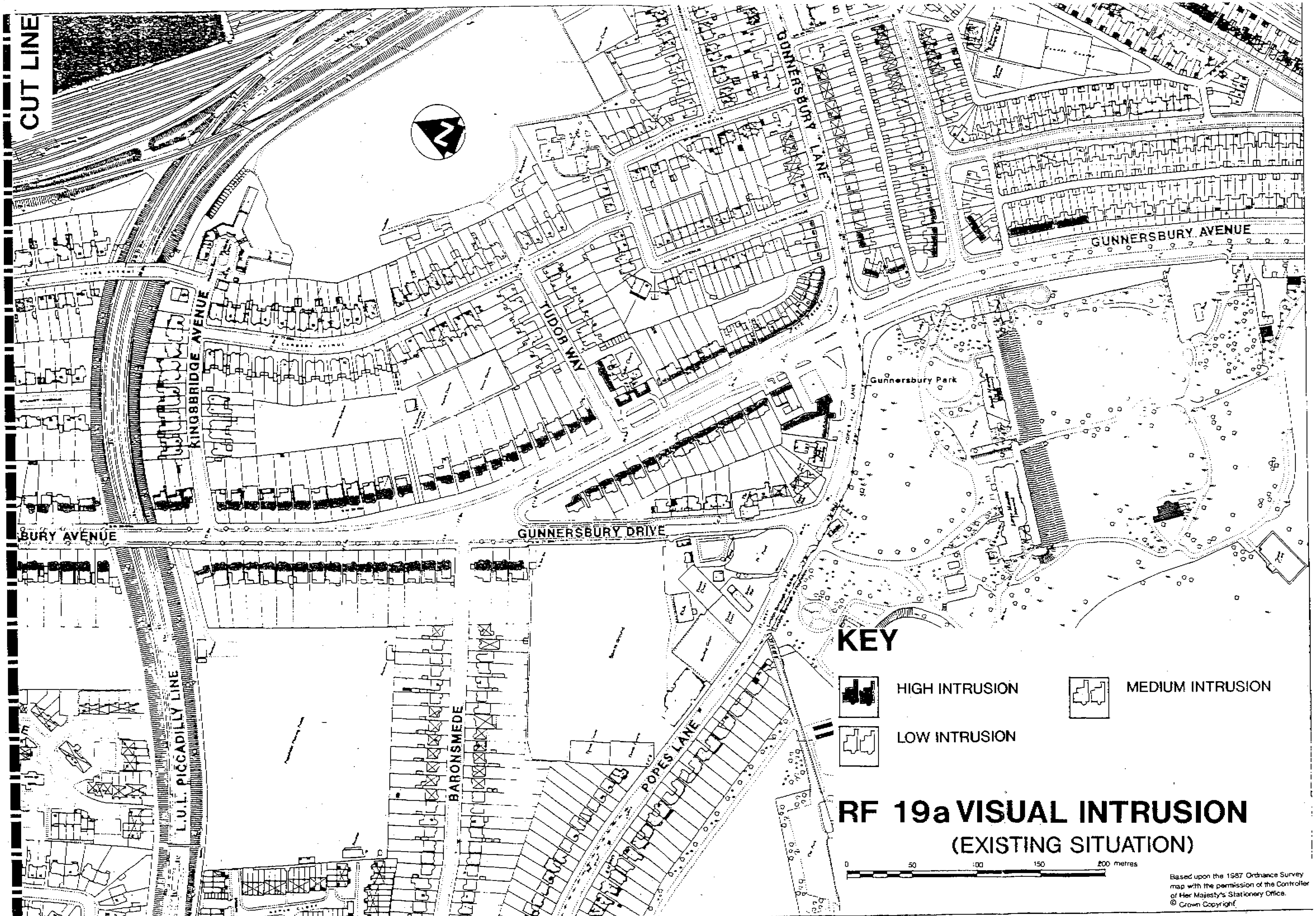


RF 17a VISUAL OBSTRUCTION

(COMPARISON BETWEEN EXISTING AND PROPOSED SITUATIONS)

Based upon the 1987 Ordnance Survey map with the permission of the Controller of Her Majesty's Stationery Office.


RF 19 a
RAILWAY
HAMILTON ROAD
NORTHERN SECTION
SOUTHERN SECTION
INGLIS ROAD
FREELAND ROAD
UXBRIDGE ROAD
NORTH COMMON ROAD
GRANGE ROAD
CREFFIELD ROAD
THE COMMON
EALING COMMON
EALING COMMON
UXBRIDGE ROAD
WARWICK ROAD
LEOPOLD ROAD
ELM AVENUE
CONNECT INGLIS ROAD
INGLIS ROAD
ST PAULS CLOS
GUNNERS
CUT LINE


CUT LINE
N
KINGSBRIDGE AVENUE
TUDOR WAY
GUNNERSBURY LANE
GUNNERSBURY AVENUE
Gunnersbury Park
BURY AVENUE
GUNNERSBURY DRIVE
L.U.L. PICCADILLY LINE
BARONSMEDE
POPES LANE
KEY
HIGH INTRUSION
MEDIUM INTRUSION
LOW INTRUSION
RF 19a VISUAL INTRUSION
(EXISTING SITUATION)
0
50
100
150
200 metres
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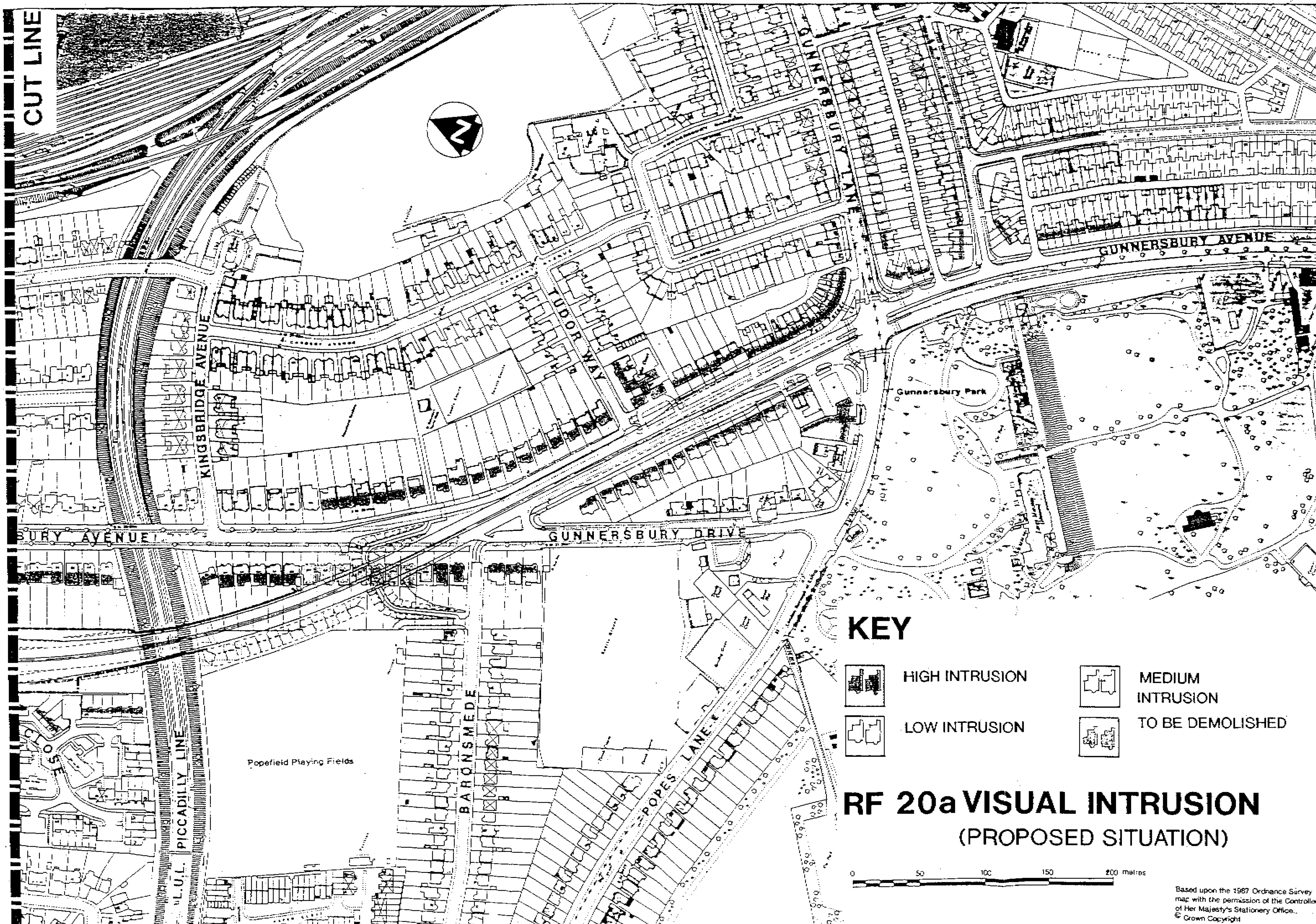
RF 20a

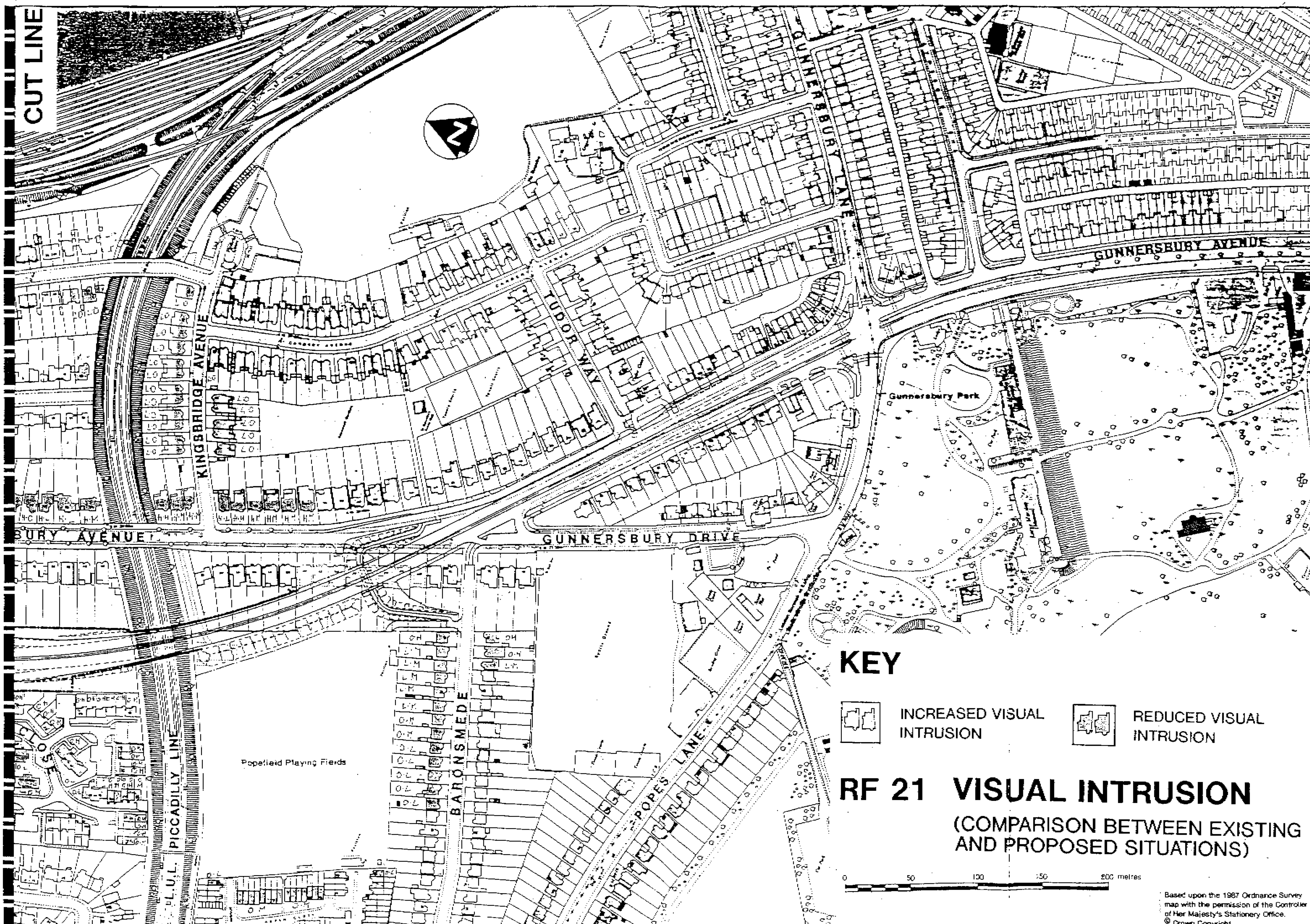

EGION RAILWAY
HAMILTON ROAD
NGER LANE
Northern Section
Southern Section
INGLIS ROAD
UXBRIDGE ROAD
NORTH COMMON ROAD
FREELAND ROAD
GRANGE ROAD
CREFFIELD ROAD
EALING COMMON
NOR IN TUNNEL
THE COMMON
EALING COMMON
UXBRIDGE ROAD
LEOPOLD ROAD
WARWICK ROAD
ELM AVENUE
CONNECT INGLIS ROAD
INGLIS ROAD
GUNNERS
CUT LINE



RF 20a VISUAL INTRUSION

(PROPOSED SITUATION)


RF21a
HAMILTON ROAD
Northern Section
Southern Section
INGLIS ROAD
FREELAND ROAD
CREFFIELD ROAD
UXBRIDGE ROAD
NORTH COMMON ROAD
GRANGE ROAD
EALING COMMON
THE COMMON
NOR IN TUNNEL
WARWICK ROAD
LEOPOLD ROAD
ELM AVENUE
CONNECT INGLIS ROAD
INGLIS ROAD
CUT LINE



RF 21 VISUAL INTRUSION

(COMPARISON BETWEEN EXISTING AND PROPOSED SITUATIONS)

Public Inquiry Document No. 3/5

Proof of Evidence on Noise

DEPARTMENT OF TRANSPORT
LONDON REGIONAL OFFICE

A406
NORTH CIRCULAR ROAD

(Gunnersbury Avenue Improvement)

PROOF OF EVIDENCE ON NOISE

Department of Transport,
London Regional Office,
2 Marsham Street,
London SW1P 3EB

Ref. 62372.0
June 1990

ACOUSTICAL INVESTIGATION & RESEARCH ORGANISATION LTD.
Duxons Turn
Maylands Avenue,
Hemel Hempstead,
Hertfordshire.HP2 4SB

A406 NORTH CIRCULAR ROAD

POPES LANE - WESTERN AVENUE IMPROVEMENT

PROOF OF EVIDENCE
ON
NOISE

Presented on behalf of the
Department of Transport

by

R C Hill, BSc FIOA MBCS

June 1990

PREFACE

Credentials of Witness

(a) I am Robert Charles Hill. I hold a Bachelor of Science Degree in Architecture, Planning and Building from London University. I am a Fellow of the Institute of Acoustics and in April 1980 was elected to Council, the governing body of that Institute and for 6 years up to 1989 held the post of Honorary Secretary. I have been engaged in work on acoustics and vibration for over twenty years, and I have specialized in the study of various aspects of planning and transportation noise problems. I am employed by the Acoustical Investigation & Research Organisation Ltd as a Senior Consultant.

(b) Acoustical Investigation & Research Organisation Limited (AIRO) is an independent consultancy, offering advisory and measurement services in acoustics, noise control and vibration problems. The services offered in the noise control field are purely and only of a consultancy nature, AIRO being neither a manufacturer nor a contractor in this sphere. Since its incorporation in 1958 AIRO has acted on behalf of Government Departments, local authorities, industry, architects and the public at large.

(c) AIRO has been appointed by Howard Humphreys & Partners Ltd as specialist sub-consultant for the Department of Transport to evaluate the noise aspects of the proposed improvement of the A406 North Circular Road Gunnersbury Avenue Improvement.

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INTRODUCTION TO NOISE UNITS

1. Before describing the results of the environmental noise analysis for this scheme, it is worth providing a brief description of the noise units involved. All quoted noise levels will be in terms of dB(A), that is "A weighted" decibels. The "A weighting" is an internationally agreed frequency response generally similar to that of the human ear, so that sound levels in dB(A) correspond reasonably well with what is heard. Table 1 presents an indication of the level of some common sounds on the dB(A) scale. It should be noted that the examples shown include both internal and external noise conditions over a wide range of noises with different characteristics. They have been included here so that sound levels quoted in the evidence may be put into perspective.

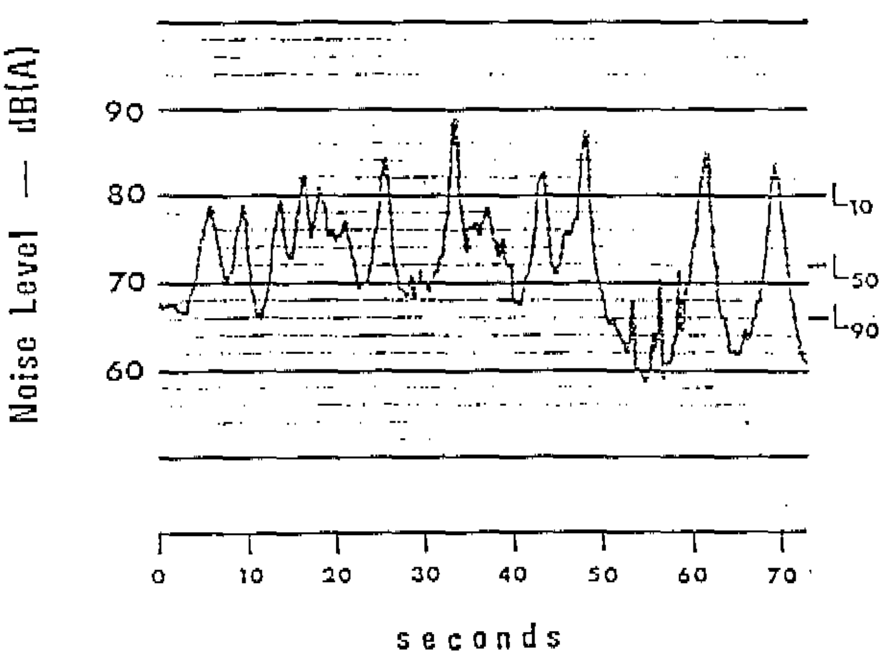
Table 1 Guide to Typical Noise Levels in various Environments

Environment	Approximate Sound Level dB(A)
Threshold of pain	140
Threshold of feeling	120
Sheet metal shop - hand grinding	110
High Speed Train at 2 metres - peak value	105 - 110
Printing Press Room	100
Heavy Lorry at 3 metres	90
Kerbside of busy street	80
Moderately loud radio in domestic room) Spin dryer in kitchen)	70
Loud speech at 1 metre	65
Restaurant or Department Store	60
Conversational speech at 1 metre	55
General Office - average value	50
Electric Fan Heater in domestic room at 1.5 metres	45 - 50
Non Executive Private Office - average value	40
Gas Fire (full on) in domestic room at 1.5 metres	35

2. In the case of road traffic, instantaneous noise levels vary continuously and it is necessary to use an index that involves averaging over an appropriate time period to arrive at a single figure estimate of the overall noise level for appraisal purposes. The L_{10} index has been selected because it has been shown to correlate well with average dissatisfaction from traffic noise and because its measurement and prediction is fairly straightforward. The L_{10} is the sound level in dB(A) exceeded for 10% of a quoted time period, and in the case of traffic noise can be taken as an indication of the mean maximum noise level. Other percentile noise indices are sometimes employed to describe other types of noise, such as the L_{50} or average sound level and the L_{90} or mean minimum sound level. However, these have not been shown to be well correlated with people's reaction to traffic noise, although they can be of some use in describing the range of sound levels experienced in a given noise climate. Figure 1 shows a typical relationship between these percentile indices and the instantaneous traffic noise level.

Figure 1

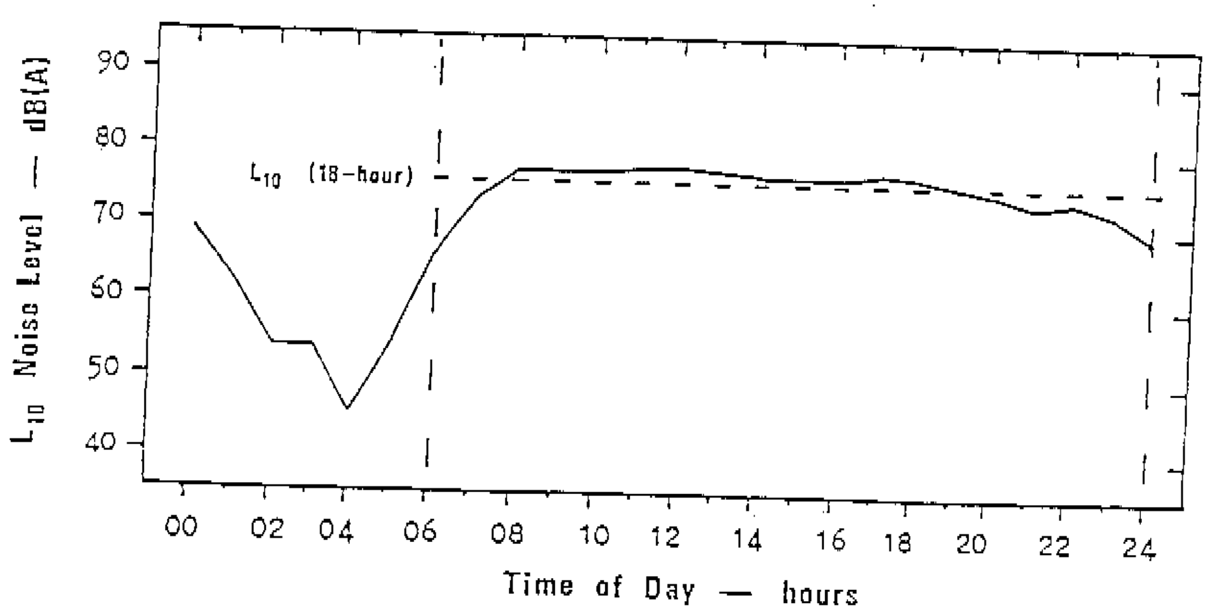
Values of L_{10}, L_{50} and L_{90} for an example of traffic noise



3. The L_{10} (18-hour) is the average of the values of L_{10} in dB(A) for each of the eighteen hours between 6 am and midnight on a normal working day. This scale is used by the Department of Transport as a representative measure of traffic noise exposure because a good correlation has been demonstrated between this index and residents' average dissatisfaction with existing traffic noise over a wide range of exposures. The L_{10} (18-hour) noise level in dB(A) is also the specified index used for the statutory assessment of compensatory measures under The Noise Insulation Regulations 1975. Figure 2 gives an illustrative example of the variation in L_{10} throughout a twenty-four hour period, showing the L_{10} (18-hour) value.

Figure 2

Example of the variation in L_{10} noise level over a 24 hour period
The dashed line respresents the L_{10} (18-hour) value



4. Because of the logarithmic nature of the decibel scale, it should be borne in mind that noise levels in dB(A) do not have a simple linear relationship to each other. It is not the case that a 100 dB(A) sound level is twice as loud as a 50 dB(A) sound level. It has been found experimentally that changes in the average level of fluctuating sound, such as traffic noise, need to be of the order of 3 dB(A) before becoming definitely perceptible to the human ear. Data from other experiments have indicated that a change in sound level of 10 dB(A) is experienced by the average listener as a doubling or halving of loudness. Using this type of information, Table 2 provides an indication of the subjective interpretation of changes or differences in noise level.

Table 2

Guide to Sound Level Changes

Band of Change in Sound Level dB(A)	Interpretation	
	Subjective Impression	Description in Evidence
0 to 2	imperceptible change in loudness	marginal
3 to 5	perceptible change in loudness	noticeable
6 to 10	up to a doubling or halving of loudness	significant
11 to 15	more than a doubling or halving of loudness	substantial
16 to 20	up to a quadrupling or quartering of loudness	substantial
21 or more	more than a quadrupling or quartering of loudness	very substantial

5. An important factor to be taken into account when planning new roads is whether the resultant noise levels are acceptable in relation to existing developments. Although individual reactions to noise of a given level vary considerably, the results of social survey work enable us to formulate some guidance as to the average response to traffic noise.

6. Such surveys have indicated that external traffic noise levels of up to 55 dB(A) on the L_{10} (18-hour) scale are acceptable to a large majority of the population. This is not surprising because such levels of traffic noise would not cause undue disturbance to conversational speech outside the home. Inside, after allowing for the insulation of the facade, noise generated by normal domestic activities could be expected to mask the sounds of the traffic. With increasing L_{10} (18-hour) traffic noise levels the level of public dissatisfaction increases accordingly, and it has been found that a substantial proportion of the population would be annoyed in their homes by traffic noise when the external level exceeds 70 dB(A). The Noise Advisory Council have stressed that this level constitutes the limit of the acceptable rather than a standard of what is desirable. They also recommended that existing residential development should not be subjected as an act of conscious policy to external noise levels in excess of 70 dB(A) on the L_{10} index unless some form of remedial or compensatory action is taken. The existing North Circular Road in this area has a large number of residential properties that are at present exposed to noise levels in excess of 70 dB(A). The Department of Transport's proposals for this Scheme are designed to restrict exposure to very high noise levels as far as possible and to provide remedial treatment where the requirements of the appropriate Regulations are met.

7. In this evidence, the predictions of traffic noise levels relate to the external facade noise exposure at the most exposed part of the building under consideration. In order to allow an approximate conversion of these external noise levels into the equivalent internal noise levels, Table 3 offers guidance as to the approximate reduction of traffic noise afforded by traditional building facades with different window types. It can be seen that the provision of a properly designed double window with suitable arrangements for ventilation can provide substantially increased attenuation over that of an ordinary "openable" window when closed.

Table 3

Guide to Typical Sound Attenuation of Facades with Windows

Window Type	Approximate Sound Attenuation dB(A)
Wide Open Window	about 5
Slightly Open Single Window	5 - 10
Closed "openable" Single Window	about 20
Fixed (6 mm to 10 mm glass) Single Window	25 - 30
Double Sliding Window with staggered opening for ventilation (eg 6 mm glass, 200 mm cavity and absorbent reveals)	25 - 30
Double Window when closed (eg 6 mm secondary glazing with 150 mm cavity, absorbent reveals, well fitted with seals)	35 or more

8. Bearing in mind an average facade insulation of 20 dB(A) for ordinary closed windows, it can be seen that an internal L_{10} noise level of about 50 dB(A) can be regarded as a minimum standard on the basis of The Noise Advisory Council's recommendations and indeed this has been adopted as such in planning guidelines from the Department of the Environment (Deposit Document Number D92). An internal L_{10} of 40 dB(A) can be regarded as a good standard.

9. Inevitably some dwellings will be seriously affected by noise from a new road, despite the careful consideration which is given in the planning process towards minimising the overall environmental impact. On the other hand, the balance of benefit to other existing developments will normally include relief for many dwellings already subject to excessively high noise levels. In addition there will be reductions in traffic on minor roads away from the Scheme as congestion is relieved and rat-running traffic returns to the major links in the network. These reductions in traffic flows will be reflected in reductions in noise level. Although the changes in level will be relatively small they will be widespread and will affect a very large number of people.

METHOD OF CALCULATION

10. The technique employed for predicting the exposure to road traffic noise is that set out in the Department's Technical Memorandum "Calculation of Road Traffic Noise". This prediction method was originally published in 1975 and a revised edition appeared in 1988 (Deposit Document Number D63). The noise level predictions presented in this evidence have been made using the 1988 edition of "Calculation of Road Traffic Noise".

11. The main determinant of traffic noise is the traffic flow itself and so the prediction of L_{10} (18-hour) noise levels involves the use of the predicted daily traffic volumes during the period of 6 am to midnight. It is normal for the calculation of future noise levels for a new road to be based on the design year, which is up to fifteen years after its opening. Calculations for the future noise environments have been based

on traffic flow forecasts for the year 2010. Pre-Scheme conditions, needed for the assessment of possible insulation works, are represented by the traffic flow forecast for 1992.

12. In addition to the traffic flow, it is necessary to consider the effects of a number of other factors in determining the noise level for a particular building. These factors include:-

(a) the traffic composition expressed as the percentage of heavy vehicles;
(b) the mean traffic speed;
(c) the road gradient;
(d) the type of road surface and texture;
(e) the distance of the building from the road;
(f) the nature of the ground cover between the road and the building;
(g) the nature of any intervening obstructions, such as other; buildings or topographical features, which cause a limited angle of view of the road;
(h) the shielding effect of any such intervening obstruction;
(i) the shielding effects of any purpose built noise barriers or cuttings forming part of the road design;
(j) any reflections from relevant surfaces;
(k) the additive effects of noise from more than one road or section of road.

13. Although these various factors interact with each other in a fairly complex manner in the detailed prediction process, it is worth outlining the approximate effects of some of them by way of illustration. Changes in traffic flow correspond to changes in noise level of the order of 3 dB(A) for each doubling or halving of the flow rate. This relationship is, of course, modified by any change in the percentage of heavy vehicles and average speed of the traffic flow as well as the gradient of the road itself. The nature and texture of the road surface will also affect noise generation. For the purposes of the noise calculations it has been assumed that this road will be constructed with a conventional bituminous surface with a texture depth of 1.5 mm.

14. Because sound energy dissipates with distance from the source, noise levels decrease accordingly. It has been shown that over hard ground, noise levels from traffic fall by approximately 3 dB(A) for each doubling of distance from the road, whilst if the noise passes over soft ground such as grassland an additional process referred to as ground absorption causes a further, often substantial, reduction in noise levels.

15. In addition to the attenuation of sound with distance, further reductions in noise level can accrue from a restricted angle of view of the road and from barriers. Noise screening from barriers can arise due to the lie of the land or intervening buildings, or from design features of the road such as cuttings, landscaping works or specified noise screens. The amount by which noise is reduced by screening depends on both the height and length of the effective barrier involved, since these factors will determine how much sound will travel around it. The best screening is obtained when as much of the road is obscured from view as possible and when the barrier is close to the source or receiver of sound so as to increase the path length round the screening. Under such circumstances, reductions in noise level of 10 dB(A) or more can be obtained, though under the often more practical circumstances of partial screening it is still possible to obtain useful improvements of a few decibels.

16. It is worth noting that although tree planting can provide useful visual screening, it is generally of little value as a noise screen unless forming a thick, densely planted area which is wholly impractical in an urban area. It will be appreciated that noise screening offers a benefit to open land and gardens as well as to the internal domestic environment. Sound reflected from some types of surfaces can increase noise levels, for example the noise level 1 metre from a facade is 2.5 dB(A) higher than the equivalent open location.

17. The engineering design of this Scheme includes solid parapets and various noise barriers and screens at the edge of the retained cutting and in the vicinity of the Piccadilly Line. These will be discussed in more detail below. The noise calculations have shown that this would provide useful screening of the road for the adjacent properties.

18. The actual calculations were performed using a suite of computer programs known as ROPLAN. This method uses a digitizing tablet to create a three dimensional model of the road structure, the surrounding buildings and other topographical features. Details of the traffic flow parameters for the various road links and details of the required calculation points are also supplied to the program. From the data the computer then calculates the contribution from each section of the road, applies the appropriate corrections for the propagation path and other relevant factors and presents the overall noise level for each of the required points. Separate models have been constructed for the Do-Nothing and Do-Something conditions so that both sets of noise calculations can be produced.

SCOPE OF THE NOISE STUDY

19. To establish the extent of the impact of traffic noise, calculations of noise levels have been carried out for affected properties in the vicinity of the existing route and the published proposals over an area extending up to three hundred metres either side of the route. The actual extent of the noise study zone has been determined by the predicted noise level rather than by an arbitrary distance from the road. Calculations have been performed out to the distance at which noise from the published proposals falls to the prevailing background noise level which is generally in the region of 50-55 dB(A) according to circumstances. At this level, domestic and local activities can be expected to provide the dominant noise source.

20. Specifically, the predictions refer to noise levels one metre from the noisiest elevation of the building under consideration within this geographical corridor around the published proposals. Because noise levels can change with increasing height, the calculations have been performed at 1.5 metres above the ground for single storey buildings and 4.0 metres above ground for two storey buildings.

21. In the case of buildings where the amount of screening of the major roads is such that it is not possible to make reliable predictions of either the Pre-Scheme (1992) or the Do-Nothing (2010) conditions then an assessment has been made of the noise level on the basis of the distance from the main road network or based on measurements of the typical existing noise climate.

22. By tabulating predicted noise levels for the noisiest facade of the buildings under consideration, it is possible to present the results of the noise calculations in a form which enables a comparison of conditions in the presence of the published proposals with the Pre-Scheme or Do-Nothing conditions. In this way it is possible to establish and demonstrate whether or not the published proposals offer a balance of environmental benefit in noise terms and if so the extent of the benefit to or burden on the community as a whole in terms of the numbers of properties affected or relieved and the magnitude of these effects.

TRAFFIC DATA USED IN CALCULATIONS

23. Traffic data for the Pre-Scheme (1992), Do-Something (2010) and Do-Nothing (2010) conditions have been supplied by Howard Humphreys & Partners Ltd.

LEGISLATION

24. The Noise Insulation Regulations 1975 (Deposit Document Number D30) were introduced under the powers of The Land Compensation Act 1973 (Deposit Document Number D26) in order to alleviate the noise problems caused by new road projects and to set down standards and criteria for remedial insulation measures. These Regulations have been amended by The Noise Insulation (Amendment) Regulations 1988. The effect of these amendments is to revise references to other legislation and to implement the revised edition of Calculation of Road Traffic Noise (Deposit Document Number D63) as the approved calculation procedure. To be considered under these Regulations a building must be an "eligible building" and the requirements are broadly as follows:-

(a) It must be a dwelling or a building used for residential purposes;
(b) It must be within 300 metres of the edge of the new or altered highway;
(c) It must have been occupied prior to the opening to traffic of the new or altered highway;
(d) It must not be subject to a Compulsory Purchase or Demolition Order or be within a Clearance area;
(e) It must not be a building receiving grant for Noise Insulation work under any other Statutory Scheme.

25. Non-residential buildings such as schools, hospitals and non-residential hotels are not legislated for. The Regulations deal with the circumstances relating to noise from the future traffic use of the highway and also with possible noise problems created during the construction works. The insulation provided under this legislation essentially comprises secondary glazing, to form double windows, and the provision of silenced ventilators to all living rooms and bedrooms on the affected facades. Windows and doors to hallways are not covered unless these form an integral part of a living room or bedroom. Such insulation can substantially counteract the adverse effects on the internal domestic noise environment caused by external sources, and can enable a good

internal standard to be achieved in many cases despite the proximity of a road.

Protection from Traffic Noise

26. The Noise Insulation Regulations 1975 require the Highway Authority to provide insulation for certain properties affected by noise from road traffic using a new or improved highway. The requirements governing qualification for noise insulation works are dealt with in full in The Noise Insulation Regulations 1975 but it is worth detailing the three basic noise conditions which must be satisfied before properties can be regarded as eligible for the offer of insulation works. These are:-

(a) The L_{10} (18-hour) noise level must not be less than 68 dB(A) at the time of the highest predicted traffic flow during the 15 year period following the opening of the road to public traffic;
(b) There must be an increase of at least 1 dB(A) when comparing the future noise level with the existing noise level immediately before construction starts;
(c) Traffic on the new road must contribute at least 1 dB(A) to the overall future noise level.

Assessment of Eligibility

27. The calculated noise levels quoted in this evidence should not be used as a basis for determining the provision of noise insulation works or grant under The Noise Insulation Regulations 1975. Subject to the completion of statutory procedures, of which this Inquiry is part, further calculations and/or measurements may be carried out when the Orders have been made. The Department of Transport will publish the Statutory Noise Maps at the appropriate time and at that time the appeals procedure given in the Regulations will become operative. However, a preliminary assessment of those dwellings which could receive an offer of improved sound insulation for at least one facade has been conducted and these are identified in Appendix 1 to this evidence.

Protection from Construction Noise

28. The Noise Insulation Regulations 1975 state that where the construction of a highway causes noise levels which in the opinion of the Highway Authority seriously affects for a substantial period of time the enjoyment of an eligible building, then the Highway Authority has discretionary powers to carry out noise insulation works prior to the road being constructed. Construction noise cannot be considered in detail until the contractor's schedule is known. Where eligibility for improved sound insulation has been established in relation to either construction noise or future traffic noise arising from the use of the road, it is the Department's intention, where possible, to carry out the insulation work before construction work commences.

29. The construction period may create some temporary problems and measures would be taken to mitigate these as far as possible. These measures would take the form of constraints on the contractor in connection with his access to the site, working hours and methods. These will be discussed in more detail with the Local Authority before work commences. Section 60 of The Control of Pollution Act 1974 (Deposit Document Number D29) enables the Local Authority to serve a Notice imposing requirements as to the way in which the works may be carried out. The Notice may specify:-

(a) The plant or machinery which is or which is not to be used;
(b) The hours during which the works may be carried out;
(c) The levels of noise which may be emitted during specified hours.

30. In formulating such a Notice the Local Authority must have regard to:-

(a) The relevant provisions of any Code of Practice under the Act;
(b) The need to ensure the best practical means of minimising noise;
(c) The need to protect any person in the locality from the effects of noise.

31. Whilst the Crown and its contractors are exempt from this legislation, it is the Department of Transport's practice to liaise with the Local Authority in advance of the construction work to arrive at agreed noise control requirements. These requirements are normally made binding on the contractor who eventually carries out the work, by incorporating them into the Contract Documents.

Compensation

32. The Land Compensation Act 1973 also provides rights to compensation for the loss of value of a property resulting from noise and other physical factors caused by the use of the road. Claims for compensation must be made during the specified claim period after the road has opened to traffic. The value of this compensation is assessed by the District Valuer.

METHOD OF PRESENTATION OF NOISE APPRAISAL

33. The implementation of a major highway improvement, such as these proposals, can be expected to have an effect on noise conditions over a wide area. Inevitably there would be some adverse changes for properties in the vicinity of, and therefore directly affected by, the new road itself. In this area of London, many of the houses have been sub-divided into flats and an individual property may contain many households. Where the numbers of residential properties affected have been identified in the tabulations it should be noted that these numbers relate to households rather than buildings.

34. In dealing with the noise implications of the published proposals, this evidence will assess the effects in the vicinity of the proposals by following the route from north to south and will appraise the wider implications of the presence of the published proposals in order to evaluate whether or not the published proposals offer an overall balance of environmental benefit in noise terms.

35. Throughout the analysis presented in this evidence, the effects of the published proposals, are based on the projected conditions in the year 2010 in the absence of the new road ("Do-Nothing") and with the published proposals ("Do-Something"). This form of analysis allows a like for like comparison of the two situations, having included equivalent traffic growth assumptions in each case.

36. In accordance with the guidance given in the Department's Manual of Environment Appraisal (Deposit Document Number D56), the Department of Transport has prepared an Assessment Framework which includes references to Pre-Scheme conditions in addition to the Do-Something and Do-Nothing conditions. The noise information for the revised framework was supplied by AIRO and is consistent with the assessment contained in this evidence. Additional tabulations of the Assessment Framework data in the same format as the evaluation in this evidence have been included in Appendix 2 for information.

EFFECTS OF TRAFFIC NOISE IN THE VICINITY OF THE PUBLISHED PROPOSALS

37. The published proposals have been described in detail in the Department of Transport's main evidence and although it is not necessary to reproduce that information it is considered appropriate to highlight some of the features that are relevant to the noise appraisal.

38. South of the BR Western Region Railway Line the North Circular Road would begin to descend into a retained cutting. On the eastern side of the road the widening would involve the demolition of the existing frontage properties which would result in increased noise levels for the properties in Inglis Road and Freeland Road but, except for the properties closest to the road, the increases would generally be less than 3 dB(A). Inglis Road would be stopped up to prevent direct entry or exit of traffic from the North Circular Road.

39. Hamilton Road would also be stopped up at its junction with Hanger Lane. At the eastern end of Hamilton Road, the easterly movement of the North Circular Road would offset the noise effect of the increased traffic volume but away from Hanger Lane, the reduced traffic on Hamilton Road would give noticeable and even significant reductions in noise for many of the properties.

40. At the Uxbridge Road junction, the main traffic flow on the North Circular Road would be taken through the tunnel section and this would give significant reductions in noise for the hotels at the junction and for the housing in Creffield Road. Uxbridge Road itself is at present a busy road and will remain so although there would be some reduction in noise level with the published scheme.

41. The proposed tunnel would carry the main traffic flow for the North Circular Road and this would have a direct benefit on Ealing Common itself. The extent of this benefit can be gauged from the 10 - 11 dB(A) reductions from which the properties along Gunnersbury Avenue would benefit. There would also be a reduction of 3 dB(A) or more over 35% of the Common. Although Ealing Common would continue to be exposed to traffic noise to some degree, the improvement to the general environment would be a major benefit of this scheme and one which would be enjoyed by the many users of this important area of open space.

42. South of Elm Avenue, the properties on the east side of Gunnersbury Avenue would have substantial decreases in noise level and this reduction, although not as marked, would also apply to the side roads such as Crosslands Avenue and Evelyn Grove where the noise levels would reduce by up to 7 dB(A). For the properties on the western side of Gunnersbury Avenue the position is more complex. The front of these properties would benefit from substantial decreases in level from around 78 dB(A) to about 59 dB(A) while the rear of the properties would be exposed to significant increases although the resulting noise levels of around 60 to 65 db(A) would not be as high as the present levels on the front facade.

43. West of the re-aligned trunk road the new area of housing known as St Paul's Close would be exposed to a range of increases according to the distance from the road and the orientation of the facades. The exposure to traffic noise of this site would be mitigated by the addition of a further 1 metre barrier to the existing 2 metre high wall which forms the existing eastern boundary of the site. With this barrier arrangement the increases will range from 2 to 10 dB(A) and a small number of units at the south eastern corner of the estate would probably be eligible for insulation under The Noise Insulation Regulations. This housing development was undertaken in the knowledge that the trunk road scheme would probably take place in due course.

44. South of the London Underground Ltd Piccadilly Line bridge, the North Circular Road would rejoin the existing Gunnersbury Avenue which would be widened to dual carriageway. This greater width and the increased traffic volume would result in significant increases in noise level and exposure to very high noise levels. These properties would however be expected to qualify for remedial treatment under the Noise Insulation Regulations and this would go some way towards mitigating the effects of the traffic noise.

45. Baronsmede would be closed to motor vehicles at its junction with the North Circular Road and this would result in marginal or noticeable decreases in noise level on the front facades of properties in this road.

46. The widening of Popes Lane and Gunnersbury Lane in the vicinity of the junction would give rise to marginal increases in noise levels for the property in this area. Along Gunnersbury Avenue south of the junction, the widening would be coupled with increased traffic flow and this would also result in noticeable increases in noise level.

47. Where it is proposed to widen the North Circular Road it will be necessary to demolish some existing frontage properties. As described above this will have a detrimental effect on the housing further from the road that is at present screened by the frontage properties. Between Inglis Road and Freeland Road it is proposed that there would be a 3.0 metre high wall behind the footway as part of the proposals. This wall would limit the noise impact on the rears of the properties in this area. It is also anticipated that some, if not all of the residual parcels of land of suitable size between the widened North Circular Road and the existing properties could be redeveloped at some future time with appropriately designed buildings. This would in many cases restore a very significant noise barrier between the trunk road and the property exposed by the demolition. The Department of Transport does not have powers to undertake this directly as part of the scheme but it considers it likely that some of the sites would be redeveloped by a third party in due course. This assessment has not assumed the presence of such redevelopment in the calculation of the noise levels.

48. In assessing the noise impact of a new road proposal it is necessary to consider both the noise levels to which people will be exposed and the changes in level to which the proposals would give rise. Tables 4 & 5 give the numbers of properties in the vicinity of the North Circular Road proposals which would be exposed to noise levels in 5 dB(A) wide bands for the Do-Nothing and With-Scheme conditions in the design year 2010.

49. It can be seen that there would be fewer residential properties with noise levels over 70 dB(A) with the published proposals than in the Do-Nothing condition although it is acknowledged that there would be some 70 households along Hanger Lane and Gunnersbury Avenue which would be exposed to very high noise levels. However it is anticipated that these properties would be provided with sound insulation under The Noise Insulation Regulations.

50. A summary of the changes in noise levels at properties in the vicinity of the proposed improvements to the North Circular Road due to the implementation of the Scheme is given in Table 6. This Table compares, on a like for like basis, the predicted levels in the year 2010 under Do-Nothing and Do-Something conditions for various categories of properties. Each property is classified according to the change in L_{10} (18-hour) noise level expected on its most affected facade.

51. From this Table it is clear that there is a large number of residential properties which would only have marginal changes in noise level. By the nature of this type of on-line improvement there are some properties which would be subjected to significant increases. However, it should be noted that there would be significantly more properties with decreases in noise level than with increases and that the magnitude of the decreases is generally larger than the increases. In addition there would also be further benefits from the removal of rat-running traffic from minor roads in the network. These reductions in traffic flow would be reflected in reductions in noise level. Although the changes in noise level would be relatively small they would be widespread and would affect a large number of people.

Table 4 : Year 2010DN Do-Nothing

Numbers of properties* within each noise band, L10 (18-hour) dB(A).

Property Types	44 & Less dB(A)	45 to 49 dB(A)	50 to 54 dB(A)	55 to 59 dB(A)	60 to 64 dB(A)	65 to 69 dB(A)	70 to 74 dB(A)	75 to 79 dB(A)	80 & More dB(A)
Houses & Flats	0	0	126	399	474	317	124	290	59
Businesses & Shops	0	0	0	1	5	5	5	20	0
Schools & Hospitals	0	0	0	1	0	0	0	0	0
Churches & Public Bldgs	0	0	0	1	0	1	1	1	0

Table 5 : Year 2010WS With-Scheme

Numbers of properties* within each noise band, L10 (18-hour) dB(A).

Property Types	44 & Less dB(A)	45 to 49 dB(A)	50 to 54 dB(A)	55 to 59 dB(A)	60 to 64 dB(A)	65 to 69 dB(A)	70 to 74 dB(A)	75 to 79 dB(A)	80 & More dB(A)
Houses & Flats	0	0	63	548	532	297	100	92	70
Businesses & Shops	0	0	0	1	6	5	4	14	5
Schools & Hospitals	0	0	0	0	1	0	0	0	0
Churches & Public Bldgs	0	0	0	0	1	1	1	1	0

* Note that in the case of residential properties the values given are for the numbers of households.

Table 6 : Year 2010DN (Do-Nothing) to 2010WS (With-Scheme)

Numbers of properties* within each noise change band, L10 (18-hour) dB(A).

Property Types	Decreases 21 & More dB(A)	16 to 20 dB(A)	11 to 15 dB(A)	6 to 10 dB(A)	3 to 5 dB(A)	1 to 2 dB(A)	No Change	Increases 1 to 2 dB(A)	3 to 5 dB(A)	6 to 10 dB(A)	11 to 15 dB(A)	16 to 20 dB(A)	21 & More dB(A)
Houses & Flats	0	41	72	110	334	402	169	259	236	73	3	2	1
Businesses & Shops	0	0	1	3	2	6	0	8	15	0	0	0	0
Schools & Hospitals	0	0	0	0	0	0	0	0	0	1	0	0	0
Churches & Public Bldgs	0	0	0	0	0	1	1	2	0	0	0	0	0

* Note that in the case of residential properties the values given are for the numbers of households.

CONCLUSION

52. Implementation of the published proposals for the improvements to the North Circular Road between Popes Lane and the Hanger Lane Gyratory will cause changes in the noise levels in the vicinity of the Road itself. The tabulations have shown that there is a total of 563 households, shops and businesses which would have decreases in level of 3 dB(A) or more. Set against this there are 330 equivalent properties which would have increases in level of 3 dB(A) or more.

53. In terms of absolute noise levels the accumulated totals from Tables 4 and 5 show that there would be 285 households, shops and businesses with external noise levels of 70 dB(A) or more with the published proposals compared with 498 properties in the Do-Nothing condition.

53. When any road improvement is carried out, it is inevitable that there will be some properties whose noise climate is considerably worsened because of their proximity to the new route. However, the noise assessment has shown that, taking the area as a whole, the introduction of the published Proposals would result in more properties with noise decreases than increases and that there would be a decrease in the number of properties with external noise levels in excess of 70 dB(A). This level has been described by the Noise Advisory Council as "the limit of the acceptable". Many of the worst affected residential properties near the proposed route would be expected to qualify for insulation work under the terms of The Noise Insulation Regulations 1975. Such improved facade insulation would minimise the adverse effects on the domestic noise environment.

55. In overall terms therefore the implementation of these proposals for the improvement of the North Circular Road would give rise to a significant improvement in the noise environment of this area compared with the Do-Nothing conditions.

REFERENCES

		Deposit Document Number
1.	Land Compensation Act 1973, HMSO	D26
2.	Control of Pollution Act 1974, HMSO	D29
3.	The Noise Insulation Regulations 1975, Statutory Instrument 1975 No. 1763	D30
4.	The Noise Insulation (Amendment) Regulations 1988, Statutory Instrument 1988 No. 2000	
5.	Calculation of Road Traffic Noise, Department of Transport and Welsh Office, HMSO 1988	D63
6.	Planning and Noise, Department of the Environment, Circular 10/73, HMSO 1973	D92
7.	Manual of Environmental Appraisal, Department of Transport, 1983	D56

APPENDIX 1

The Noise Insulation Regulations 1975

Preliminary Schedule of properties likely to be eligible
for an offer of insulation work against noise
from traffic using the new highway

Address	Number of Households
37 - 40 St Pauls Close	4
43 - 48 St Pauls Close	6
45 - 53 Gunnersbury Avenue	5
66 - 88 Gunnersbury Avenue	12
Tudor Court	24
96 - 114 Gunnersbury Avenue	10
71 - 79 Gunnersbury Avenue	5
83 - 117 Gunnersbury Avenue	29
142 - 160 Gunnersbury Avenue	10
Gunnersbury Park Mansions	8
1 - 14 Park Parade	14
162 - 176 Gunnersbury Lane	8
187 - 205 Gunnersbury Lane	10
2 - 8 The Ridgeway	4
1 - 15 The Ridgeway	9
Total	158

APPENDIX 2

Additional Tabulations
of Noise Data supplied for the
Assessment Framework

Table 7 : Year 1992 Pre-Scheme

Numbers of properties* within each noise band, L10 (18-hour) dB(A).

Property Types	44 & Less dB(A)	45 to 49 dB(A)	50 to 54 dB(A)	55 to 59 dB(A)	60 to 64 dB(A)	65 to 69 dB(A)	70 to 74 dB(A)	75 to 79 dB(A)	80 & More dB(A)
Houses & Flats	0	0	166	450	424	298	122	329	0
Businesses & Shops	0	0	0	2	5	4	15	10	0
Schools & Hospitals	0	0	0	1	0	0	0	0	0
Churches & Public Bldgs	0	0	0	1	0	1	2	0	0

* Note that in the case of residential properties the values given are for the numbers of households.

Table 8 : Year 1992 (Pre-Scheme) to 2010DN (Do-Nothing)

Numbers of properties* within each noise change band, L10 (18-hour) dB(A).

Property Types	Decreases 21 & More dB(A)	16 to 20 dB(A)	11 to 15 dB(A)	6 to 10 dB(A)	3 to 5 dB(A)	1 to 2 dB(A)	No Change	Increases 1 to 2 dB(A)	3 to 5 dB(A)	6 to 10 dB(A)	11 to 15 dB(A)	16 to 20 dB(A)	21 & More dB(A)
Houses & Flats	0	0	0	0	0	0	356	1433	0	0	0	0	0
Businesses & Shops	0	0	0	0	0	0	7	29	0	0	0	0	0
Schools & Hospitals	0	0	0	0	0	0	1	0	0	0	0	0	0
Churches & Public Bldgs	0	0	0	0	0	0	0	4	0	0	0	0	0

Table 9 : Year 1992 (Pre-Scheme) to 2010WS (With-Scheme)

Numbers of properties* within each noise change band, L10 (18-hour) dB(A).

Property Types	Decreases 21 & More dB(A)	16 to 20 dB(A)	11 to 15 dB(A)	6 to 10 dB(A)	3 to 5 dB(A)	1 to 2 dB(A)	No Change	Increases 1 to 2 dB(A)	3 to 5 dB(A)	6 to 10 dB(A)	11 to 15 dB(A)	16 to 20 dB(A)	21 & More dB(A)
Houses & Flats	0	32	52	83	261	368	201	318	256	119	9	2	1
Businesses & Shops	0	0	0	3	2	7	0	6	16	1	0	0	0
Schools & Hospitals	0	0	0	0	0	0	0	0	0	1	0	0	0
Churches & Public Bldgs	0	0	0	0	0	0	1	3	0	0	0	0	0

* Note that in the case of residential properties the values given are for the numbers of households.

Public Inquiry Document No. 3/6

Proof of Evidence on Air Quality including addendum

DEPARTMENT OF TRANSPORT
LONDON REGIONAL OFFICE

A406
NORTH CIRCULAR ROAD

(Gunnersbury Avenue Improvement)

PROOF OF EVIDENCE ON AIR QUALITY

Department of Transport,
London Regional Office,
2 Marsham Street,
London SW1P 3EB

Ref.62372.0
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ASHDOWN ENVIRONMENTAL LTD
Consulting Environmental
Scientists & Engineers
The Oast House,
Hodore,
Upper Hartfield,
East Sussex TN7 4AR

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Appendix A : Figures

Appendix B : Summary of Terms

1043/A/M: 5.6.90

1.0 INTRODUCTION

1.01 My name is Christopher John Muskett. I hold a BSc in Zoology and a PhD in Applied Biology from the University of London and I am a Member of the Institute of Biology. I am a Director of Ashdown Environmental Limited and am responsible for providing consultancy services in various areas of environmental science including air and water pollution studies; environmental impact assessment and ecology.

1.02 I have worked as a professional environmental scientist for approximately 15 years and have held posts both within industry and local authorities. I have been responsible for numerous environmental assessment studies in the industrial and transportation fields both in the UK and overseas. I formerly held the position of Head of the Air Pollution Consultancy section of the (former) GLC Scientific Branch. In this post I was responsible for providing expert scientific advice on air pollution matters to the Council in its role as the Strategic Planning Authority for Greater London. Whilst in this post, I was responsible for conducting air pollution impact studies of several road development and traffic management schemes throughout London. I have also carried out research into the dispersion of air pollutants into roadside environments and was responsible for the development of a number of empirically based models for predicting air pollution levels near roads.

1.03 Ashdown Environmental Limited has been commissioned by Howard Humphreys and Partners to undertake, on behalf of the Department of Transport, an assessment of the air quality impacts of the proposed A406 improvement scheme from Popes Lane to Western Avenue. This evidence therefore considers the changes in air quality that could arise from the implementation of these improvements and discusses the implications as regards current air quality criteria. My evidence also covers the results of an extended air quality monitoring study that was carried out by Ashdown Environmental Limited to determine the existing or baseline conditions in the vicinity of the proposed scheme.

2.0 OUTLINE OF THE SCHEME

2.01 The North Circular Road (NCR) between Popes Lane and Western Avenue is a heavily trafficked single lane road which presently runs at-grade through a residential area and adjacent to Ealing Common. At peak hours in the morning and evening, long queues of traffic are seen at the junctions of the NCR with Uxbridge Road, Popes Lane and Gunnersbury Avenue. Much of this queuing can be attributed to effect of the narrowing of the trunk road over the railway lines.

2.02 The proposed scheme would widen the road into a dual two lane carriageway from Popes Lane to a point north of Uxbridge Road. The proposed route passes through a 520 metre tunnel under Ealing Common, on an alignment to the west of the present NCR. South of the tunnel, the new road would follow a route to the west of the present NCR until it rejoins the existing road at its junction with Baronsmede.

2.03 The junction at Uxbridge Road and Popes Lane would be widened and improved. The junctions between the NCR and Hamilton Road, Inglis Road, North Common Road and Baronsmede would be closed and become cul-de-sacs. The proposed scheme would therefore reduce traffic flows on the side roads and reduce queues at the two main junctions on the scheme.

3.0 POLLUTION FROM ROAD VEHICLES

3.01 Motor vehicles emit a wide variety of gaseous and particulate materials. The major components are carbon dioxide, water and nitrogen. Carbon dioxide is one of the gases which contribute to the 'greenhouse effect', although it is not a significant pollutant in the context of roadside situations. The main pollutants emitted from motor vehicles are carbon monoxide (CO); hydrocarbons (HC); oxides of nitrogen (NO_x); lead (Pb) and particulates (smoke).

3.02 The amount of pollution detectable at the kerbside depends inter alia on the composition of the traffic flow, particularly the number of heavy goods vehicles with diesel engines. Diesel engines emit smaller amounts of carbon monoxide, hydrocarbons and oxides of nitrogen than petrol engines. However, it has been estimated that diesel engines produce up to ten times as many particulates in their exhaust as petrol engines. Lead is not added to diesel fuel.

3.03 Other factors that influence vehicle emissions include the engine type, its age and state of maintenance, operating mode and speed of the vehicle. Carbon monoxide levels show a pronounced increase with decreasing vehicle speed, as shown in Figure 1.

3.04 Once emitted, pollutants disperse into the roadside environment depending on the combined effects of wind speed, direction and vehicle turbulence. With low wind speeds, the effects of turbulence predominate whilst at higher wind speeds, vehicle turbulence becomes less significant.

3.05 Air pollution levels tend to be highest at junctions or other sites where slow moving queues of traffic form due to the increased emission rates at slow speeds. Other sites where high air pollution can occur are in areas of restricted dispersion, such as in cuttings or in urban streets surrounded by high buildings, and around portals of long tunnels. Lateral dispersion of pollutants is also significantly affected by such road configurations and requires special techniques to model.

3.06 Generally speaking, roadside air pollution levels can be reduced in three main ways:

i. Reduction in emission of various pollutants by means of emission controls;

ii. Reduction in the flow of vehicles;

iii. Increase the speed of vehicles and minimise congestion.

3.07 The implementation of the above approaches leads to different degrees of improvement in air quality.

3.08 The quantification of the air quality impacts of a particular road scheme is normally carried out by examining predicted changes in air pollution level that will arise as a result of the scheme, and comparing these changes with the existing baseline level. Thus the degree of benefit or disbenefit of a particular proposal can be directly identified in air pollution terms.

3.09 I have examined the changes that would be likely to arise with this proposed scheme and discuss these in the evidence.

4.0 REVIEW OF LEGISLATION

4.01 A variety of existing and new legislative initiatives have been introduced into the UK to safeguard the air quality in the external environment. The Air Quality Standards Regulations 1989 introduced into the UK air quality standards for sulphur dioxide, lead, nitrogen dioxide (NO_2) and total suspended particulates (TSP). These standards derive from European Community Air Quality Directives.

4.02 Additional air quality criteria related to roadside sites are proposed in the Department of Transport's Manual of Environmental Appraisal (MEA). These criteria have been developed in order to assess the impact of new road schemes on the local environment. They can also be used to assess existing roadside sites in order to determine the relative air quality in an area.

4.03 Carbon monoxide (CO) is one of the principal gaseous pollutants associated with motor vehicles and it is often used as a surrogate for other road traffic pollutants. There is currently no UK air quality standard for CO, however in the United States, a Federal Air Quality Standard has been set at 9ppm for an 8 hour exposure period and 35ppm for one hour. These standards have been established to protect human health by maintaining the level of CO in the blood within 1-2%. The 9ppm 8 hour criterion has been adopted in the MEA as the threshold above which an 'air quality problem' is deemed to occur.

4.04 An air quality criterion was established for lead in Britain in the 'Report to the Secretary of State for Health and Social Security on Lead and Health (The Lawther Report), 1980'. The report recommended that the annual mean concentration of airborne lead should not exceed 2 microgrammes per cubic metre (μgm^{-3}) in places where people might be continuously exposed for long periods. This level also forms the basis of the European Community Air Quality Directive on lead.

4.05 The EEC Air Quality Directive on nitrogen dioxide (NO_2) introduced a limit value of 0.1ppm (200μgm^{-3}) for a 98th percentile hourly mean, not to be exceeded during the course of a year. A guide value of 50μgm^{-3} as a median value was also proposed. In addition, the MEA recommends that attention should be drawn to places where the annual average levels of NO_2 exceed 100μgm^{-3}.

4.07 An EEC Directive on air quality limit values for suspended particulates established a standard of 80μgm^{-3} as an annual average, and a guide value of 40-60μgm^{-3}.

4.08 The latest regulations governing emissions from motor vehicles were agreed by the EEC Environmental Council in June 1989. These regulations provide for a substantial reduction in emissions on all new cars by January 1993 through the introduction of catalytic converters. When fully implemented, it is estimated that these emission controls could reduce emissions from the UK petrol engined vehicle fleet overall by as much as 80%.

5.0 BASELINE AIR QUALITY STUDY

5.01 In order to assess the existing air quality along the route of the proposed scheme, a programme of air quality monitoring was initiated. Monitoring sites were set up at sites close to the portals of the proposed Ealing Common Tunnel. In order to gain further information about the behaviour of pollutants emitted from road tunnels, two further sites were set up at the Hatfield Tunnel on the A1(M). One site was located adjacent to the tunnel portal and the second on an embankment above the cutting, approximately 25 metres from the portal. The sites were set up to continuously monitor carbon monoxide concentrations and to determine weekly averages of lead, total suspended particulates (TSP) and nitrogen dioxide (NO_2). The location of the monitoring sites on the North Circular Road is shown in Figure 2.

5.02 The carbon monoxide concentration was recorded every ten minutes by means of a data logging device. The results for each month were then analysed to produce hourly average values and the maximum 8 hour average value recorded during each day. The results from the monitoring are shown in Figures 3-6 and summarised in Tables 1-4, together with the results from the monitoring of lead, TSP and NO_2.

5.03 The daily (24 hour) average carbon monoxide concentration at the sites located near the existing North Circular Road (NCR) was in the range 0.5-31.6ppm, with monthly averages between 2.0 and 10.9ppm. The concentrations recorded at the site of the proposed southern portal were generally lower than those at the site of the proposed northern portal, due to its position 50m away from the roadside. The results show, however, that the 9ppm MEA criterion for the maximum 8 hour CO level was exceeded regularly at both the monitoring sites. The maximum 8 hour average value recorded during the period was 32ppm. This suggests that, even if carbon monoxide emissions are decreased by 50% as expected over the next 5-10 years, the 9ppm MEA criterion is likely to still be exceeded at these sites if the existing road layout and traffic flow arrangements remain.

5.04 At the sites located at the portal of Hatfield Tunnel, it was anticipated that the concentrations of pollutants would be high, as emissions of gaseous pollutants from vehicles in the tunnel will accumulate within the tunnel. The results of the monitoring at the portal show that the concentrations of all the parameters measured were consistently above recommended air quality criteria. The daily average carbon monoxide concentration at the portal was in the range 0.04-25.2ppm, with monthly averages between 2.6-10.5ppm. The 9ppm MEA criterion for carbon monoxide was exceeded almost daily at this site.

5.05 Consideration of the results from the monitoring at the embankment show that the carbon monoxide concentrations were up to 80% lower than those recorded at the portal and the 9ppm criterion was rarely exceeded. The daily average carbon monoxide was in the range 0.6-15.2ppm with monthly averages between 1.6 and 5.3ppm.

5.06 Lead concentrations recorded at the NCR sites averaged $0.4\mu gm^{-3}$-$0.2\mu gm^{-3}$ at the northern and southern portal sites respectively. A maximum value of $0.9\mu gm^{-3}$ was recorded. These values are well below the maximum concentration of $2\mu gm^{-3}$ recommended by the 'Lawther Report' and specified in EEC Directive 82/884/EEC.

5.07 Lead concentrations recorded at the Hatfield Tunnel portal were regularly in excess of the $2\mu gm^{-3}$ criterion. A maximum concentration of $3.9\mu gm^{-3}$ was recorded at this site. At the site on the tunnel embankment, lead concentrations had generally reduced by up to 75% of the concentration recorded at the portal. No concentrations in excess of $2\mu gm^{-3}$ were noted during the monitoring period at the embankment site.

5.08 NO_2 concentrations at the NCR sites ranged from 25 to $107\mu gm^{-3}$. The average concentration over the monitoring period was $73.7\mu gm^{-3}$ at the site closest to the proposed northern portal and $56.8\mu gm^{-3}$ at the site closest to the proposed southern portal. These values represent the average for the monitoring period between December and June 1988/89 and it is not possible to relate this directly to the relevant EEC criterion, which is based upon a 98th percentile value. However, national surveys of NO_2 conducted by Warren Spring Laboratory suggest that it is possible to predict the 98th percentile from an annual average by multiplying by a factor of 2.5. Using this factor, existing NO_2 levels at both NCR sites are likely to be within the EEC limit value.

5.09 NO_2 concentrations at the Hatfield Tunnel portal site ranged from 74 to $289\mu gm^{-3}$. The higher of these values exceeds the EEC criterion by a substantial margin. At the embankment site, the concentrations ranged from 23 to $114\mu gm^{-3}$ with an average over the period of $77\mu gm^{-3}$. Applying a factor of 2.5 to convert this average level to a 98th percentile, gives a concentration of $194\mu gm^{-3}$, which is very close to the EEC limit value.

5.10 From the monitoring work conducted at both the NCR locations, it is concluded that the existing air quality at the sites is generally poor with CO levels in excess of the 9ppm MEA criterion indicative of an 'air quality problem'.

5.11 From the monitoring work conducted at the sites located at the Hatfield Tunnel, it can be concluded that the air quality at the tunnel portal is poor. This is not unexpected, due to the accumulation of vehicle pollutants within the tunnel. Measurements at the embankment site however, indicate that dispersion of the pollutants away from the tunnel portal is very rapid with concentrations falling by around 60% on average within 25m of the portal.

6.0 AIR QUALITY ASSESSMENT

6.01 There are various techniques available to model the impact of air pollution from road schemes. The technique most commonly used in the UK is that described in the MEA and in the Transport and Road Research Laboratory's Report No. LR1052. The technique consists of calculating the strength of the emission source from a road, taking into account vehicle flow and speed, and then estimating the dispersion into the surrounding environment.

6.02 The TRRL model was developed from data in flat terrain conditions and the MEA specifically notes that it should not be used in situations where roads are not at ground level, or where they emerge from tunnel portals. In such situations, the predictive ability of the TRRL model is severely restricted and it is likely to fail to accurately predict air pollution levels. The MEA therefore states that, for such road configurations, advice should be sought from TRRL.

6.03 I have discussed these matters with TRRL and it has been agreed that the standard MEA methodology would not be appropriate in this instance. As an alternative, it was decided to use a more sophisticated model, capable of taking into account the variation in road height that will arise with this scheme. The model chosen was CALINE3 (California Line Source Dispersion Model), which is a line source model developed by the California Department of Transportation and is part of the United States Environmental Protection Agency Users Network for Applied Modelling of Air Pollution (UNAMAP) suite of air dispersion models. A full description of CALINE3, together with its validation is given in the accompanying Air Quality Report.

6.04 Emissions from the tunnel portals have been modelled using a combination of empirical and theoretical techniques to modify the basic CALINE3 model. These modifications have been discussed and agreed with TRRL.

6.05 The MEA recommends the use of one vehicle pollutant, carbon monoxide, as a general indicator of vehicle pollution. The CALINE3 model has therefore been used to predict carbon monoxide concentrations at peak hour traffic flows. Using the predicted peak hour traffic flows, the rate of emission of carbon monoxide and the distance from the receptor to the road, the peak one hour average carbon monoxide concentration can be calculated. This can then be converted to the eight hour concentration likely to be exceeded more than once a year. The relationship between the average hourly concentration and the maximum eight hourly average is derived from the results of monitoring studies carried out by TRRL on a number of different types of road.

6.06 The CALINE3 model has been subject to extensive validation studies and has been shown to give good agreement between predicted and observed concentrations of carbon monoxide. However, individual estimates can only be considered as a general indication of the level likely to be experienced. Therefore, the model should be used primarily for comparison purposes between various schemes, and between air pollution levels with and without a particular scheme.

6.07 The assessment method given in the MEA and in TRRL LR1052 is based on emission data for vehicles in the 1970's. The CALINE3 model takes emission data as input and this allows the model to calculate the changes in air pollution levels as reductions in exhaust emissions come into effect. The effect of the reduction in carbon monoxide emissions has been estimated by the Warren Spring Laboratory and their data have been used for this assessment.

6.08 Full details of the assessment techniques used in this study are given in the Air Quality Report.

7.0 PREDICTION OF AIR POLLUTION LEVELS

7.01 The techniques outlined in Section 5 above have been applied to the scheme so that predicted pollution levels with the scheme in the year of opening and the year 2010 (15 years after opening) can be compared with the 'DO MINIMUM Option' in the same years. To examine the worst case, the DO-MINIMUM and DO-SOMETHING options have been examined using 1987 emission data. However, the effect of the anticipated reduction in vehicle emissions through emission controls has also been examined. Emission data for vehicles reported by the Warren Spring Laboratory suggest substantial reductions in carbon monoxide emissions will occur during the period from now to the year 2010 following stricter regulatory controls. These data suggest emissions will decrease by 45% and 80% by the years 1995 and 2010 respectively.

7.02 The traffic figures used for this study were those given in the Proof of Evidence on Traffic.

7.03 CALINE3 was used to calculate AM and PM peak carbon monoxide concentrations along the route. The model was run four times using four wind directions, one from each quadrant. The results were then combined by calculating a weighted average of the four model runs. The actual weight used for each model result was in proportion to the frequency of occurrence of that wind direction. For instance, if the frequency of each of the four wind directions was 25% then each of the four CALINE3 results for each receptor would be multiplied by 0.25. The four resulting numbers for each receptor would then be added to give the weighted average. The CALINE3 model calculates hourly average concentrations; from these results the annual maximum 8 hour averages have been calculated using the methodology described in TRRL 1052.

7.04 The TRRL has developed a method of predicting the concentrations of lead, nitrogen dioxide and hydrocarbon in the atmosphere from the results of the carbon monoxide modelling. The TRRL methodology was used to calculate future concentrations of these pollutants.

7.05 The concentrations of lead in air have been calculated assuming the present amount of lead in petrol of 0.15g/l continues. This represents the worst case and in practice lower levels of lead emission will result due to the increasing use of unleaded fuel.

7.06 Results from the monitoring programme indicate that the peak concentrations of CO are reached between approximately 12.00-2.00pm. Concentrations measured at this time are generally two to three times higher than the peak hour concentrations at times of peak traffic flow. This increase is due to the increase in background concentration of carbon monoxide during the day.

7.07 The background concentration has been used in the calculation of the carbon monoxide concentration for both the DO-MINIMUM and DO-SOMETHING schemes.

7.08 Modelling of carbon monoxide concentrations along the length of the present NCR route indicates that the areas around the junctions of the NCR with Uxbridge Road and with Gunnersbury Lane and Popes Lane experience high peak hour concentrations, in excess of the 9ppm MEA criterion. These areas of high concentration are caused by the queues of traffic at the junctions at the morning and evening peak hours.

7.09 The proposed new scheme, including the tunnel, would relieve the congestion at the junction between the NCR and Uxbridge Road. The new road scheme would ensure that traffic was free flowing along the length of the scheme. The area adjacent to the tunnel would show considerable improvements in carbon monoxide concentration. This is due to the confinement of the vehicle emissions within the tunnel and therefore they are unable to disperse into the atmosphere.

7.10 Emissions from the tunnel would occur at the tunnel portals. The results from both monitoring and modelling of the emissions from tunnel portals indicate that, although pollutant concentrations at the portal can be high, pollutant dispersal is rapid. A comparison between the DO-MINIMUM and DO-SOMETHING options indicates that carbon monoxide concentrations would decrease in the vicinity of the proposed northern portal if the scheme was implemented. Near the proposed southern portal, carbon monoxide concentrations would be similar to present day conditions. At the site of the proposed southern portal there is a block of flats. I have therefore examined the predicted changes in carbon monoxide concentration with height at this site. The results indicate that the carbon monoxide concentration is at its greatest at ground level and has dispersed to extremely low concentrations at a height of 25 metres above ground level.

7.11 The results from the modelling exercise are summarised in Figures 7 and 8. These show the predicted maximum 8 hour average CO concentration for the DO-MINIMUM and DO-SOMETHING schemes. Figure 9 shows the areas where air quality would be expected to improve or deteriorate following construction of the scheme. This plot has been used to determine the number of households that would experience a benefit or disbenefit within 200m of the NCR along the entire Southern Section. 681 households are expected to show an improvement in the carbon monoxide concentrations and 223 a decline.

7.12 The results from the calculations of the concentrations of carbon monoxide, lead, nitrogen oxides (NO_x) and hydrocarbons are summarised in Table 5, in terms of the number of households experiencing a benefit or disbenefit from the scheme.

7.13 Calculation of lead levels for the proposed scheme indicates that no households would be subject to lead concentrations in excess of EEC limit value of $2\mu gm^{-3}$. The maximum concentration is predicted to be $1.7\mu gm^{-3}$. The highest concentrations are predicted to occur at the junctions between the NCR, Gunnersbury Lane, Popes Lane and Uxbridge Road. Similarly high concentrations are predicted for the Do-Nothing scheme with an additional area of high concentration at the junction with Gunnersbury Drive.

7.14 The calculation of lead concentrations along the scheme, indicates that 662 households would experience decreased concentrations, whilst 192 households would experience small increases in lead concentrations. These are mainly located around both tunnel portals. This would be due to the combined emissions from the portal and the roads leading away from the tunnel. The increased speed of the traffic would also increase lead emissions (see Figure 10). The increases in concentration are, however, generally small, with a increase of $0.3\mu gm^{-3}$ typically predicted. Most households affected would experience lead concentrations in the range $0.6-0.8\mu gm^{-3}$, which is well within the relevant air quality standard. These levels can be expected to decrease further as the use of unleaded petrol increases.

7.15 Calculation of the concentration of nitrogen dioxide indicates that 1243 households would experience decreased concentrations and 159 would show an increase. The households that experience the greatest increase are located around the tunnel portals. A maximum increase of $0.4\mu gm^{-3}$ is predicted. Concentrations of NO_x are also expected to decrease with the introduction of the EEC Regulations controlling exhaust emissions.

7.16 Hydrocarbon concentrations would be expected to decrease in most areas after implementation of the scheme. 47 households would experience increased hydrocarbon concentrations. Decreases in concentration would occur along the present route of the NCR where the existing road passes beside Ealing Common.

Effect of Emission Controls

7.17 As already noted, European Directives in the field of vehicle emission control will result in substantial reductions in emissions by the end of the century. As a consequence, roadside air quality is expected to show a general improvement in coming years. The effect of which will depend upon a combination of factors such as traffic growth, road configuration and flow conditions.

7.18 In order to evaluate the significance of these vehicle emission improvements in the context of this scheme, further modelling of air pollution levels was carried out for the DO-MINIMUM and DO-SOMETHING scenarios. This modelling assumed that emission controls reduce overall emissions by 45% in the early years of the scheme, increasing to 80% by 2010.

7.19 The effect of emission controls will be to reduce carbon monoxide concentrations on the existing route of the NCR. In 1995 the effect of emission controls is to reduce carbon monoxide concentrations to a maximum of 7ppm on the DO-MINIMUM scheme and 3ppm on the DO-SOMETHING scheme. 316 households would experience decreased concentrations and 131 households would experience increased concentrations if the scheme was implemented and emissions were decreased by 45%. No households would experience carbon monoxide concentrations greater than the 9ppm MEA criterion. In 2010 the predicted 80% reduction in emissions of carbon monoxide would reduce carbon monoxide concentrations to low levels for both the DO-MINIMUM and DO-SOMETHING schemes. However, for the DO-SOMETHING scheme, all properties would still experience similar or decreased concentrations of carbon monoxide compared to the DO-MINIMUM scheme.

7.20 The predicted effect of emission controls on NO_x is to reduce NO_x emissions by 30% by 1995 and 70% by 2010. Thus it is unlikely that the EEC limit value for NO_2 would be exceeded at any point on the scheme in 1995.

8.0 CONCLUSIONS

8.01 Measurements and modelling of the present air quality along the existing route of the NCR shows that air quality conditions are poor. The 9ppm carbon monoxide threshold, indicative of an air quality problem, is regularly exceeded. The primary reason for this is the queuing of traffic, particularly at the junctions between the NCR, Gunnersbury Lane and Popes Lane and between the NCR and Uxbridge Road. Traffic queuing results in a greater emission of carbon monoxide per vehicle than under free flow conditions.

8.02 The provision of a tunnel under Ealing Common would result in a free flow of traffic along the NCR with a concomitant reduction in carbon monoxide emissions. Most households adjacent to the existing route would experience an improvement in air quality. In particular, properties in Gunnersbury Avenue between Baronsmede and Uxbridge Road would experience decreased concentrations of vehicle related pollutants.

8.03 Emissions from vehicles in the tunnel would be emitted at the tunnel portals. These emissions would disperse rapidly, giving rise to only small areas of elevated concentration immediately adjacent to the portals. Overall, some 681 households are expected to experience a decrease in carbon monoxide levels, whilst 223 would experience a small increase.

8.04 Because of the different relationships between vehicle speed and emission rate for the other primary vehicle pollutants (lead, oxides of nitrogen and hydrocarbons) the relative benefits and disbenefits of the scheme are different. For hydrocarbons, most households would experience decreased concentrations, for lead and nitrogen oxides some households would experience an increase in concentrations.

8.05 The introduction of emission controls into the UK in coming years is likely to result in a substantial improvement in roadside air quality, compared to the present day. With these improvements, air quality at households in the vicinity of the existing NCR will show a significant improvement. With the implementation of the proposed scheme, the effect of the anticipated emission controls will be to bring about even greater improvements in air quality, with no households experiencing pollutant levels in excess of relevant standards.

TABLE 1 : AIR QUALITY MONITORING : SUMMARY OF RESULTS

NM = Not Measured

Site: North Circular Road Ref: HHA Year: 1988-1989

Pollutant	December	January	February	March	April	May
CO Average daily 8 hr Maximum	5.0	6.9	7.7	6.1	6.9	10.9
Range ppm	1.6-10.5	1.5-15.7	3.1-31.6	1.9-11.0	2.7-11.7	4.2-19.8
Monthly Mean 24 hour Average	3.3	4.7	4.9	3.9	4.5	7.0
Range ppm	1.1-9.2	0.9-14.9	1.9-15.2	1.2-8.4	1.8-9.6	2.4-11.9
TSP Monthly Mean μgm^{-3}	25.2	23.1	11.7	10.0	30.0	45.3
Range	15.6-31.5	17.22-32.12	4.1-19.4	5.75-15.3	23.8-41.56	6.3-74.9
Pb Monthly Mean μgm^{-3}	0.45	0.56	0.16	0.17	0.29	0.5
Range	0.25-0.6	0.41-0.87	0.078-0.21	0.10-0.23	0.08-0.56	0.14-0.68
NO_2 Monthly Mean μgm^{-3}	NM	67.1	75.4	69.1	NM	83.8
Range	NM	48-93	72-82	61-76		61-107

Key : CO = Carbon Monoxide
TSP = Total Suspended Particulates
Pb = Lead
NO_2 = Nitrogen Dioxide

TABLE 2 : AIR QUALITY MONITORING : SUMMARY OF RESULTS

NM = Not Measured

Site: Ealing Riding School Ref: HHB Year: 1988-1989

Pollutant	December	January	February	March	April	May
CO Average daily 8 hr Maximum	4.3	6.2	3.3	2.7	2.0	5.0
Range ppm	0.8-12.5	0.7-23.3	1.0-12.3	0.5-9.2	0.6-4.6	0.9-9.5
Monthly Mean 24 hour Average	3.2	4.6	1.8	1.5	1.4	2.7
Range ppm	0.6-8.7	0.6-20.2	0.7-8.2	0.4-4.4	0.3-3.30	0.7-5.4
TSP Monthly Mean μgm^{-3}	22.4	27.0	23.2	11.5	15.1	28.5
Range	3.5-34.9	16.0-38.3	14.7-27.6	4.0-18.2	8.3-22.8	5.91-50.3
Pb Monthly Mean μgm^{-3}	0.24	0.27	0.26	0.13	0.10	0.15
Range	0.13-0.32	0.21-0.36	0.16-0.33	0.02-0.22	0.06-0.16	0.05-0.32
NO_2 Monthly Mean μgm^{-3}	NM	48.1	62.8	55	NM	61.4
Range		25-72	53-72	51-59		44-72

Key : CO = Carbon Monoxide
TSP = Total Suspended Particulates
Pb = Lead
NO_2 = Nitrogen Dioxide

TABLE 3 : AIR QUALITY MONITORING : SUMMARY OF RESULTS NM = Not Measured

Site: Hatfield Tunnel Portal Ref: HTA Year: 1988-1989

Pollutant	December	January	February	March	April	May
CO Average daily 8 hr Maximum	7.1	5.0	14.3	15.6	15.2	13.1
Range ppm	1.9-12.4	0.04-13.0	4.4-21.6	6.9-25.2	9.3-23.4	3.1-23
Monthly Mean 24 hour Average	4.3	2.6	9.5	10. 5	9.6	7.6
Range ppm	0.9-7.4	0.1-7.1	2.6-13.4	4.8-13.9	4.8-13.3	2.4-12.0
TSP Monthly Mean μgm^{-3}	62.9	77.5	56.3	56.4	52.6	51.7
Range	25.9-109.1	47.3-147.5	48.7-70.6	47.8-62.0	22.8-77.3	42.3-57
Pb Monthly Mean μgm^{-3}	3.7	2.1	2.1	2.0	1.8	1.5
Range	3.55-3.89	1.93-2.78	1.85-2.31	1.77-2.29	1.67-1.97	0.14-1.87
NO_2 Monthly Mean μgm^{-3}	NM	182	140	190	NM	236
Range	NM	148-225	74-168	150-229		145-289

Key : CO = Carbon Monoxide
TSP = Total Suspended Particulates
Pb = Lead
NO_2 = Nitrogen Dioxide

TABLE 4 : AIR QUALITY MONITORING : SUMMARY OF RESULTS   NM = Not Measured

Site: Hatfield Tunnel Embankment   Ref: HTB   Year: 1988-1989

Pollutant	December	January	February	March	April	May
CO Average daily 8 hr Maximum	6.7	3.7	3.3	3.1	2.6	4.4
Range ppm	1.0-15.2	0.6-7.5	1.4-5.3	0.8-5.3	0.8-5.6	1.5-8.0
Monthly Mean 24 hour Average	5.3	2.2	2.0	1.7	1.6	2.3
Range ppm	0.6-12.9	0.4-5.5	0.8-3.2	0.4-3.3	0.4-3.1	1.0-3.9
TSP Monthly Mean μgm^{-3}	57.0	69.2	21.2	19.9	18.8	21.1
Range	56.97	21.9-147.1	13.4-27.3	15.5-24.3	11.1-25.7	16.3-27.9
Pb Monthly Mean μgm^{-3}	0.98	0.69	0.58	0.55	0.41	0.3
Range	0.61-1.61	0.53-0.84	0.41-0.85	0.43-0.71	0.23-0.67	0.14-0.41
NO_2 Monthly Mean μgm^{-3}	NM	58.6	50.0	94.3	NM	107
Range	NM	23-114	89-99	89-99		99-112

Key : CO = Carbon Monoxide
TSP = Total Suspended Particulates
Pb = Lead
NO_2 = Nitrogen Dioxide

TABLE 5 : SUMMARY OF RESULTS OF MODELLING OF CONCENTRATIONS OF CARBON MONOXIDE, LEAD, NITROGEN OXIDES AND HYDROCARBONS

Pollutant	Number of Households Showing –	
	Increased Concentration	Decreased Concentration
Carbon Monoxide	223	681
Lead	192	662
Nitrogen Oxides	159	1243
Hydrocarbons	47	1378

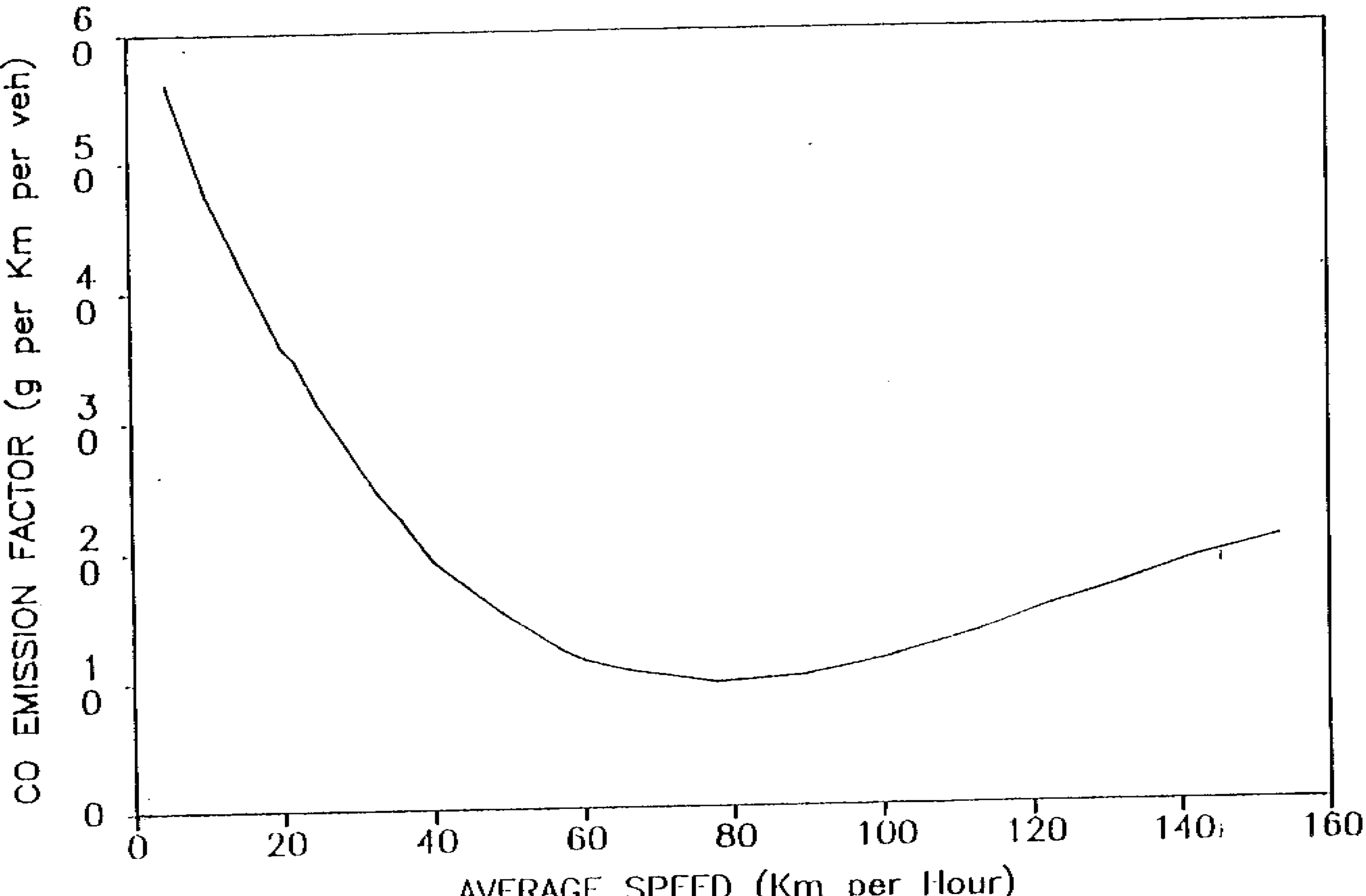

FIGURE 1 : VARIATION OF CARBON MONOXIDE EMISSION FACTORS WITH VEHICLE SPEED

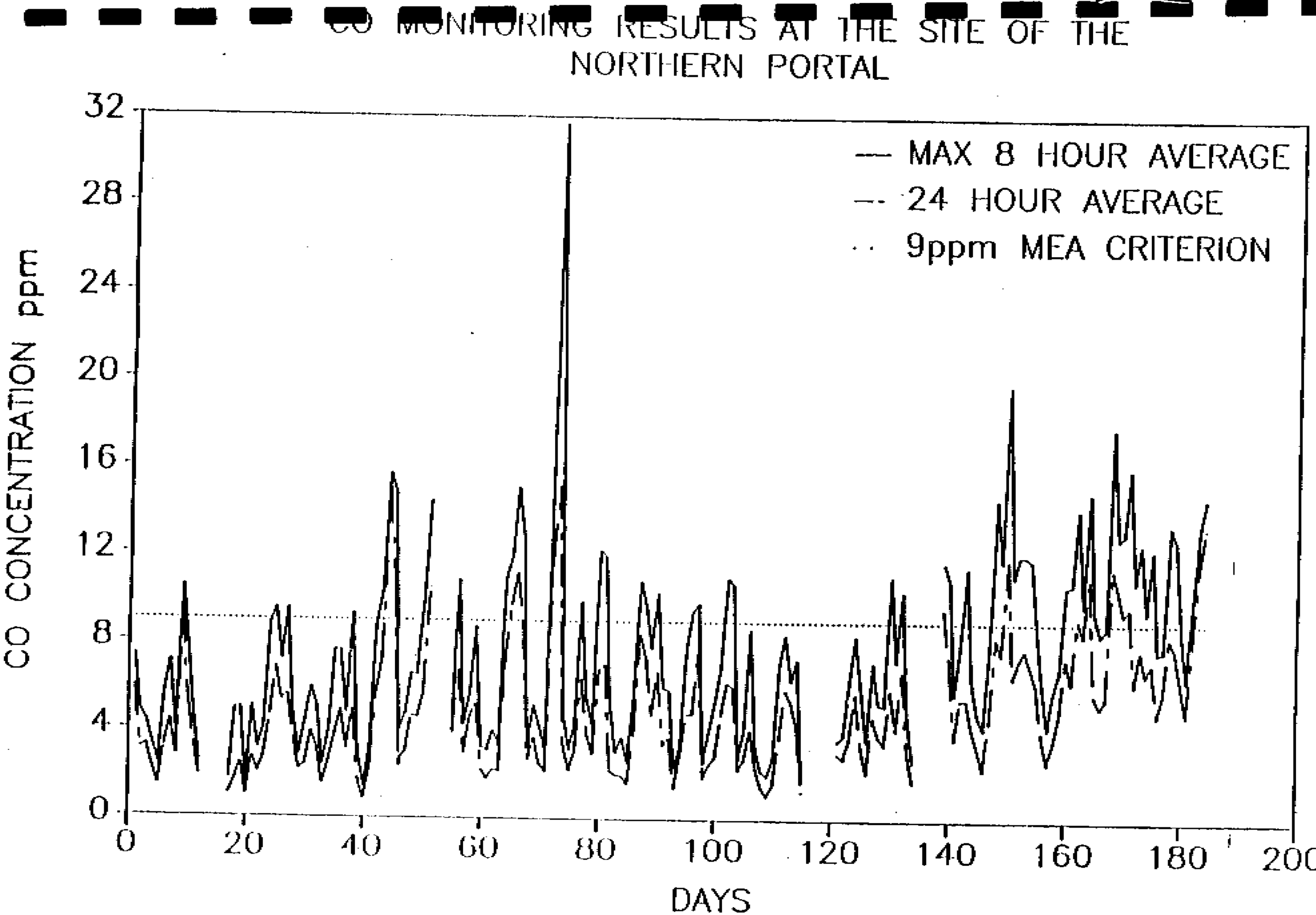

FIGURE 3 : RESULTS OF CARBON MONOXIDE MONITORING AT THE SITE OF THE NORTHERN PORTAL

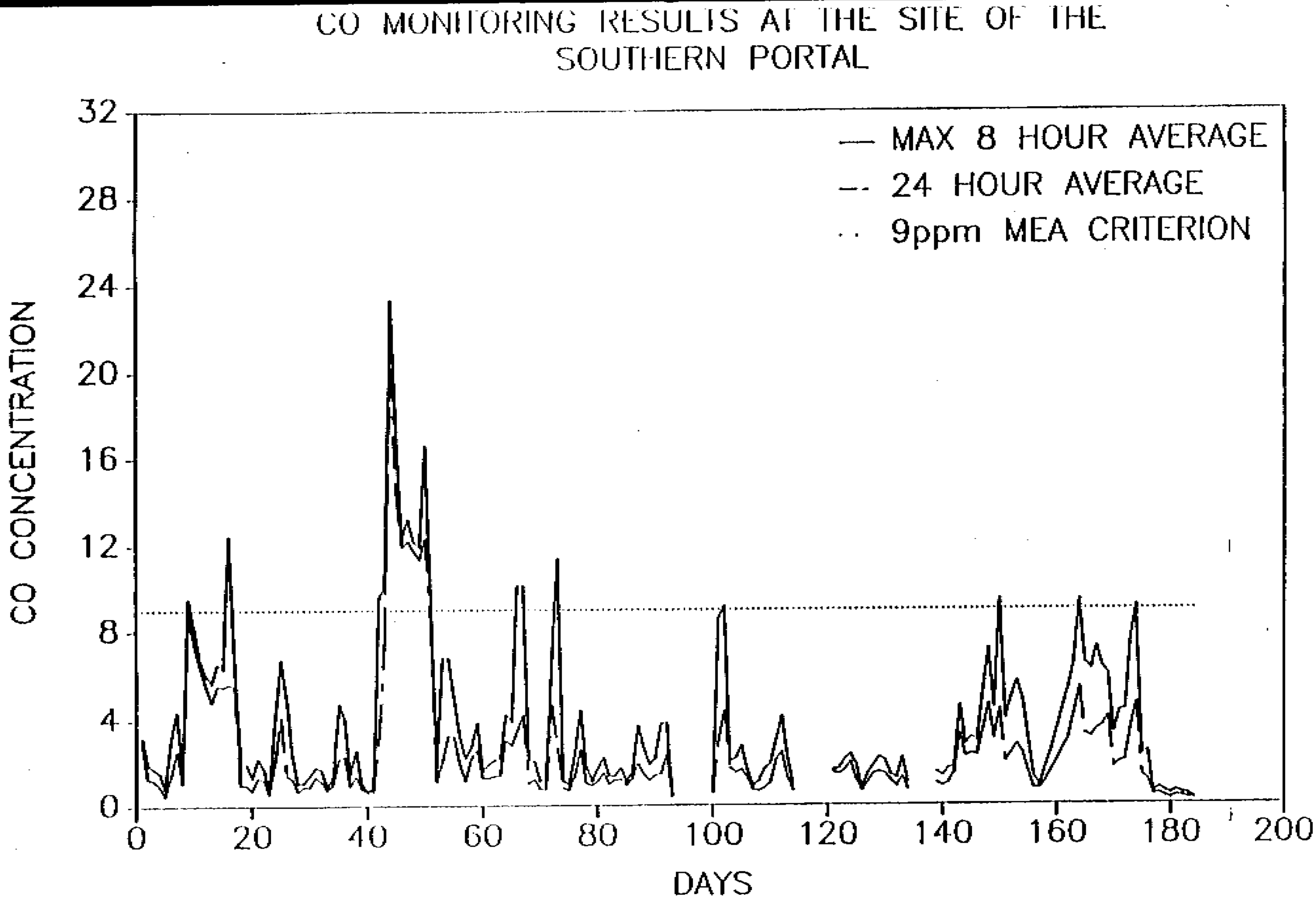

FIGURE 4 : RESULTS OF CARBON MONOXIDE MONITORING AT THE SITE OF THE SOUTHERN PORTAL

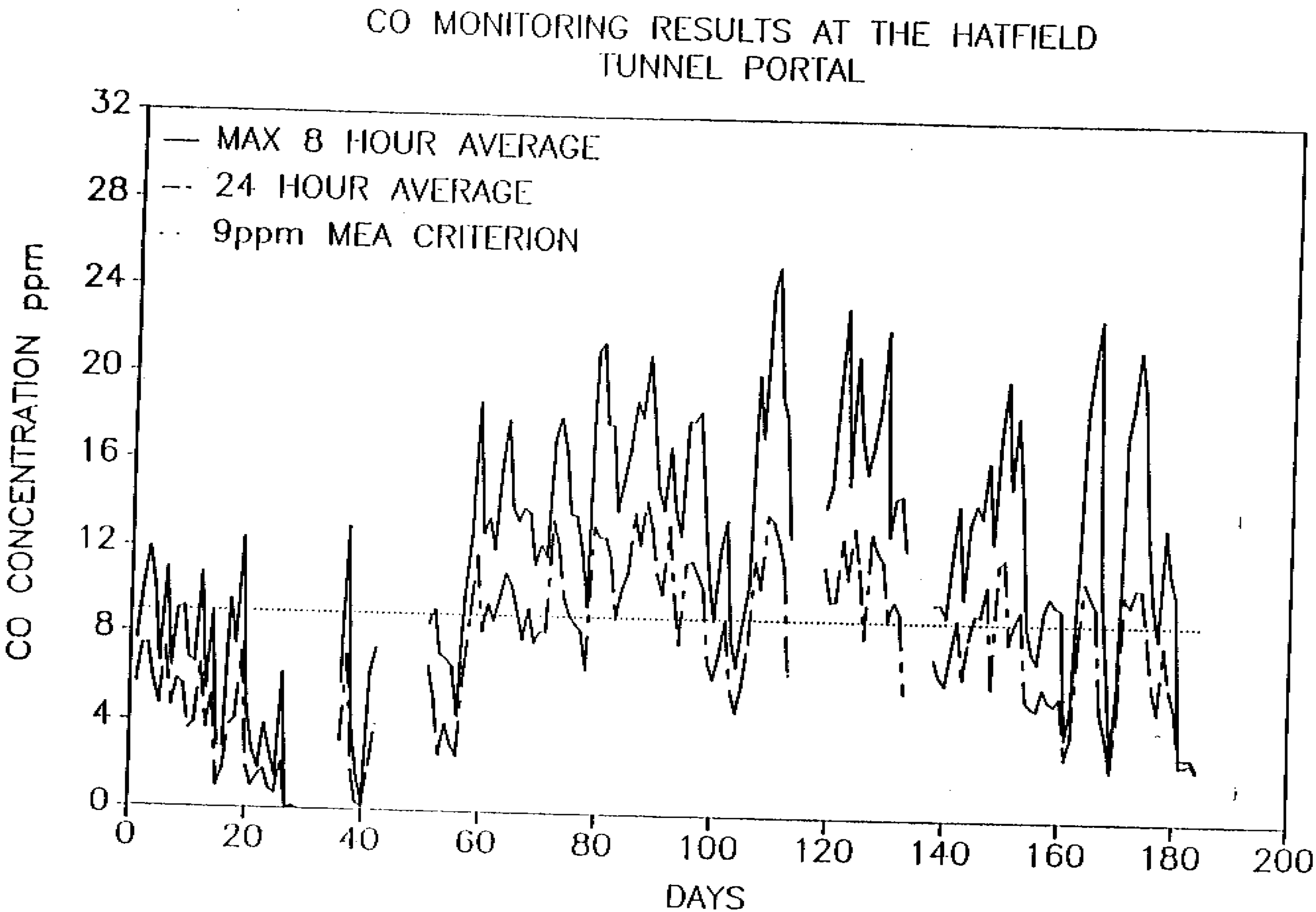

FIGURE 5 : RESULTS OF CARBON MONOXIDE MONITORING AT HATFIELD TUNNEL PORTAL

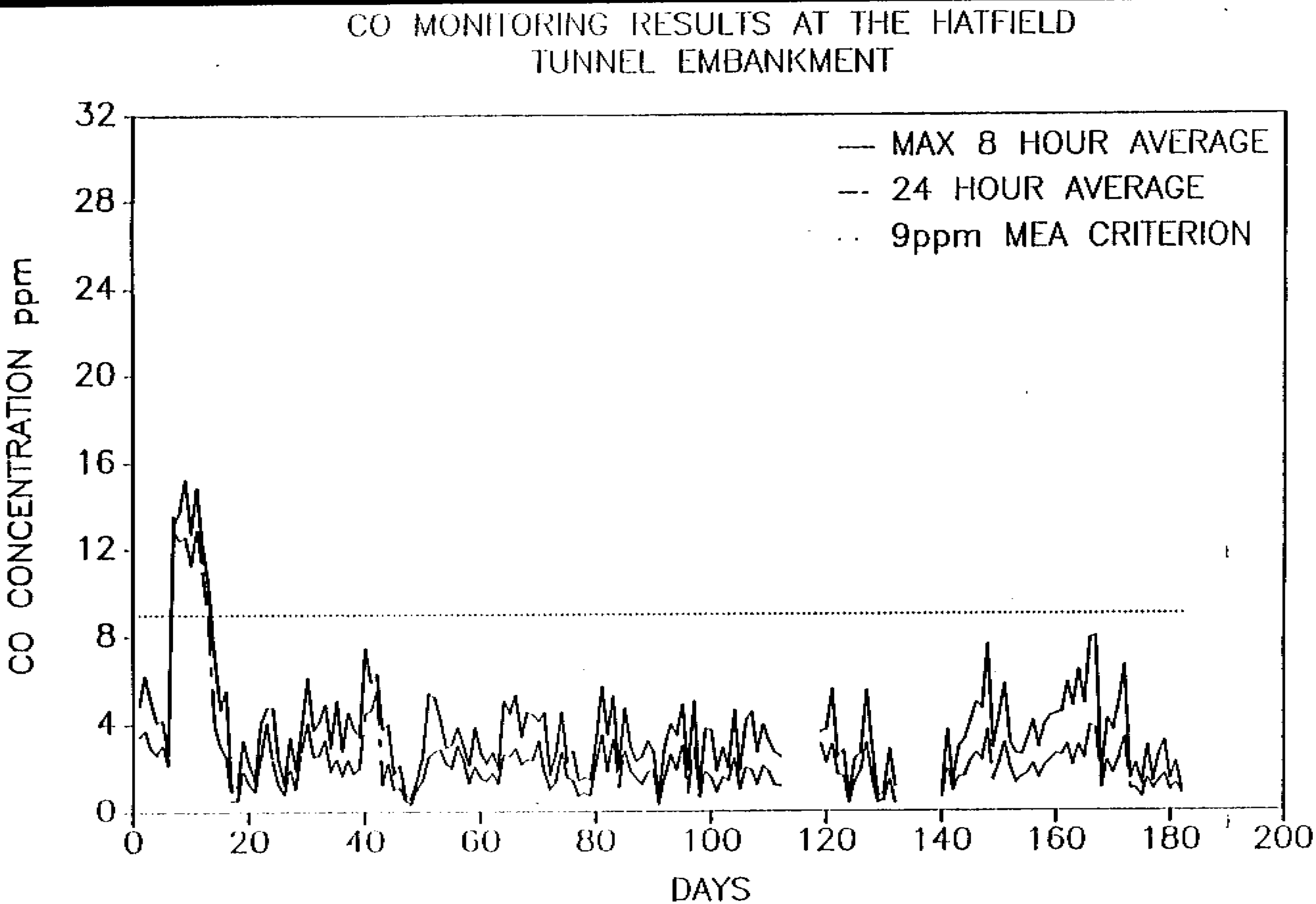

FIGURE 6 : RESULTS OF CARBON MONOXIDE MONITORING AT HATFIELD TUNNEL EMBANKMENT

DEPARTMENT OF TRANSPORT
LONDON REGIONAL OFFICE

A406
NORTH CIRCULAR ROAD

(Gunnersbury Avenue Improvement)

AIR QUALITY REPORT

Department of Transport
London Regional Office,
2 Marsham Street,
London SW1P 3EB

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ASHDOWN ENVIRONMENTAL LTD.
Consulting Environmental
Scientists & Engineers
The Oast House,
Hodore,
Upper Hartfield,
East Sussex TN7 4AR

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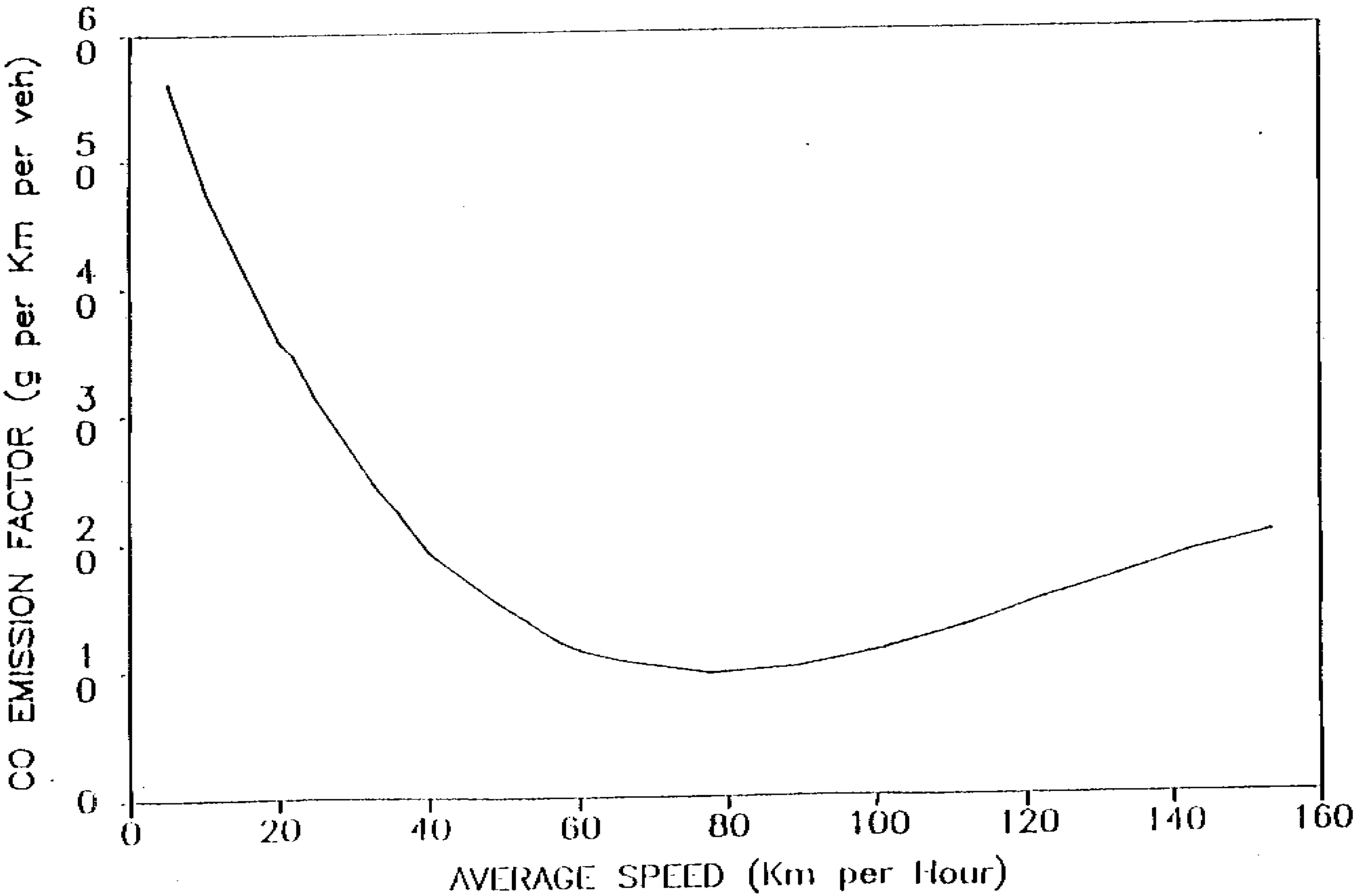

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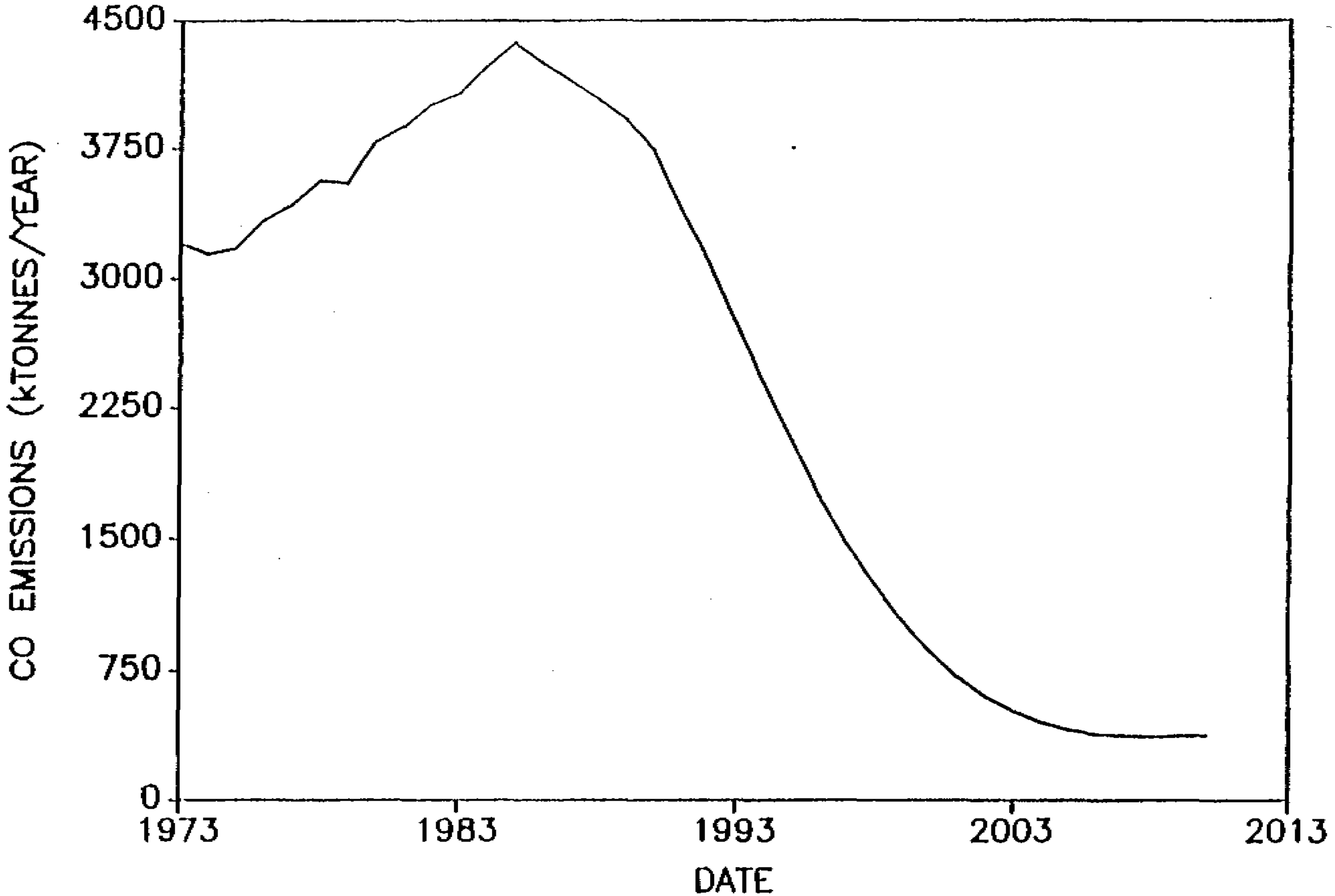


Figure 3.1 : Predicted Change in Total Carbon Monoxide Emissions From Vehicles 1983-2010

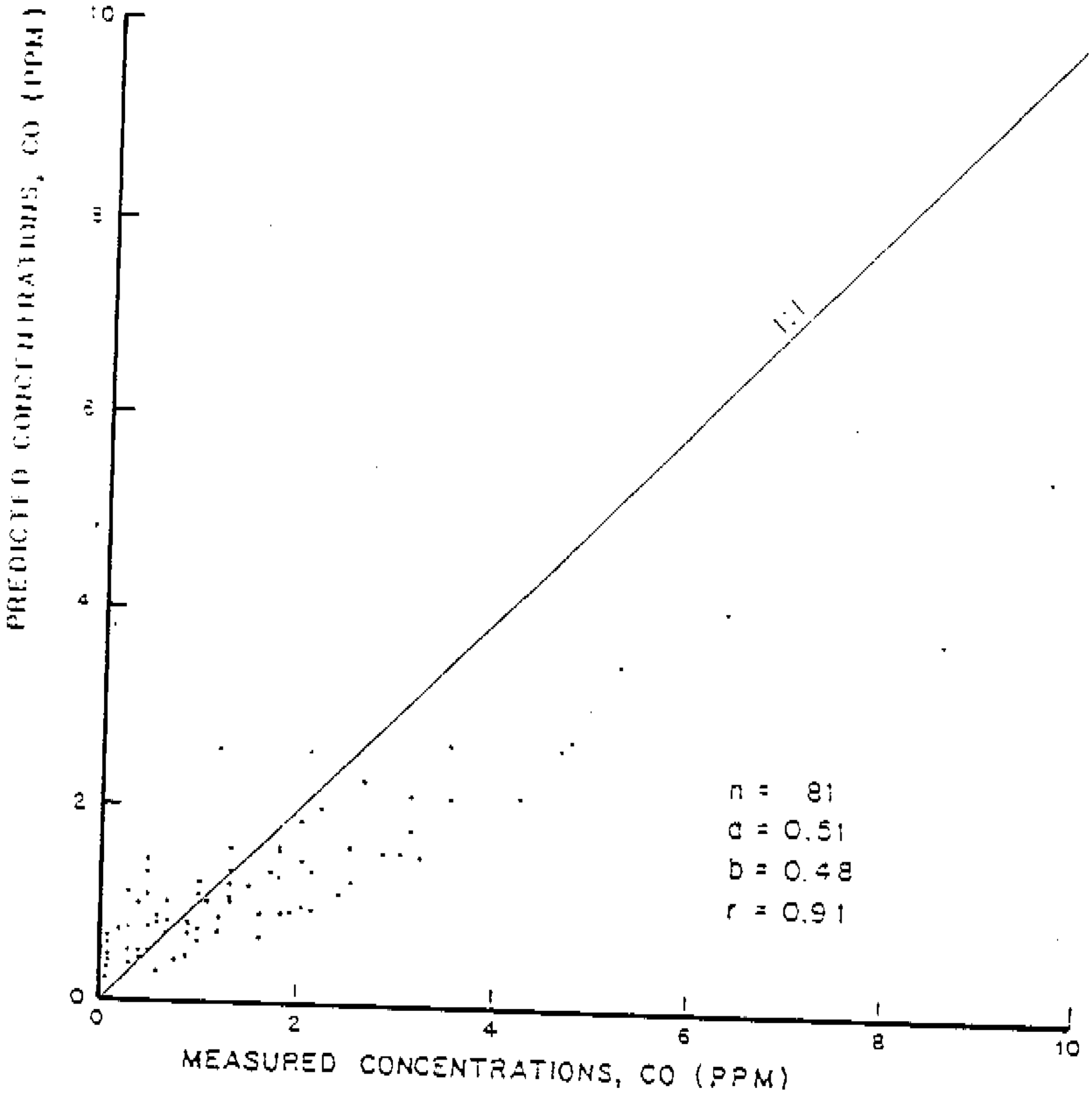
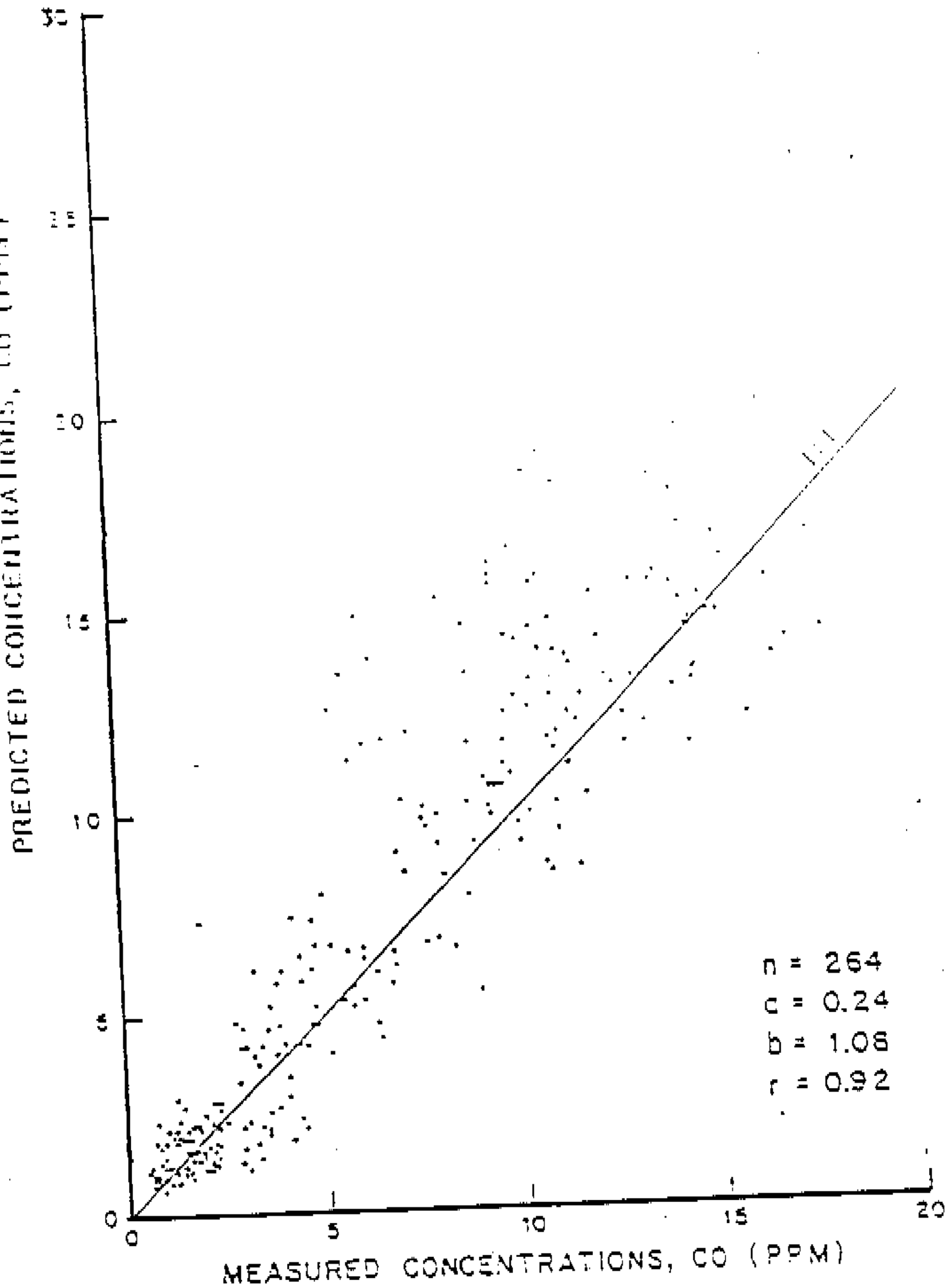


Figure 3.2 : Validation of CALINE3. Pasquill Stability Classes A and C



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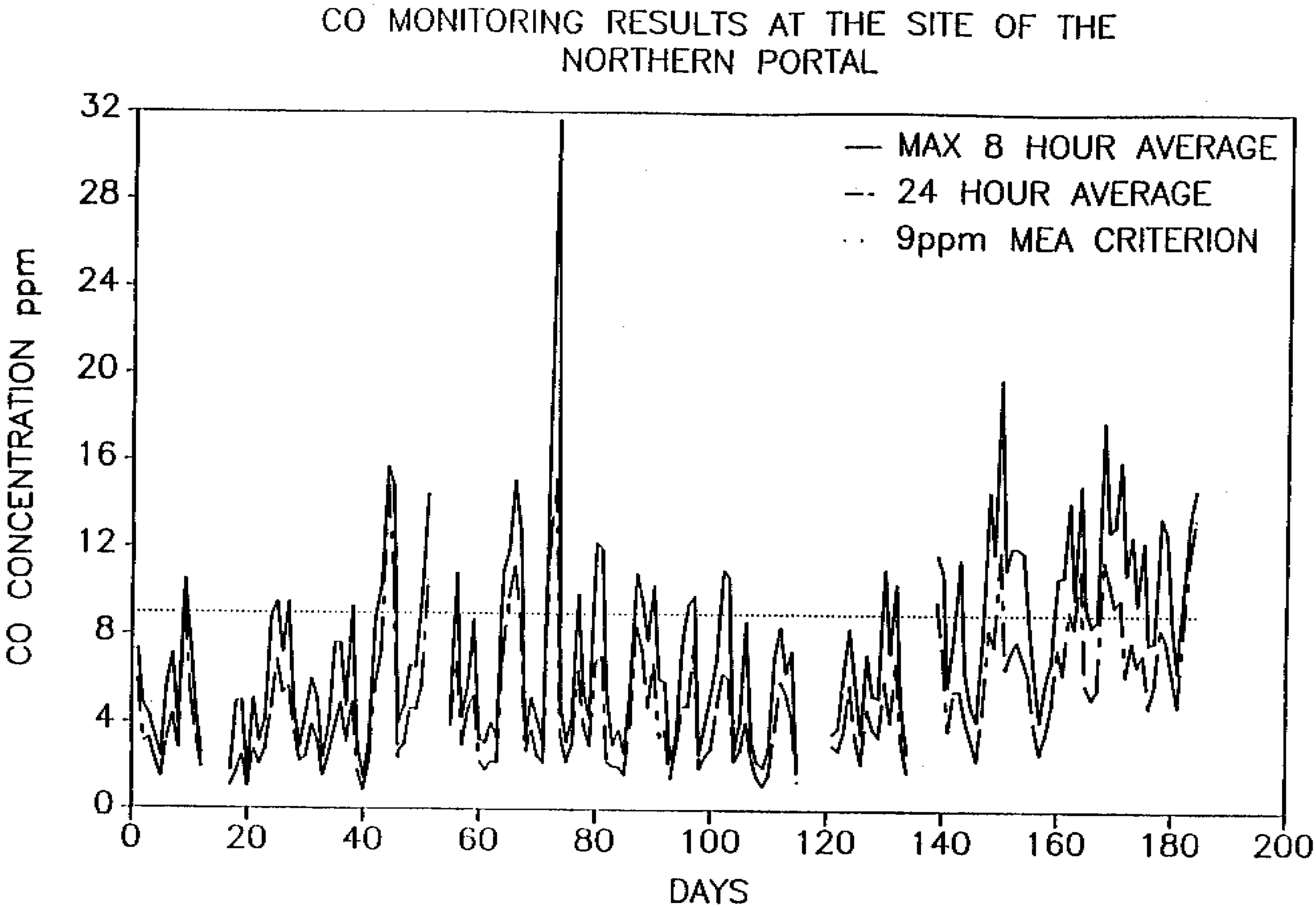

FIGURE 4.1 : RESULTS OF CARBON MONOXIDE MONITORING AT THE SITE OF THE NORTHERN PORTAL

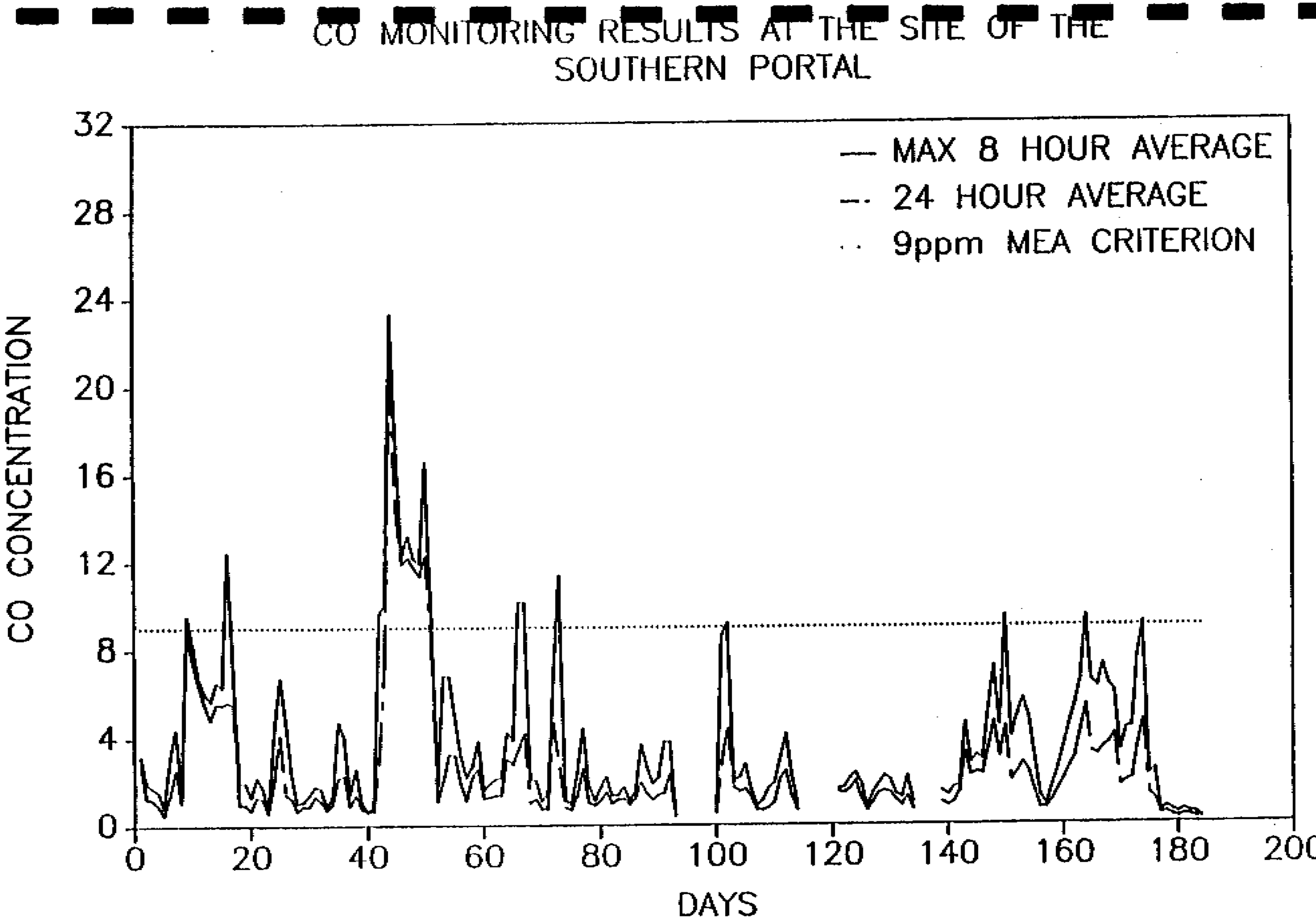

FIGURE 4.2 : RESULTS OF CARBON MONOXIDE MONITORING AT THE SITE OF THE SOUTHERN PORTAL

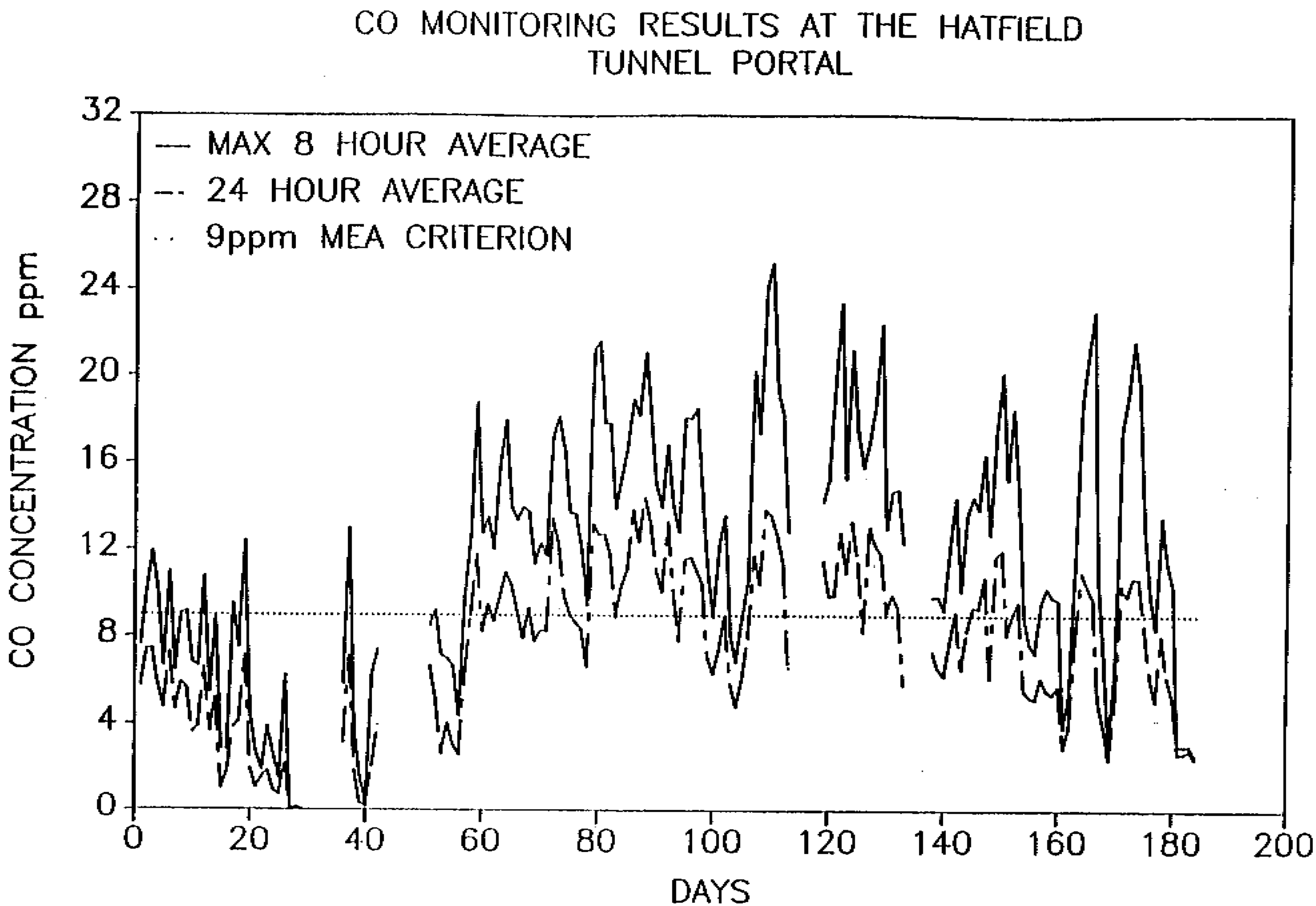

FIGURE 4.3 : RESULTS OF CARBON MONOXIDE MONITORING AT HATFIELD TUNNEL PORTAL

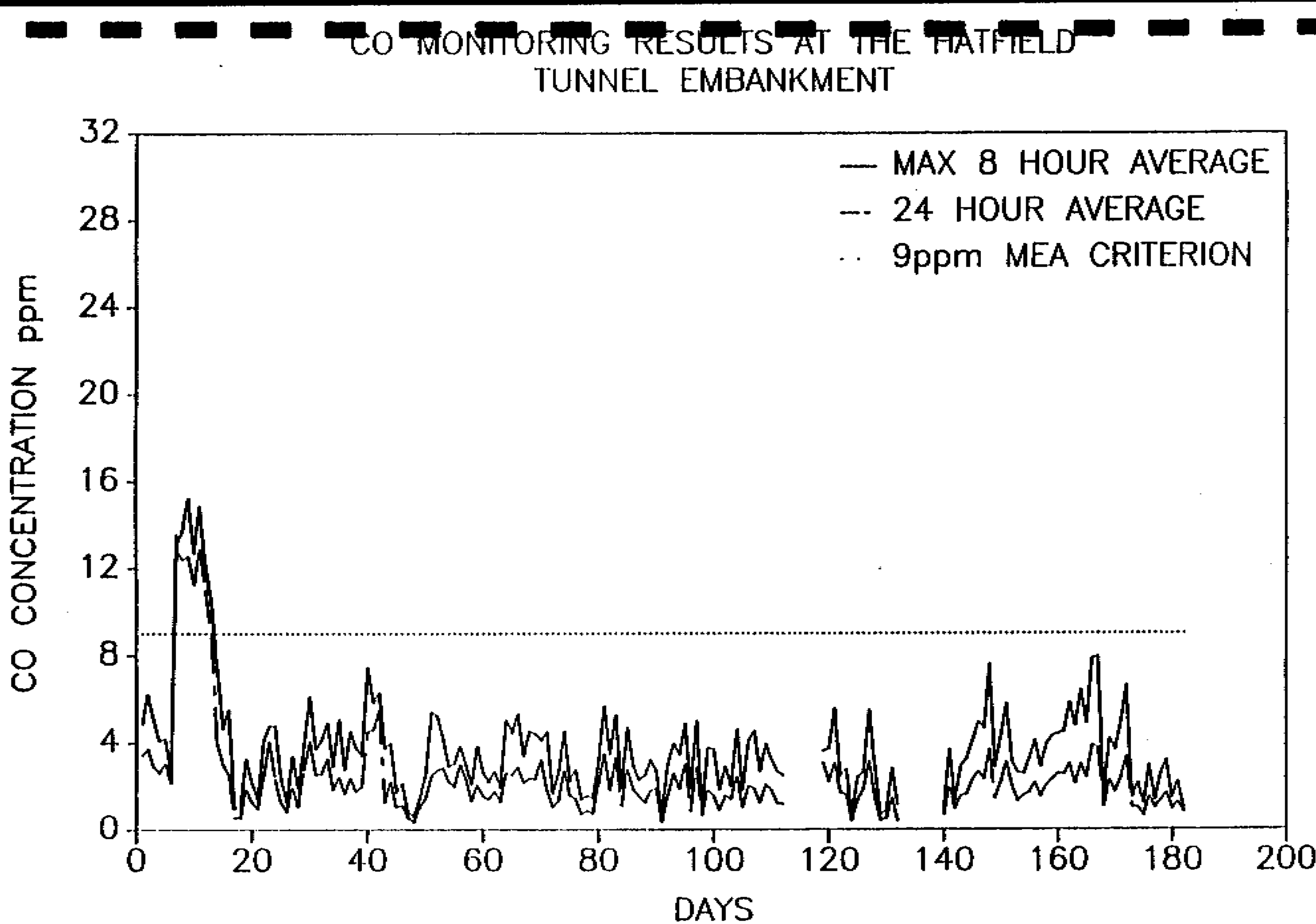

FIGURE 4.4 : RESULTS OF CARBON MONOXIDE MONITORING AT HATFIELD TUNNEL EMBANKMENT

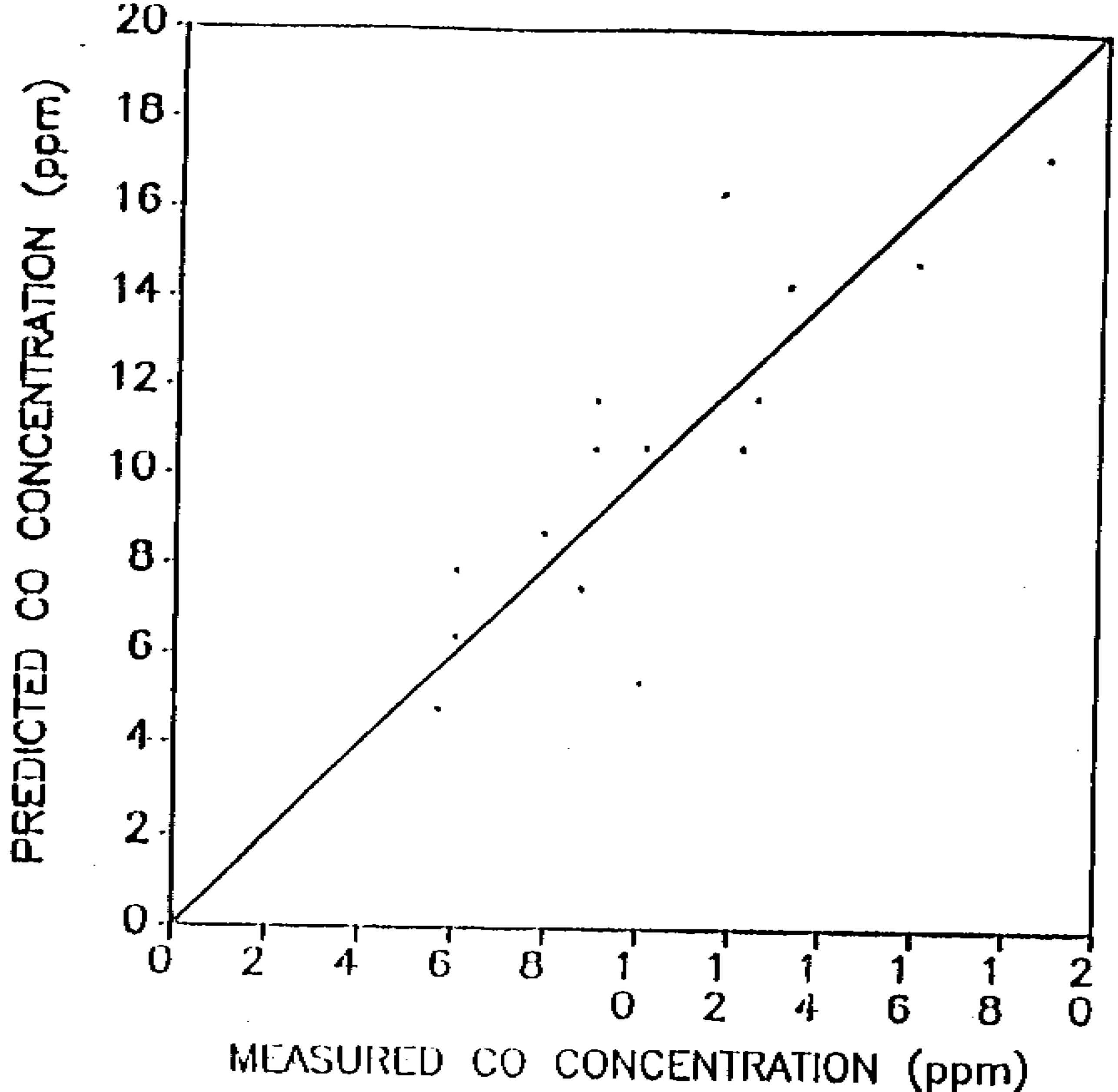

Figure 5.2.1 : Comparison of Predicted and Measured Carbon Monoxide Concentrations

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(GUNNERSBURY AVENUE IMPROVEMENT)

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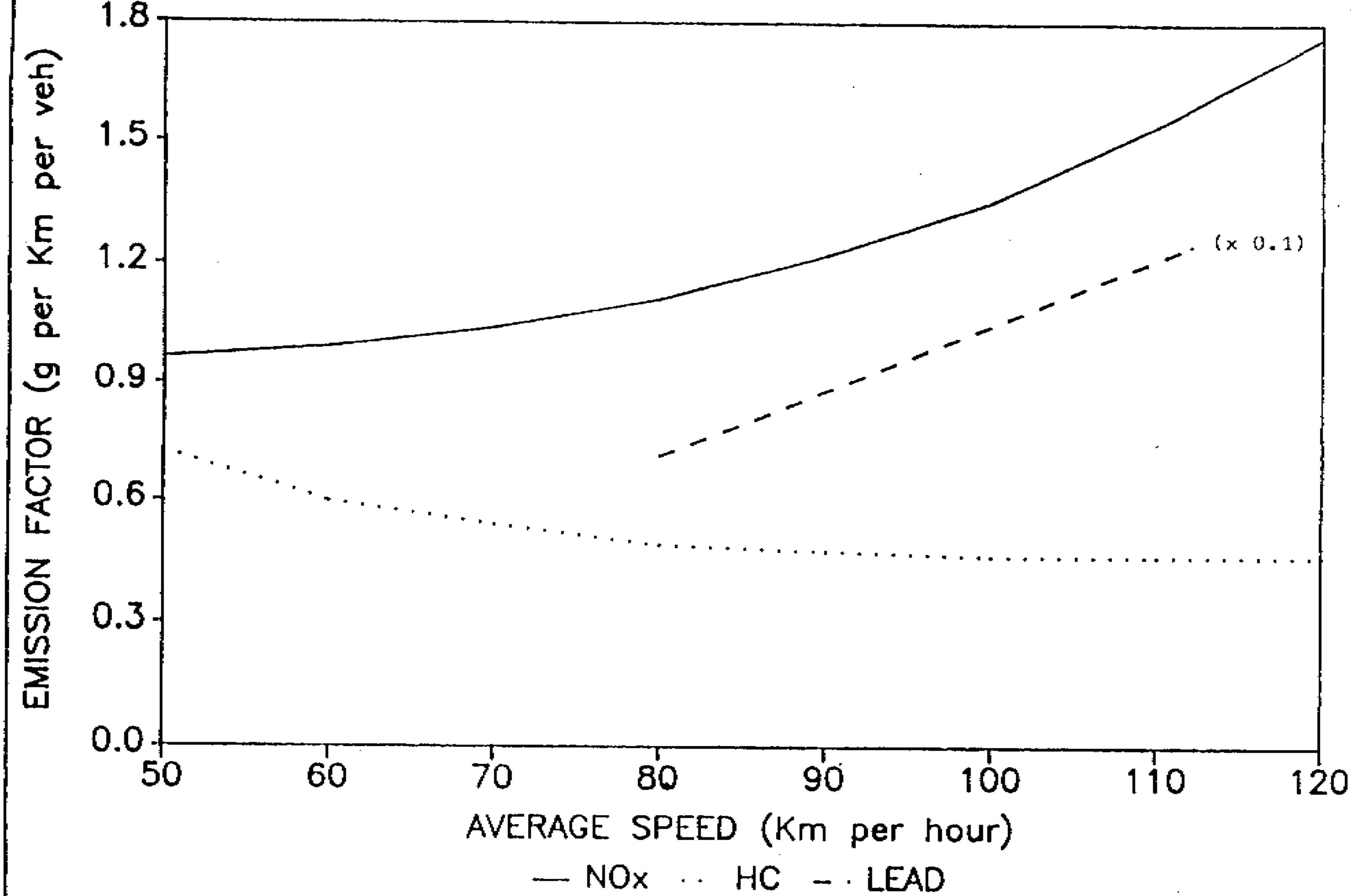

FIGURE 10 : EMISSION FACTORS OF NITROGEN OXIDES (NO_x), HYDROCARBONS (HC) AND LEAD AS A FUNCTION OF VEHICLE SPEED

Public Inquiry Document No. 3/7

Air Quality Report including addendum

DEPARTMENT OF TRANSPORT
LONDON REGIONAL OFFICE

A406
NORTH CIRCULAR ROAD

(Gunnersbury Avenue Improvement)

AIR QUALITY REPORT

Figures

Department of Transport
London Regional Office,
2 Marsham Street,
London SW1P 3EB

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ASHDOWN ENVIRONMENTAL LTD.
Consulting Environmental
Scientists & Engineers
The Oast House,
Hodore,
Upper Hartfield,
East Sussex TN7 4AR

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Air Quality Figures

DEPARTMENT OF TRANSPORT
LONDON REGIONAL OFFICE

A406 NORTH CIRCULAR ROAD (GUNNERSBURY AVENUE IMPROVEMENT)

ADDENDUM TO AIR QUALITY REPORT

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1043/A/M: 6.6.90

1.0 INTRODUCTION

1.01 The A406 is a heavily trafficked road and during peak hour periods the junctions at Uxbridge Road, Popes Lane and Gunnersbury Lane are characterised by long queues of slow moving traffic. In order to improve traffic flow on the North Circular Road, particularly at peak hour periods, it is proposed to construct a tunnel to take the road under Ealing Common. The road will follow its present route from the north until it reaches Uxbridge Road. It will then follow a route to the west of the Gunnersbury Avenue before rejoining the original route close to the junction with Gunnersbury Drive.

1.02 Motor vehicles emit a wide variety of substances classified as pollutants, including carbon monoxide (CO), lead (Pb), particulates (smoke), oxides of nitrogen (NO_x) and hydrocarbons (HC). Their effects on people are either as a nuisance or as a long or short term health hazard. Carbon monoxide is often used as a general indicator of road traffic pollution and this pollutant is therefore taken to be a useful index of general air quality at a particular location. An air pollution problem is defined in the Department of Transport's Manual of Environmental Appraisal (MEA) as exposure, more than once a year, to an 8 hour average concentration of carbon monoxide exceeding 9 parts per million (ppm). A methodology to assess air quality near roadsides is described in the MEA. The approach uses a graphical screening method to calculate an approximate carbon monoxide concentration near to the road scheme. Where this initial assessment of air quality indicates that the 9ppm criterion is exceeded, a more detailed assessment is required. A provisional assessment of the air quality impacts from the proposed scheme indicated that a more detailed air quality report was required and this report presents the findings of the air quality study.

1.03 The basic approach used for this study has two main elements. Firstly, an extended air pollution monitoring programme was set up at the sites of the northern and southern portals of the proposed tunnel. The monitoring was intended to establish the current air quality in the area. In addition, to gain further information about the dispersion of pollutants from road tunnel portals, two further sites were set up at the Hatfield Tunnel on the A1(M). One site was set up at the portal and a second on an embankment approximately 25m from the portal. Secondly, modelling techniques were used to predict future concentrations of pollutants at various times up to 15 years after the scheme opens. Modelling was conducted for the existing (DO-MINIMUM) and the proposed (DO-SOMETHING) road layouts, in order that a comparison could be made. Modelling was performed for the design year (1987), the year of opening (1995) and fifteen years after opening (2010).

2.0 ROAD TRAFFIC POLLUTANTS

2.01 The amount of pollution produced by a vehicle depends on several factors such as the engine type; its age and state of maintenance; operating condition and the speed of the vehicle. Vehicle speed is of great importance, the amount of CO emitted increases rapidly as the speed decreases (see Figure 2.1).

2.02 The amount of pollution detected at a receptor near a road depends on a number of factors. One factor is the composition of traffic, particularly the number of diesel engined heavy goods vehicles. Diesel engines emit smaller amounts of carbon monoxide, hydrocarbons and oxides of nitrogen than petrol engines. However, it has been estimated that diesel engines produce up to ten times as many particulates in their exhaust as petrol engines. Table 2.1 compares the emissions from diesel and petrol engines.

2.03 Numerous studies have shown that the concentration of pollutants decreases rapidly with distance from the roadway. The rate of decrease depends on meteorological conditions, such as wind direction and speed, atmospheric stability and vehicle turbulence. With low wind speeds, the effects of turbulence predominates whilst at higher wind speeds, vehicle turbulence becomes less significant.

2.04 Air pollution levels tend to be highest where traffic is slow moving, at road junctions and other sites where vehicle congestion occurs. Other sites where high air pollution levels can occur are in areas of restricted dispersion, such as cuttings or in urban streets surrounded by tall buildings, and around tunnel portals. Lateral dispersion of pollutants is also significantly affected by such complex road configurations and requires special techniques to model.

2.05 In general, roadside air pollution levels can be reduced in three ways:

(a) Reduction in emission of various pollutants by means of emission control;

(b) Reduction in the flow of vehicles;

(c) Increase the speed of vehicles and minimise congestion.

2.06 Since the early 1970's the Government has introduced progressively more stringent regulations controlling the levels of exhaust emissions from passenger cars. From this period, the lead content of petrol has undergone a phased reduction from 0.4 grams per litre in the 1970's to its present level of 0.15 grams per litre. Unleaded fuel is now progressively being introduced in the UK and by 1990, all new cars sold in the UK must be able to run on unleaded fuel. It can therefore be anticipated that total lead emissions from vehicles will decline over the next decade as the proportion of cars running on unleaded fuel increases in the UK car fleet. Because of price differentials between leaded and unleaded fuel, it is expected that the market sales of unleaded fuel will escalate rapidly.

2.07 Regulations have also been introduced governing the levels of carbon monoxide, hydrocarbons and nitrogen dioxide in exhaust emissions. The latest regulations governing gaseous pollutant emissions from cars were agreed by the European Environmental Council in 1989. This agreement provides for substantial reductions in emissions from new vehicles which, when fully implemented, is estimated could reduce emissions for the UK from petrol engined cars by up to 80%. Table 2.2

compares the emission rates to which vehicles presently conform (EEC Regulation 83 351) to those scheduled under the new agreement.

2.08 Various standards have been set for air quality. The EEC have recently introduced a European Community Air Quality Directive for lead which sets a recommended annual mean concentration of 2 microgrammes per cubic metre in places where people may be continuously exposed for long periods. This level was also recommended in the 'Report to the Secretary of State for Health and Social Security on Lead and Health (The Lawther Report), 1980'(8). The report assessed what proportion of lead in the environment is contributed by lead in petrol. Taking account of all the sources of lead, the Committee recommended the 2 microgramme per cubic metre concentration.

2.09 The MEA recommends that attention should be drawn to places where the likely annual average concentration of nitrogen dioxide (NO_2) exceeds 0.05ppm ($100\mu g.m^{-3}$). The World Health Organisation (WHO) recommend NO_2 concentrations of 0.21ppm and 0.08ppm for 1 hour and 24 hour exposure respectively. In addition, an EEC Air Quality Limit value has been set to protect human beings against the effects of nitrogen dioxide in the environment. To satisfy this limit value, 98% of mean hourly nitrogen dioxide values recorded throughout the year must not exceed 200 μgm^{-3} (106 parts per billion (ppb)). This limit value applies to the UK by virtue of its membership of the EEC and the implementation of the Air Quality Standards Regulations (SI 317), 1989.

2.10 The World Health Organisation has recommended guidelines for particulate matter of $120\mu gm^{-3}$ as an annual mean, whilst the EEC has established a limit value of $80\mu g.m^{-3}$ for an annual mean.

2.11 Carbon monoxide is often taken as a key indicator of vehicle pollution. It is rapidly absorbed into the bloodstream, displacing oxygen and reducing the oxygen carrying capacity of the blood. The absorbtion of carbon monoxide into the blood is reversible when an individual moves to an area of lower carbon monoxide concentration. There is at the present, no UK recommended air quality standard for carbon monoxide. However, the United States Federal Air Quality standards specify that concentrations of carbon monoxide of 9ppm and 35ppm should not be exceeded for more than once a year for exposure periods of eight hours and one hour respectively. These levels are equivalent to 1-2% blood carbon monoxide saturation. The United States Air Quality standards have been adopted in the MEA to indicate the threshold at which an air quality problem is considered to arise.

3.0 PREDICTION OF AIR POLLUTION LEVELS

3.01 The DTp's Manual of Environmental Appraisal sets out a methodology for assessment of air pollution around roadways. A graphical screening method is used in the initial stages of scheme design to determine the extent of air pollution and to see if an air quality problem is likely to arise. The procedure involves the identification of all buildings within 200m of the road and in which people are likely to spend an 8 hour day. If the initial estimates of carbon monoxide concentration exceed 9ppm for an 8 hour average, then an air quality problem is indicated and the MEA recommends that a detailed assessment should be made.

3.02 Where an air quality problem is indicated by an initial assessment, a detailed air pollution study is required. The Transport and Road Research Laboratory (TRRL) have developed a atmospheric dispersion model to predict concentrations of carbon monoxide from road networks. This model is based on Gaussian dispersion techniques, modified for a line source. The model has been calibrated and validated by comparison between predicted and measured values of carbon monoxide at several sites around the UK and it is described in detail in the TRRL report No. LR1052(1).

3.03 The modelling technique splits each section of road into straight links in which vehicle speeds are constant. The contribution from each link to the carbon monoxide concentration at a particular receptor is then summed to give the total concentration. Varying wind speeds and wind directions are also considered by the method.

3.04 The emission rate of carbon monoxide from each link depends on the volume and speed of traffic. The TRRL model takes the speed of the traffic as an input and calculates the emission rate from this value. The model takes no account of the composition of the traffic, and it is assumed that petrol and diesel engined vehicles emit the same amount of carbon monoxide. This is justified by the fact that, although diesel engines emit lower concentrations of carbon monoxide, far greater volumes of exhaust fumes are produced, therefore total carbon monoxide emissions are considered similar to petrol engines.

3.05 The emission data used in the TRRL model were derived from analysis of data from in-service emissions from vehicles in the UK and USA. These data were obtained during the mid 1970's and there is no way to adjust these for present day or likely future emissions. Subsequent studies by Warren Spring Laboratories have however shown reasonable agreement between the emission estimates of the model and measured values. However, it is anticipated that as new EEC regulations come into force, emission rates from vehicles will reduce substantially from 1990 onwards and this needs to be taken account of in the assessment.

3.06 The likely future trends in total UK vehicle emissions have been examined by Warren Spring Laboratory for various regulatory scenarios. These are shown in Figure 3.1. It can be seen that large reductions in emissions from petrol engined vehicles are anticipated between 1990 and 2010. The effect of this reduction should therefore be considered in any air quality assessment.

3.07 The TRRL model was developed from data in flat terrain conditions and has no intrinsic ability to model situations where the road passes over flyovers or through tunnels. Indeed, the MEA specifically notes that the model should not be used where roads are not at ground level, or where they emerge from tunnel portals. In such conditions the TRRL model is likely to fail to accurately predict air pollution levels.

3.08 As it was apparent that the standard TRRL model was not appropriate for assessment of this scheme, an alternative model was used. It was decided to use a more sophisticated model, capable of taking into account the variation in road height that would arise with these schemes. The model chosen was CALINE3 which was developed by the California Department of Transportation and is part of the United States Environmental Protection Agency (USEPA) UNAMAP (Users Network for Applied Modelling of Air Pollution) suite of air dispersion models.

3.09 CALINE3 is a line source air quality model. It is based on the Gaussian diffusion equations identical to the TRRL model. In principle the model is similar to the TRRL model in that it splits the road network into smaller straight line links of similar traffic volume and speed. However, the emission rate is also required by the model as an input and these have been taken from a Warren Spring Report (2).

3.10 For depressed sections (e.g. the cuttings leading to the tunnel portal), the model uses empirical data based on site observations in the USA (3). Compared to an equivalent at-grade site the model predicts higher concentrations within or close to the roadway 'mixing zone', and lower values than would be obtained for an at-grade section for down-wind receptors. The maximum depth of cutting allowed is 10m.

3.11 The model also takes the following meteorological data as input: wind speed; wind direction; mixing height and atmospheric stability. The effect of local topography on dispersion can be assessed by changing the surface roughness factor.

3.12 The CALINE3 model has been extensively verified in the USA using data from three databases. The results are given in detail in the CALINE3 user guide (3), some examples of the verification are shown in Figures 3.2 and 3.3.

3.13 As well as a depressed region of road, the proposed scheme also includes a tunnel section. The exhaust emissions from the vehicles inside tunnels are emitted at the tunnel portals, where they are released as a jet of air caused by the natural ventilation of the tunnel.

3.14 At the tunnel portals, the dispersion of air pollution is complex. Neither the TRRL model nor CALINE3 are able to explicitly model the emissions from tunnel portals. Therefore some modification of a standard line source model is required.

3.15 The behaviour of emissions from tunnel portals has been studied by Marsault and Gabet (4). These authors particularly considered tunnel portals located in depressed cuttings for which existing models do not predict concentrations accurately. They measured the rate of decrease of carbon monoxide concentration from the portal along the road centre line. The rate of decrease was found to be highly dependent upon the position of the tunnel portal. When the portal is positioned in a cutting, the rate of decrease is much lower than a similar portal in an exposed position.

3.16 The concentration at the tunnel portal itself can be determined using the method given by Dayman and Rubenstein (5). The method calculates the exit velocity (and hence the volumetric flow rate) of air through the tunnel. It considers such factors as traffic composition, vehicle volume and speed, tunnel construction and entrance and exit portal design. With a knowledge of the volumetric flow rate and the total emission in the tunnel, the carbon monoxide concentration at the portal can be calculated.

3.17 The approach to modelling the emissions from the tunnel portal in this scheme has been to integrate the portal emissions into the standard CALINE3 model. The ramps leading away from the tunnel portal were split into three sections. In addition to the actual traffic flow on the ramp, the vehicle numbers have been increased on the sections of the ramp nearest the portal. The amount of increase of traffic on each section was determined by two factors:

(a) A requirement to ensure that the emissions from the tunnel and the portal were considered exactly. The total increase in traffic numbers on the ramp is calculated, such that the emissions from the additional traffic flow equal the actual exhaust emissions within the tunnel;

(b) An approach that simulates the decay curve of carbon monoxide on the ramp, reported by Marsault and Gabat for tunnel portals in similar locations.

This methodology has been reviewed by the TRRL and they have given their approval to this approach.

3.18 The modified CALINE3 model was used to predict carbon monoxide concentrations for both the present day situation and for the proposed scheme. As well as CO, the TRRL report LR1052 also gives methods for calculating concentrations of three other important vehicle pollutants, oxides of nitrogen, lead and hydrocarbons. The methods are based on correlations between each pollutant and the carbon monoxide concentration. These correlations have been developed from observations from sites around the UK and have been used to predict the future levels of the three pollutants from the results of the CALINE3 model.

3.19 Although air quality modelling can be used to provide a good comparison between various road schemes and give some indication of the likely air quality, the MEA notes that air pollution from carbon monoxide and other pollutants will vary considerably depending on local factors. Therefore some air quality monitoring is required in the area of the proposed scheme to provide this information. Monitoring work conducted at the site of the scheme is discussed in Section 4 of this report.

4.0 AIR QUALITY MONITORING

Monitoring Programme

4.01 Monitoring Sites

Four monitoring sites were set up, two at the North Circular Road (NCR) and two at the Hatfield Tunnel on the A1(M). The first site at the NCR was located on the north west side of the junction between the NCR and Uxbridge Road (the proposed location of the northern portal of the tunnel). The second monitoring site on the NCR was located in the Ealing Riding School (the proposed location of the southern portal of the tunnel). At the Hatfield Tunnel on the A1(M), one monitoring site was set up by the southern portal of the southbound carriageway. The second site was located approximately 25m from the portal on the embankment above the road. The monitoring equipment was placed in metal cabinets, at the roadside sites the cabinets were approximately 0.5m from the kerb.

4.02 Study Period

The monitoring period commenced in December 1988 and continued until the end of May 1989. This provided a sufficiently long data base to allow for pollution variations with meteorological conditions. The sites were visited weekly to replace batteries, filters, diffusion tubes and to download data from the data loggers. During the monitoring period, the carbon monoxide monitors were re-calibrated twice, and the air sampling pumps calibrated on-site twice a month using a rotameter to measure the flow rate.

4.03 Carbon monoxide, lead and total suspended particulates were monitored continuously during the study period. Nitrogen dioxide was measured for three, four week periods.

Total Suspended Particulates

4.04 The weekly average total suspended particulate concentration was measured by continuously sampling air taken at a height of approximately 1 metre above ground level and passing this through a membrane filter.

4.05 A Casella constant flow long period sampler (Model Ref. T13160/1) with a flow rate of 2 l/min was used to collect the air sample. The air was then passed through a Millipore aerosol monitor (Ref. MAWPO 37A0). This monitor contains a membrane filter with a pore size of 0.8 microns. The filters were dried in an oven at a temperature of 80°C for a period of at least seven days, and weighed on three subsequent days until constant, prior to use.

4.06 After exposure, the filters were dried for at least seven days before they were re-weighed to constant weight. Total suspended particulates were then determined using the following formula.

$$\frac{\text{Weight Difference}}{\text{Air Flow Rate x Time Exposed}} = \text{TSP } (\mu g m^{-3})$$

4.07 Particulate Lead

Following measurement of total suspended particulates, the exposed membrane filters were analysed for lead. The filters were digested in 3mls of concentrated nitric acid (ARISTAR grade) until all the solids had dissolved. The mixture was allowed to cool and then made up to 25ml with deionized water. The lead concentration was then determined using a Jobin Yvon JY38 Sequential ICP Spectrometer. Blanks were determined similarly, but a Perkin Elmer PE500 Atomic Absorbtion Spectometer was used to give a lower limit of detection. The analysis was carried out in the laboratories of Southern Water.

4.08 Carbon Monoxide

Carbon monoxide was continuously monitored using a portable carbon monoxide monitor, model EC50 manufactured by Bedfont Technical Instruments. The monitor detects carbon monoxide using an electrochemical sensor. The carbon monoxide concentration was recorded every ten minutes using a Squirrel SQ8 Meter/Logger. The data was downloaded weekly onto a portable computer for further analysis.

4.09 Nitrogen Dioxide

Weekly average nitrogen dioxide concentrations were determined using passive diffusion tubes. The tubes consist of a perspex tube 71mm long by 12mm internal diameter. The tube is sealed at one end with a polythene cap containing two chemically coated discs. When not in use the other end is sealed with a removable polythene cap.

4.10 During a monitoring period, any nitrogen dioxide present in the atmosphere diffuses along the tube and is absorbed by triethanolamine on the stainless steel mesh. The rate of absorbtion is directly related to the nitrogen dioxide concentration in the surrounding air.

4.11 After exposure, the absorbent in the tubes is analysed and the average nitrogen dioxide concentration during the monitoring period may be calculated.

4.12 Results of Air Quality Monitoring

The results for the air quality monitoring are summarised in Tables 4.1-4.4. These tables give the monthly mean and the range of the total suspended particulates, lead and nitrogen dioxide concentrations over the monitoring period. The carbon monoxide monitoring results are given as the monthly mean and range of the 24 hour average concentration and the monthly mean and range of daily maximum 8 hour average concentrations.

4.13 The results of the carbon monoxide monitoring are also shown graphically in Figures 4.1 and 4.4, which give the daily maximum 8 hour average concentration and the 24 hour average over the study period.

North Circular Road

4.14 Consideration of Figures 4.1 and 4.2 shows that, at both sites, the daily maximum 8 hour average carbon monoxide concentration regularly exceeded the 9ppm MEA criterion. During the study period, the 9ppm criterion was exceeded on 57 occasions at the northern site and 21 occasions at the southern site.

4.15 It can therefore be concluded that at the sites located near the route of the present NCR, the existing air quality is poor and frequently in excess of the 9ppm MEA criterion indicative of an air quality problem.

4.16 The lead concentrations recorded at the sites were in the range 0.02-0.87μgm^{-3}. These levels are within the 2μgm^{-3} concentration specified in EEC Directive No. 82/884/EEC, 1982 and would not therefore be regarded as cause for concern.

4.17 Nitrogen dioxide concentrations were found to range from 25-107μgm^{-3}. Concentrations at both the sites were consistently over 50μgm^{-3}, the level set out in the MEA where attention should be drawn. However, the concentrations were within the 200μgm^{-3} limit value set by the EEC.

Hatfield Tunnel

4.18 Figure 4.3 shows that the carbon monoxide concentrations recorded at the tunnel portal are consistently above the 9ppm MEA criterion. This would be expected as all the emissions from vehicles in the tunnel would accumulate within the tunnel to be emitted at the tunnel portal. Consideration of Figure 4.4, which gives the carbon monoxide concentrations at the embankment site, shows that the concentrations of carbon monoxide have decreased by up to 75%. This indicates that dilution and dispersion of the carbon monoxide emitted from the portal is extremely rapid. The 9ppm MEA criterion was exceeded on only 7 occasions at this site.

4.19 The rapid dilution of pollutants from the portal is also illustrated by comparing the concentrations of lead and nitrogen dioxide at both the sites. Air quality criteria for both these pollutants were exceeded by the portal, however, their concentration was diminished by up to 80% at the embankment site.

4.20 It can therefore be concluded from the monitoring at the two sites that, although high concentrations of gaseous pollutants exist at the tunnel portal, their initial dilution and dispersion is extremely rapid.

5.0 MODELLING

5.01 Description of Modelling Approach

The CALINE3 line source model described in Section 3 was used to model the proposed scheme. To compare against the existing situation, this was also modelled using similar techniques.

5.02 The model requires traffic flows and emission factors as input as well as the link positions and lengths. Traffic flows and speeds are those given in the Proof of Evidence on Traffic. Peak hour traffic flows and corresponding speeds were used in the predictions of carbon monoxide levels.

5.03 Emission data for vehicles in the years of study were taken from data reported by Warren Spring Laboratory (2). This report suggests that emissions will substantially reduce over the period 1987-2010 because of the introduction of emission controls, although the timing for the full implementation will depend on legislation introduced by the UK Government. Recognising that these reductions may not be achieved in practice, the main comparison of the existing and proposed schemes was carried out using 1987 emission data. Modelling using 1995 and 2010 emission data was also carried out to give an indication of the likely air quality, should the proposed reductions be achieved. The various scenarios studied are summarised in Table 5.1.

TABLE 5.1 : Modelling Scenarios Examined for the North Circular Road Improvements

Road Network	Traffic Data	Emission Date
DO-MINIMUM	1987	1987
DO-MINIMUM	1995	1995
DO-MINIMUM	2010	2010
DO-SOMETHING	1995	1987
DO-SOMETHING	1995	1995
DO-SOMETHING	2010	2010

5.04 Meteorological data (wind speed and direction) for the nearest monitoring station (Northolt) were supplied by the Meteorological Office. The prevailing wind direction for the area is south west. However, in order to obtain the average concentration at any receptor, all wind directions should be considered. This was done by the method recommended by TRRL (6). With this method the model is run for four wind directions, one from each quadrant. The results are then combined by weighting the concentration predicted for a particular wind direction by its frequency of occurrence and then calculating the average.

5.05 Since low wind speeds produce the worst air pollution conditions and it was wished to examine the worst case, modelling was done for a wind speed of 1m/s. This is the lowest wind speed for which the modelling technique is valid and the value recommended by TRRL for air pollution evaluations of this type.

5.06 The CALINE3 model was used to predict the 1 hour average concentration at all receptors within 200m of the roadway. The annual maximum eight hour average concentration was then calculated from the hourly average using a relationship derived by TRRL (6).

5.07 Concentrations of lead, oxides of nitrogen and hydrocarbons were calculated from the results of the carbon monoxide runs using inter-pollutant correlations derived by TRRL from results of several monitoring studies. These relationships are as follows:

$$H = 1.8CR + 4.0$$
$$N = CR + 0.1$$
$$L = 0.2CR + 0.8$$

Where

H = hydrocarbon concentration (ppm)
N = oxides of nitrogen concentration (ppm)
L = lead concentration (μgm^{-3})
C = carbon monoxide (ppm)

R = ratio of pollutant emission to that of carbon dioxide for a given vehicle speed.

5.08 The correlation for lead was derived when the average lead content of petrol was 0.40g/l. The concentrations have therefore been reduced by a factor of 0.375 to take into account the reduction in the lead content of petrol to 0.15g/l.

5.09 The factor R must be determined for a particular vehicle speed. This has been taken as 50km/hr for the DO-MINIMUM scheme and 70km/hr for the DO-SOMETHING scheme.

5.10 Comparison of Model with Monitoring Results

In order to ensure that the CALINE3 model would predict valid concentrations for the proposed and existing road schemes, a validation exercise was carried out. In this exercise the results from peak hour modelling were compared against the actual air quality recorded at that time. To ensure that unpredictable local wind direction changes caused by the surrounding buildings were not included, only those days where the wind direction was from the road towards the monitoring site were selected.

This exercise also included results from the monitoring at Hatfield Tunnel sites, both by the portal and the embankment site.

5.11 The results in Figure 5.2.1 indicate excellent agreement between the predicted and the actual measured values for the four sites. Therefore the CALINE3 model can be used with confidence for this study.

Results of Modelling

5.12 The results of modelling for carbon monoxide are shown as contour points in Figures 5.3.1-5.3.3 which show the results for the existing situation for the three different years of study. Figures 5.3.4-5.3.6 show the results for the proposed scheme.

5.13 Figure 5.3.1 shows the predicted concentrations for the present situation. One area can be identified where the 9ppm MEA criterion is exceeded. By the year 2010, the anticipated decrease in emission factors reduce concentrations to below 9ppm.

5.14 Figure 5.3.4 shows the predicted concentrations of carbon monoxide for the proposed scheme. Considerably reduced concentrations are predicted for much of this area due to the increase in traffic speed and the effect of the tunnel restricting dispersion of the pollutants. Any pollutant emitted in the tunnel would be emitted at the tunnel portals. The areas around the portals show no deterioration in carbon monoxide concentrations. At the northern portal, air quality is predicted to improve as the traffic at the junction of Gunnersbury Avenue and Uxbridge Road is now free flowing. Increased concentrations are predicted for the junction between Gunnersbury Avenue, Popes Lane and Gunnersbury Lane where one area is predicted to exceed the 9ppm criterion.

5.15 In order to compare the existing and proposed schemes in more detail, the predicted carbon monoxide concentrations for the proposed schemes have been subtracted from the concentrations predicted for the existing scheme. The results have been used to produce a further contour plot (Figure 5.3.7). In this plot, areas where air quality improves or deteriorates are indicated by clearly defined shaded areas. It can be seen that most areas experience an improvement in air quality.

5.16 Overall, the modelling results show that 681 households would experience an improvement in carbon monoxide concentrations, whereas 223 households would experience a deterioration within 200 metres of the road scheme, compared with present conditions.

5.17 The predicted lead concentrations for the proposed scheme are generally in the range 0.6-1.5μgm^{-3} with a maximum value of 1.7μgm^{-3} close to the site of the southern portal. This compares with a maximum value of 1.57μgm^{-3} for the existing scheme. At the air quality monitoring sites, the predicted values for the existing scheme compare favourably with the peak values measured at the sites.

5.18 The predictions of the DO-SOMETHING (1987) scheme indicate that lead concentrations would generally remain similar or decrease by 0.1-0.3μgm^{-3}. There are, however, three significant areas where lead concentrations are predicted to increase. These are the northern and southern portals and the junction between Gunnersbury Avenue, Gunnersbury Lane and Popes Lane. The worst increase is nearly 1.0μgm^{-3} at the Popes Lane junction, however, even at this location, the lead concentration below the EEC Directive limit by over 20%.

5.19 Overall, the lead modelling results show that 662 households would experience an improvement in air quality and 192 would experience a deterioration within 200m of the road scheme, compared with present conditions.

5.20 The concentrations of hydrocarbons and nitrogen oxides were also calculated using TRRL correlations. The maximum hydrocarbon concentration predicted for the proposed scheme is 11.1ppm compared to 12.6ppm for the present scheme. In general, hydrocarbon concentrations are predicted to be in the range 6-9ppm.

5.21 Overall, the modelling results show that for hydrocarbons, 1378 households would experience an improvement in concentration and 47 a deterioration.

5.22 The predicted nitrogen oxides (NO_x) concentrations are in the range 0.45-1.9ppm for both the existing and the proposed scheme. It is difficult to make comparisons between the predicted and the measured values of NO_x as only nitrogen dioxide was measured. Nitric oxide is the other major component of NO_x and its concentration is typically up to four times the nitrogen dioxide level by a roadside. However, in terms of human health risks, it is the NO_2 component that is of concern.

5.23 Predictions for the DO-SOMETHING scheme show a general decrease in nitrogen oxides for most of the scheme. Overall, the modelling results show that 1243 households would experience an improvement in concentration and 159 a deterioration.

5.24 The number of households affected by each pollutant is summarised in Table 5.2.

Effect of Emission Controls

5.25 Following implementation of European Directives limiting pollutant concentrations in vehicle exhausts, substantial reductions in emissions of vehicle related pollution will occur by the end of the Century. Thus it can be anticipated that roadside air quality will show a general improvement in coming years. The level of improvement would depend upon a combination of factors such as vehicle growth, road configuration and flow conditions.

5.26 Figures 5.3.2 and 5.3.5 show the predicted carbon monoxide concentrations for the DO-MINIMUM and DO-SOMETHING following the 45% reduction in petrol engined vehicle emissions predicted for 1996. Reductions in carbon monoxide concentrations are noted with no properties experiencing concentrations in excess of the 9ppm MEA criterion. A maximum concentration of 7ppm and 3ppm is found for the DO-MINIMUM and DO-SOMETHING schemes respectively. 316 households would experience decreased concentrations and 131 households would experience an increase in concentration if the scheme was implemented.

5.27 In 2010, pollutant emissions from motor vehicles are expected to have decreased by 80%. Consequently, pollutant concentrations for both the DO-MINIMUM and DO-SOMETHING scheme would reduce to low levels (Figures 5.3.3 and 5.3.6). However, for the DO-SOMETHING scheme, all properties experience similar or decreased concentrations of carbon monoxide compared to the DO-MINIMUM scheme.

6.0 CONCLUSIONS

6.01 Measurements and modelling of the present air quality conditions at the junction of Gunnersbury Avenue and Uxbridge Road show that the existing air quality is poor. The 9ppm carbon monoxide threshold, indicative of an air quality problem, is regularly exceeded at this site. The primary reason for this situation is the long queues of traffic at the junction at peak hours and during much of the day. Traffic queuing results in a greater emission of carbon monoxide per vehicle than under free flowing conditions.

6.02 Measurements and modelling of the present air quality in Ealing Riding School at the site of the southern portal show that the air quality is also poor. The 9ppm criterion is also regularly exceeded at this site.

6.03 The proposed improvements to the NCR would result in free flow of traffic along most of the route. Therefore, concentrations of vehicle related pollutants would be expected to decrease at most properties adjacent to the road.

6.04 The provision of a tunnel under Ealing Common would result in a speeding up of traffic flow with a reduction in CO emissions along much of the route. Where the road is in the tunnel, all pollutants emitted in this section would be emitted at the tunnel portals. Thus, properties close to the underground section would generally experience improved air quality. Overall, some 681 households are expected to experience a decrease in CO level, whilst 223 would experience a small increase.

6.05 Because of the different relationships between vehicle speed and emission rate for the other primary vehicle pollutants (lead, oxides of nitrogen and hydrocarbon), the relative benefits and disbenefits of the scheme are different to that assessed for CO. However, no properties are expected to experience an increase in pollutant level that would exceed acceptable international standards.

6.06 The introduction of emission controls into the UK in coming years is likely to result in a substantial improvement in roadside air quality. With these improvements, air quality at properties in the vicinity of the scheme would show a significant improvement. With the implementation of the proposed scheme, the effect of the anticipated emission controls would be to bring about even greater improvements in air quality, with no properties experiencing pollutant levels in excess of relevant standards.

7.0 REFERENCES

1. Hickman, A J and Colwill, D M. The estimation of air pollution concentrations from road traffic. Department of the Environment. Department of Transport, TRRL Report LR 1052, Crowthorne, 1982.

2. Eggleston, H S. The calculation of emissions from UK petrol engined motor vehicles. Department of Trade and Industry, Warren Spring Laboratory, Report LR 612 (AP)M.

3. Benson, P E. CALINE3 - A versatile dispersion model for predicting air pollutant levels near highways and arterial streets. California Department of Transportation, Sacramento, California. Report No. 19701-604167, 1979.

4. Marsault, J P and Gabet, M C. Pollution Dispersion : In-situ measurements at tunnel portals. 5th International Symposium on the Aerodynamics and Ventilation of Vehicle Tunnels, Lille, France, 20-22 May 1985.

5. Dayman, B and Rubenstein, L D. Concentrations of exhaust emissions inside a series of highway tunnels. 5th International Symposium on the Aerodynamics and Ventilation of Vehicle Tunnels, Lille, France 20-22 May 1985.

6. Hickman, A J and Waterfield, U H. A user's guide to the computer programs for predicting air pollution from road traffic. Department of the Environment. Department of Transport, TRRL Supplementary Report No. 806, Crowthorne, 1984.

7. Department of Transport. Manual of Environmental Appraisal, London 1983.

8. Lead and Health. Report of the Working Party on Lead in the Environment. Chairman, P J Lawther, 1980 (HMSO).

9. Air Quality Guidelines for Europe. WHO Regional Publications, European Series No. 23, 1987.

TABLE 2.1 : COMPARISON OF THE COMPOSITION OF EXHAUST GASES EMITTED BY PETROL AND DIESEL ENGINES (FIGURES IN PPM)

	Pollutant	Idling	Accelerating	Cruising	Deceleration
Petrol Engines	Carbon Monoxide	69000	29000	27000	39000
	Hydrocarbons	5300	1600	1000	10000
	Nitrogen Oxides	30	1020	630	20
Diesel Engines	Carbon Monoxide	Trace	1000	Trace	Trace
	Hydrocarbons	400	200	100	300
	Nitrogen Oxides	60	350	240	30

TABLE 2.2 : SCHEDULES OF EMISSIONS UNDER EEC REGULATION 83 351 AND THE LUXEMBOURG AGREEMENT

Engine Size Pollutant		Large Greater than 2 Litres g/test	Medium 1.4-2 Litres g/test	Small Less than 1.4 Litres g/test
Carbon Monoxide	EEC Regulation 83 351	95	67	58
	Luxembourg Agreement	25	30	45
Hydrocarbons & Nitrogen Oxides	EEC Regulation 83 351	25	20.5	19
	Luxembourg Agreement	6.5	8	15

TABLE 4.1 : AIR QUALITY MONITORING : SUMMARY OF RESULTS NM = Not Measured

Site: North Circular Road **Ref:** HHA **Year:** 1988-1989

Pollutant	December	January	February	March	April	May
CO Average daily 8 hr Maximum	4.97	6.93	7.69	6.09	6.86	10.88
Range ppm	1.6-10.5	1.5-15.7	3.1-31.6	1.9-11.0	2.7-11.7	4.2-19.8
Monthly Mean 24 hour Average	3.26	4.73	4.94	3.95	4.46	7.00
Range ppm	1.1-9.2	0.9-14.9	1.9-15.2	1.2-8.4	1.8-9.6	2.4-11.9
TSP Monthly Mean μgm^{-3}	25.25	23.13	11.75	9.95	29.99	45.3
Range	15.6-31.5	17.22-32.12	4.1-19.4	5.75-15.3	23.8-41.56	6.3-74.9
Pb Monthly Mean μgm^{-3}	0.45	0.56	0.16	0.17	0.29	0.5
Range	0.25-0.6	0.41-0.87	0.078-0.21	0.10-0.23	0.08-0.56	0.14-0.68
NO_2 Monthly Mean μgm^{-3}	NM	67.14	75.4	69.1	NM	83.8
Range	NM	48-93	72-82	61-76		61-107

TABLE 4.2 : AIR QUALITY MONITORING : SUMMARY OF RESULTS

NM = Not Measured

Site: Ealing Riding School Ref: HHB Year: 1988-1989

Pollutant	December	January	February	March	April	May
CO Average daily 8 hr Maximum	4.32	6.19	3.28	2.70	1.96	4.97
Range ppm	0.8-12.5	0.7-23.3	1.0-12.3	0.5-9.2	0.6-4.6	0.9-9.5
Monthly Mean 24 hour Average	3.18	4.64	1.84	1.52	1.45	2.74
Range ppm	0.6-8.7	0.6-20.2	0.7-8.2	0.4-4.4	0.3-3.30	0.7-5.4
TSP Monthly Mean μgm^{-3}	22.38	27.045	23.22	11.546	15.125	28.5
Range	3.5-34.9	16.0-38.3	14.7-27.6	4.0-18.2	8.3-22.8	5.91-50.3
Pb Monthly Mean μgm^{-3}	0.24	0.27	0.26	0.13	0.10	0.15
Range	0.13-0.32	0.21-0.36	0.16-0.33	0.02-0.22	0.06-0.16	0.05-0.32
NO_2 Monthly Mean μgm^{-3}	NM	48.1	62.8	55	NM	61.42
Range		25-72	53-72	51-59		44-72

TABLE 4.3 : AIR QUALITY MONITORING : SUMMARY OF RESULTS   NM = Not Measured

Site: Hatfield Tunnel Portal   Ref: HTA   Year: 1988-1989

Pollutant	December	January	February	March	April	May
CO Average daily 8 hr Maximum	7.14	4.99	14.35	15.61	15.21	13.10
Range ppm	1.9-12.4	0.04-13.0	4.4-21.6	6.9-25.2	9.3-23.4	3.1-23
Monthly Mean 24 hour Average	4.29	2.56	9.50	10.25	9.62	7.62
Range ppm	0.9-7.4	0.1-7.1	2.6-13.4	4.8-13.9	4.8-13.3	2.4-12.0
TSP Monthly Mean μgm^{-3}	62.9	77.47	56.27	56.37	52.57	51.7
Range	25.9-109.1	47.3-147.5	48.7-70.6	47.8-62.0	22.8-77.3	42.3-57
Pb Monthly Mean μgm^{-3}	3.66	2.10	2.10	2.05	1.78	1.46
Range	3.55-3.89	1.93-2.78	1.85-2.31	1.77-2.29	1.67-1.97	0.14-1.87
NO_2 Monthly Mean μgm^{-3}	NM	181.9	140	190	NM	236
Range	NM	148-225	74-168	150-229		145-289

TABLE 4.4 : AIR QUALITY MONITORING : SUMMARY OF RESULTS **NM = Not Measured**

Site: Hatfield Tunnel Embankment Ref: HHA Year: 1988-1989

Pollutant	December	January	February	March	April	May
CO Average daily 8 hr Maximum	6.74	3.68	3.30	3.15	2.63	4.40
Range ppm	1.0-15.2	0.6-7.5	1.4-5.3	0.8-5.3	0.8-5.6	1.5-8.0
Monthly Mean 24 hour Average	5.28	2.24	1.97	1.74	1.57	2.29
Range ppm	0.6-12.9	0.4-5.5	0.8-3.2	0.4-3.3	0.4-3.1	1.0-3.9
TSP Monthly Mean μgm^{-3}	56.97	69.17	21.22	19.88	18.8	21.1
Range	56.97	21.9-147.1	13.4-27.3	15.5-24.3	11.1-25.7	16.3-27.9
Pb Monthly Mean μgm^{-3}	0.98	0.69	0.58	0.55	0.41	0.3
Range	0.61-1.61	0.53-0.84	0.41-0.85	0.43-0.71	0.23-0.67	0.14-0.41
NO_2 Monthly Mean μgm^{-3}	NM	58.57	50.00	94.3	NM	107
Range	NM	23-114	89-99	89-99		99-112

TABLE 5.2 : SUMMARY OF RESULTS OF MODELLING OF CONCENTRATIONS OF CARBON MONOXIDE, LEAD, NITROGEN OXIDES AND HYDROCARBONS

Pollutant	Number of Households Showing	
	Increased Concentration	Decreased Concentration
Carbon Monoxide	223	681
Lead	192	662
Nitrogen Oxides	159	1243
Hydrocarbons	47	1378

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HA 044/027/000549 1

ENVIRONMENT & LANDSCAPE
Environmental Statement

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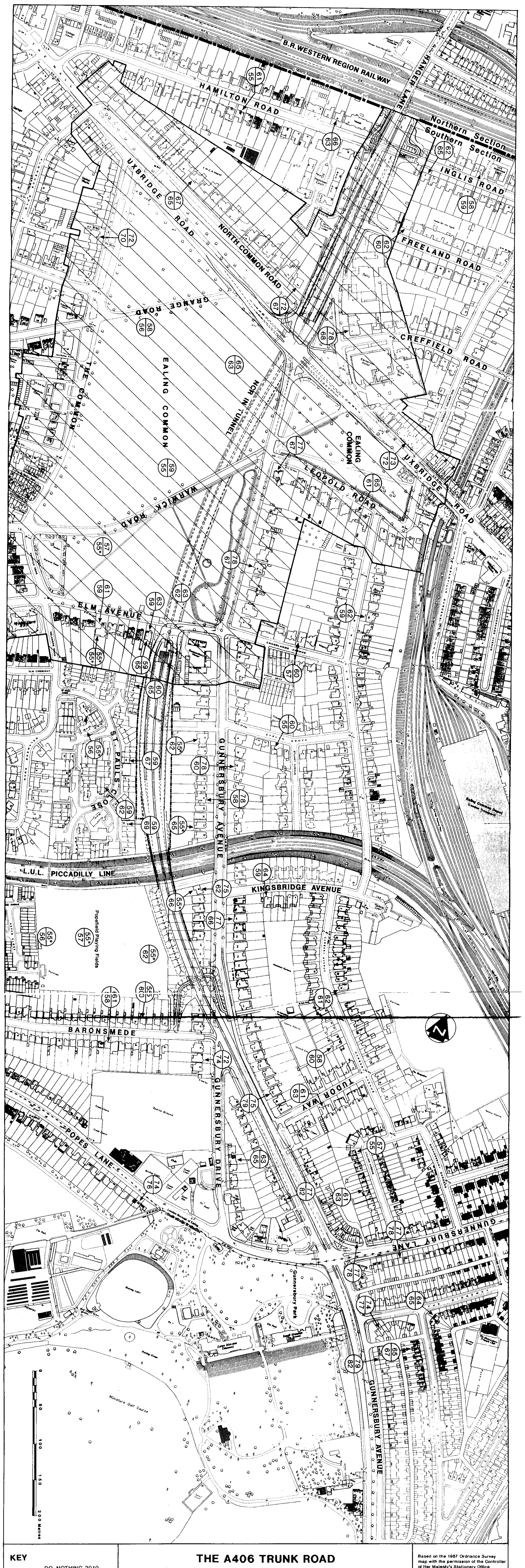
HA 44/27/549 1*



KEY

DO-NOTHING 2010

DO-SOMETHING 2010

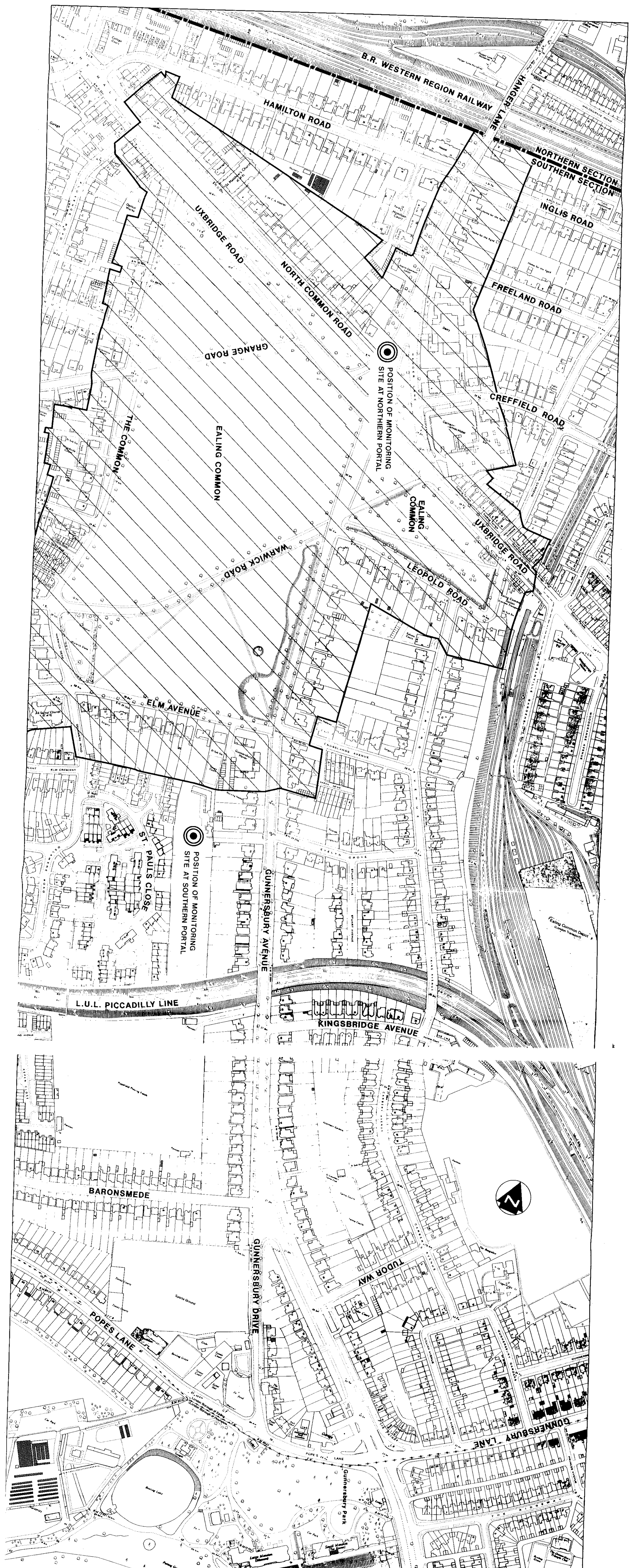
55* Ambient value

THE A406 TRUNK ROAD
(GUNNERSBURY AVENUE IMPROVEMENT)

CHANGES IN NOISE LEVELS

Figure 3

Scale 1:2500



THE A406 TRUNK ROAD
(GUNNERSBURY AVENUE IMPROVEMENT)

POSITION OF AIR QUALITY MONITORING SITES ON NCR

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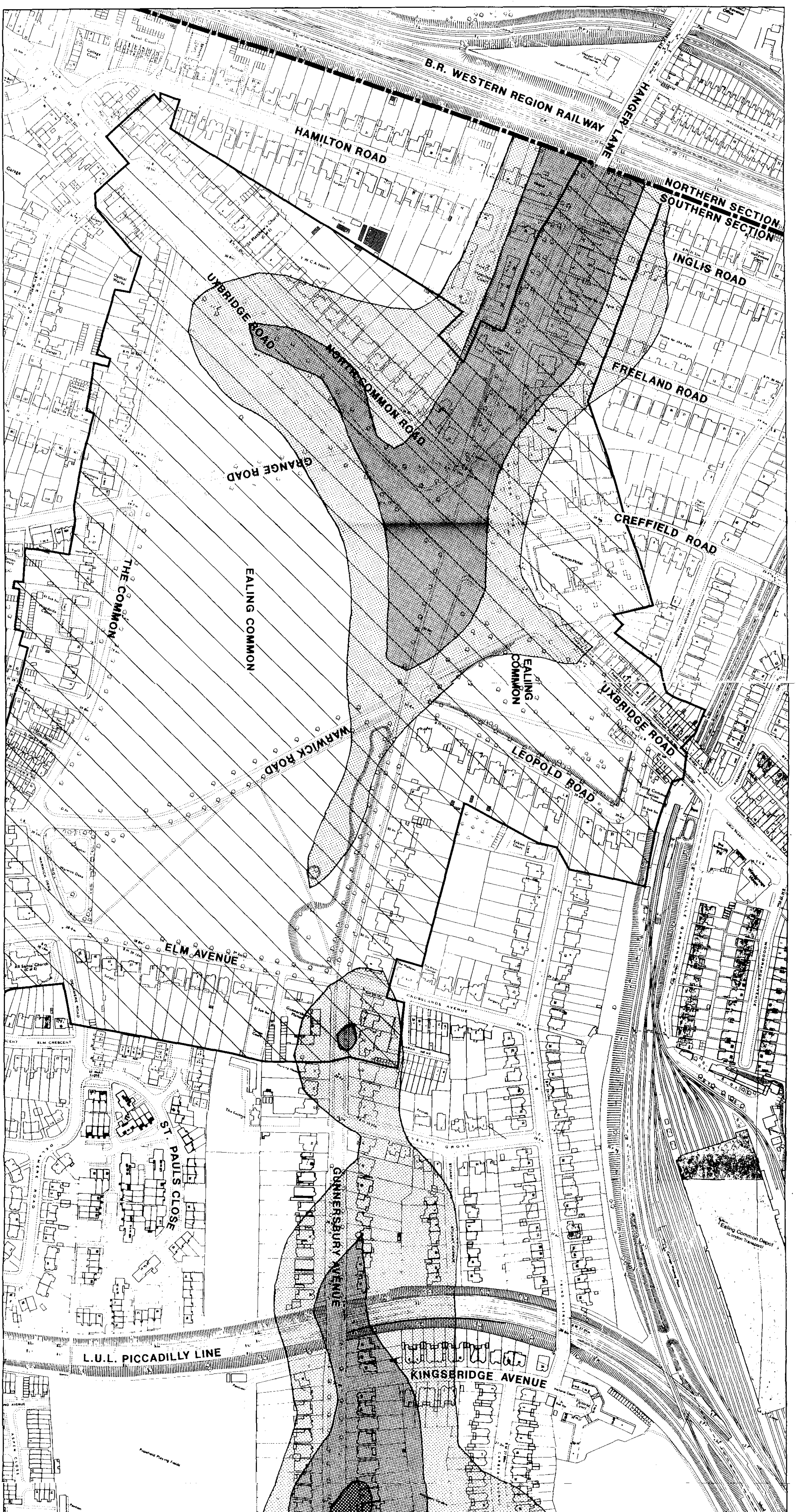
Figure 2
Scale 1:2500



THE A406 TRUNK ROAD

(GUNNERSBURY AVENUE IMPROVEMENT)

DO–MINIMUM SCHEME, CONTOURS OF CARBON MONOXIDE CONCENTRATIONS, 1987 EMISSION FACTORS

Figure 5.3.1

Scale 1:2500

THE A406 TRUNK ROAD

(GUNNERSBURY AVENUE IMPROVEMENT)

DO-MINIMUM SCHEME, CONTOURS OF CARBON MONOXIDE CONCENTRATIONS, 1995 EMISSION FACTORS

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Figure 5.3.2

Scale 1:2500

THE A406 TRUNK ROAD

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DO-MINIMUM SCHEME, CONTOURS OF CARBON MONOXIDE CONCENTRATIONS, 2010 EMISSION FACTORS

Figure 5.3.3

Scale 1:2500

THE A406 TRUNK ROAD

(GUNNERSBURY AVENUE IMPROVEMENT)

DO-SOMETHING SCHEME, CONTOURS OF CARBON MONOXIDE CONCENTRATIONS, 1987 EMISSION FACTORS

Figure 5.3.4

Scale 1:2500

THE A406 TRUNK ROAD

(GUNNERSBURY AVENUE IMPROVEMENT)

DO–SOMETHING SCHEME, CONTOURS OF CARBON MONOXIDE CONCENTRATIONS, 1995 EMISSION FACTORS

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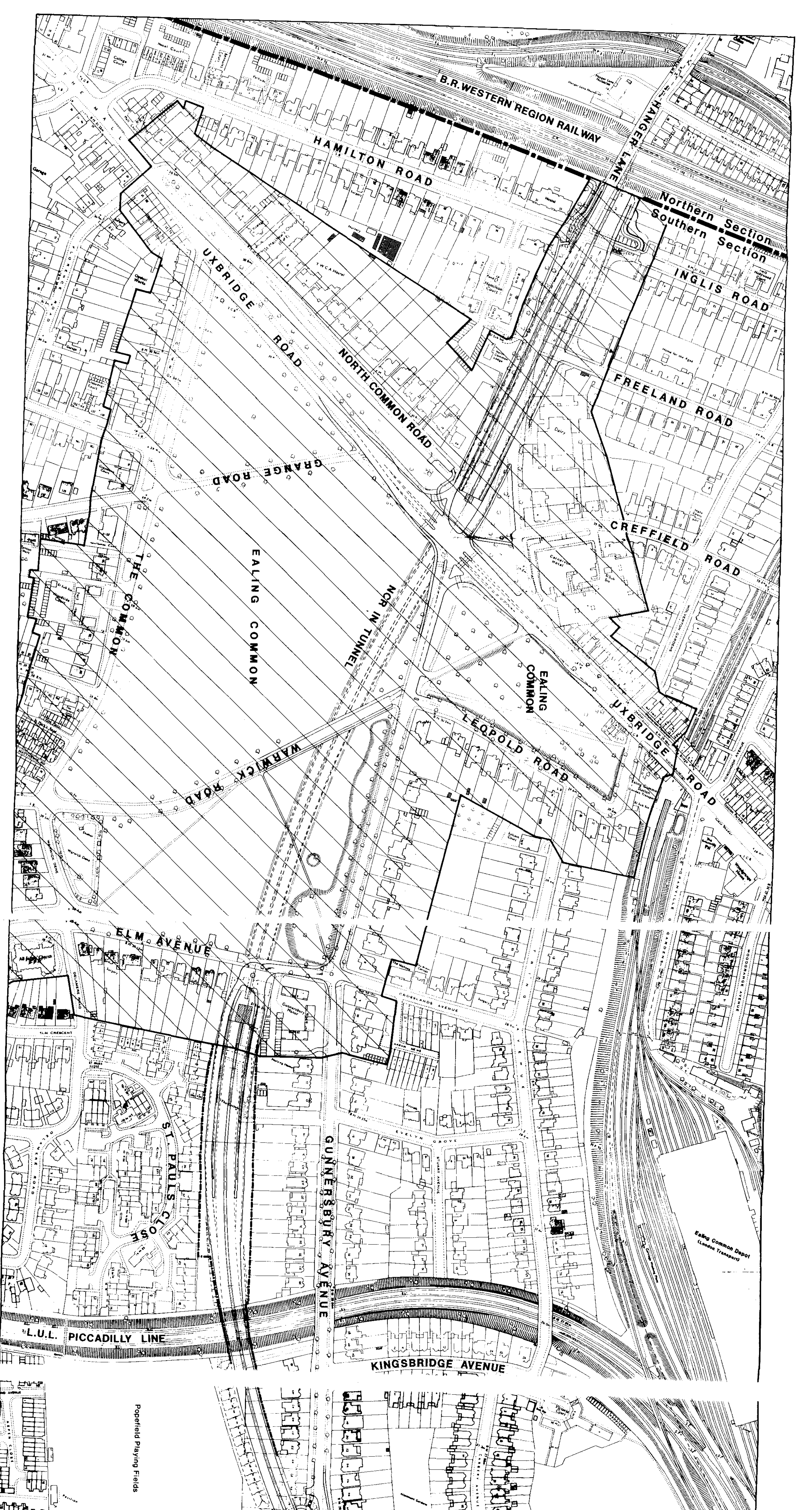
Figure 5.3.5

Scale 1:2500



THE A406 TRUNK ROAD
(GUNNERSBURY AVENUE IMPROVEMENT)

DO-SOMETHING SCHEME, CONTOURS OF CARBON MONOXIDE CONCENTRATIONS, 2010 EMISSION FACTORS

Figure 5.3.6

Scale 1:2500

THE A406 TRUNK ROAD

(GUNNERSBURY AVENUE IMPROVEMENT)

AREAS SUBJECT TO IMPROVEMENT OR DETERIORATION IN AIR QUALITY AFTER CONSTRUCTION OF THE PROPOSED SCHEME

Figure 5.3.7

Scale 1:2500

THE A406 TRUNK ROAD

(GUNNERSBURY AVENUE IMPROVEMENT)

DO-MINIMUM SCHEME, CONTOURS OF CARBON MONOXIDE CONCENTRATIONS, 1987 EMISSION FACTORS

Figure 7

Scale 1:2500

THE A406 TRUNK ROAD

(GUNNERSBURY AVENUE IMPROVEMENT)

DO-SOMETHING SCHEME, CONTOURS OF CARBON MONOXIDE CONCENTRATIONS, 1987 EMISSION FACTORS

Figure 8

Scale 1:2500

THE A406 TRUNK ROAD

(GUNNERSBURY AVENUE IMPROVEMENT)

AREAS SUBJECT TO IMPROVEMENT OR DETERIORATION IN AIR QUALITY AFTER CONSTRUCTION OF THE PROPOSED SCHEME

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Figure 9

Scale 1:2500