LONDON CANTERBURY DOVER TRUNK ROAD A2

BRIDGE BYPASS

DEPARTMENT OF THE ENVIRONMENT

P. A. Bays, G.M., F.I.C.E., M.I.Mun.E., M.R.T.P.I.
Regional Controller (Roads and Transportation),
Department of the Environment,
Guildford.

A. D. W. Smith, B.Sc.(Eng.), F.I.C.E., F.I.Mun.E., F.Inst.H.E., M.I.S.W.M.,
County Surveyor,
Maidstone,
Kent.

CONTENTS

			Page
Section	I	Introduction	1
1).		Early History	1
2).		Existing Conditions	1
3).		Alternative Routes	2
4).		Planning	3
5).		Relationship of Bridge Bypass to Existing and Proposed Network	6
6).		Landscape Works	5
7).		Accident Record	6
Section	II	General Discription and Site	10
1).		Dimensions	10
2).		Interchanges and Accesses	12
3).		Outline Costs	12
Section	III	Design Considerations and Standards	13
Section	IV	Ground Conditions and Geology	22
Section	V	Construction Details	27
Section	VI	Public Utilities and Bodies	35
Section	VII	Bridges	36
Section	VIII	Highway Services	44

APPENDICES

I	Main Contractor's Tender and Sub-Contractors
II	Progress Photographs
III	Major Accommodation Works

D I A G R A M S

No.	Title	Page
1	Alternative Routes At Preliminary Report Stages	4
2	Relationship Between Bridge Bypass and the Existing and Proposed A.2 Network	5
3	Landscape Re-Contouring	7
4	Landscape Cross Section Diagram	8
5	Landscape Cross Section Diagram	8
6	Landscape Cross Section Diagram	9
7	Landscape Cross Section Diagram	9
8	Routes of Bridge Bypass	14
9	Typical Earthworks Cross Section - Bekesbourne Road Cut	15
10	Typical Earthworks Cross Section - Bridge Down Cut	16
11	Typical Earthworks Cross Section - Coldharbour Lane Embankment	17
12	Predicted Noise Contours Before Landscape Treatment	19
13	Vehicles/Average 16 Hrs. Day in August 1970	20
14	Geological Long Section - Part I	23
15	Geological Long Section - Part II	24
16	Geological Long Section - Part III	25
17	Standard Detail for 7.9 metre Construction in Flexible or Composite Materials - In Cutting	30
18	Standard Detail for 7.9 metre Construction in Flexible or Composite Materials - On Embankment	30
19	Standard Detail for 7.9 metre Construction in Flexible or Composite Materials - Detail A	31
20	Standard Detail for 7.9 metre Construction in Flexible or Composite Materials - Detail B	31
21	Typical Ditch Detail	31
22	Flexible and Composite Paving Alternative Designs	32
23	Concrete Paving Alternative Designs	33
24	Concrete Paving Alternative Designs	33
25	Warping Joints	33
26	Standard Details for 8.6 metre Concrete Construction - In Cutting	34
27	Standard Detail for 8.6 metre Concrete Construction - On Embankment	34
28	Bifron's Park Subway	37
29	Bekesbourne Road Bridge	38
30	Patrixbourne Road Bridge	40
31	Coldharbour Lane Bridge	41
32	Highland Court Accommodation Bridge	42

S E C T I O N I

GENERAL INTRODUCTION

1. Early History

The last three decades have seen a dramatic increase in the flow of traffic through Kent to Europe. Coupled with this, the North Kent coastal towns have expanded rapidly during the same periods. As a result, the two main trunk roads in the County of Kent and particularly the A.2, became overloaded. Recognising this, the then Ministry of Transport adopted a policy of progressive improvement of the London-Canterbury-Dover Trunk Road, starting with the construction of the Medway Towns Bypass, M.2, which was opened to traffic in 1961. Since that time, there have been a series of schemes. Bridge Bypass forms one of the later projects in this series along with bypasses for the villages of Boughton and Harbledown.

In January, 1967, a meeting between representatives of the Divisional Road Engineer, Rural District Councils and the Kent County Council was held to discuss a policy for improving the London-Canterbury-Dover Trunk Road, A.2, from the eastern end of the Motorway M.2, at Brenley Corner, to the Borough of Dover.

Following this meeting, the Divisional Road Engineer outlined a comprehensive plan for improving the A.2, which was to carry out a number of schemes to improve the existing road and to construct bypasses of villages where necessary. Included among the latter was a proposal to construct a bypass of Bridge by the mid-1970's.

2. Existing Conditions

The village of Bridge (population 1,225 as at 1971/72 census) lies on the existing A.2 between Canterbury and Dover. The built-up area of the village covers a length of approximately 1.1 miles and the central 0.6 mile length has continuous frontage development on both sides of the road. This section has a 30 mph speed limit and has recently been made the subject of a conservation area.

The average existing road width is 7.0 metres and the minimum width is 5.3 metres in the centre of the village.

The village lies at the bottom of a valley and the existing highway gradients 0.5 miles east and west of the central area are 7.5% and 5.5% respectively.

The village acts as a shopping centre for surrounding smaller villages, giving a shopping population of approximately 2,800; there are twenty shops in the central area, including a supermarket and some congestion is caused by associated private and commercial vehicles. Trunk road traffic, especially heavy lorries, make the environment in the centre of the village unpleasant. The footway width varies, but is as narrow as 1.2 metres in parts of the central shopping area.

The figures for a traffic count at Bridge in September 1969 produced an August 16 hr. daily flow of 13,030 vehicles, or 16,430 p.c.u's. Three projected figures were considered for the design year 1990 and are as follows:-

a) Assuming M.20 in use and Channel Tunnel in use, projected daily flow is 15,488 vehicles.
b) Assuming no M.20 in use and no Channel Tunnel, projected daily flow is 23,828 vehicles.
c) Assuming M20 in use and no Channel Tunnel, projected daily flow is 19,063 vehicles.

The percentage of goods vehicles was found to be 16¾% of weekday traffic, 4% of weekend traffic and 13½% of total traffic. The goods vehicle traffic, largely T.I.R.'s, is predominantly generated by the docks at Dover.

3. Alternative Routes

Three lines were considered at preliminary report stage, shown on a diagram overleaf. Each route was designed so as to ultimately join the proposed Canterbury Bypass to the north-west and the proposed dual carriageway on the existing A.2 to the south-east as follows:-

i) Route 'A' (north-east of Bridge) From the Canterbury end the route swung eastwards in cutting under the Bekesbourne Road, descending across Bifron's Park and the Nailbourne Valley and then rose, passing west of Highland Court to rejoin the existing A.2 at Coldharbour Lane. This route was adopted for the scheme.

ii) Route 'B' was an improvement of the existing alignment through the village.

iii) Route 'C' (south-west of Bridge) From the Canterbury end the route swung west close to Renville Farm and descended into the Nailbourne Valley via Great Pett Farm and then rose through Bourne Park, rejoining the A.2 at Frog Lane, Bishopsbourne.

At a later date, other southern routes were investigated in outline detail, including the suggested use of the old Canterbury-Folkestone railway line. It was found that all the southern routes had disadvantages with respect to route planning and access. They were also considered by the Kent County Council Planning Department to be more damaging to the local environment than the proposed northern route.

The northern route was subsequently investigated in full detail and the proposals put to a Public Enquiry held in May 1973 and accepted. The Secretary of State for the Environment confirmed the orders in August, 1973.

4. Planning

Widening the existing A.2 (Route 'B') was considered the least desirable alternative for the following reasons:-

(i) There would have been an unacceptable amount of demolition to private property compared with the other alternative routes. Between 30 and 40 private dwellings would have been affected, plus two Public Houses and about ten shops. Many of the private houses are of a high quality, some with preservation orders in force and the cost of acquiring all the necessary land and property would have been in the region of £300,000 at 1969 prices.

(ii) Since the existing approach gradients to the village are 5½% to the west and 7½% to the east, the alterations to these gradients would have been impossible without causing further demolition of property along re-aligned side roads.

(iii) A considerable number of at-grade junctions would have been perpetuated.

Routes to the N.E. and S.W. (Routes 'A' the adopted route and 'C') were both lines which were designed to clear the envelope of existing development, but which remained as close as possible to the existing line.

As the routes traversed similar strata there was no geological advantage in either route.

The gradients and curvatures for both routes were similar. The route chosen however, allowed a better horizontal alignment approach to all the proposed routes of Canterbury Bypass than Route 'C' and there would have been a redundant length of carriageway if Route 'C' were adopted.

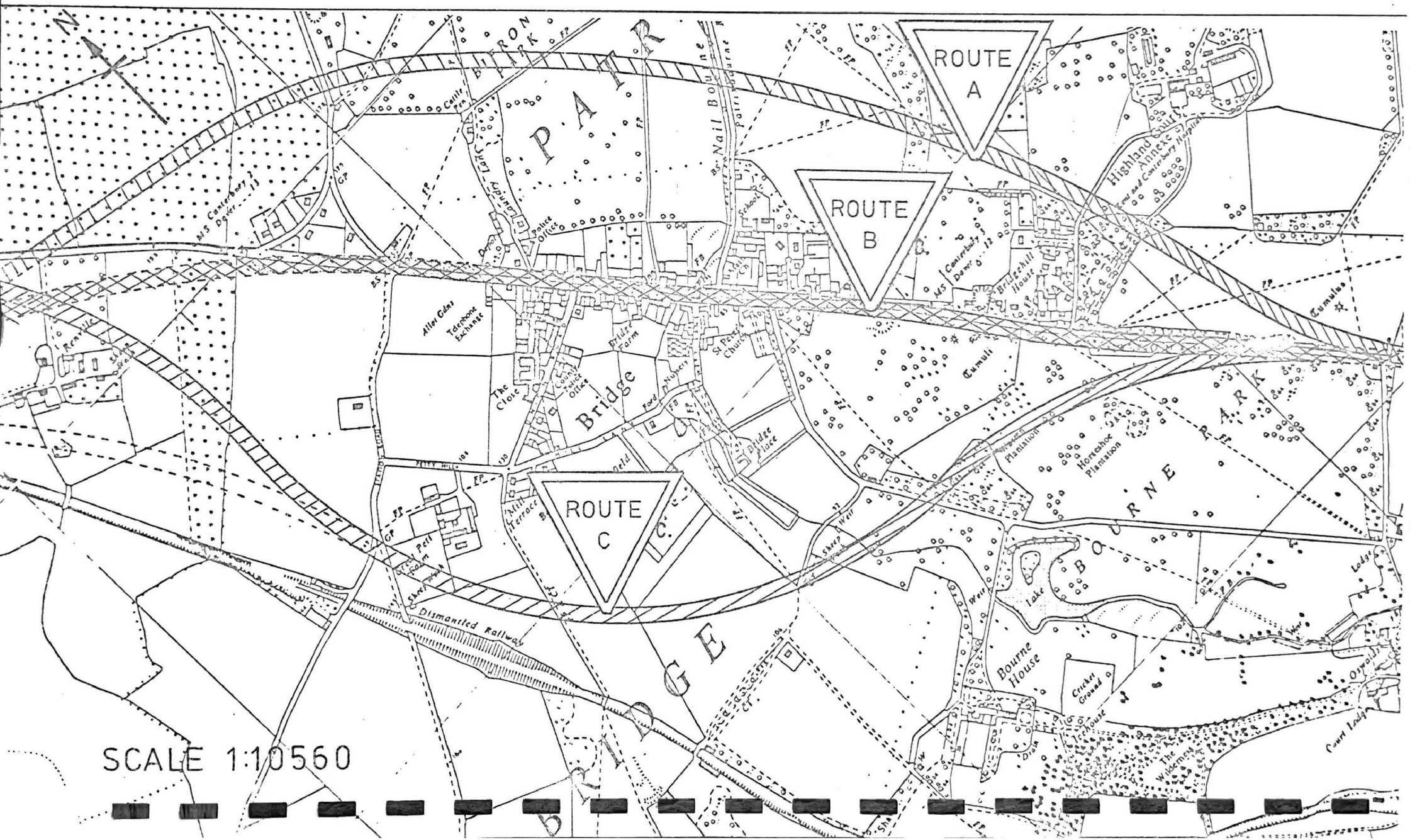
From planning considerations, the adopted route was preferred and was in fact the route shown on the County Development Plan. Route 'C' would have caused the more serious and far reaching damage to amenity and farming, including Renville Farm, Great Pett Farm and Bourne Park, the latter being a fine example of 18th Century landscape together with Bourne House, a Grade I listed building.

The Kent River Authority had no preference for either scheme and were only concerned that the bridge crossing the Nailbourne Valley had sufficient flood relief capacity.

The Ministry of Agriculture, Fisheries and Food preferred the northern route and requested that it be kept as close as possible to the village, so as to minimise the amount of orchard land taken at the Canterbury end and because through Bifron's Park the land to the south-west was poorer and the top loam soil thinner.

DIAGRAM 1

ALTERNATIVE ROUTES AT PRELIMINARY REPORT STAGES



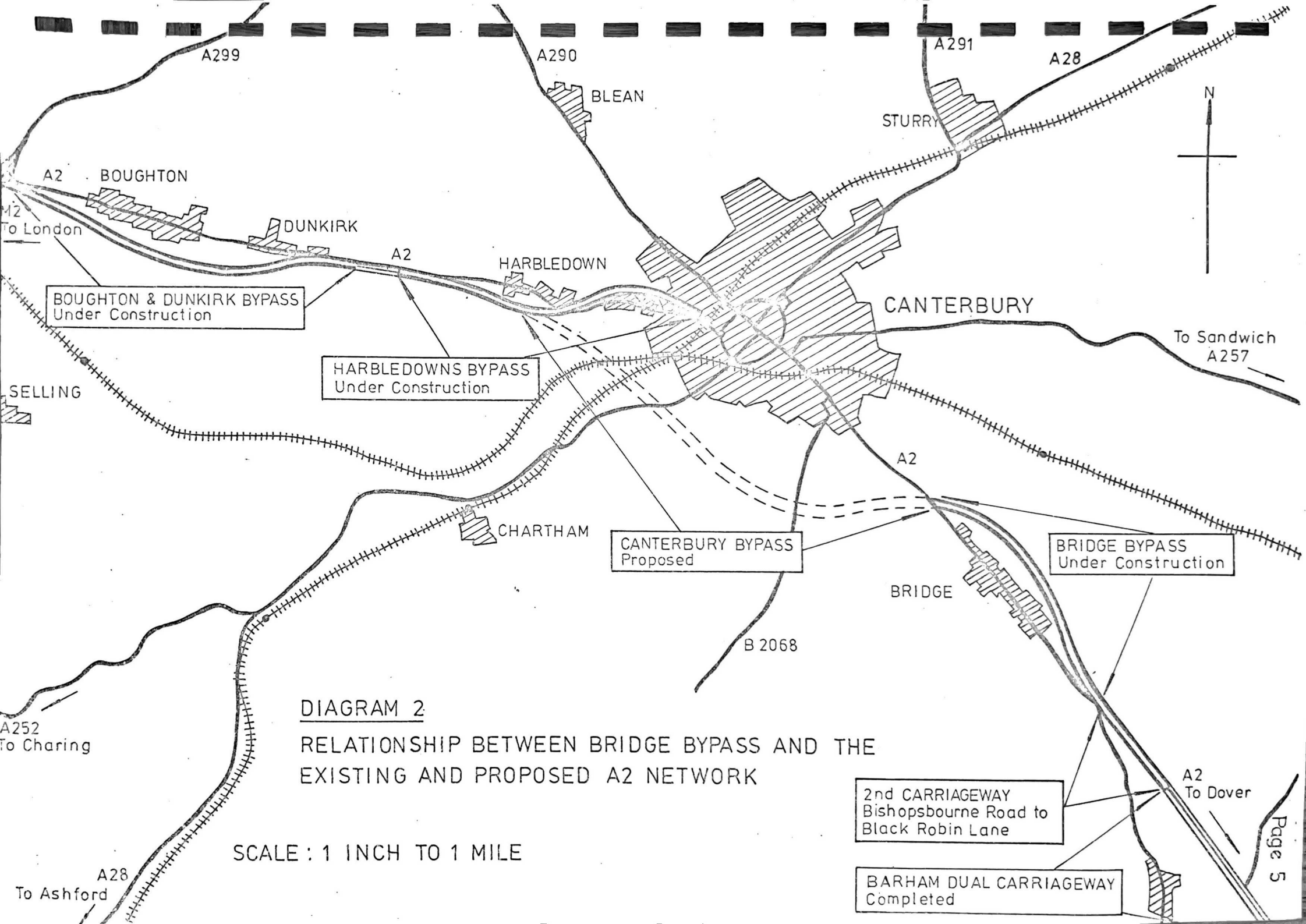


DIAGRAM 2

RELATIONSHIP BETWEEN BRIDGE BYPASS AND THE EXISTING AND PROPOSED A2 NETWORK

SCALE : 1 INCH TO 1 MILE

5. Relationship of Bridge Bypass to Existing and Proposed Networks

Bridge Bypass is one of a series of bypasses between Faversham and Dover, which were designed to take long-distance and local inter-urban traffic out of the villages. All traffic approaching Bridge from Canterbury is diverted on to the Bypass and traffic requiring to stop at Bridge departs via a slip road. Similarly, at the Dover end of the scheme, the A.2 traffic is channelled along the Bypass and local traffic uses a slip road to reach the village.

The proposed Canterbury Bypass will link with Bridge Bypass at Renville Farm and the old A.2 road can be restored to become a local route from Canterbury to Bridge.

The Barham end of Bridge Bypass connects with existing dual carriageway.

The map on the preceeding page shows the route continuity between Boughton and Dunkirk Bypass, Harbledown Bypass, Canterbury Bypass and Bridge Bypass.

6. Landscape Works

The County Planning Officer suggested at Preliminary Report Stage that due consideration be given to landscaping the route through the Nailbourne Valley. Following a Public Exhibition held in Bridge Village Hall in November 1972, a large number of local residents expressed the opinion that the embankment crossing the Nailbourne Valley would be unsightly and it was decided to lower the embankment so that the completed embankment line became compatible with the end of Conyngham Lane. As a result, the earthworks balance could no longer be achieved and the surplus chalk and head material were re-deployed on extensive landscaping works to disguise the main embankment.

Land was acquired under licences in order to carry out these landscaping works and in full consultation with the Department of the Environment's Landscape Architect the necessary plans were evolved.

The accompanying drawings describe these proposals.

7. Accident Record of Old A.2

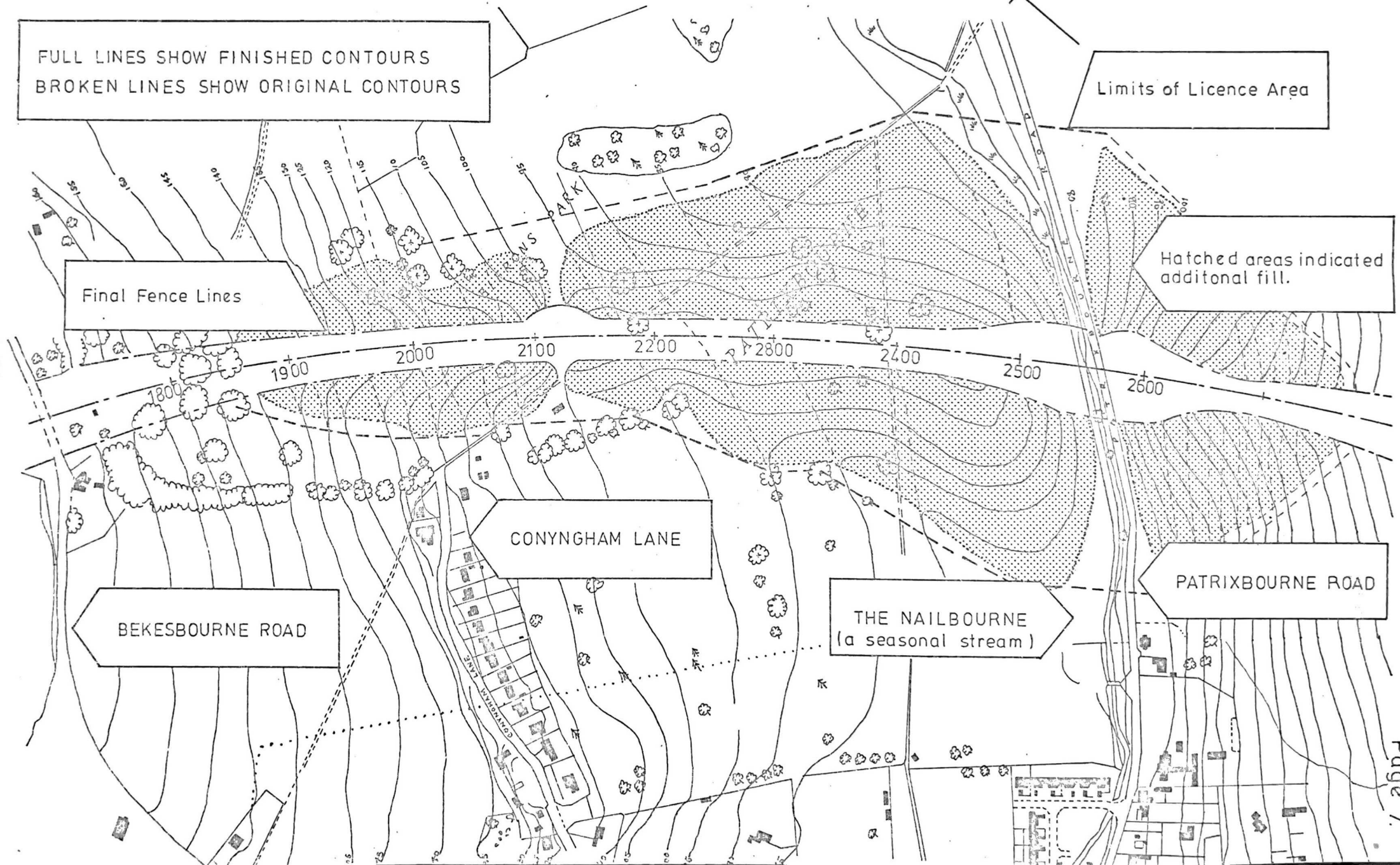
In the three years from October 1969 to September 1972, there were 26 personal injury accidents along the section of old A.2 between Bonny Bush Hill (B.2065) and the Canterbury end of the Bypass in which 43 people were injured, one fatally.

LANDSCAPE RE-CONTOURING

DIAGRAM 3.

(Road chainages shown are in metres)

Scale 1:10560



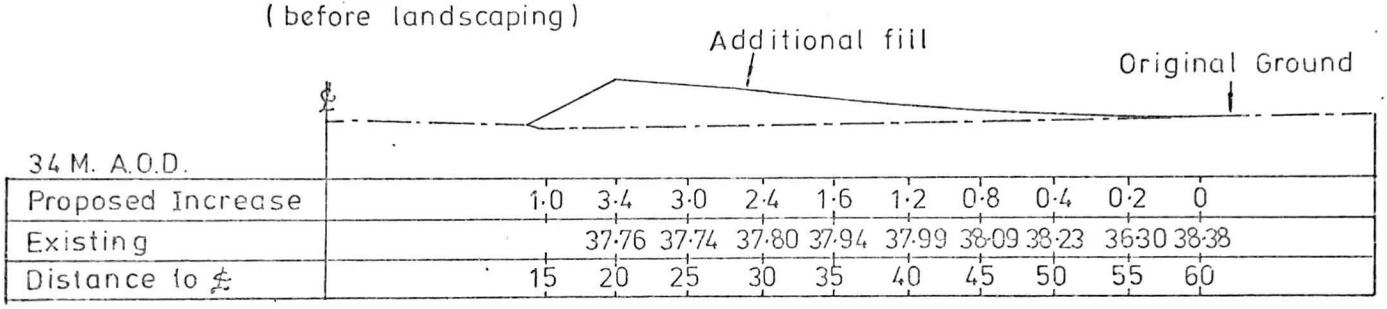
LANDSCAPE CROSS SECTION DIAGRAMS 4 - 7

The following cross sections indicate the additional fill on the Bridge Village side of the Bypass. The cross sections indicating the landscape fill on the Patrixbourne side are similar.

Each section shown commences at the centre line of the road. Sections 1980 and 2000 indicates the method of falsifying the cut-fill line, whilst sections 2380 and 2420 indicate the method of disguising the embankment. Note that a nominal 1.0 - 1.5 metres of embankment is still evident above the landscape fill and that the landscape fill rounds off into the embankment slope and gently merges into original ground level.

DIAGRAM 4

CUT-FILL LINE
(before landscaping)

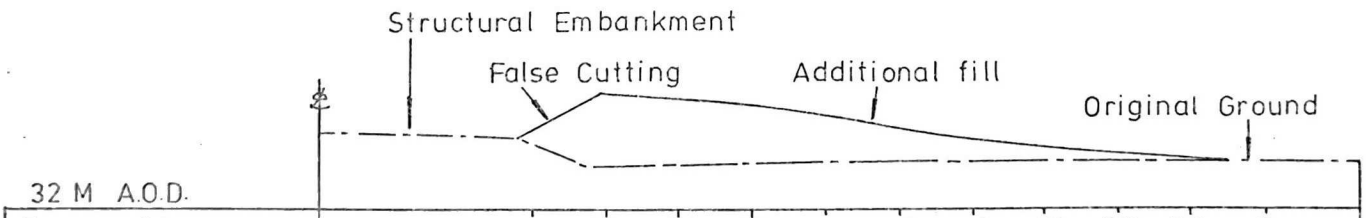


Proposed Increase	1·0	3·4	3·0	2·4	1·6	1·2	0·8	0·4	0·2	0
Existing	37·76	37·74	37·80	37·94	37·99	38·09	38·23	36·30	38·38	
Distance to ℄	15	20	25	30	35	40	45	50	55	60

CHAINAGE 1980·00 M

DIAGRAM 5

STRUCTURAL EMBANKMENT

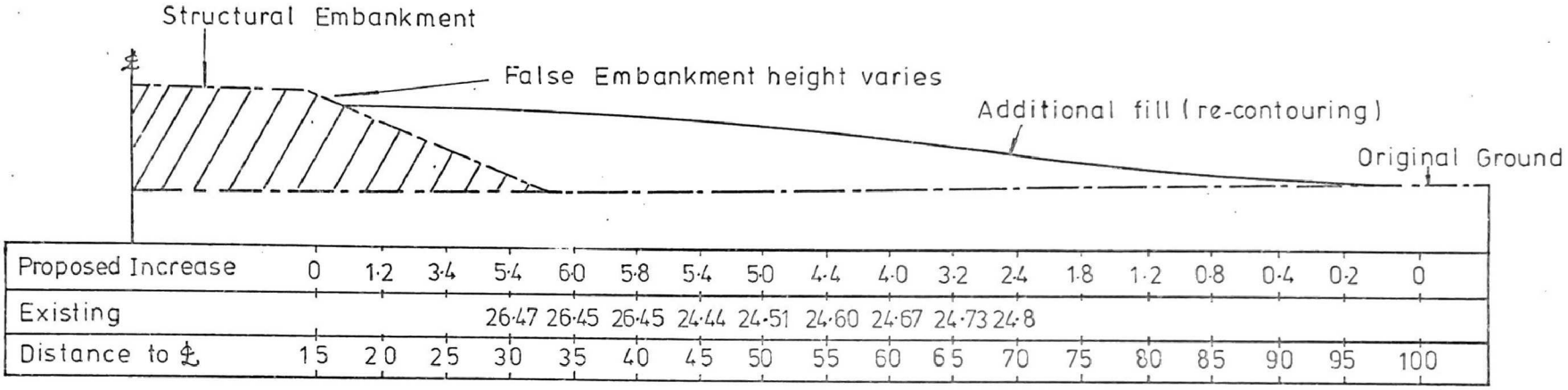


Proposed Increase	1·2	5·0	4·6	4·0	3·2	2·2	1·6	1·0	0·7	0·4	0
Existing	35·46	35·57	35·67	35·79	35·87	35·99	36·04	35·97	36·13	36·28	
Distance to ℄	15	20	25	30	35	40	45	50	55	60	65

CHAINAGE 2000·00 M

DIAGRAM 6

STRUCTURAL EMBANKMENT

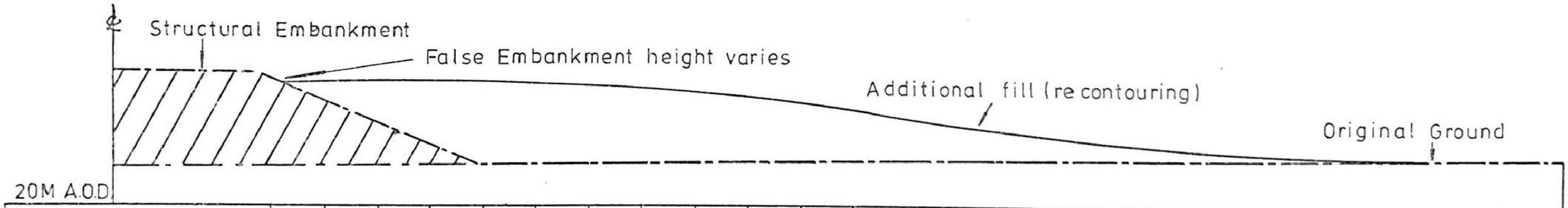


Proposed Increase	0	1·2	3·4	5·4	6·0	5·8	5·4	5·0	4·4	4·0	3·2	2·4	1·8	1·2	0·8	0·4	0·2	0
Existing				26·47	26·45	26·45	24·44	24·51	24·60	24·67	24·73	24·8						
Distance to ℄	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100

CHAINAGE 2380·00 M

DIAGRAM 7

STRUTURAL EMBANKMENT



Proposed Increase	0	1·6	3·8	5·6	7·6	7·2	7·0	6·8	6·4	6·0	5·4	4·6	4·0	3·2	2·6	2·0	1·6	1·2	1·0	0·6	0·4	0·2	0
Existing					23·87	23·95	23·93	23·90	23·92	23·97													
Distance to ℄	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	105	110	115	120	125

CHAINAGE 2420·00 M

S E C T I O N I I

GENERAL DESCRIPTION AND SITE

1. Dimensions

(a) The total length of this scheme was 5.6 km which included 2.0 km of dualling to the previous A.2 single carriageway, between Bonny Bush Hill (B.2065) and Black Robin Lane at Barham. There were additional works to Bekesbourne Road and Coldharbour Lane, together with junction works at Renville Farm, Bridge Hill, Bonny Bush Hill and Poorstart Lane. Re-routed farm access roads comprised Hode Farm Access, Bifron's Park Access, Highland Court Hospital Access, Highland Court Farm Access and Ileden Farm Road.

(b) The scheme included five bridges which were:-

(i) Bekesbourne Road Overbridge.

(ii) Bifron's Park Subway - provides access between fields for agricultural vehicles and has two footpaths and one bridlepath diverted through it.

(iii) Patrixbourne Road Underbridge - carries the bypass over both Patrixbourne Road and the Nailbourne stream.

(iv) Highland Court Accommodation Bridge - carries a private access road over the bypass.

(v) Coldharbour Lane Underbridge

The principal dimensions of these bridges are given on the table opposite.

(c) The Bypass has dual 7.3 m carriageways, with 0.3 m edge-strips and a 0.3 m drainage channel on the low side. The dualling to the existing carriageway which traverses flatter ground has a 1.0 metre hardened strip on the low side and no drainage channel. There is a central reserve 4.5 m wide between road markings, of which the central 3.9 m is grassed and dished off-centre. The verge width is 3.5 m measured from the road edge markings, is dished in cutting and falls away from the road on embankment.

The maximum depth of the cut at Bekesbourne Road is 9.80 m at chainage 1520, whilst that at Bridge Down it is 11.76 m at chainage 3320. The maximum height above original ground level of the structural embankment in the valley is 10.01 m at chainage 2420 and is 700 metres in length. A second embankment 1,000 metres long and reaching a height of 6 m is located at Bishopsbourne.

PRINCIPAL DIMENSIONS OF BRIDGES

	Main Span (between bearings)	Side Spans (between bearings)	Width between Parapets	Skew Angle	Headroom
Bekesbourne Road Overbridge	28.3m	-	12.16m	1°15'45"	6.27m
Bifron's Park Agricultural Subway	5.1m	-	24.10m	square	3.20m
Patrixbourne Road Overbridge	22.40m	18.50m	24.10m	21°15'	8.20m
Highland Court Accommodation Bridge	24.87m	13.09m	6.50m	8°29'	6.25m
Coldharbour Lane Underbridge	13.13m	-	24.07m	3°6'29"	5.11m

Slip roads are 6.0 m wide between edge linings and 6.6 m overall and are unkerbed.

Access roads are between 2.5 m and 5.5 m in overall width depending on the landowner's requirements.

2. Interchanges and Accesses

The vertical and horizontal design of the adopted route is shown on Diagram 8.

At the north-western end the Bypass was designed to connect with all proposed routes of the Canterbury Bypass, although no firm route was established for the Canterbury Bypass, at the design stage of the scheme.

For through traffic the alignment swings north-east avoiding 'Upper Lodge' in Bifron's Park and properties in Conyngham Lane. At the south-eastern end the alignment clears Bridge Down housing estate, passes west of Highland Court and rejoins the Trunk Road at Bishopsbourne.

For local traffic travelling towards Bridge from Canterbury, use is made of the slip road at Bekesbourne Road and Canterbury bound traffic joins the A.2 by another road near Renville Farm.

There is no connection between the Bypass and Patrixbourne Road nor at Highland Court Access.

The existing length of the A.2 between Bishopsbourne Road and Bonny Bush Hill (B.2065) has been re-used as a local road and the new dual carriageway runs parallel with it, but upon embankment. The re-built A.2 route between Bonny Bush Hill and Barham is re-used as the London bound carriageway. The bridge over Coldharbour Lane at Bishopsbourne serves to provide interchange facilities between the surrounding villages and the A.2 as well as taking A.2 traffic over a side road. Traffic bound for Bridge from Dover utilises slip road facilities at Bonny Bush Hill.

Central reservation crossovers are provided just north of Coldharbour Bridge and just south of the slip road on to Bonny Bush Hill, for maintenance and emergency purposes.

There had been a proposal for lay-by facilities in the vicinity of the Nailbourne Valley, but owing to very strong local objections, it was not incorporated into the final scheme. Lay-by facilities exist at Barham, however.

3. Outline Costs

The tender sum for construction of the scheme was £2.4 million (June 1974) and the total overall cost of construction of the scheme was just over £3.0 million. The increase in cost being due to the variation of price increase as per the Contract.

S E C T I O N I I I

DESIGN CONSIDERATIONS AND STANDARDS

1. The road was designed in accordance with the recommendations of "Roads in Rural Areas" published by H.M.S.O., as updated by the Department of the Environment in accordance with Memorandum H7/69 and Corrigenda. The vertical clearance at bridges is in accordance with requirements for a high load route.

The following criteria were used:

Design Speed	120 k.p.h.
Carriageways	dual 7.3 metres
Central Reservation	4.5 metres
Verges	3.5 metres
Minimum vertical clearance	6.250 metres
Standard overall width between backs of verges	26.1 metres
Marginal strips	0.3 metres
Minimum Horizontal Curvature	1000 metres
Maximum Super-elevation	1 in 21
Maximum Gradient - Main Carriageway	4%
- Slip Roads	5%

2. The road is in a rural area and the vertical alignment was originally designed to achieve an earthworks balance with respect to chalk cut and fill, but following a decision to carry out extensive landscaping works in conjunction with the lowering of the embankment height through Bifron's Park, a complete earthworks balance to include unsuitable material has been achieved.

3. The cutting at Bekesbourne Road was widened on the inside of the bend to meet the criteria for minimum visibility.

4. It was decided that a positive drainage system should be incorporated to collect water on the low side of the carriageway. The Bypass has two long descents into the Nailbourne Valley (1,250 metres and 1,900 metres) down which surface water run-off could achieve a high velocity if not collected. It was considered that carriageway water should not be allowed to find its way on to the verges or embankment slopes, since it would attain a high velocity and would flush out filter media and verge material. Filter drains on embankments were discounted as they could give rise to slip failures.

5. In order to minimise the number of major side road connections with the A.2 at Bishopsbourne, use was made of the existing A.2 route as a link between the Elham Valley and Bridge. A grade-separated junction was then designed, utilising a side road underbridge at Coldharbour Lane.

DIAGRAM 8.

ROUTE OF BRIDGE BYPASS

(Embankments shown are those prior to Landscape Treatment.)

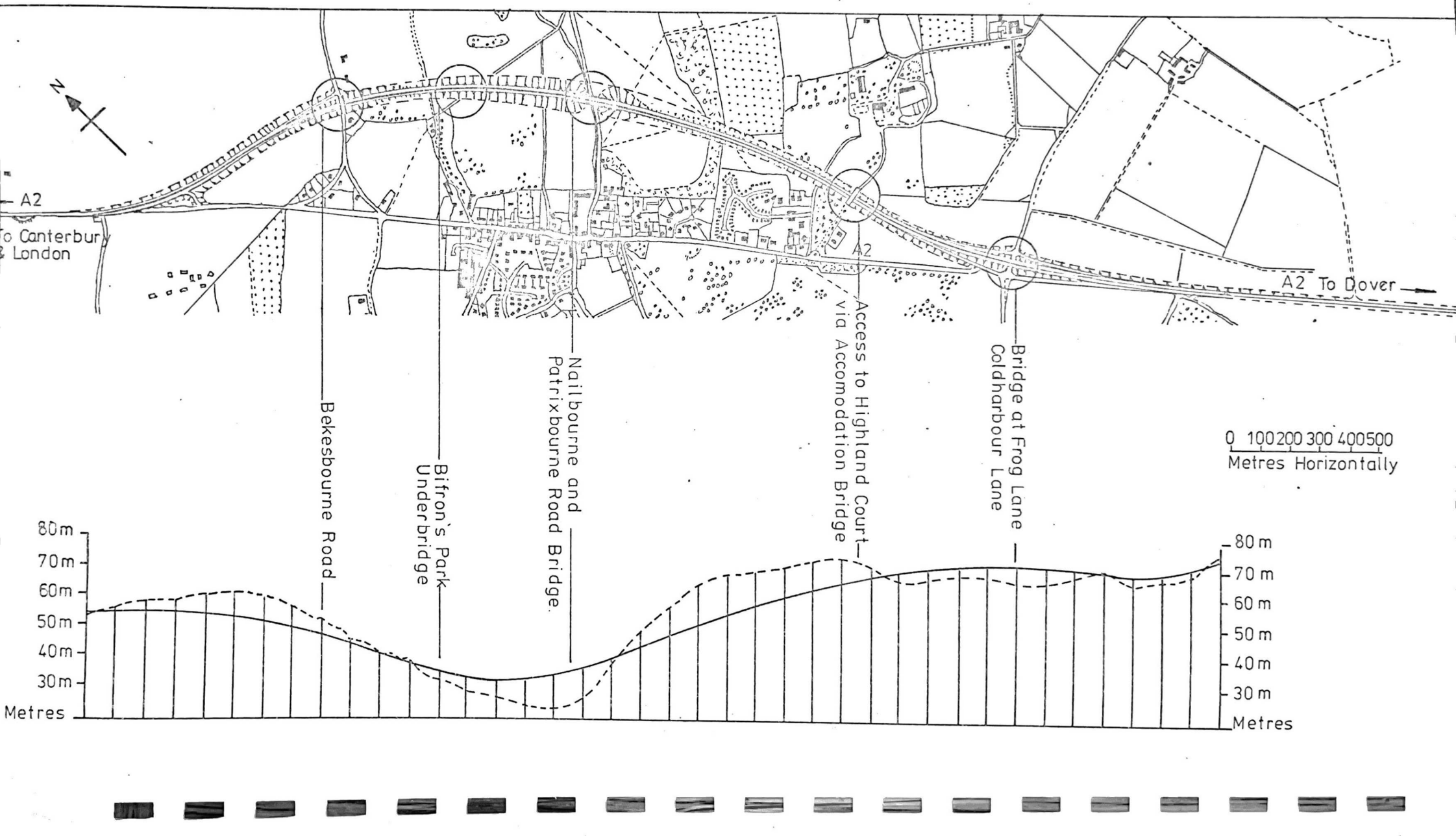
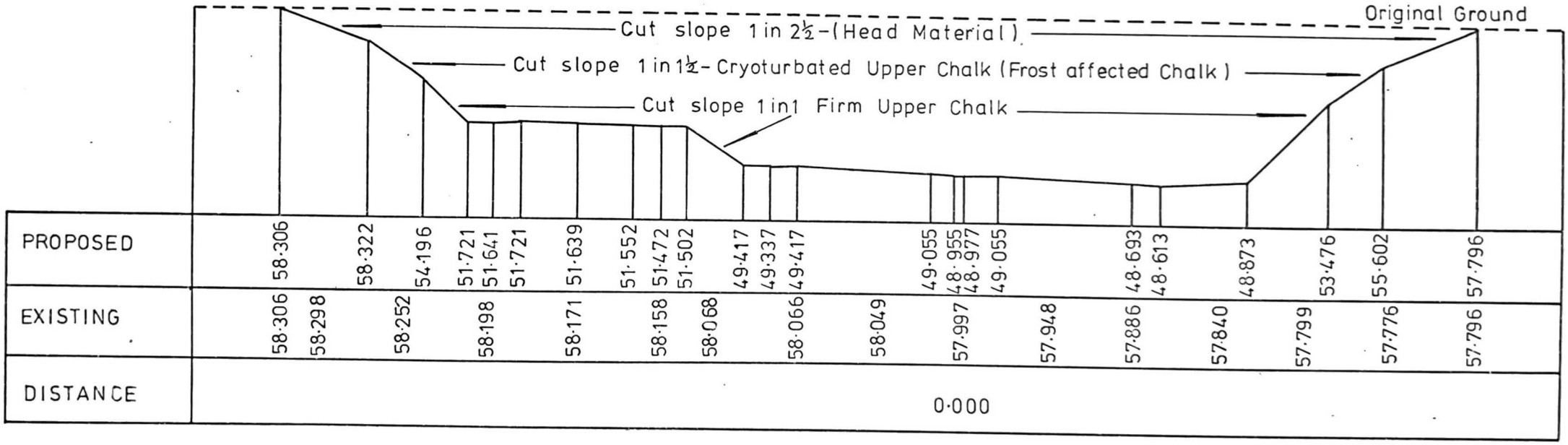


DIAGRAM 9

TYPICAL EARTHWORKS CROSS SECTION

Example at Chainage 1580

BEKESBOURNE ROAD CUT



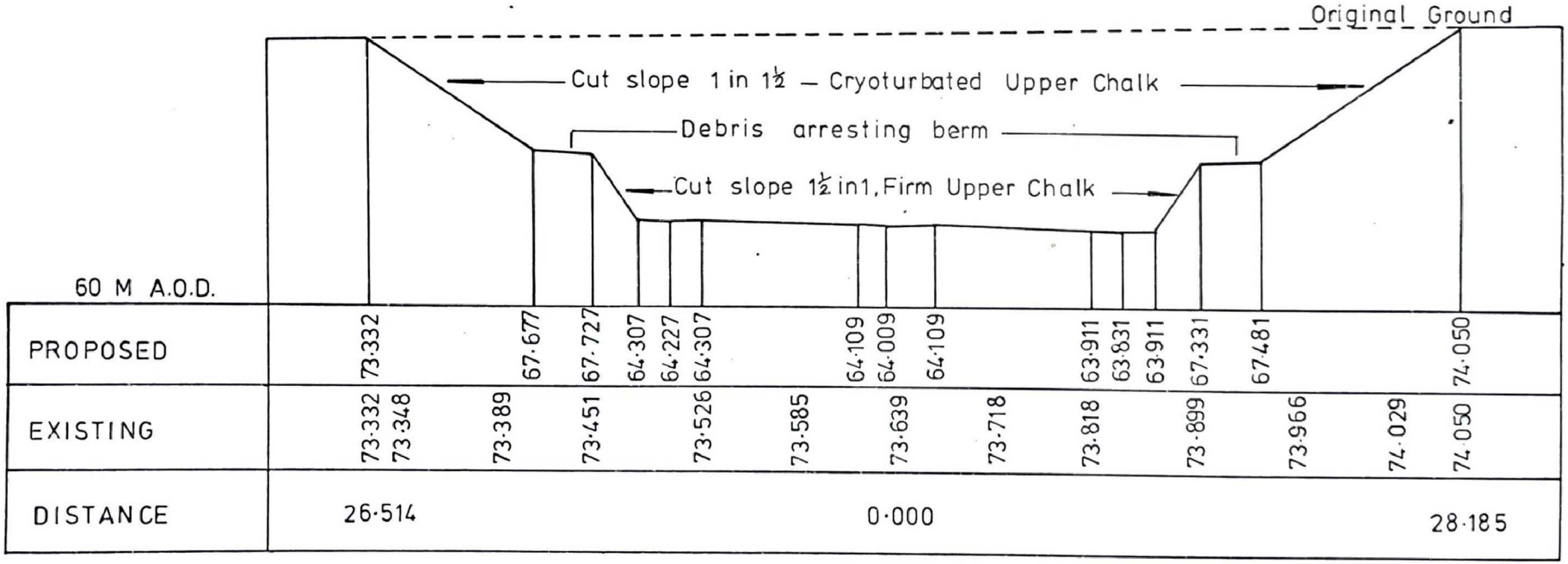
CHAINAGE 1580.00 M

TYPICAL EARTHWORKS CROSS SECTION

DIAGRAM 10

Example at Chainage 3440

BRIDGE DOWN CUT



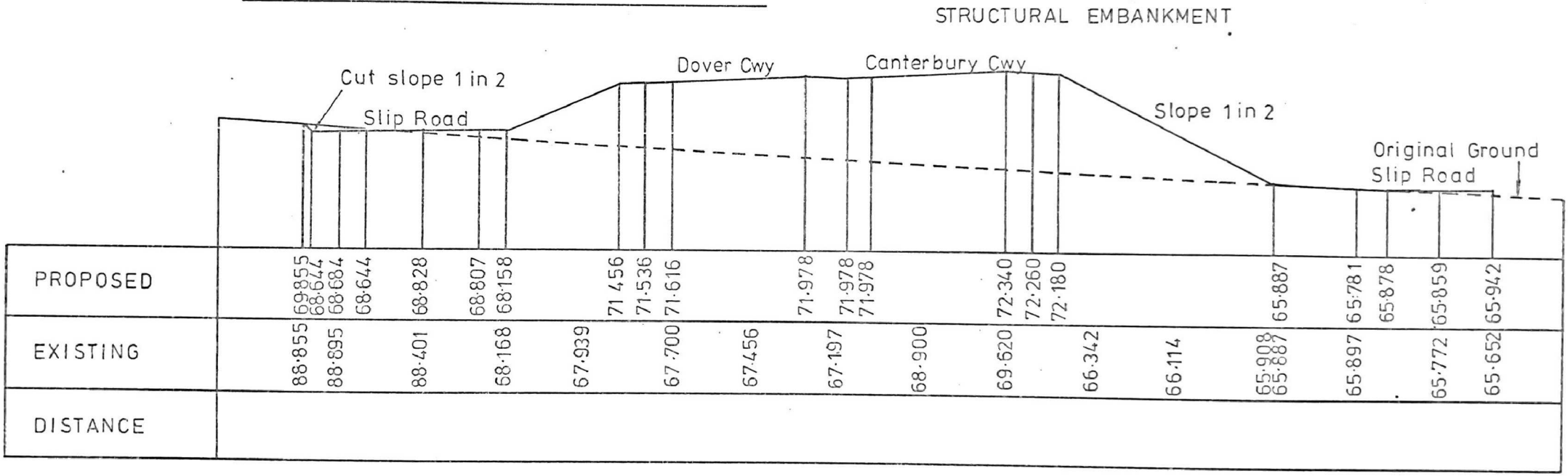
CHAINAGE 3440.00 M

TYPICAL EARTHWORKS CROSS SECTION

DIAGRAM 11.

Example at Chainage 4040

COLDHARBOUR LANE EMBANKMENT

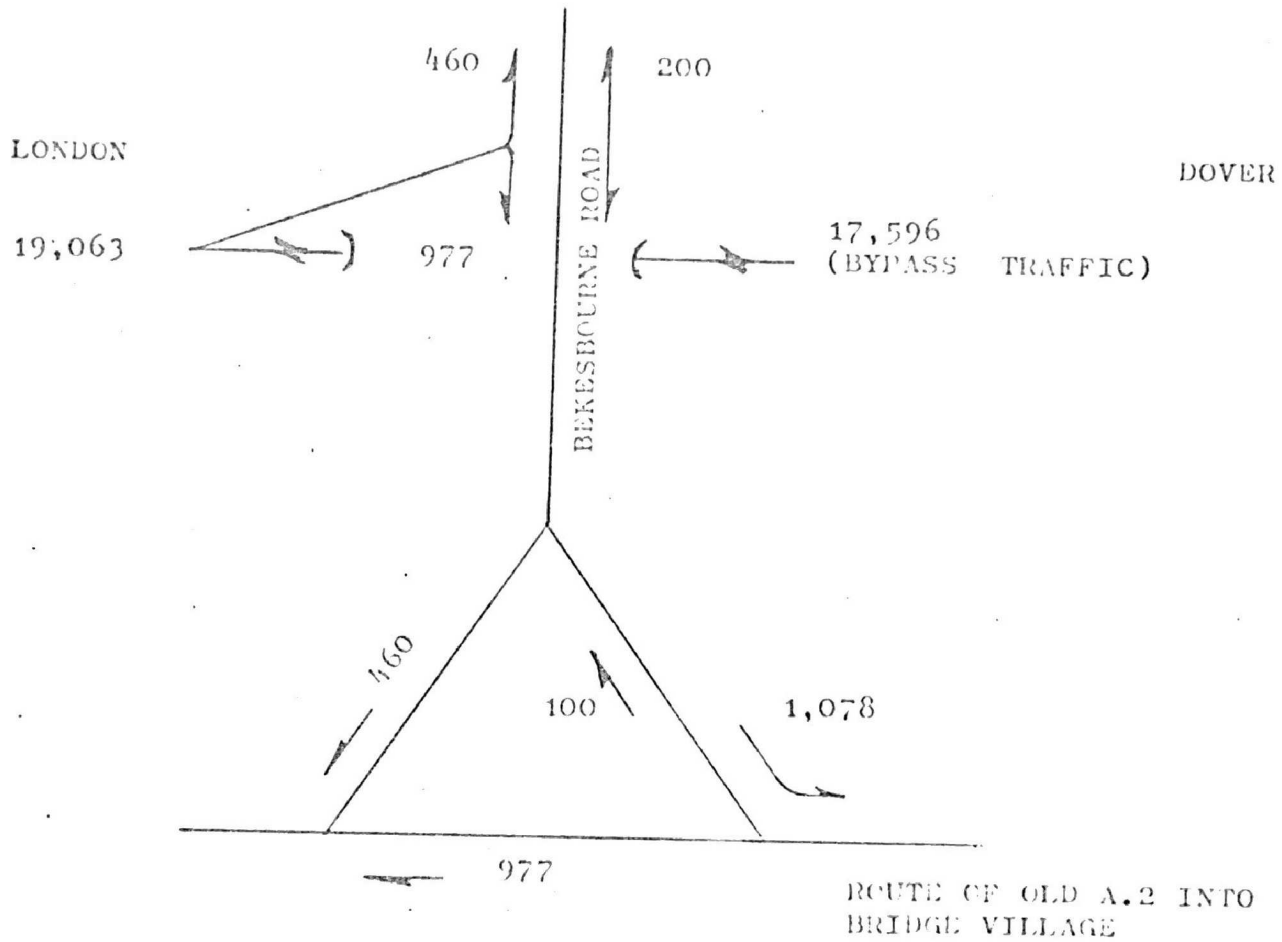


CHAINAGE 4040.00 M

6. In the cutting at Bridge Down, a rough chalk face has been left on the 1½ upon 1 slopes, these being areas of good "rock" chalk, with the resultant ledges being soiled and seeded by hydraseeding techniques.

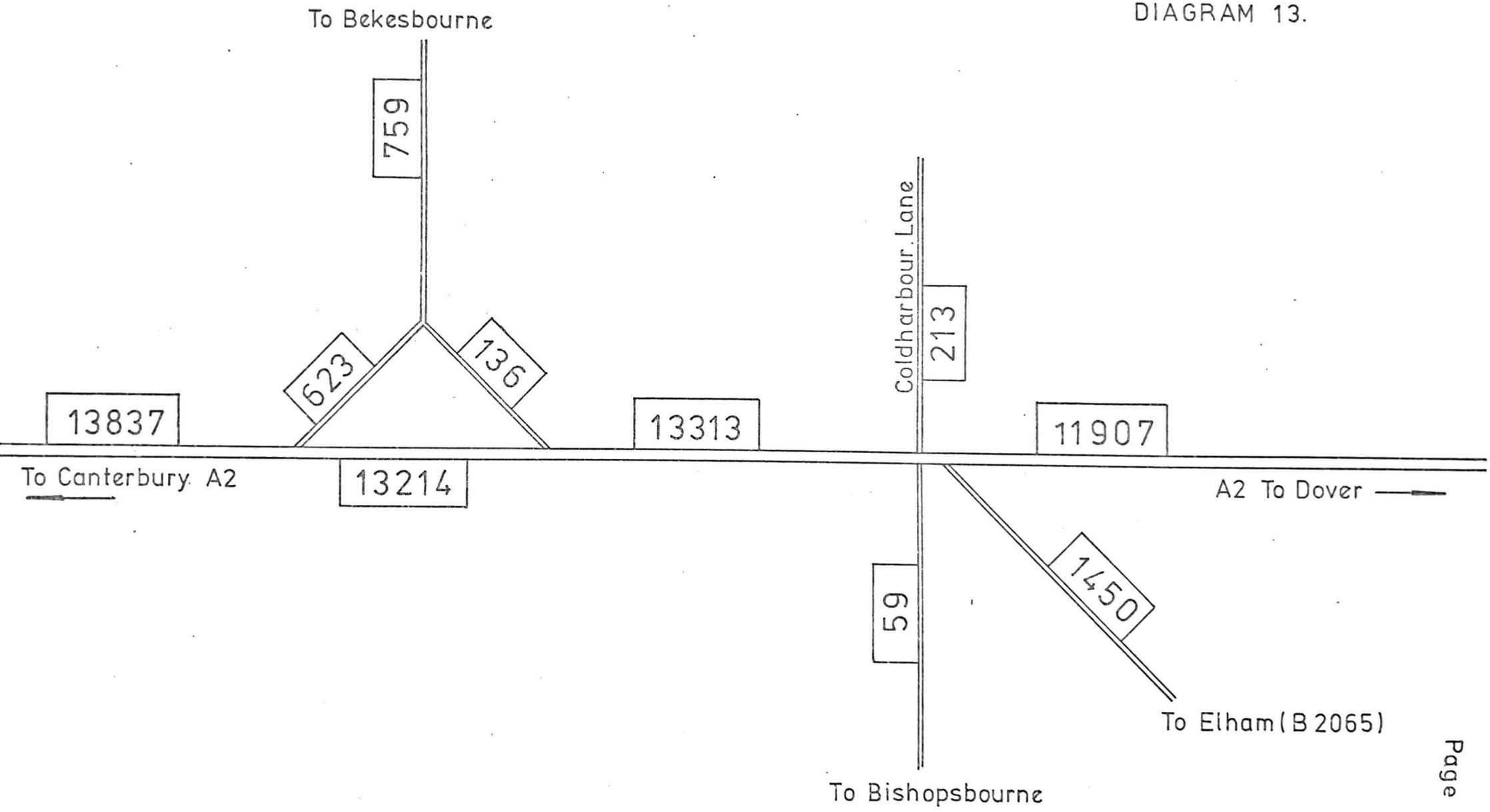
7. The existing traffic pattern through Bridge is shown on the traffic map opposite for an average 16 hr. day in August, 1970.

8. The predicted bypass traffic flows for the year 1990 were summarised under Section 1 and below is a detail of the no tunnel/M20 case at Bekesbourne Road:-



VEHICLES / AVERAGE 16 Hrs. DAY IN AUGUST 1970

DIAGRAM 13.



PREDICTED NOISE CONTOURS BEFORE LANDSCAPE TREATMENT

For Bypass running to full capacity.

Noise Survey Stations eg. (3)

LEGEND

NOISE SHADOW

NOISE LEVELS BETWEEN 70 d B(A) & 65 d B(A)

VILLAGE HOUSING DEVELOPMENT 1975

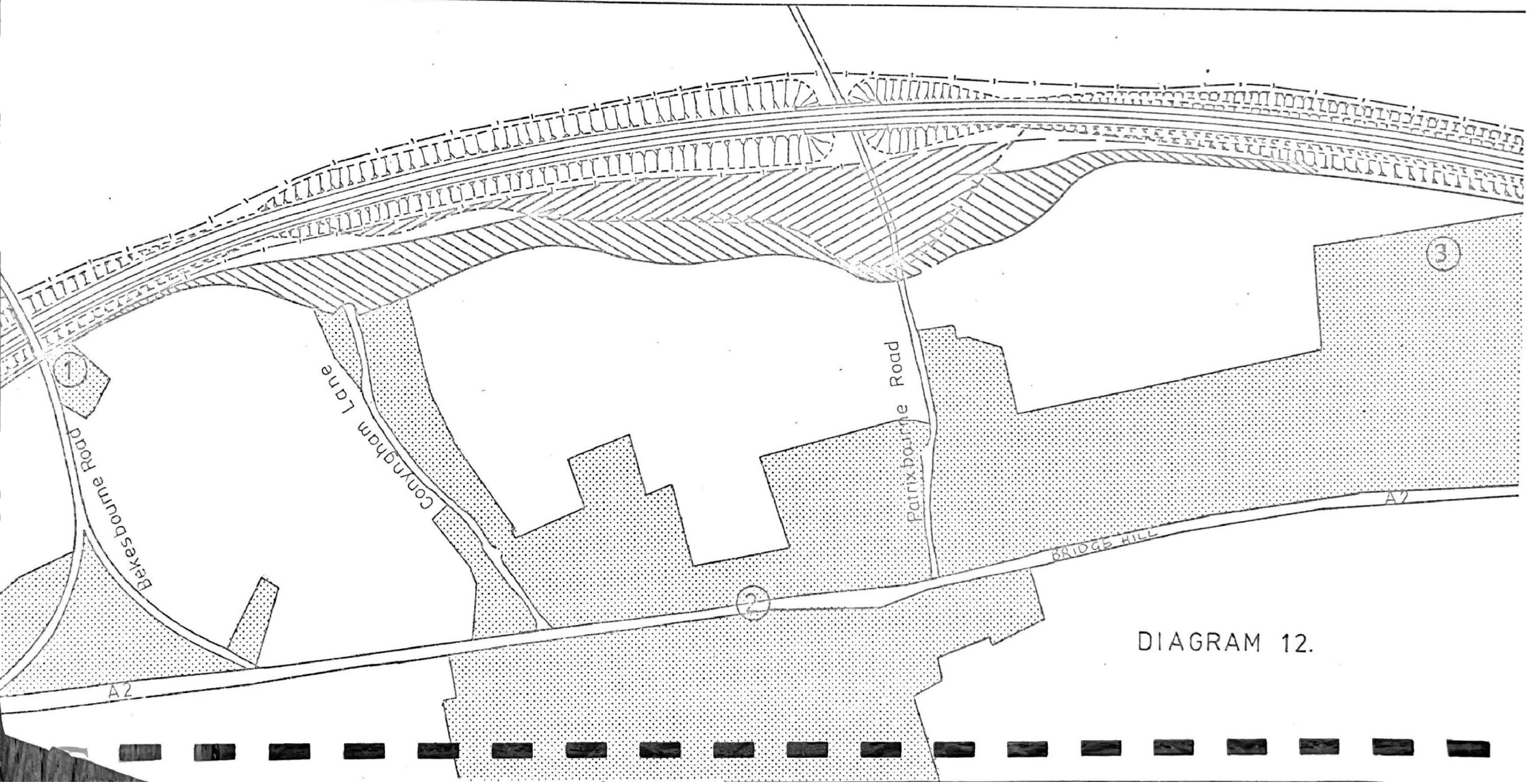


DIAGRAM 12.

9. A survey of existing traffic noise was made in March 1973 at three key locations. Sites 1 and 3 were considered the most vulnerable to increase in noise from bypass traffic and similarly Site 2 was considered representative of a site where the greatest reduction in noise would be expected. The measurements were made over an 18 hour period from 6 a.m. to midnight. The corresponding L 10 noise indices were determined by statistical analysis. The instrument used was a Brüell & Kjaer Sound Level Metre Type 2209 and was calibrated regularly during the exercise. Readings were taken every 15 seconds for 15 minutes in each hour.

At Site 2 a traffic count was made concurrently with noise level readings.

Traffic noise was predicted for the year 1990 for the section of route between Bekesbourne Road and Highland Court Hospital, assuming 19,063 vehicles/day, (24,000 p.c.u's.) on the Bypass using Section IV of the Department of the Environment's Design Bulletin No. 26 "New Housing and Road Traffic Noise, a design guide for Architects". The predictions were plotted on a map, a copy of which is reproduced overleaf. These predictions do not, however, take into account the noise attenuations, caused by the landscape treatment in the Conyngham Lane vicinity, where the cut has been falsely extended. This effect was investigated and it was found that in comparison:-

(a) The existing noise level (1973) at the bypass end of Conyngham Lane = 49 dBA

(b) The predicted noise level (1990) at the bypass end of Conyngham Lane = 65 dBA (without landscape treatment).

(c) The predicted noise level (1990) at the bypass end of Conyngham Lane = 57 dBA (with landscape treatment).

10. Extensive use was made of the British Integrated Program System and the Kent County Council ICL 1905 computer. A ground model of the area of interest along the Bypass was compiled using a 10 metre grid, based on aerial survey data. The programs for horizontal and vertical alignment were used, together with plotting programs for long sections and cross sections. The bulk earthworks quantities were also taken off by computer techniques. Modifications to the output for difficult areas, such as merges and slip roads were carried out by hand.

The second carriageway between Bonny Bush Hill and Black Robin Lane, Barham, was designed without the use of a computer as it was originally an earlier, separate scheme. It was incorporated into the Bypass scheme late in the preparation stage.

The drainage network was designed using the ICL 1900 Storm Sewer Design and Analysis program.

Use was made of other programs at computer bureaux, particularly S.I.A. for many aspects of bridge design.

S E C T I O N I V

GROUND CONDITIONS AND GEOLOGY

1. Following preliminary soils investigations in 1969/1970, a full investigation with emphasis on information for bridge foundations was completed in 1972/1973. The latter programme of investigation included thirteen machine bore-holes of shell and auger type, three hand borings and two trial pits. Disturbed and 105 mm undisturbed samples were taken. 'Standard Penetration' tests were carried out in gravel and chalk. A piezometer was installed in the valley gravel at Patrixbourne Road at a depth of 3.67 m below ground level to observe pore water movement in soliflucted chalk.

Trial pits gave information on CBR and compaction characteristics of head materials.

'Quick Undrained Triaxial' tests and 'Consolidated Undrained Triaxial' tests with pore water pressure measurements were carried out. Cohesion, angle of shearing resistance and densities were obtained for slope stability analysis.

Attenberg Limits and moisture contents were found and oedometer tests were carried out on Head Brickearth and Soliflucted Chalk materials.

California Bearing Ratios for Head materials were also obtained.

The survey was carried out by the Kent County Council Laboratory Staff at an estimated cost of £3,500.

2. Soils encountered consisted of :-

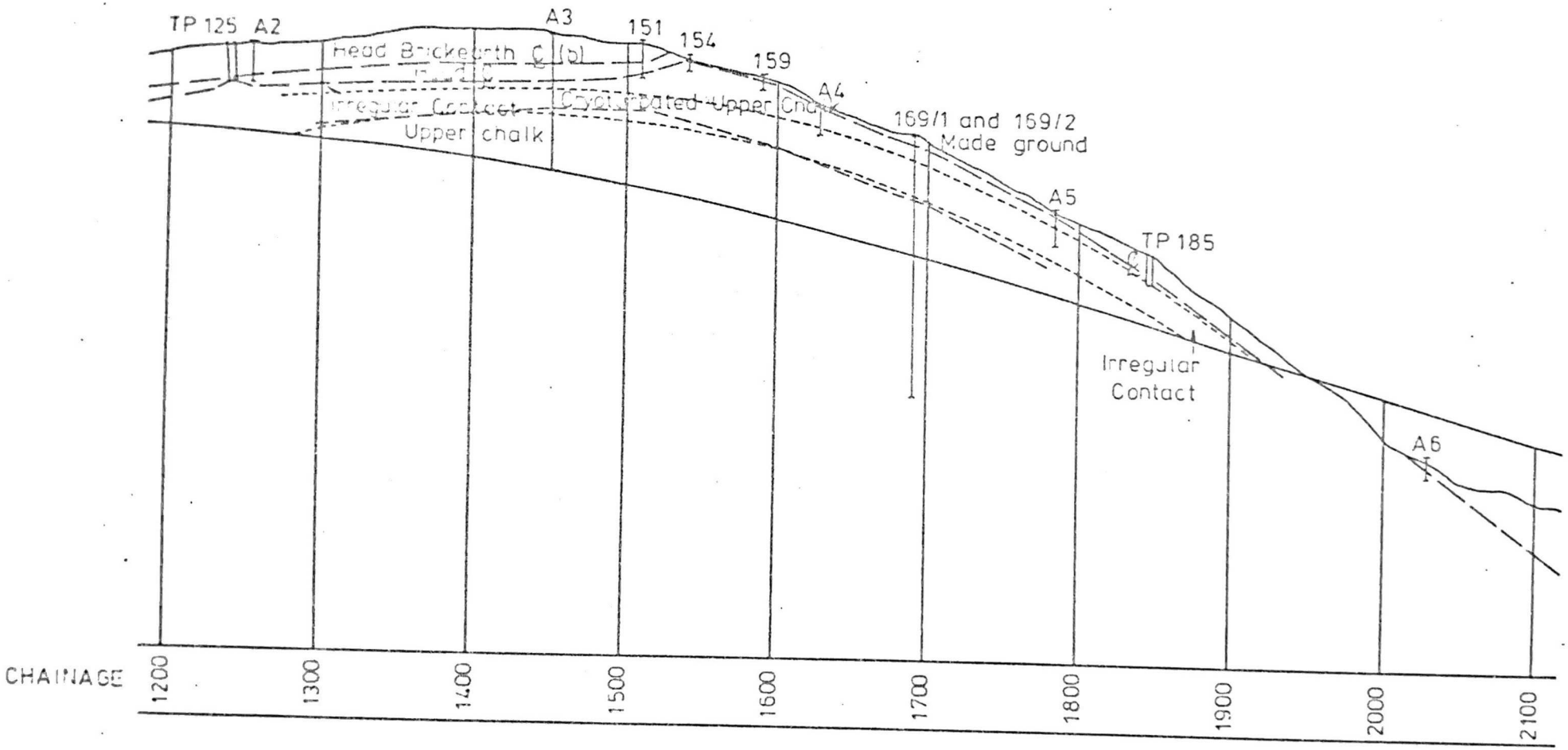
(a) Head Brickearth
(b) Head (Clay with flints)
(c) Cryoturbated Upper Chalk
(d) Upper Chalk
(e) Soliflucted Chalk
(f) Valley Gravel
(g) River Alluvium
(h) Areas of Hillwash

The following three diagrams depict the geology encountered.

GEOLOGICAL LONG SECTION

DIAGRAM 14.

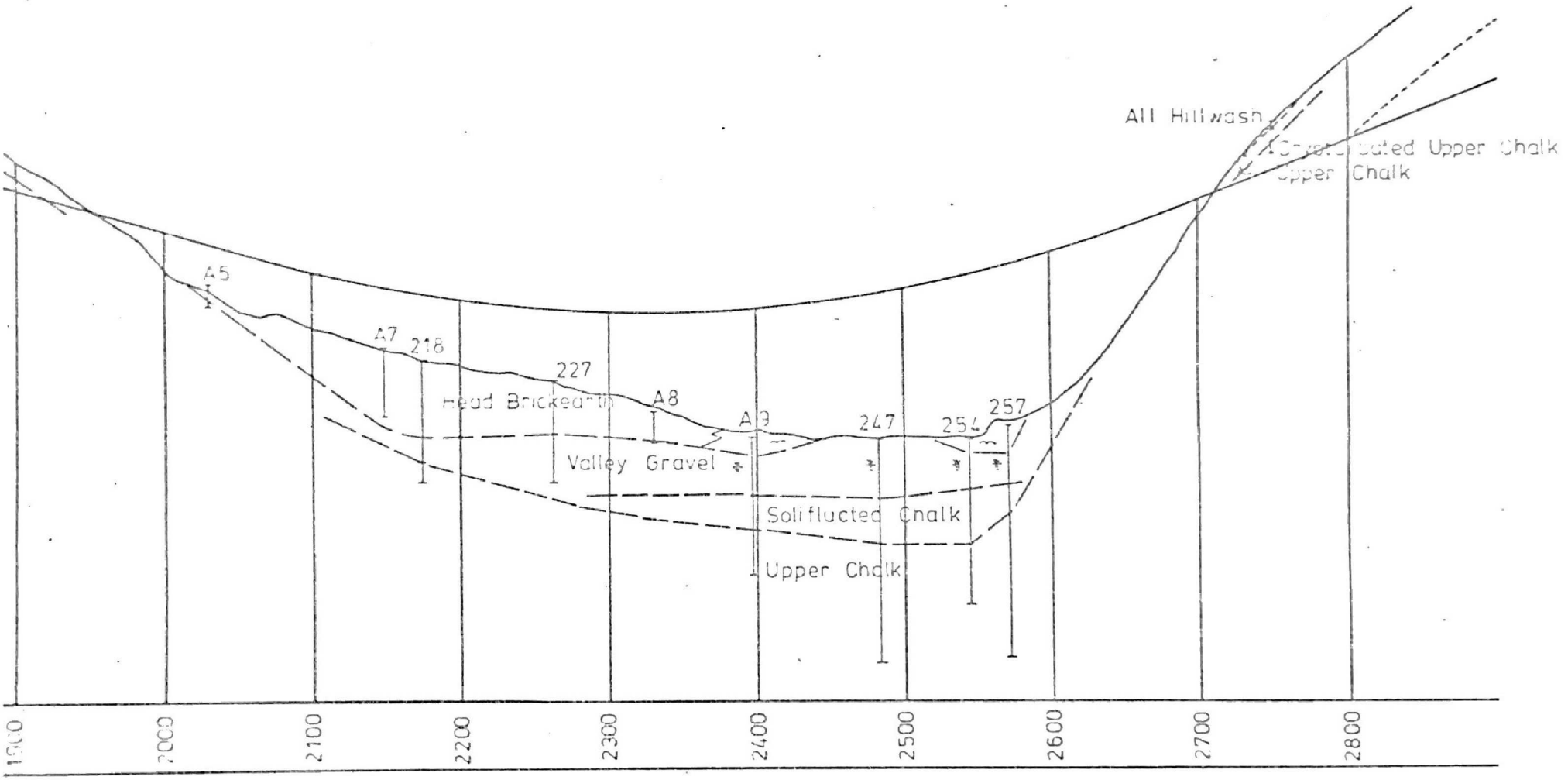
PART I



GEOLOGICAL LONG SECTION

DIAGRAM 15

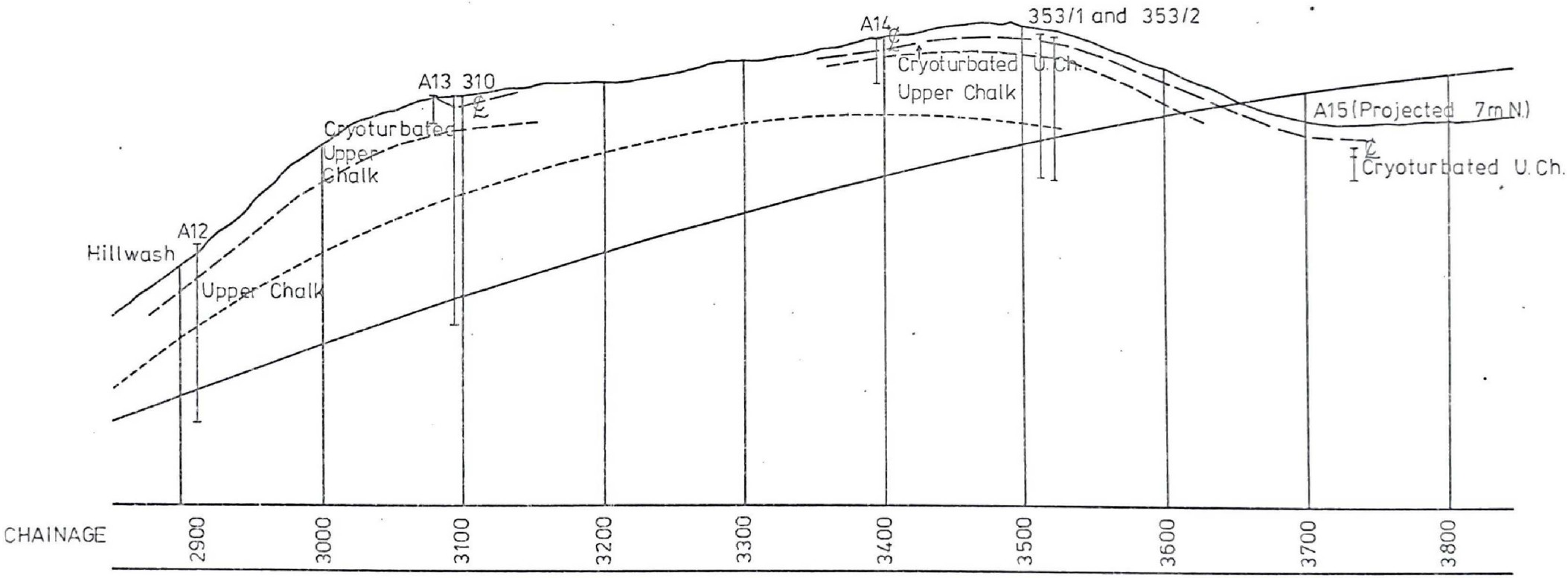
PART II



GEOLOGICAL LONG SECTION

DIAGRAM 16

PART III



3. The Geology :-

The solid formation underlying the entire route is Upper Chalk. The formation is overlain by varying thicknesses of the superficial deposits previously listed. 'Recent Alluvium' is confined to the flood plain of the Nailbourne, a stream which predominantly flows through the 'Valley Gravel' and only shows itself along the river bed when the water level is sufficiently high. The Head Brickearth is confined to two distinct areas, one at the northern end as a capping to the high ground and two, as a deposit in the valley. The Head Material, sensu strictu, underlies the Head Brickearth at the northern end and is found again on the high ground at Bridge Down. Another type of head, namely the soliflucted chalk, lies on the valley floor beneath the gravel. Small irregular deposits of Hillwash overlie the area known as 'Side Hill', which is the north facing slope of the valley. The upper chalk can be described as medium hard to hard white fissured chalk containing occasional bands of flints.

Archaeological Remains

Numerous Saxon graves were investigated by the Canterbury Archaeological Society, together with various other phenomena of interest historically. The findings were in the main, concentrated at the Barham end of the scheme.

S E C T I O N V

CONSTRUCTION DETAILS

The scheme costs are summarised below and are divided into Bypass costs and those for the dualling of the A.2 between Bishopsbourne Road and Black Robin Lane. The estimates are based upon the tender received from Mears Construction Limited on 4th June, 1974.

	BR to BRL £	Bridge £	Total £
1. ROADWORKS			
General items, Site Clearance, etc.	25,728	203,576	229,304
Accommodation Works and Fencing	5,758	98,840	104,598
Drainage	46,091	225,440	271,531
Earthworks	6,898	517,943	524,841
Carriageway Construction and Surfacing	141,415	559,952	701,367
Signs, Crash Barriers	12,145	13,377	25,522
Pedestrian Subways/ Cattle Creep	-	67,745	67,745
	238,035	1,686,873	1,924,908
2. BRIDGEWORKS	-	624,719	624,719
3. CONTRACT TOTALS	238,035	2,311,592	2,549,627

10% has been added to each item to include for contingencies.

The tender received was for a variable price contract related to the Baxter Formulae, in line with the recommendations of the Economic Development Committee for Civil Engineering (May 1971).

Earthworks :

The major earthworks quantities are as follows:-

Total excavation of suitable material	478,000 m^3
" " " unsuitable "	106,000 m^3
Total Fill required for structural embankment	305,000 m^3
" " " " landscaping	279,000 m^3

Landscape requirements were to some degree relatively flexible and an earthworks balance was achieved.

No fill material was imported, and free draining material for use under the embankments was obtained from the valley gravel.

The landscape area was stripped firstly to a depth of 150 mm (called the top soil strip) and secondly, to a further depth of 350 mm (called the sub-soil strip), where possible. The material thus accrued was stored for replacement over the landscape fill.

The cut slopes at Bekesbourne Road give a rounded appearance. The strata order is Head, Cryoturbated Chalk, and Upper Chalk for which cut slopes of 1 upon $2\frac{1}{2}$, 1 upon $1\frac{1}{2}$ and 1 upon 1 were used.

The cut slopes at Bridge Down were based upon two layers of material, Cryoturbated Upper Chalk and Firm Upper Chalk, for which cut slopes of 1 upon $1\frac{1}{2}$ and $1\frac{1}{2}$ upon 1 were used. A 3 metre wide berm separates these two cut slopes and acts as an arresting platform for possible falling scree.

For the excavation of chalk the standard Department of the Environment specification was modified by Kent County Council's method specification. This proved highly successful beacuse chalk earthworks progressed in adverse wet conditions. Briefly the specification requires the use of face shovels and trucks for the excavation and transportation of chalk, so that the chalk structure is disturbed as little as possible. The rocky chalk fill layer is placed 500 mm thick and compacted by three passes of a dead weight roller (2.6 - 5.2 kN/100 mm width of roll). (Finer chalk is placed as per standard specification). From previous experience it has been found that scraper and vibratory compaction equipment can apply too much work to the chalk structure, resulting in break down of chalk structure and increased putification.

Sections of these cuttings have been given in Diagrams 7 and 8.

Drainage :

The dished central reservation is drained by a french drain, as are the dished verges in cutting. On the main embankment, run off from the verges is allowed to pass over the embankment and is collected at the toe either in a french drain or a ditch, as appropriate. Run off from the metalled carriageway is collected in a positive drainage system, consisting of a continuous dished channel with gullies.

On the high ground where the carriageway gradients are slacker, there is no positive drainage and 1 metre hardened strip is constructed on the low side.

As mentioned before, use was made of the ICL 1900 drainage program and the system is designed against a one year storm.

The cost of constructing soakaways of differing sizes was compared with the mounting cost of consecutively larger diameter drainage pipes, discharging into each soakaway, in order to optimise the spacing of soakaways. Thirteen soakaways were needed, each approximately 8 metres deep. In addition, the central area of the Bypass discharges into the Nailbourne. At the request of the Kent River Authority, oil-traps were built at all soakaways and the Nailbourne, to avoid pollution of the water-bearing strata.

The drainage was designed for uPVC pipes and again for concrete pipes. These two alternatives were billed separately and the choice of construction was offered to the tenderers. The uPVC design was marginally cheaper and therefore adopted for the construction of the drainage systems.

Carriageway Construction :

Flexible, rigid and composite pavements were designed so that a total of six different pavement designs were optional in the bill. These are summarised on the diagram overleaf. The construction utilising a lean mix base was adopted as it was the cheapest solution.

Flexible or composite pavement designs only were considered for side road construction. Machine laid concrete pavement was not considered on grounds of economy and discontinuity of construction. The existing side roads are flexible and are thus compatible with this decision. Again lean mix base carriageways were chosen for economy.

For the concrete/flexible/composite alternatives, the area of carriageway was 47,000 m^2. Unavoidable main road flexible/composite construction amounted to 34,000 m^2. Side Road flexible/composite construction amounted to 13,000 m^2.

Construction Programme :

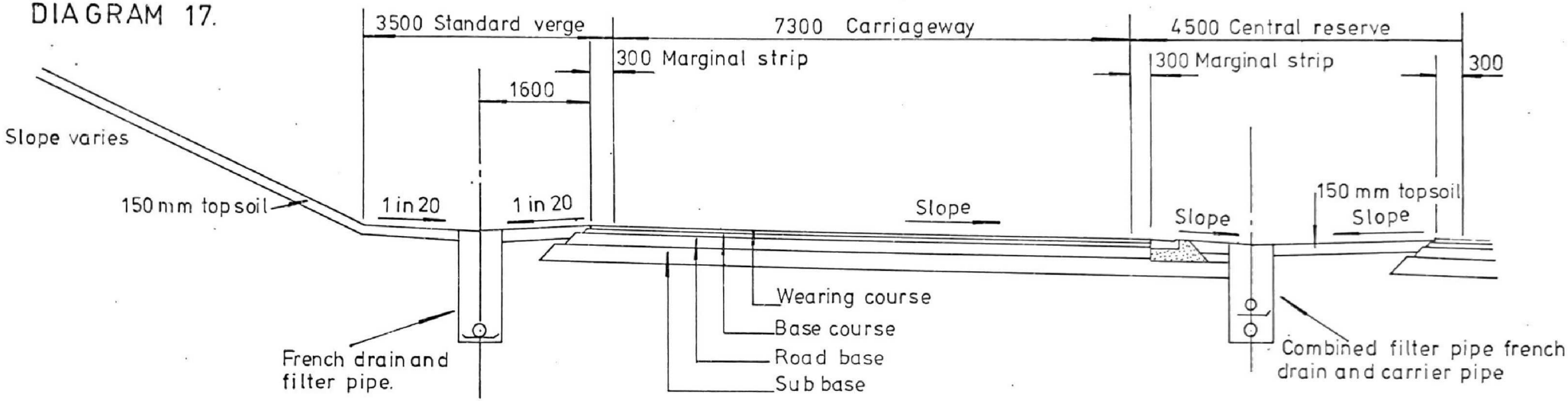
The key areas for early activity were near Bekesbourne Bridge and Highland Court Bridge, for which diversions were needed. The ensuing earthworks then released bridgeworks activity and a further diversion over the Doverbound carriageway at the Canterbury end of the scheme allowed early advancement of remaining earthworks at Bekesbourne Bridge. The Construction of Patrixbourne Bridge became closely associated in programme with the Highland Court Bridge due to the fact that the final earthworks activity, dependant on finishing Highland Court Bridge was used to complete the earthworks around Patrixbourne Bridge.

There were very few minor alterations to design detail during construction and drainage, formation, sub-base, lean mix and surfacing activities followed each other with very little delay.

STANDARD DETAIL FOR 7·9 METRE CONSTRUCTION IN FLEXIBLE OR COMPOSITE MATERIALS

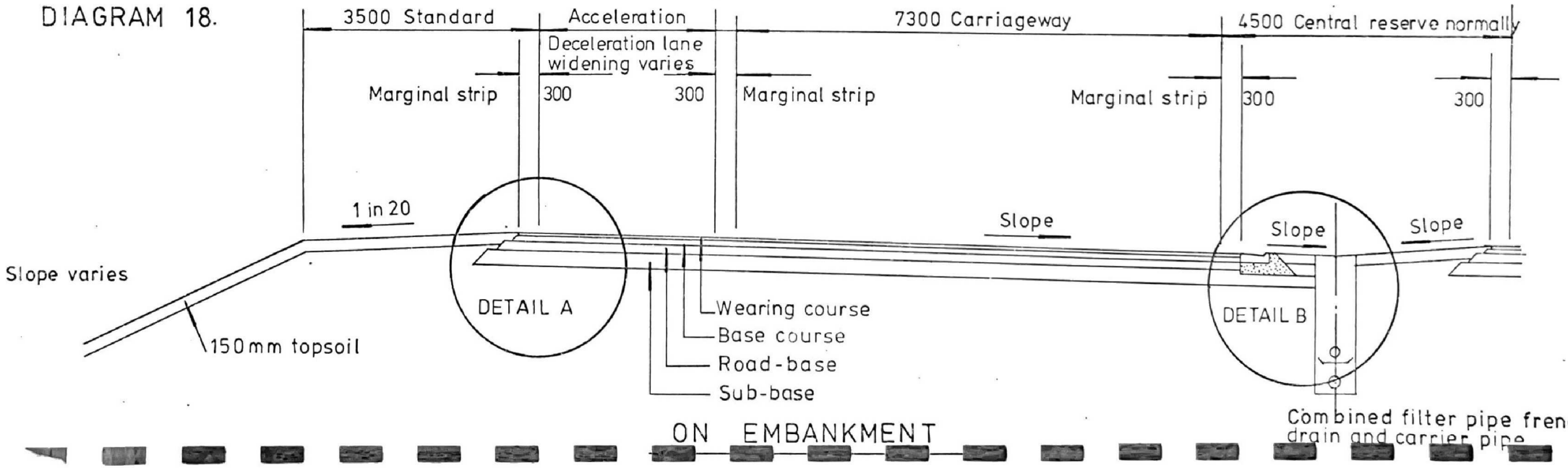
(8.6 Metre construction is similar except one 300 mm marginal strip is widened to 1000 m) as shown for concrete construction)

DIAGRAM 17.



IN CUTTING

DIAGRAM 18.

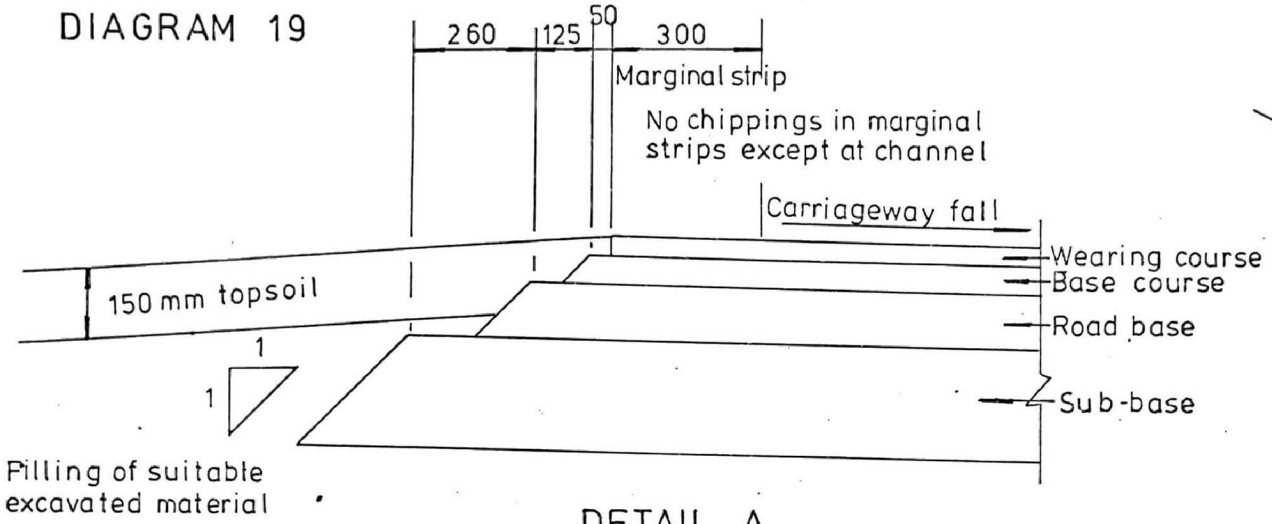


ON EMBANKMENT

STANDARD DETAIL FOR 7·9 METRE CONSTRUCTION IN FLEXIBLE OR COMPOSITE MATERIALS

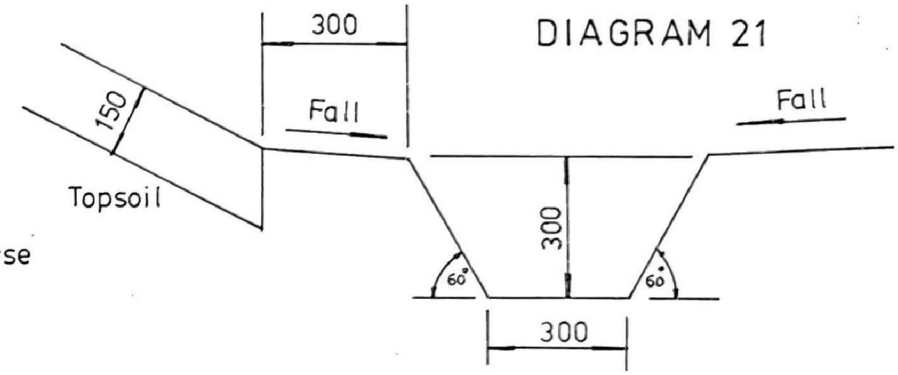
(8·6 Metre construction is similar except one 300 mm marginal strip is widened to 1000 m) as shown for concrete construction

DIAGRAM 19



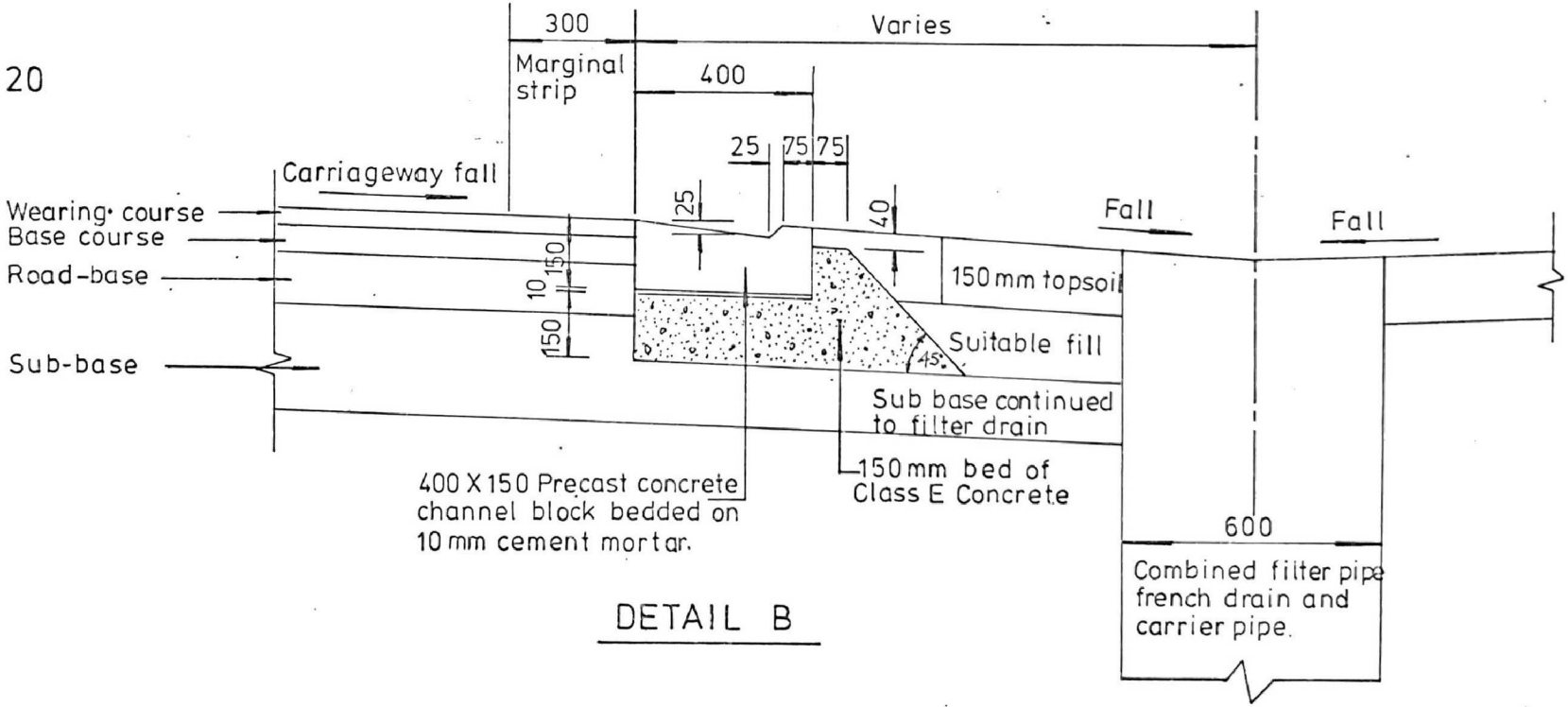
DETAIL A

DIAGRAM 21



TYPICAL DITCH DETAIL

DIAGRAM 20



DETAIL B

FLEXIBLE AND COMPOSITE PAVING ALTERNATIVE DESIGNS

DIAGRAM 22

(Note for this scheme the Lean Concrete Road Base Design was adopted)

CONSTRUCTION THICKNESS TYPES OF ROADBASE					
	FLEXIBLE PAVEMENT (Table 8.S.) (Group P)		COMPOSITE PAVEMENT (Table 8.S. Group P)		
	ROLLED ASPHALT	DENSE TARMACADAM DENSE BITUMAN MACADAM	LEAN CONCRETE	WET MIX MACADAM	DRY BOUND MACADAM
WEARING COURSE (Table 21c, Group W)	40	40	40	40	40
BASE COURSE (Table 21c, Group W)	60	60	75	75	75
ROADBASE (As indicated)	115	135	190	210	210
SUB-BASE (Chalk CBR >30) (Table TS. Group L) (Standard thickness)	235	215	145	125	125
ADDITIONAL SUB BASE (Head) (Table T.S. Group Subgrade CBR ≤2%	305	325	385	405	405
ALTERNATIVE TO ADDITIONAL SUB-BASE	1 METRE OF CHALK FILL OVER LOWERED HEAD-SUB BASE				
TOTAL CONSTRUCTION THICKNESS ON CHALK	450	450	450	450	450
TOTAL CONSTRUCTION THICKNESS ON HEAD	755	775	835	855	855
OR WITH ALTERNATIVE	1.450 METRES IF CHALK OVERLAY IS USED				

NOTE.
Rolled Asphalt Wearing Course shall be as described in Table 21A and Clause 907S and in addition shall conform to Table 7, Schedule 1 using rock types 1 to 7, or Table 9 Schedule 9 of B.S. 594 (1962).

CONCRETE PAVING ATTERNATIVE DESIGN (Not adopted)

DIAGRAM 23.

CONCRETE SLAB CONSTRUCTION

LONGITUDINAL JOINTS

At ℄ concrete slab (reinforced or unreinforced)

UNREINFORCED SLABS

TRANSVERSE JOINT SPACING

Expansion joints at 60 m max. (72 m if limestone aggregate is used throughout.)
Intermediate contraction joints at 5m. (6m if limestone aggregate is used throughout.)
Warping joints may replace not more than 3 contraction joints in succession except where dowel bar placers used.

REINFORCED SLAB

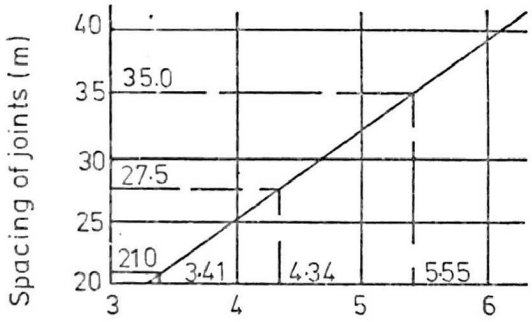
REINFORCEMENT

Mesh: min 3.9 kg/m².
Bar : min 450 mm²/m.
Cover : 60 m m from top of slab.

TRANSVERSE JOINTS

Every 3rd joint to be an expansion joint remainder to be contraction joints.

RELATION OF REINFOREMENT WEIGHT AND JOINT SPACING



[Extract from Road Note 29. 3rd Edition figure 13]

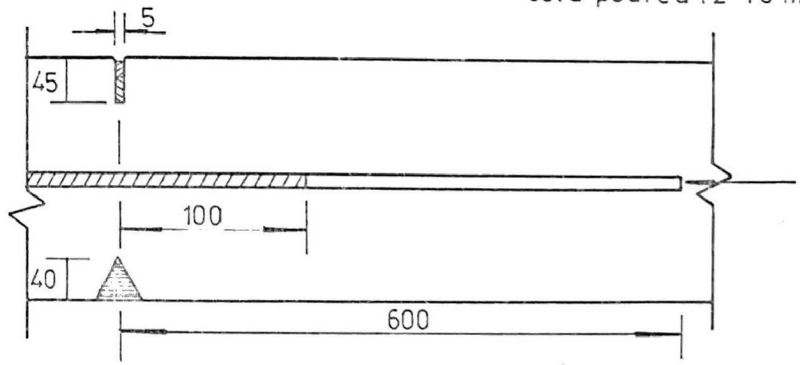
DIAGRAM 24.

CONSTRUCTION THICKNESS	CHALK	
	Subgade CBR 15%	Subgrade CBR 2 15%
CONCRETE SLAB REINFORCED OR UNREINFORCED	220	240
SUB BASE (Table 7S Group N) STANDARD THICKNESS	0	80
ADDITIONAL SUB BASE CHALK (Table 7S Group N) (Frost susceptible subgrade)	230	130
TOTAL CONSTRUCTION THICKNESS (Frost susceptible subgrade)	450	450

DIAGRAM 25.

WARPING JOINTS

Sealant depth: hot poured 15 20 mm
cold poured 12 15 m m



STANDARD DETAIL FOR 8.6 METRE CONCRETE CONSTRUCTION (not adopted)

(7.9 metre construction is similar as shown for flexible / composite construction, Diagrams 17. & 18.)

DIAGRAM 26.

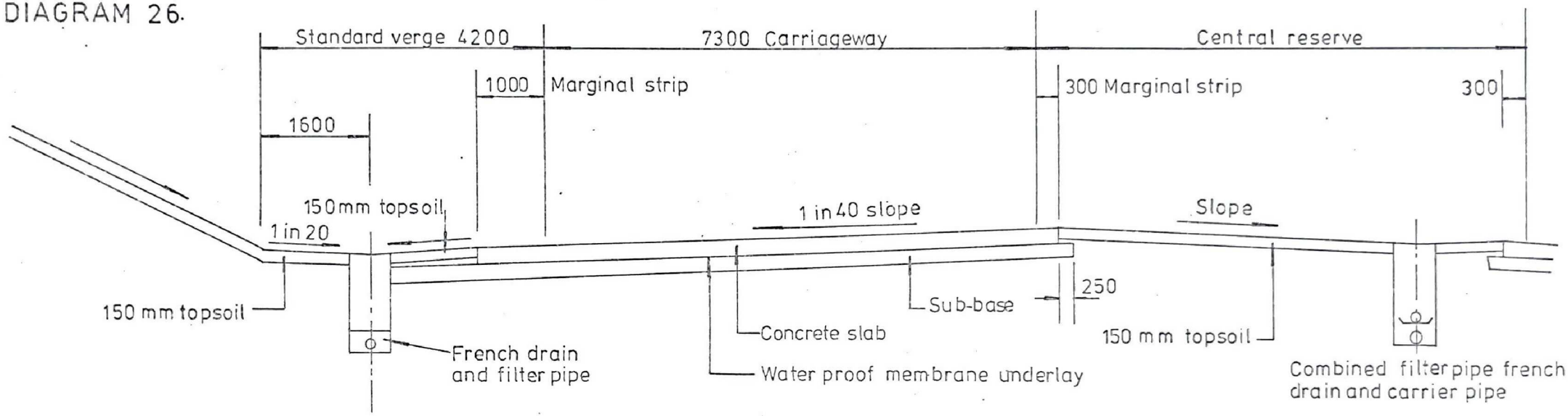
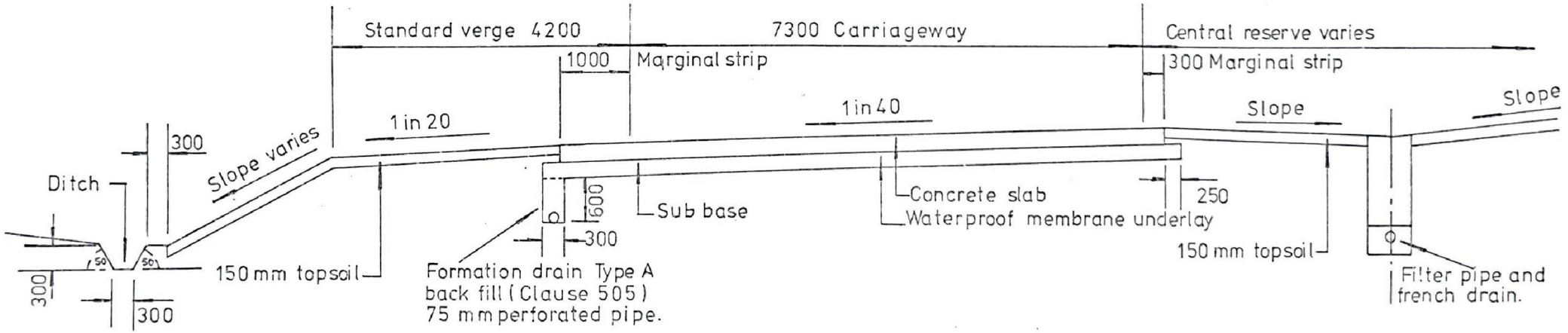


DIAGRAM 27.

IN CUTTING DOVER BOUND CARRIAGEWAY



ON EMBANKMENT DOVER BOUND CARRIAGEWAY

S E C T I O N V I

PUBLIC UTILITIES AND BODIES'

Enquiries were sent out to the following public bodies and services for their observations and no objections were received:-

(1) The South Eastern Gas Board

(2) The South Eastern Electricity Board

(3) The Thanet Water Board) Now Combined as
) Southern Water Authority
(4) The Kent River Authority)

(5) The Post Office Telephones

(6) The Central Electricity Generating Board

(7) The Ministry of Agriculture, Fisheries & Food

(8) Bridge Blean District Council
(now Canterbury District Council)

(9) Kent County Constabulary

(10) Kent County Council, Planning Department

The cost of modifying the Statutory Undertakers plant was £90,000 approximately, made up of £68,000 for the Bypass section and £22,000 for the dualling scheme.

No extraordinary or difficult works were undertaken under this heading.

S E C T I O N V I I

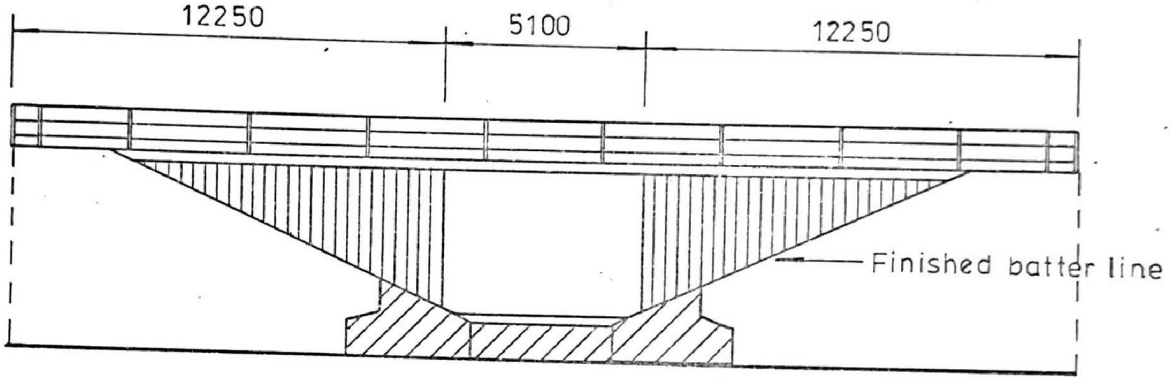
BRIDGES

Bekesbourne Road Overbridge is a single span bridge with a cast in situ post-tensioned concrete deck of constant cross-section. The reinforced concrete abutments and wing walls are on spread foundations. The deck is simply supported and free to move longitudinally one end, but is restrained transversely by side restraint bearings, whereas at the other end it is restrained from movement both longitudinally and transversely by mortice and tenon joints between the underside of the deck and the top of the abutment beam seat. The deck is free to rotate at both abutments. The concrete face on the abutments is "as struck" without featuring - whereas wing walls have a feature formed by implanting rectangular shapes of 20 mm plywood on the formwork. Each abutment is inclined towards the deck both to improve the visibility around the Bypass curve and to achieve a better structural balance between the abutments and wing walls. The other solutions considered were firstly, a four span bridge with a reinforced concrete simply supported deck on leaf columns and end bank seats with spread foundations to the sub-structure and secondly, a three span continuous post-tensioned deck on similar sub-structure. Both solutions reduce the visibility on the Bypass and the latter has a more complicated deck articulation leading to a more costly design.

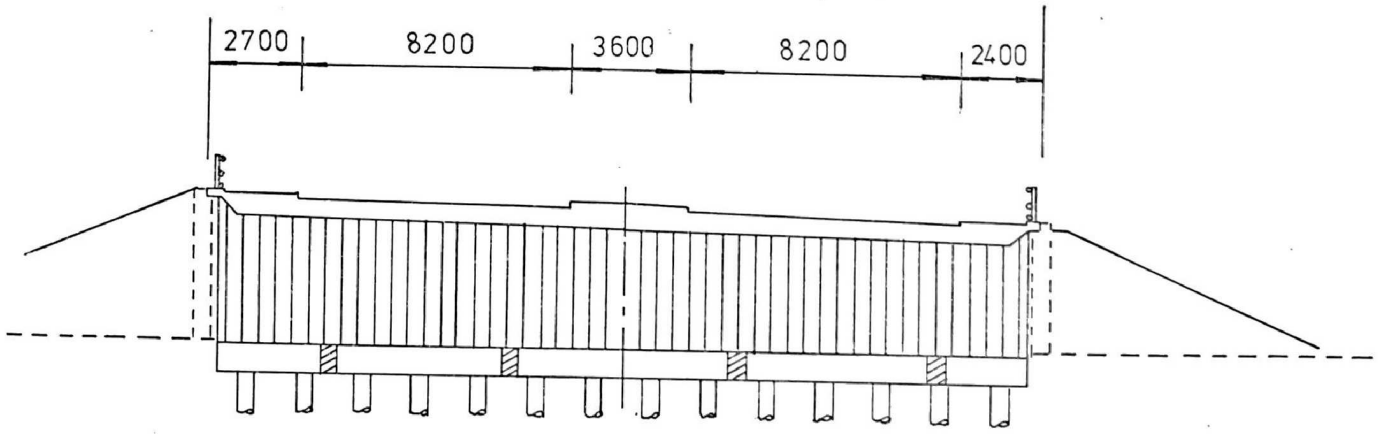
Bifron's Park Subway is a single span bridge with a cast in situ reinforced concrete deck on mass concrete abutments. The abutments and wing walls are on piled foundations. The abutments are designed as propped cantilevers with the deck providing the prop reaction, thus backfilling of the abutments cannot take place until the deck has been cast and the concrete has attained the required strength. The foundations are piled because of the low bearing capacity of the sub-soil. Reinforced concrete cast in situ ground beams are used as struts between the abutment foundations to prevent a rotational failure of the abutments. Vertical groove featuring is employed on the faces of the abutments and wing walls. The headroom clearance of 3.2 m was agreed with both the landowner and the tenant farmer for whom the subway is being provided. The other solutions considered were firstly, an Armco subway and secondly, a simply supported reinforced concrete deck on combined reinforced concrete abutments and base slab. The first was eliminated because of the small construction depth available and the second considered to be marginally more costly.

BIFRON'S PARK SUBWAY

DIAGRAM 28.

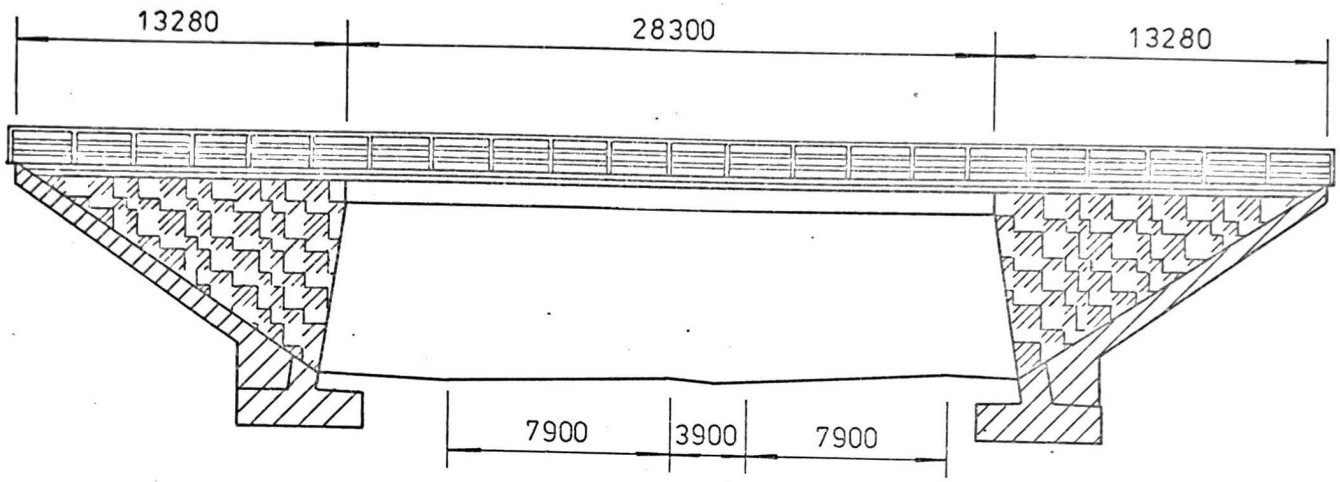


SECTION ELEVATION

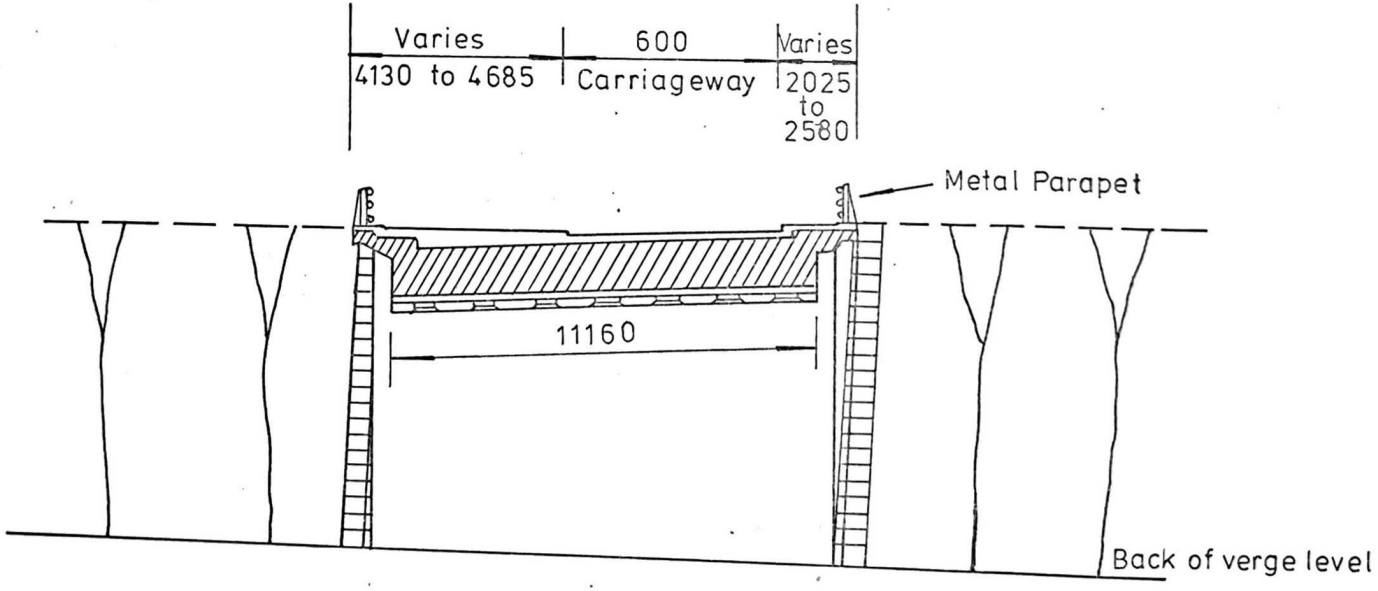


ELEVATION ON EAST ABUTMENT

BEKESBOURNE ROAD BRIDGE DIAGRAM 29.



SECTIONAL ELEVATION



ELEVATION OF EAST ABUTMENT

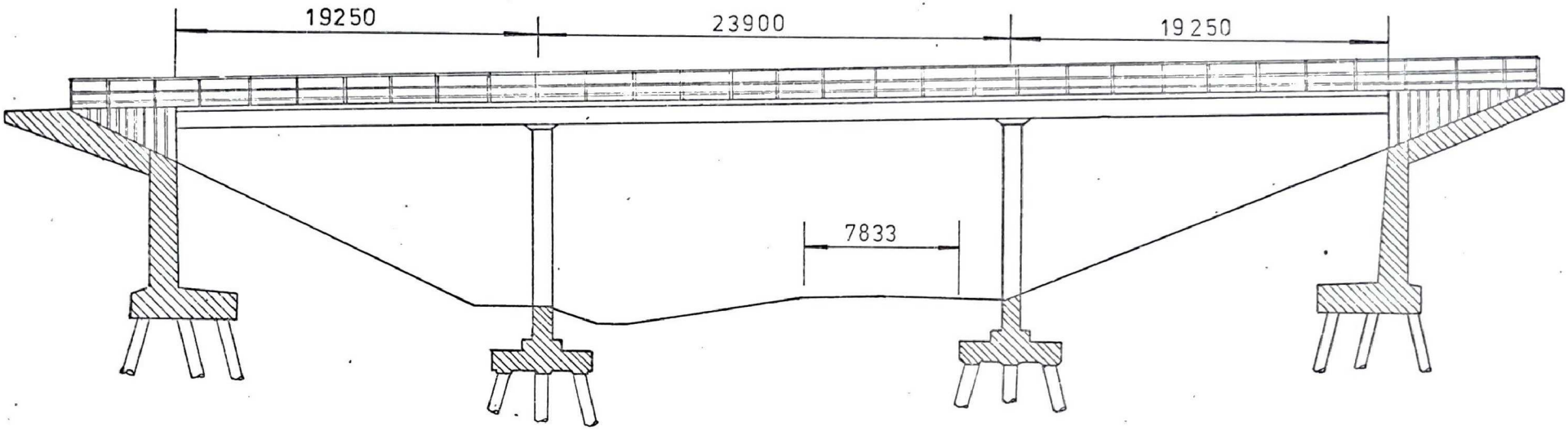
Patrixbourne Road Underbridge is a three span bridge in which each deck span is simply supported and consists of precast, pretensioned concrete 'M' beams and in situ slab. The deck spans are supported on piled reinforced concrete lintels and columns and on piled cantilever abutments. The deck is restrained from movement both longitudinally and transversely at the column lintels and at the north abutment by dowel bars through the bearings. At the south abutment PTFE sliding bearings allow longitudinal movement but transverse movement is prevented by side restraint bearings. Rotation is allowed at all joints. The intermediate supports including the lintel beams are designed to resist all forces resulting from restraint to thermal movement and flexure of the columns. Piled foundations are used to avoid the high settlements which would result with spread foundations. The concrete finish to the abutment walls and columns is "as struck" and vertical groove featuring is used on the wing walls. The alternative solution of an in situ reinforced concrete deck with all spans simply supported on similar sub-structure was considered to be more costly and the chosen solution was selected both on the basis of economy and ease of construction over a river.

Highland Court Accommodation Bridge is a three span bridge with a continuous cast in situ post-tensioned deck on reinforced concrete abutments and piers with spread foundations. The deck is restrained from movement both longitudinally and transversely at one end by a reinforced concrete mortice and tenon joint between the underside of the deck and the abutment beam seat. At the other end a side restraint bearing allows longitudinal movement only. Sliding bearings on the columns allow both longitudinal and transverse movement. The deck is free to rotate at all supports. The columns are free standing, encastre with their foundations. A plain "as struck" finish is used for all concrete faces. For accommodation reasons the height of the parapet railing is increased to 1.8 m by modifying the standard P2 posts and the parapet posts and connections are designed to resist the higher wind forces generated by the additional wind resistance. The other solutions considered were firstly, a single 40 m span, post-tensioned deck of varying section and secondly a four span continuous deck in reinforced concrete. The first was found to be too costly, the second was considered to be about the same cost as the chosen solution, but was rejected in favour of the three span solution which was felt to be safer.

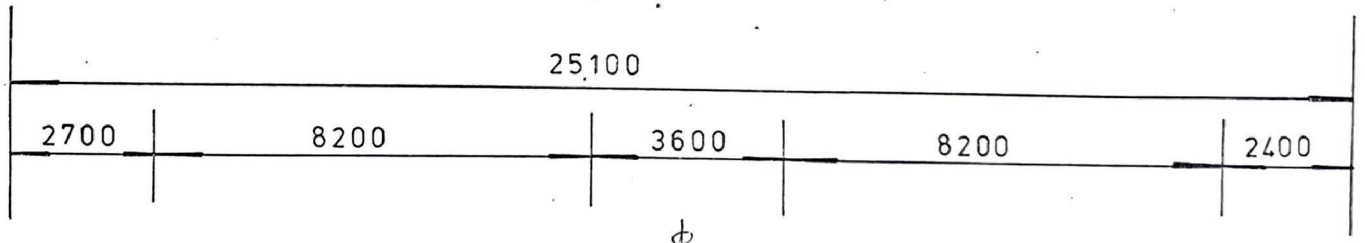
Coldharbour Lane Underbridge is a single span bridge with a reinforced concrete deck of constant cross-section on reinforced concrete abutments. The abutments and wing walls are on spread foundations. At one end the simply supported deck is free to move longitudinally, but prevented from transverse movement by side restraint bearings. At the other end the deck is restrained from movement both longitudinally and transversely by mortice and tenon joints between the underside of the deck and the top of the beam seat. Rotation is permitted at both ends. The abutment face has a plain concrete "as struck" finish whereas the wing walls have a feature formed by implanting a pattern of rectangular shapes of 20 mm plywood on the formwork. The alternative solution considered was a three span bridge with a simply supported reinforced concrete deck on leaf columns with end bank seats, but this was considered to be more costly.

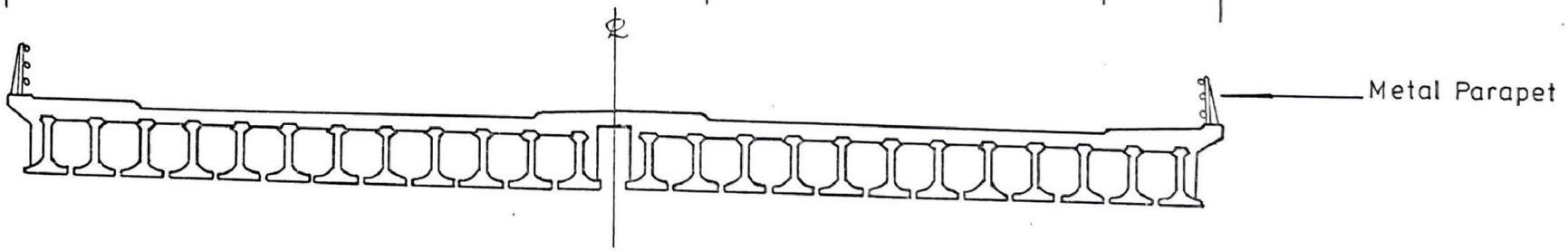
PATRIXBOURNE ROAD BRIDGE

DIAGRAM 30.



SECTIONAL ELEVATION

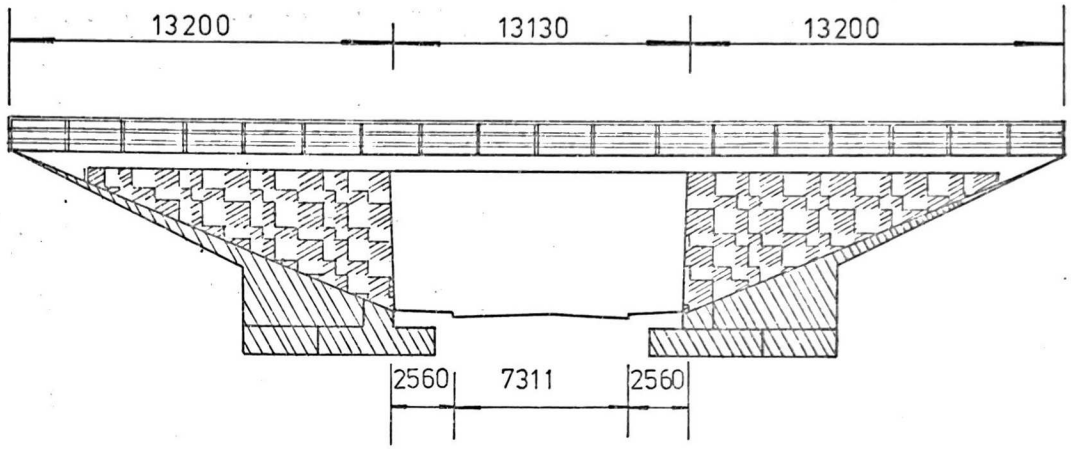




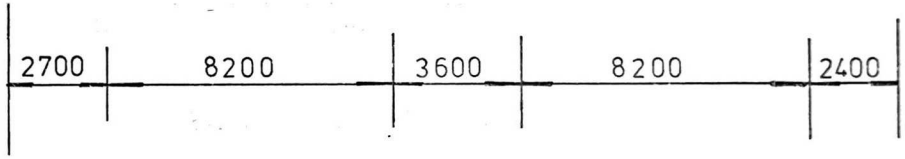
CROSS SECTION

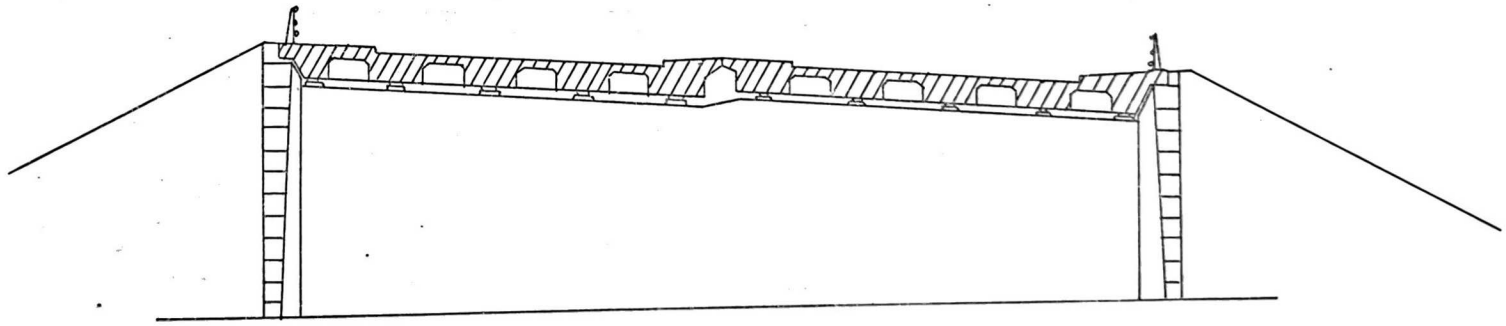
COLDHARBOUR LANE BRIDGE

DIAGRAM 31.



SECTIONAL ELEVATION

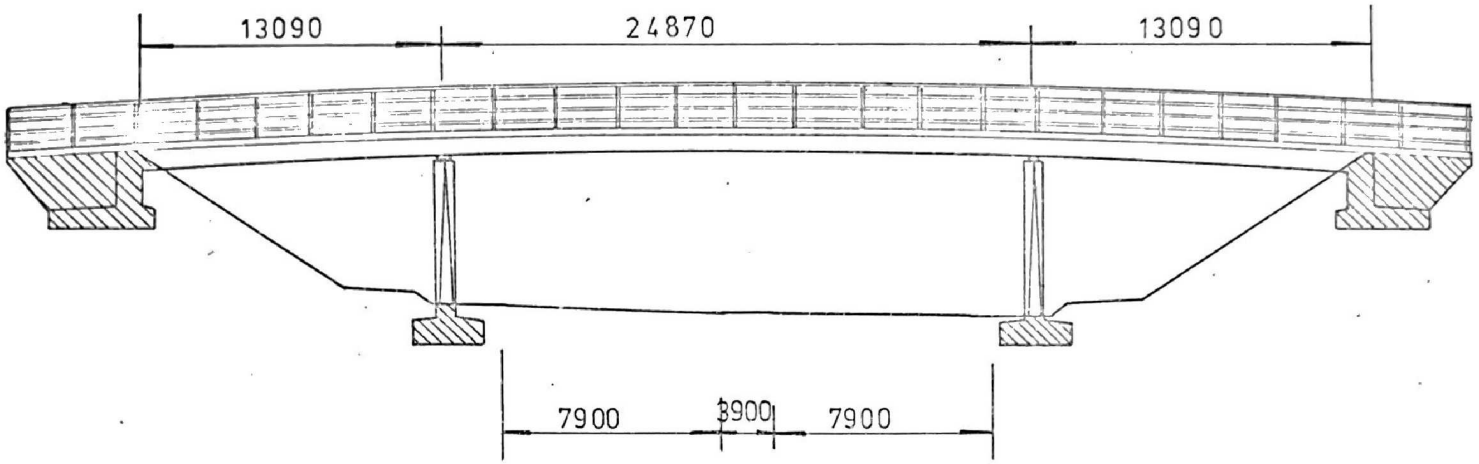




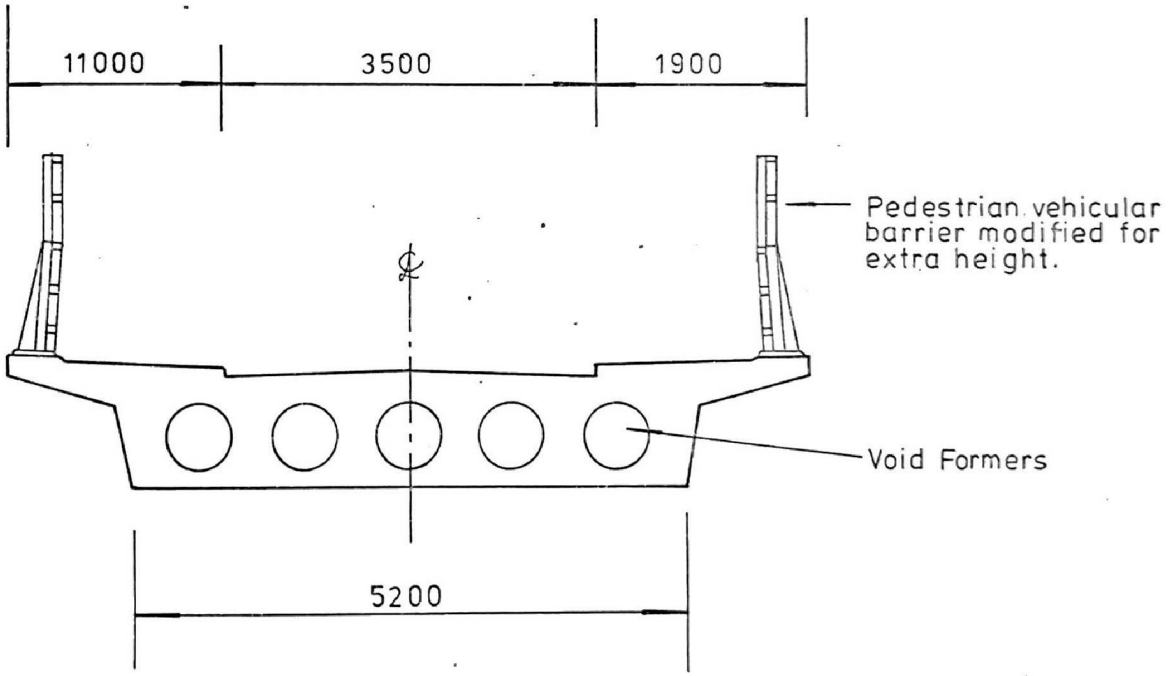
ELEVATION OF WEST ABUTMENT

HIGHLAND COURT ACCOMODATION BRIDGE

DIAGRAM 32.



SECTIONAL ELEVATION



TYPICAL CROSS SECTION

Materials Used

Driven, cast in situ piling	2563 lin.m.
In situ concrete	5320 cu.m.
Steel reinforcement	600 tonne
Prestressing steel (stressed in situ)	28 tonne
Precast concrete pretensioned beams	72 No.
Rubber bearing pads	84 No.
Vehicle parapet railing (aluminium)	531 lin.m.

S E C T I O N V I I I

HIGHWAY SERVICES

No special highway services are incorporated into the scheme.

The majority of signs are reflective, the remainder, in particular locations being lit.

APPENDICES

I Main Contractor

a) Mears Construction Ltd., Sydenham, London

b) Contract start date : 27th August, 1974.

c) Contract completion date : 26th August, 1976.

d) Length 3.8 km of dual carriageway
1.8 km of single carriageway (dualling alongside existing A.2)

e) Variable Price tender sum £2,325,028
(concrete alternative .....£2,478,068)

f) Tender Date : 4th June, 1974.

Principal Sub-Contractors

a) Blackwell's (Earthmovers), Earls Colne, Essex

b) Frankipile Ltd.

c) Anglian Building Products Ltd.

d) P.S.C. Equipment Ltd.

e) E.J.Ellis & Co. Ltd. (Paving)

A P P E N D I C E S

II Progress Photographs

These were taken at six weekly intervals at key positions throughout the site. A selection of these is included in order to show the nature of the scheme, the plant used and methods of construction

APPENDICES

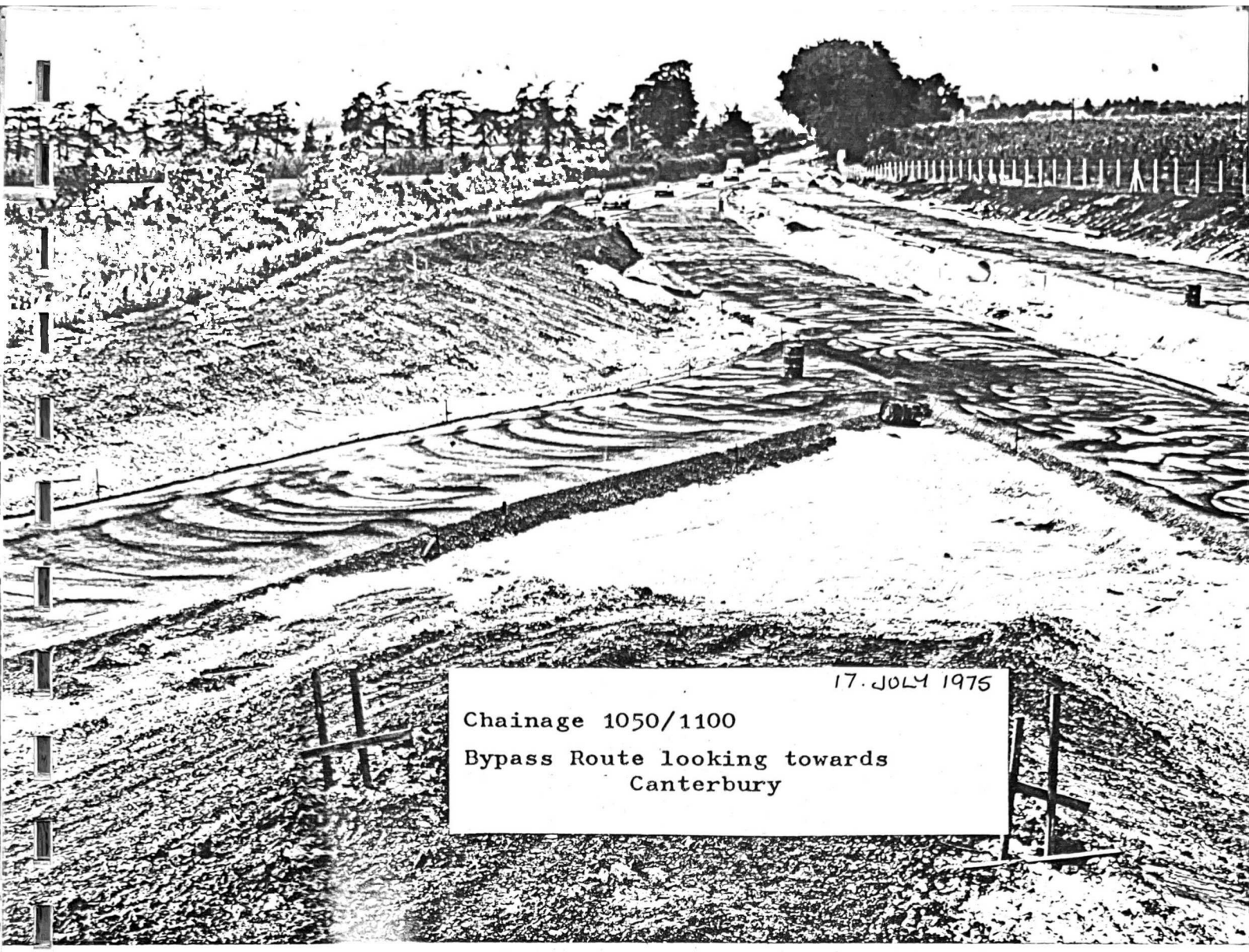
III Major Accommodation Works

At the Canterbury end of the scheme, the route crossed over a major farm artery between the A.2 and Hode Farm. A new track was constructed off Bekesbourne Road, 3 metres wide and 550 metres long.

At the Bishopsbourne end of the Bypass, the route eliminated a private track between the A.2 and Highland Court Farm Cold Storage Depot. New internal farm roads were constructed to enable this traffic to be re-routed from Coldharbour Lane and consisted of approximately 250 metres of new 5 metres wide roadway and 200 metres of widened existing roadway.

PHOTOGRAPHS ILLUSTRATING

CONSTRUCTION OF THE SCHEME



17. JULY 1975

Chainage 1050/1100

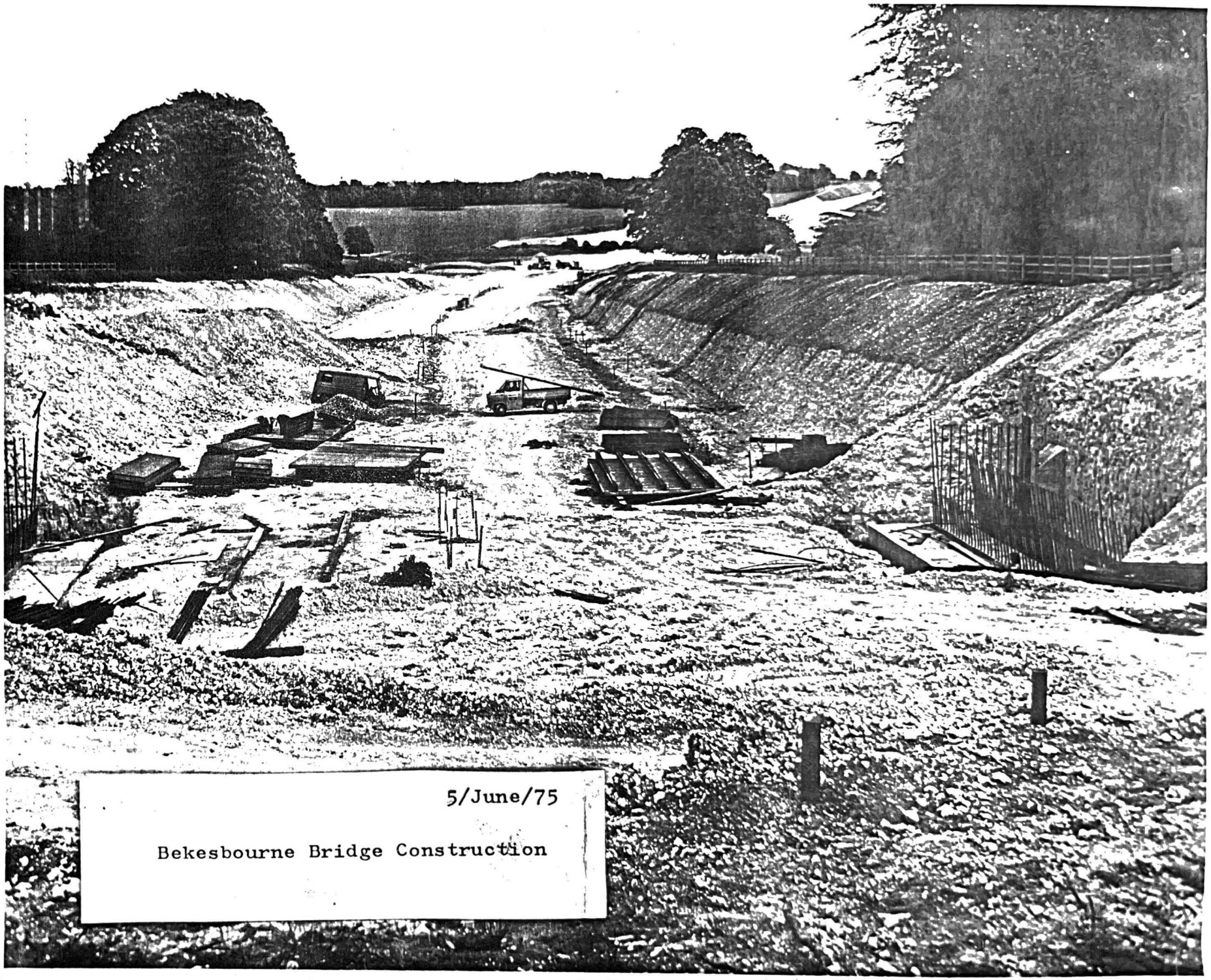
Bypass Route looking towards Canterbury



5. SEPT. 1975

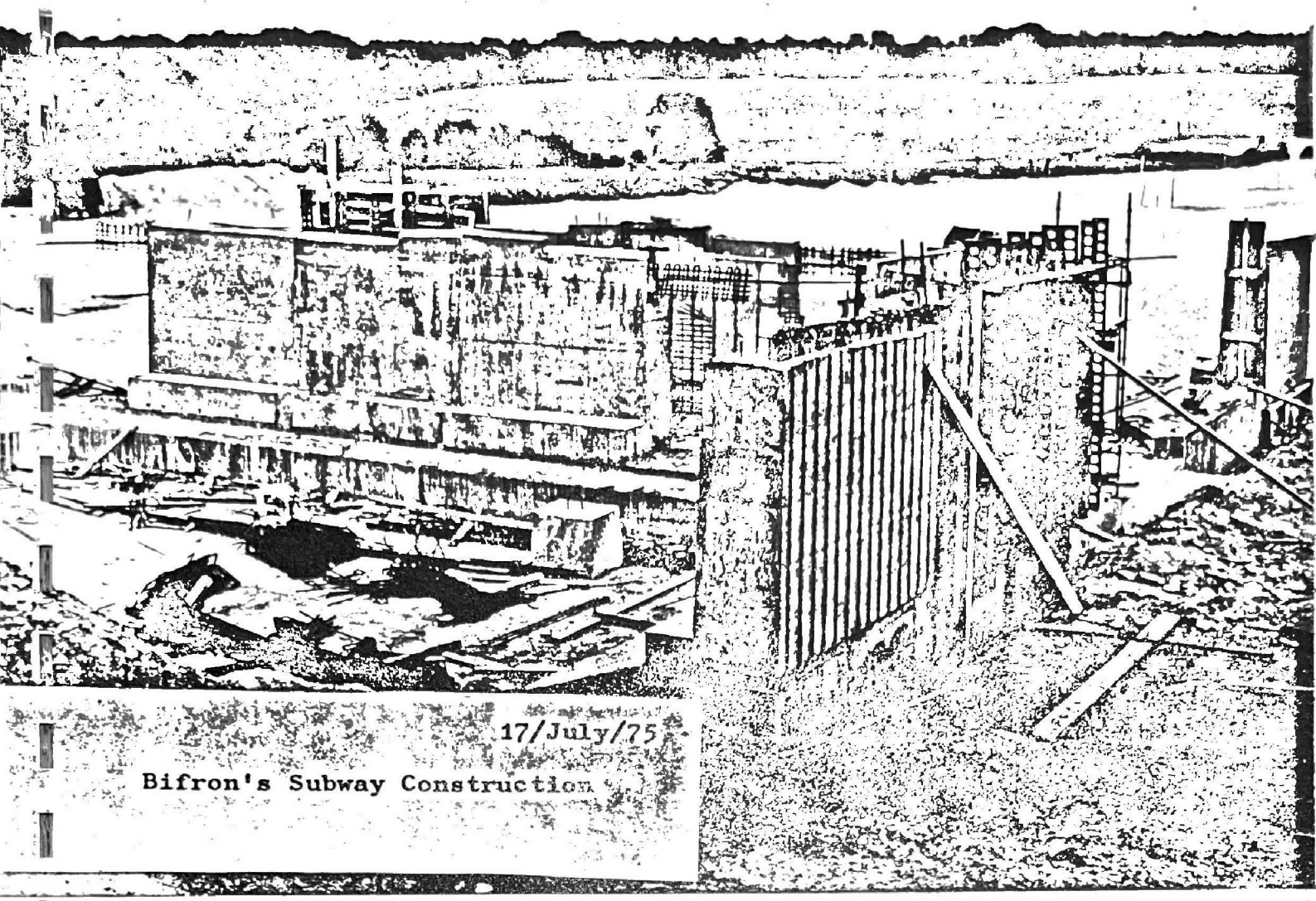
Chainage 1050/1100

Bypass Route looking towards Canterbury



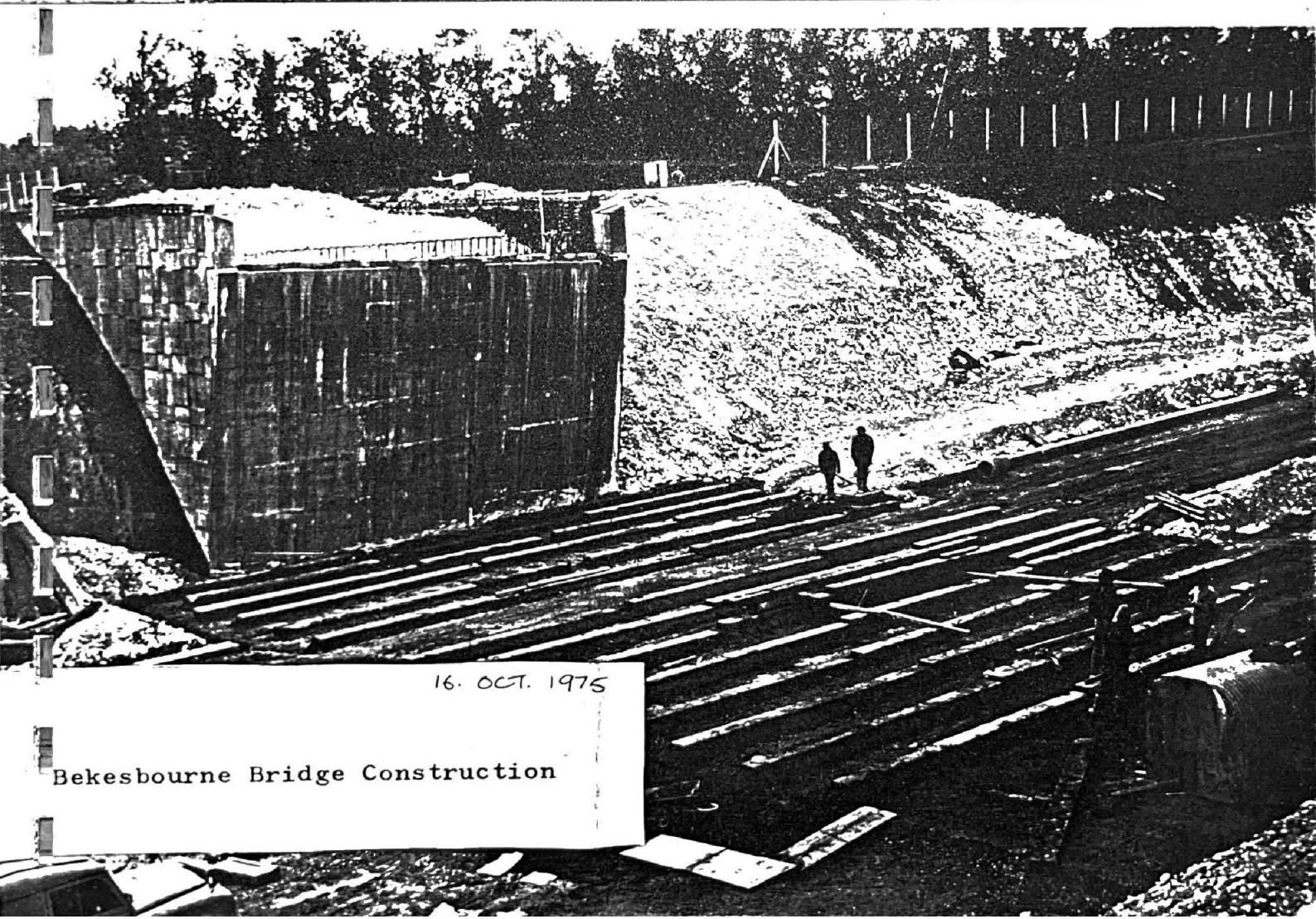
5/June/75

Bekesbourne Bridge Construction



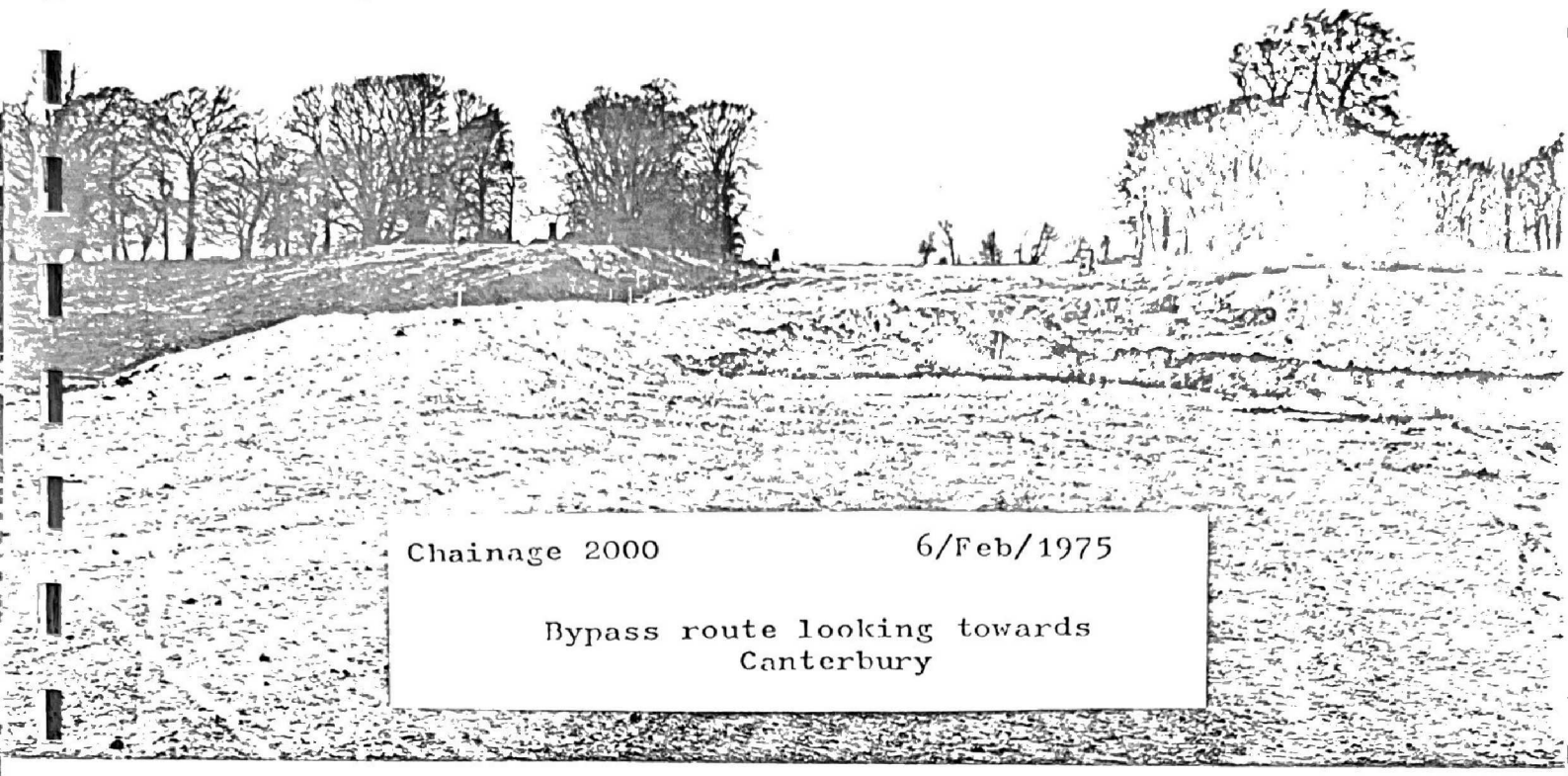
17/July/75

Bifron's Subway Construction



16. OCT. 1975

Bekesbourne Bridge Construction



Chainage 2000 6/Feb/1975

Bypass route looking towards Canterbury

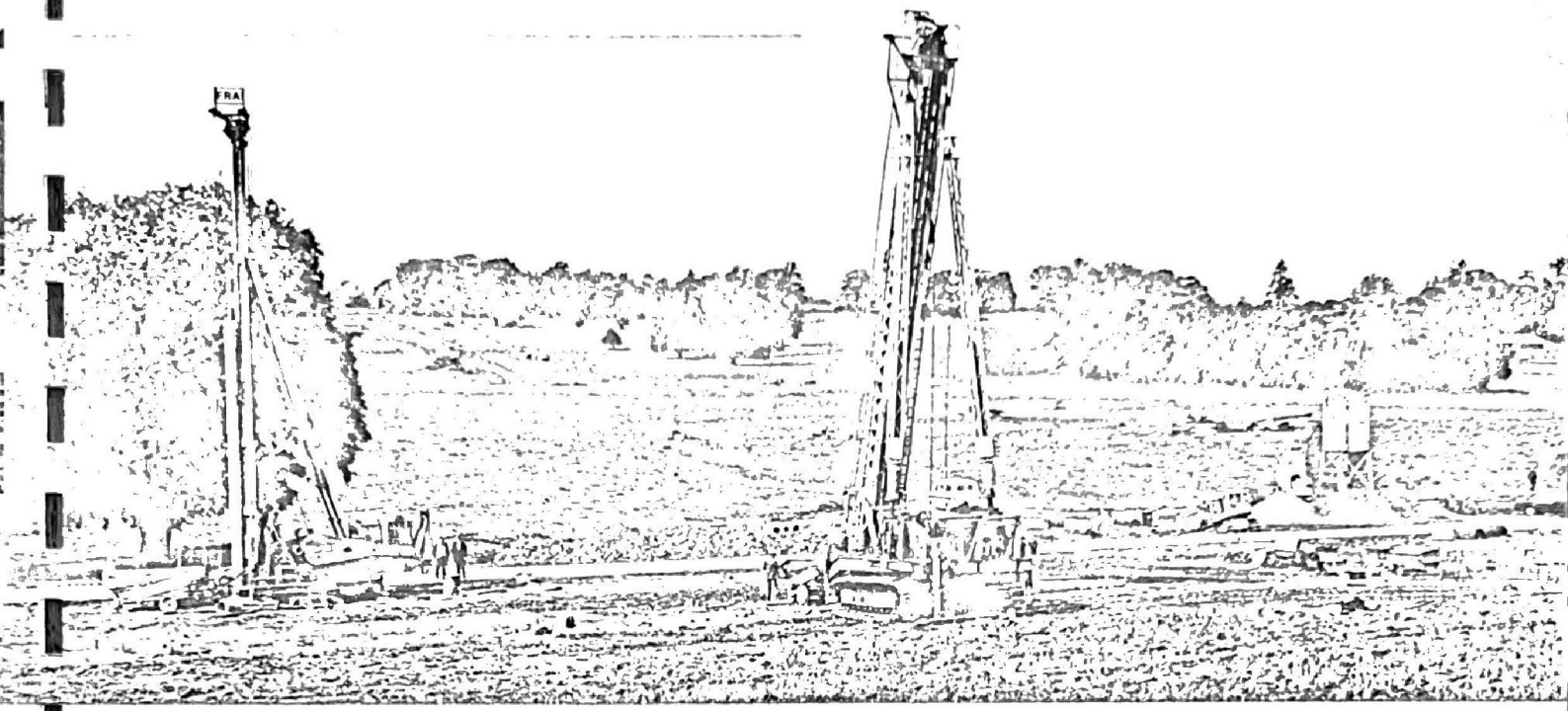


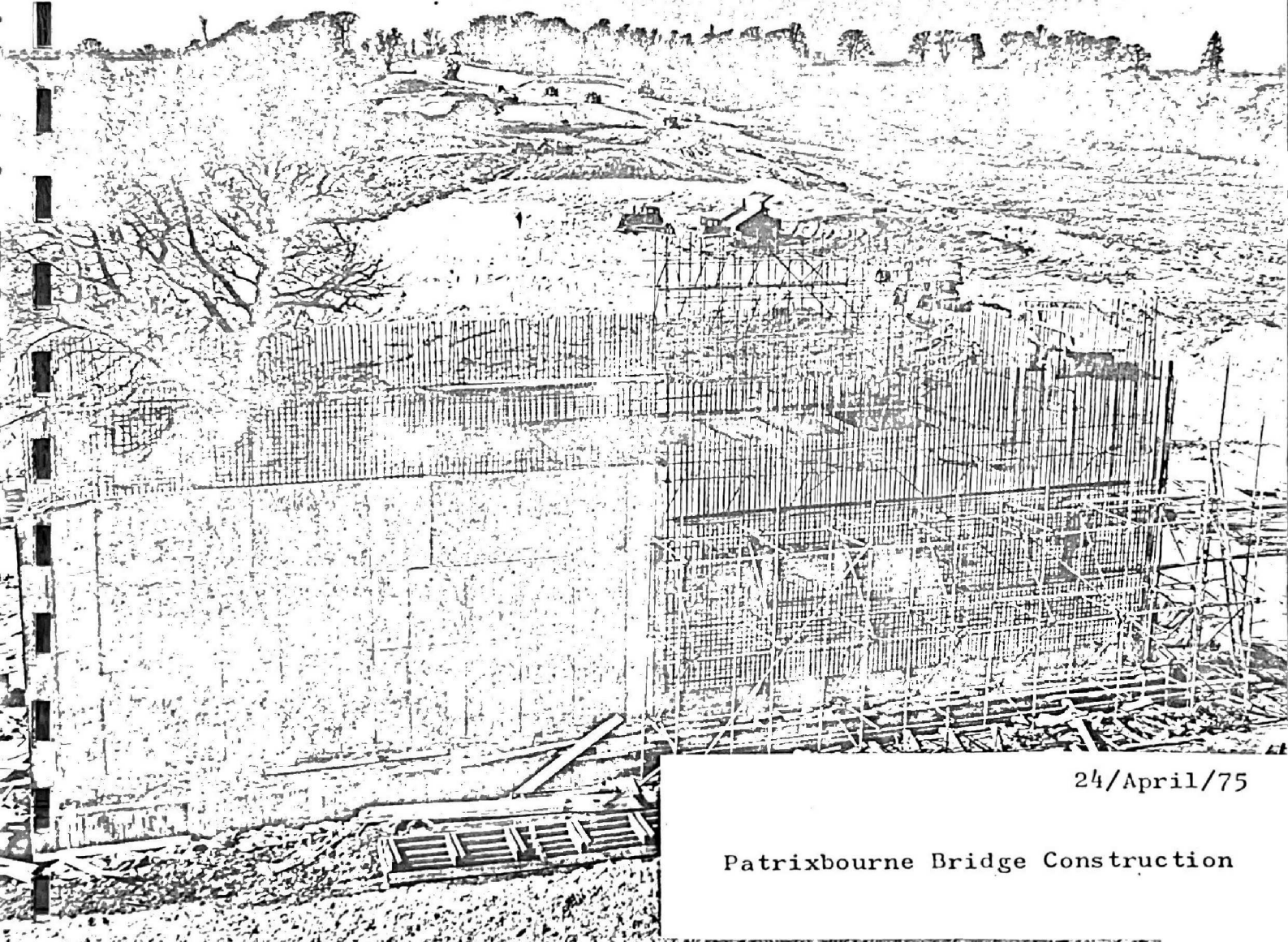
Chainage 2150 19/Dec/1974

Bypass Route looking towards Canterbury

Chainage 2600/2700 26/Sept/1974

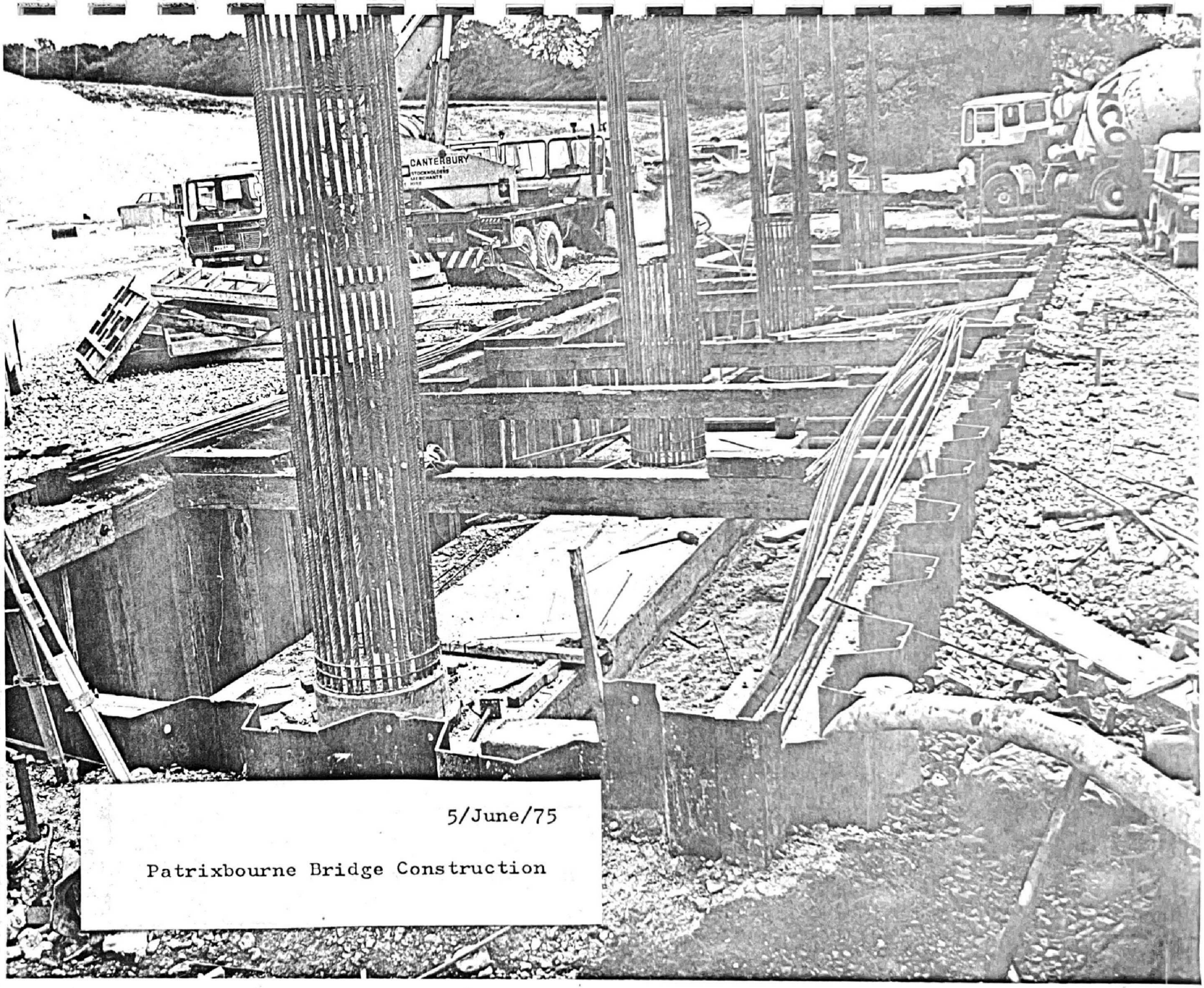
Piling Rigs and Batching Plant
at Patrixbourne - looking towards
Canterbury





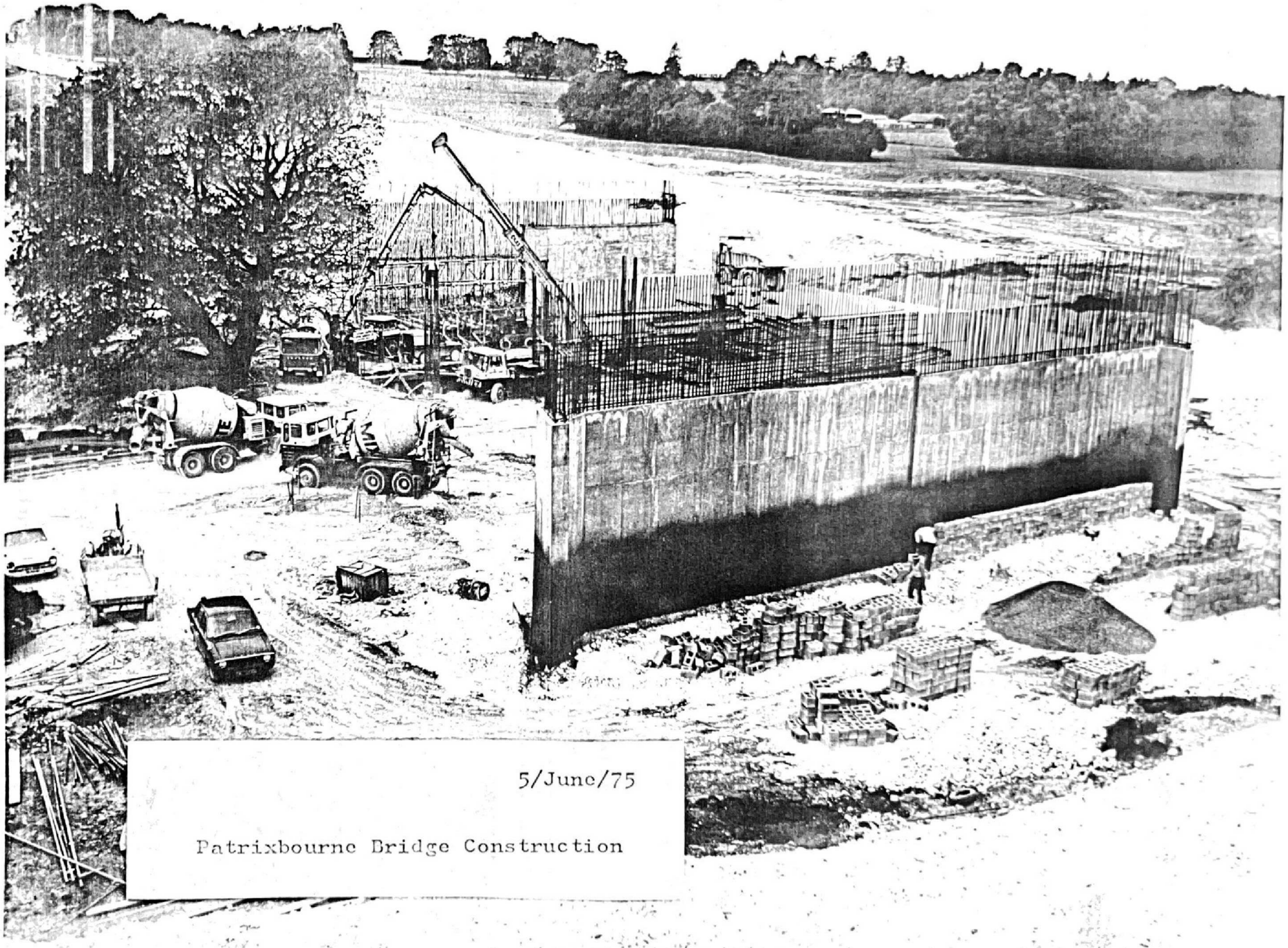
24/April/75

Patrixbourne Bridge Construction



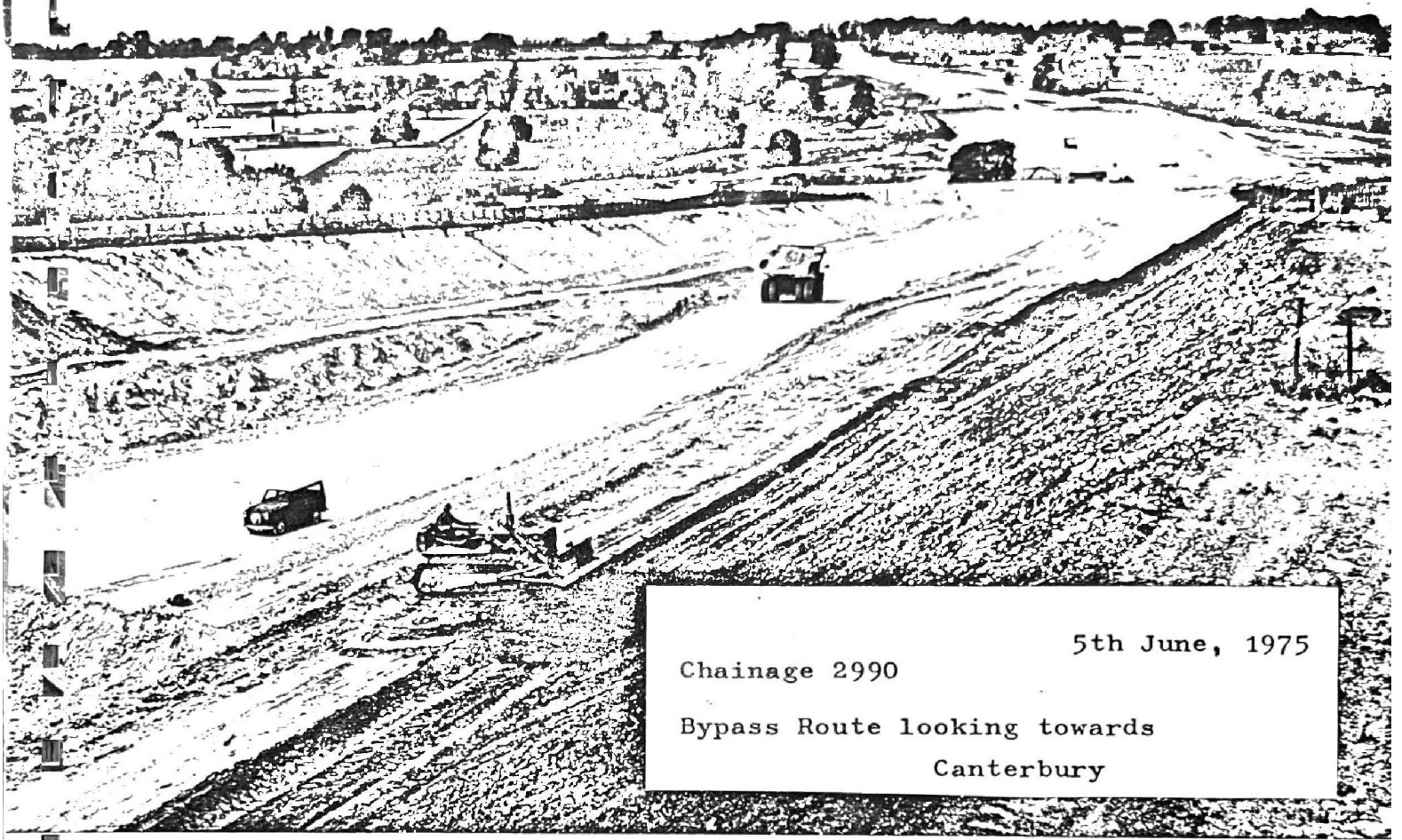
5/June/75

Patrixbourne Bridge Construction



5/June/75

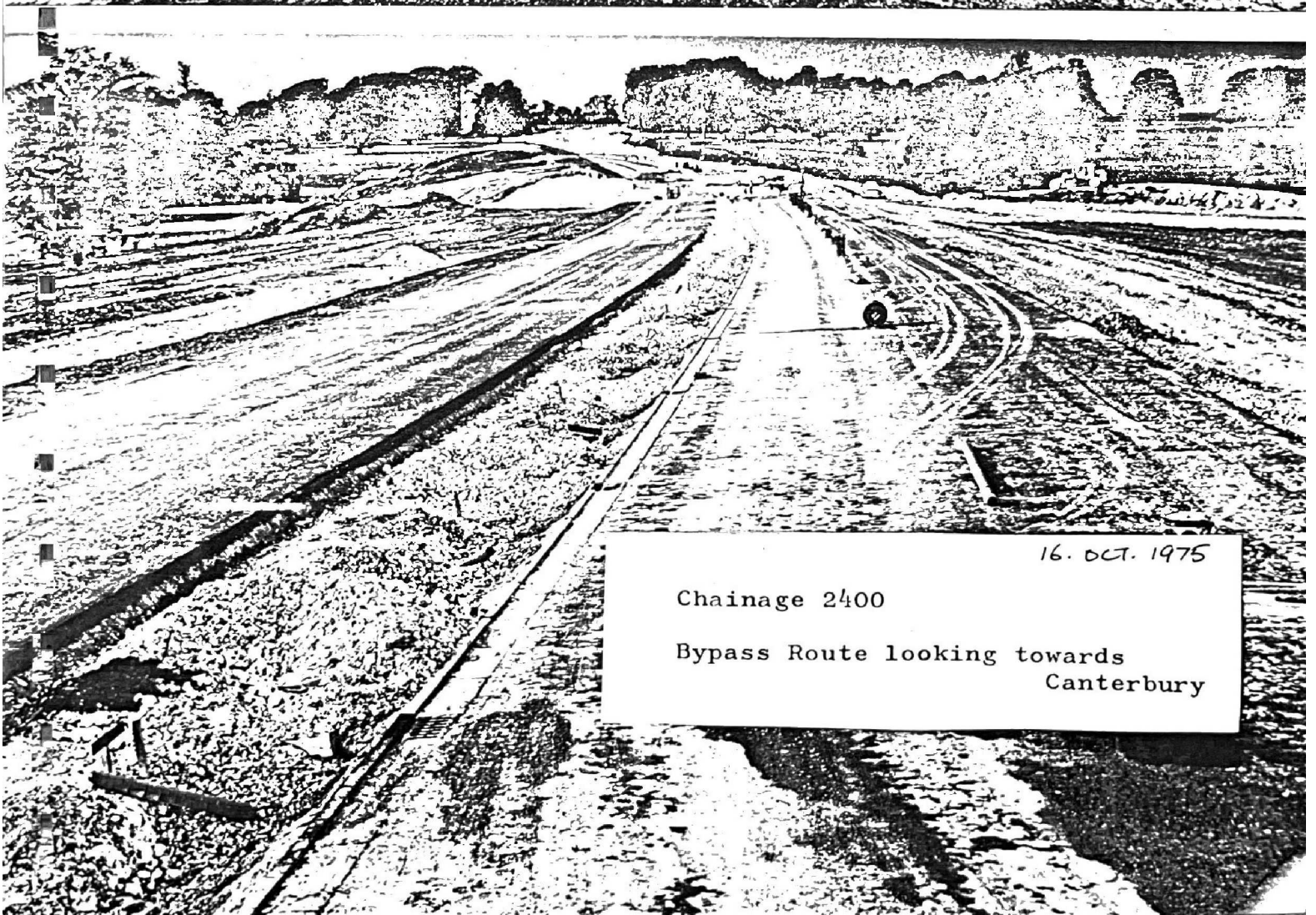
Patrixbourne Bridge Construction



5th June, 1975

Chainage 2990

Bypass Route looking towards Canterbury



16. OCT. 1975

Chainage 2400

Bypass Route looking towards Canterbury



Chainage 3400 26/Sept/1974

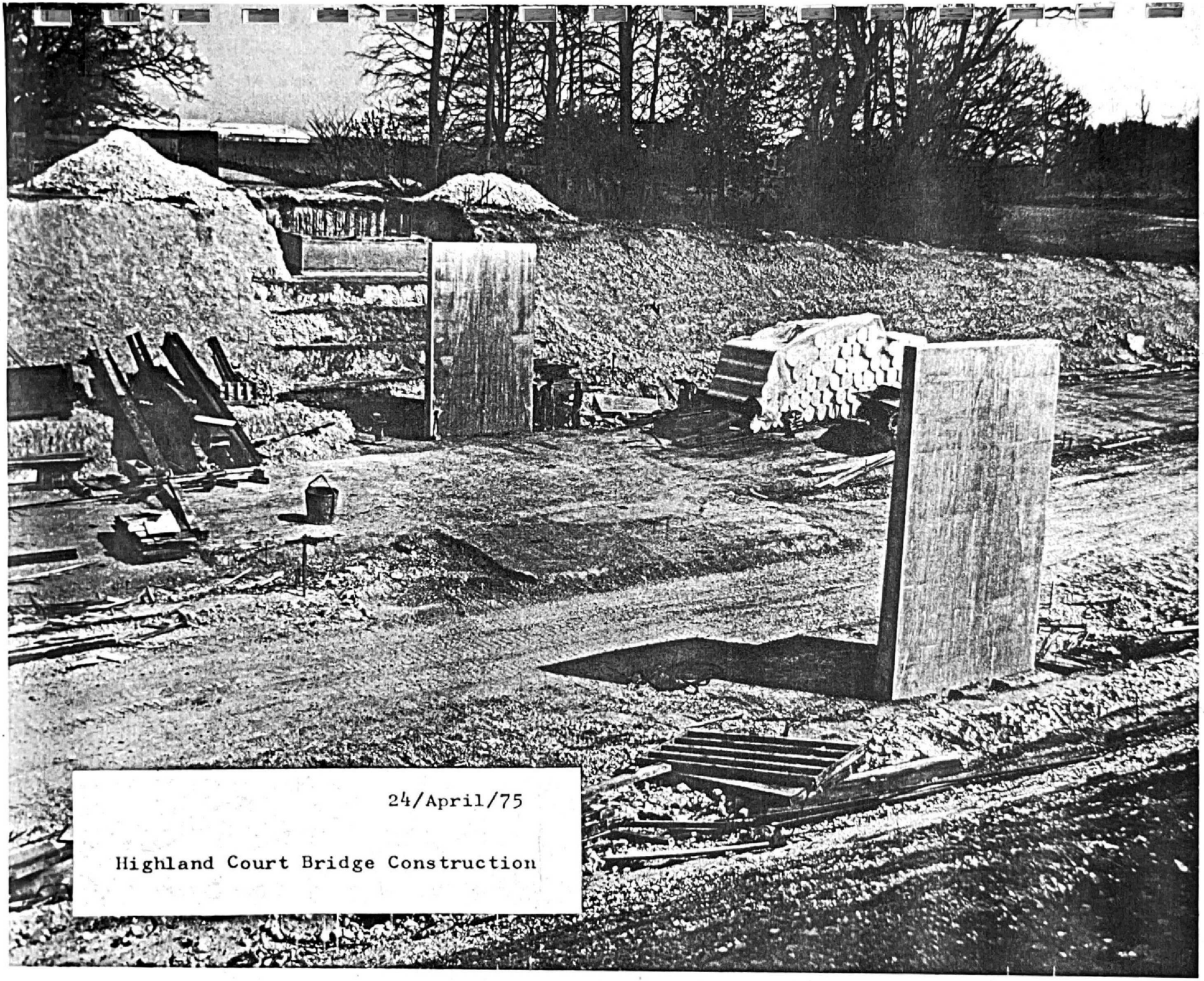
Side Hill Wood

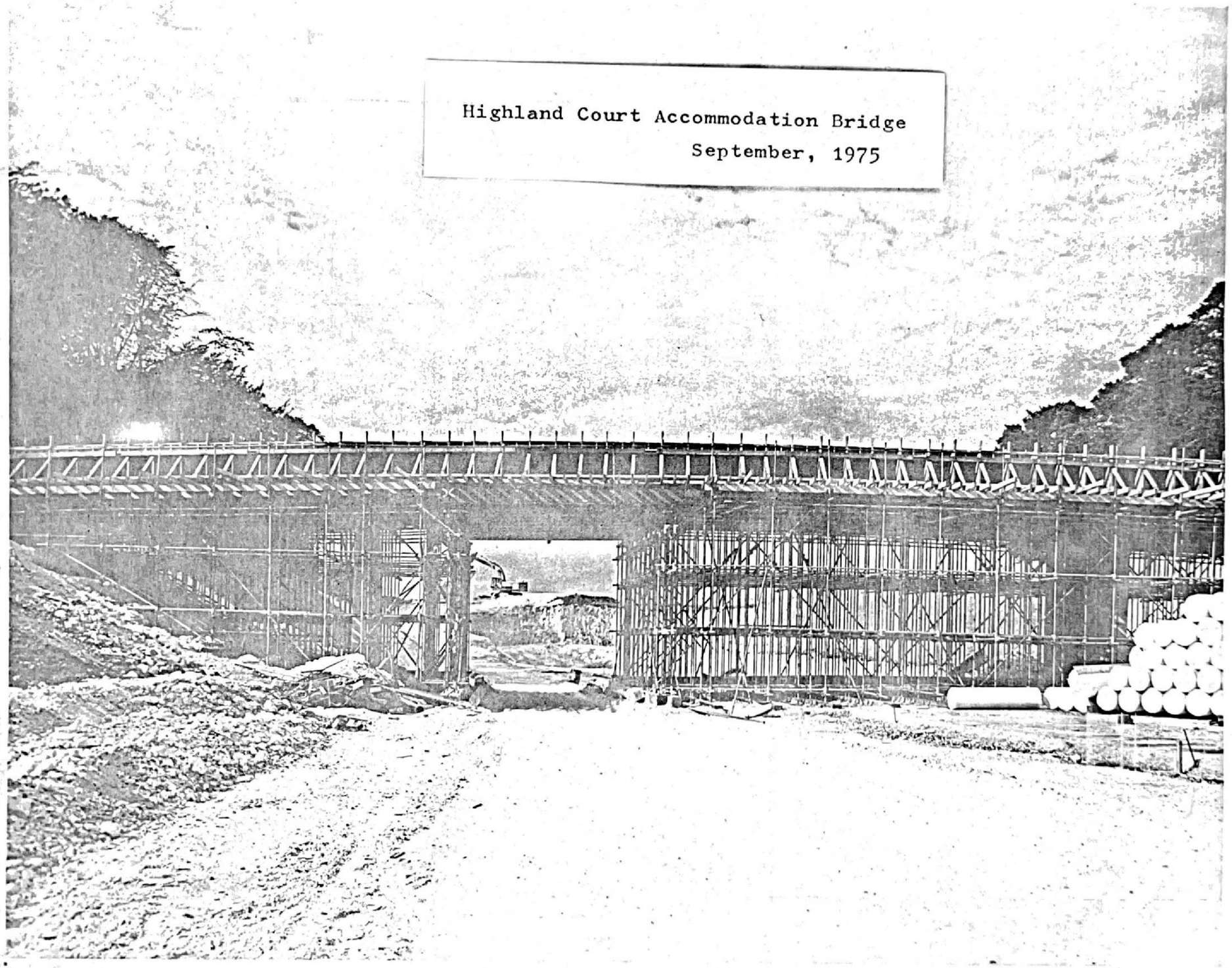
Shows access road to Highland Court



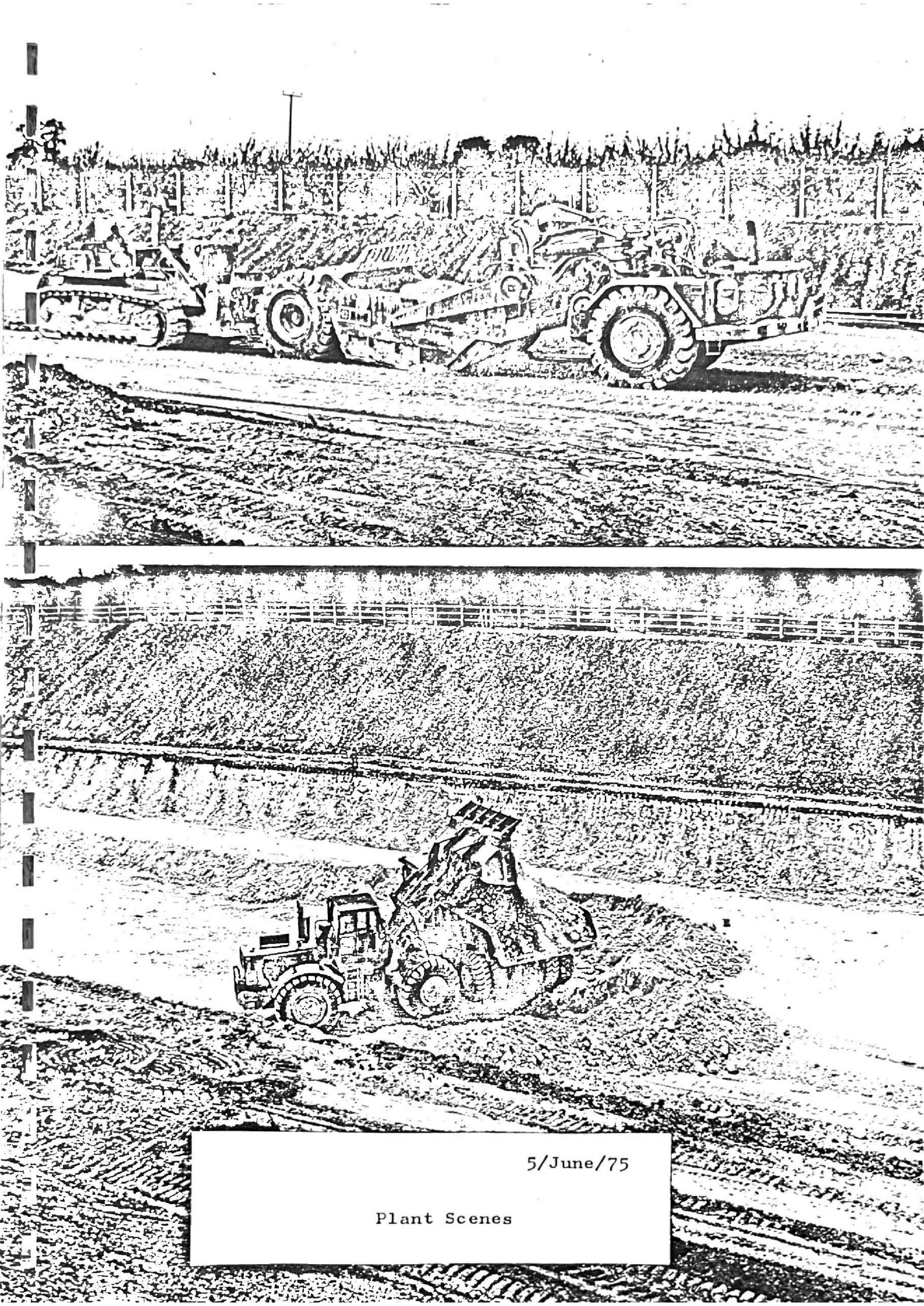
Chainage 3400 5. SEPT. 1975

Bypass Route looking towards Canterbury


24/April/75
Highland Court Bridge Construction



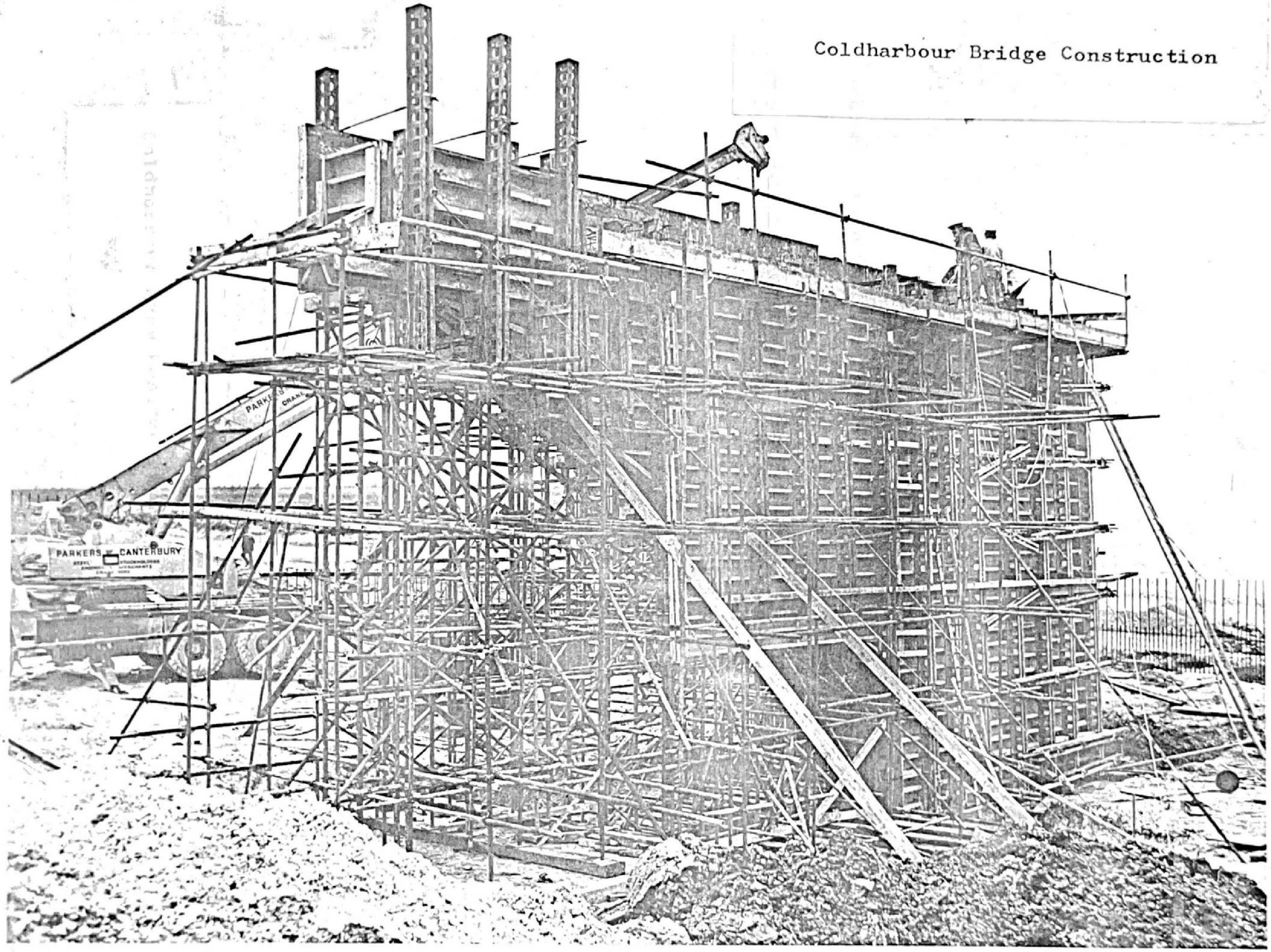
Highland Court Accommodation Bridge
September, 1975



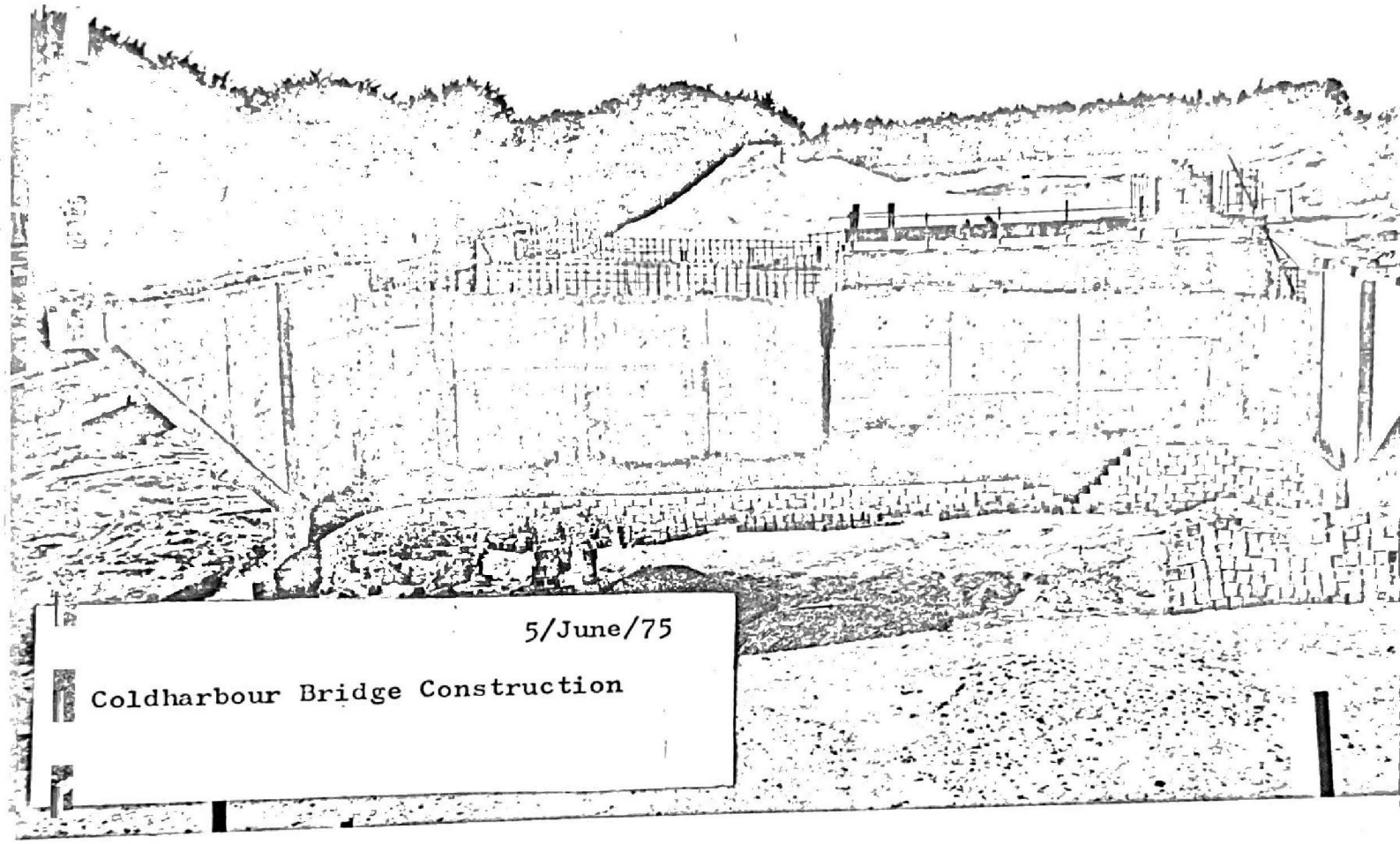
5/June/75

Plant Scenes

Coldharbour Bridge Construction

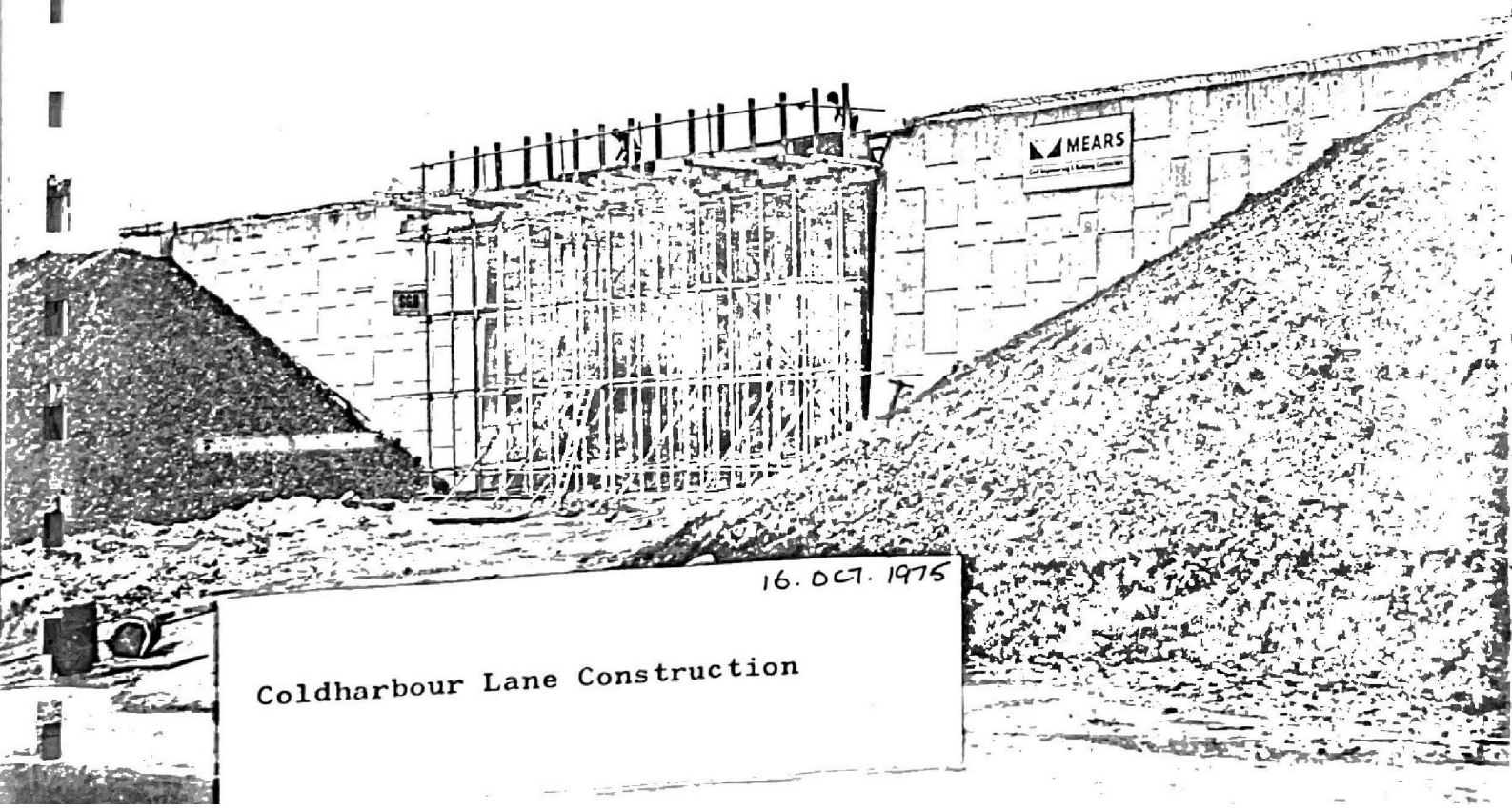


13 MAR 1975



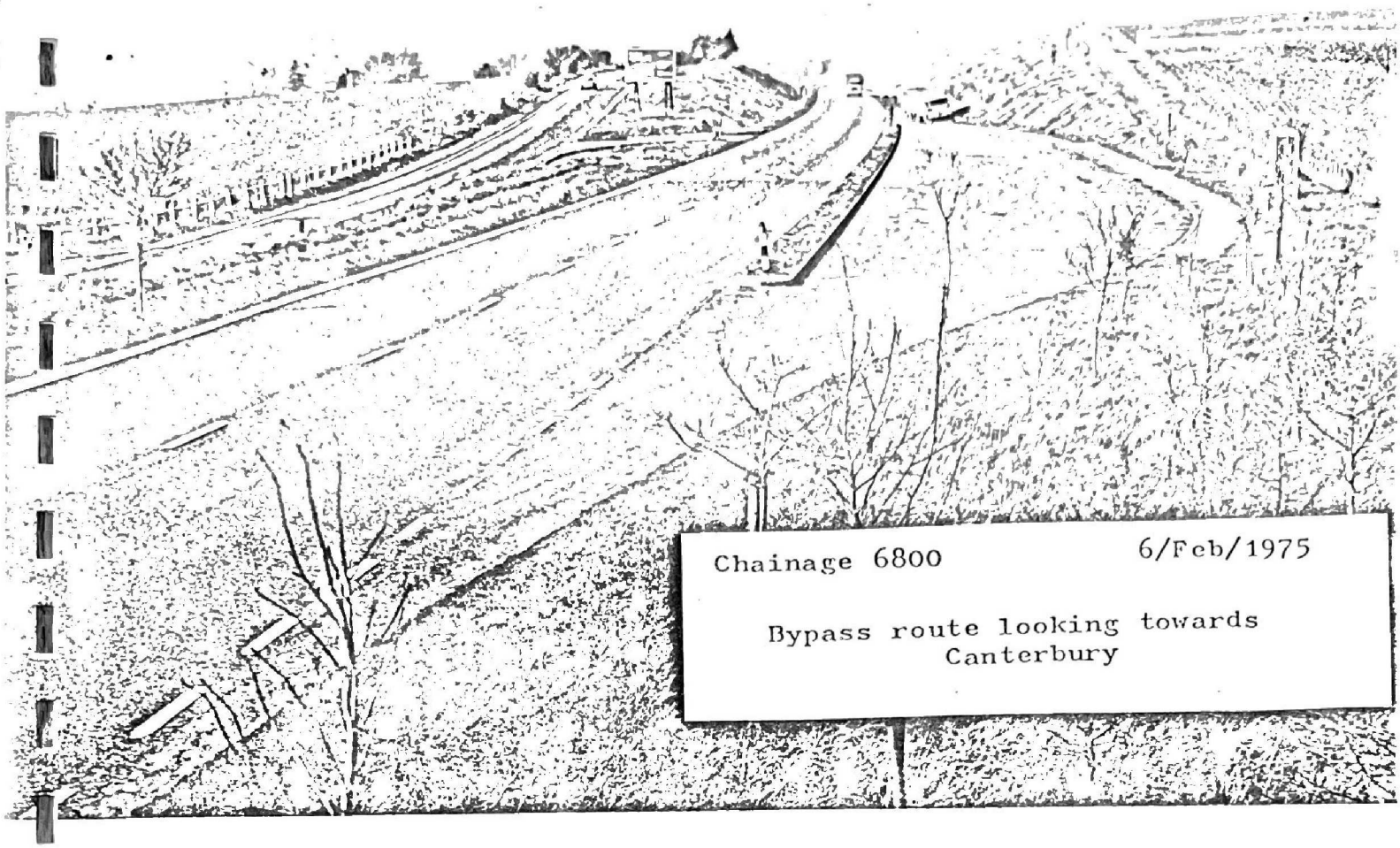
5/June/75

Coldharbour Bridge Construction



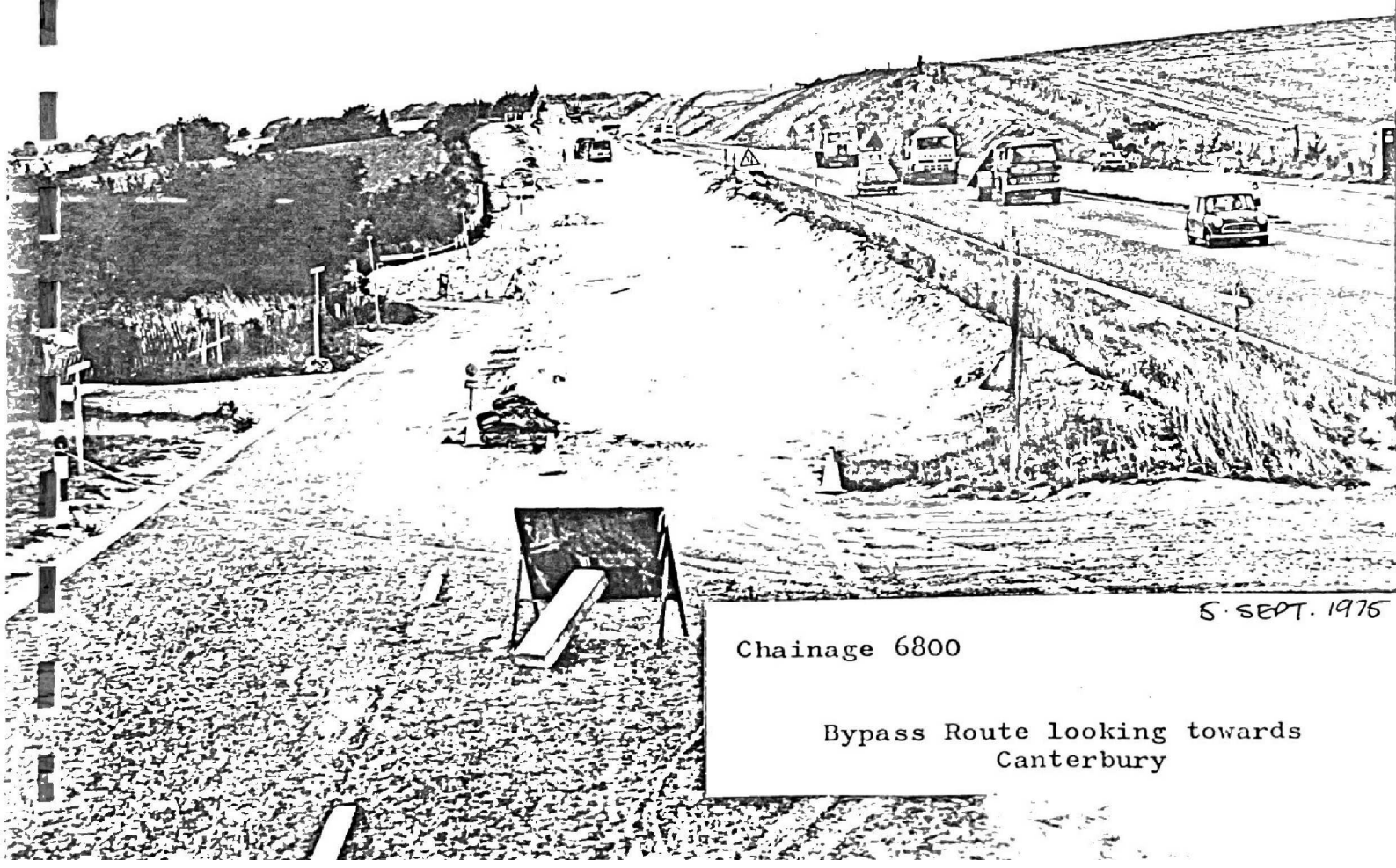
16. OCT. 1975

Coldharbour Lane Construction



Chainage 6800 6/Feb/1975

Bypass route looking towards Canterbury



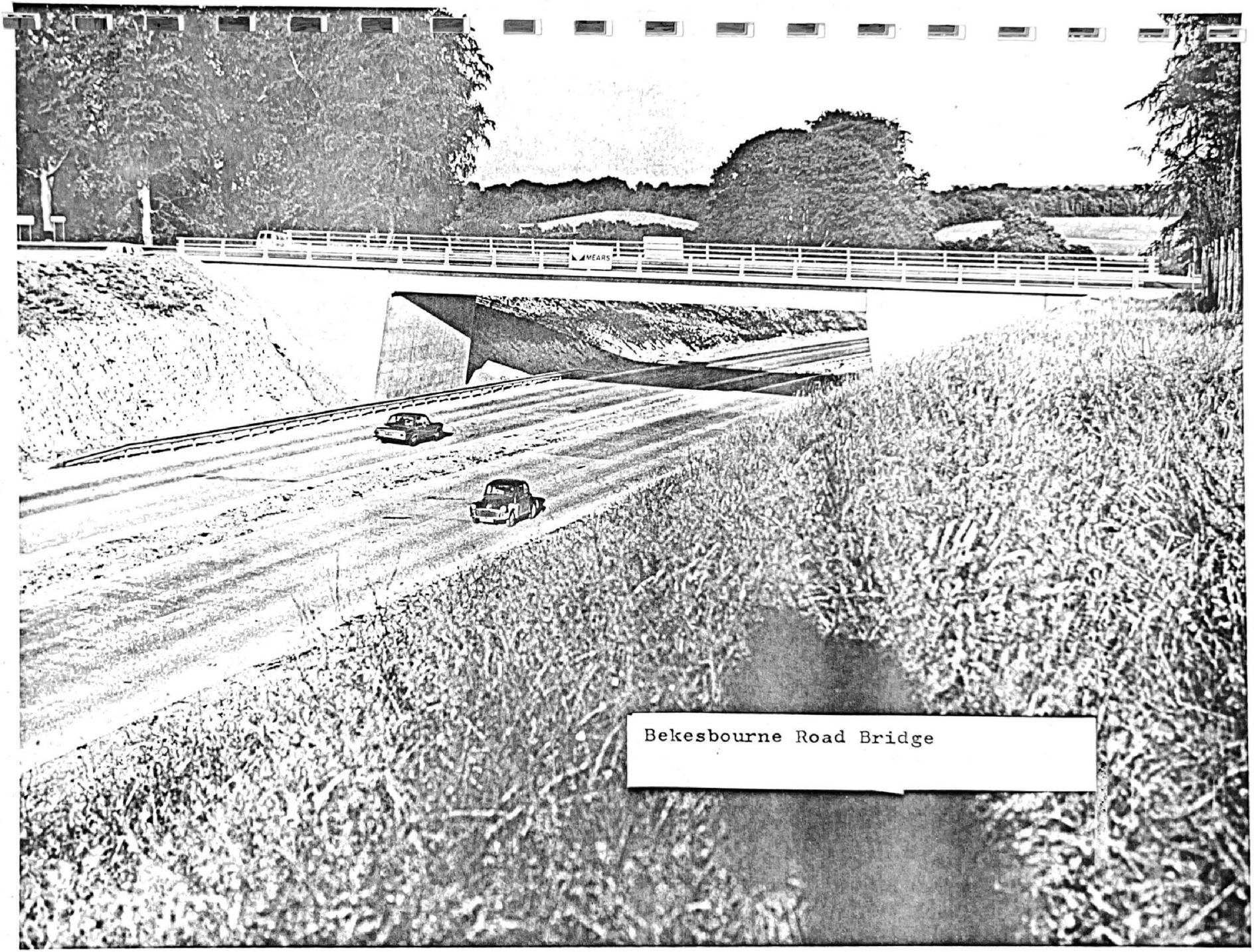
5 SEPT. 1975

Chainage 6800

Bypass Route looking towards Canterbury

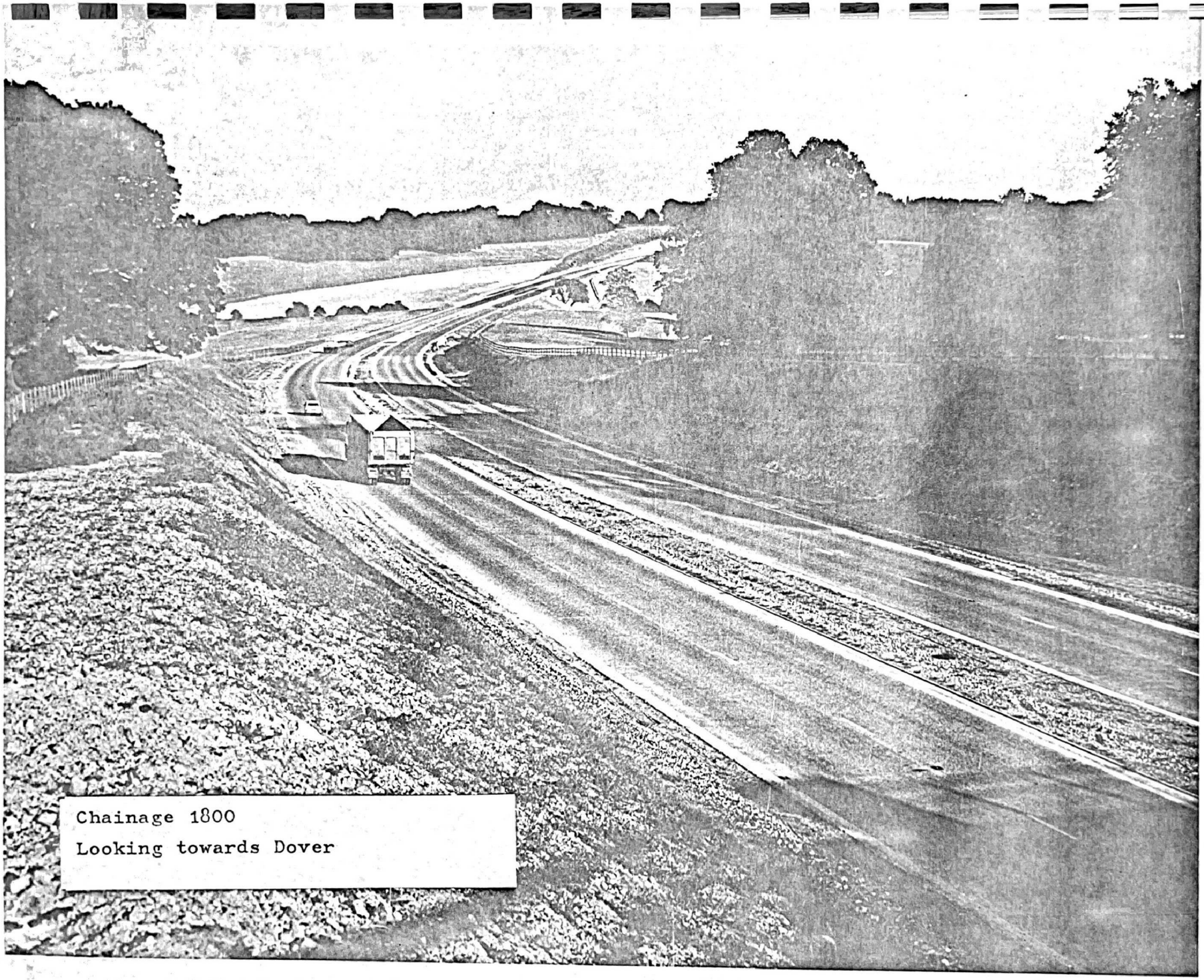
PHOTOGRAPHS ILLUSTRATING

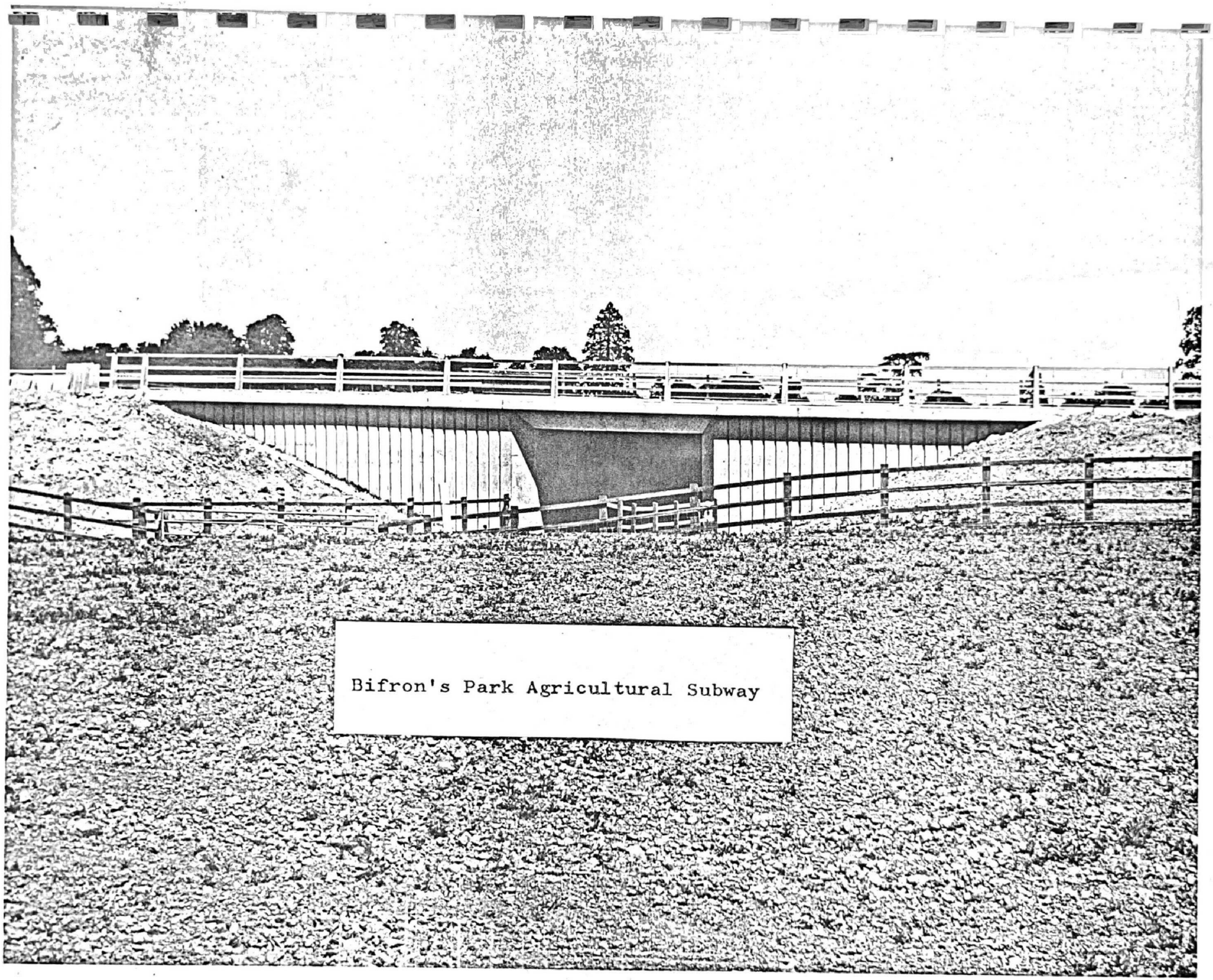
THE COMPLETED SCHEME



Bekesbourne Road Bridge

29 JUL 1976


Chainage 1800
Looking towards Dover

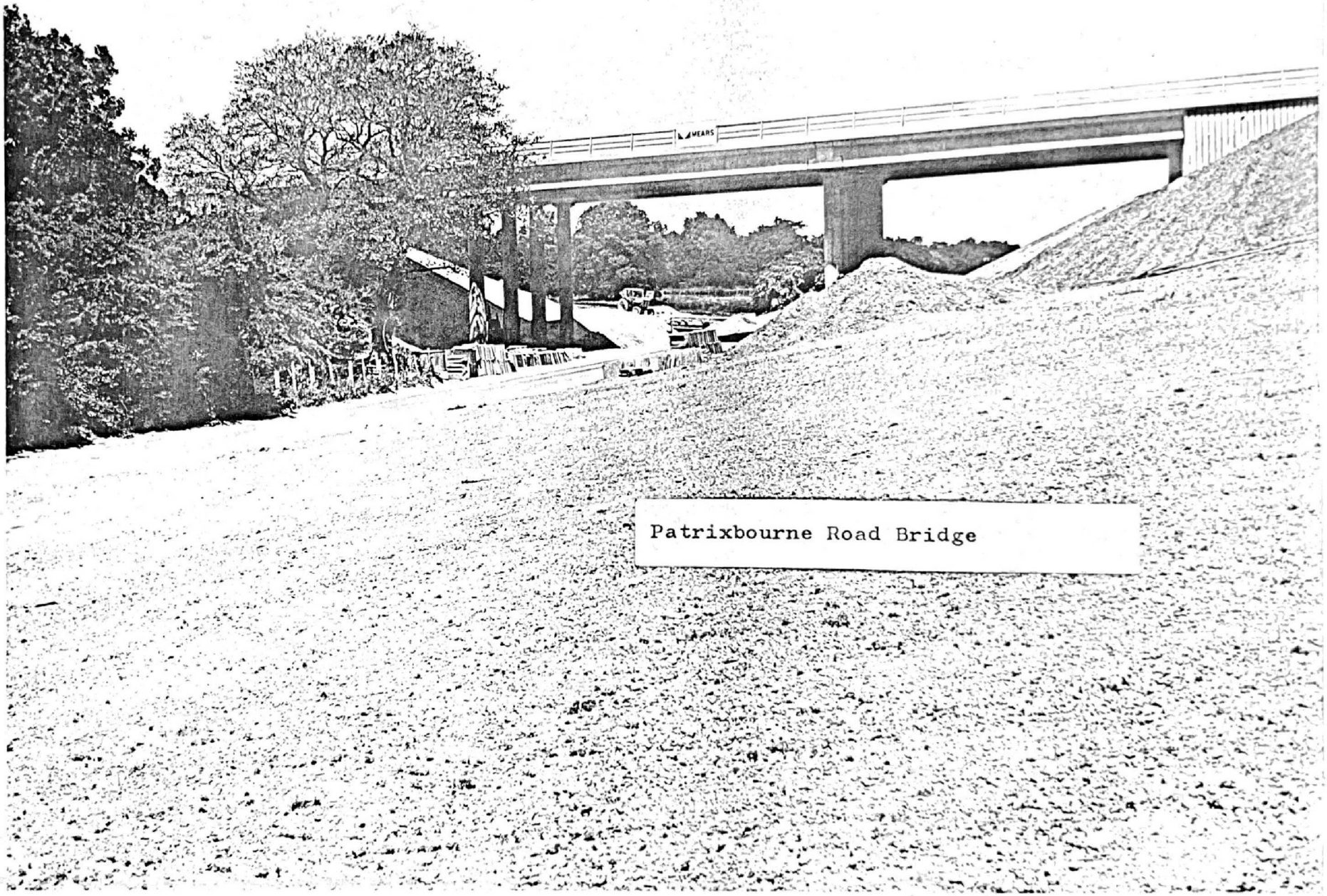


Bifron's Park Agricultural Subway



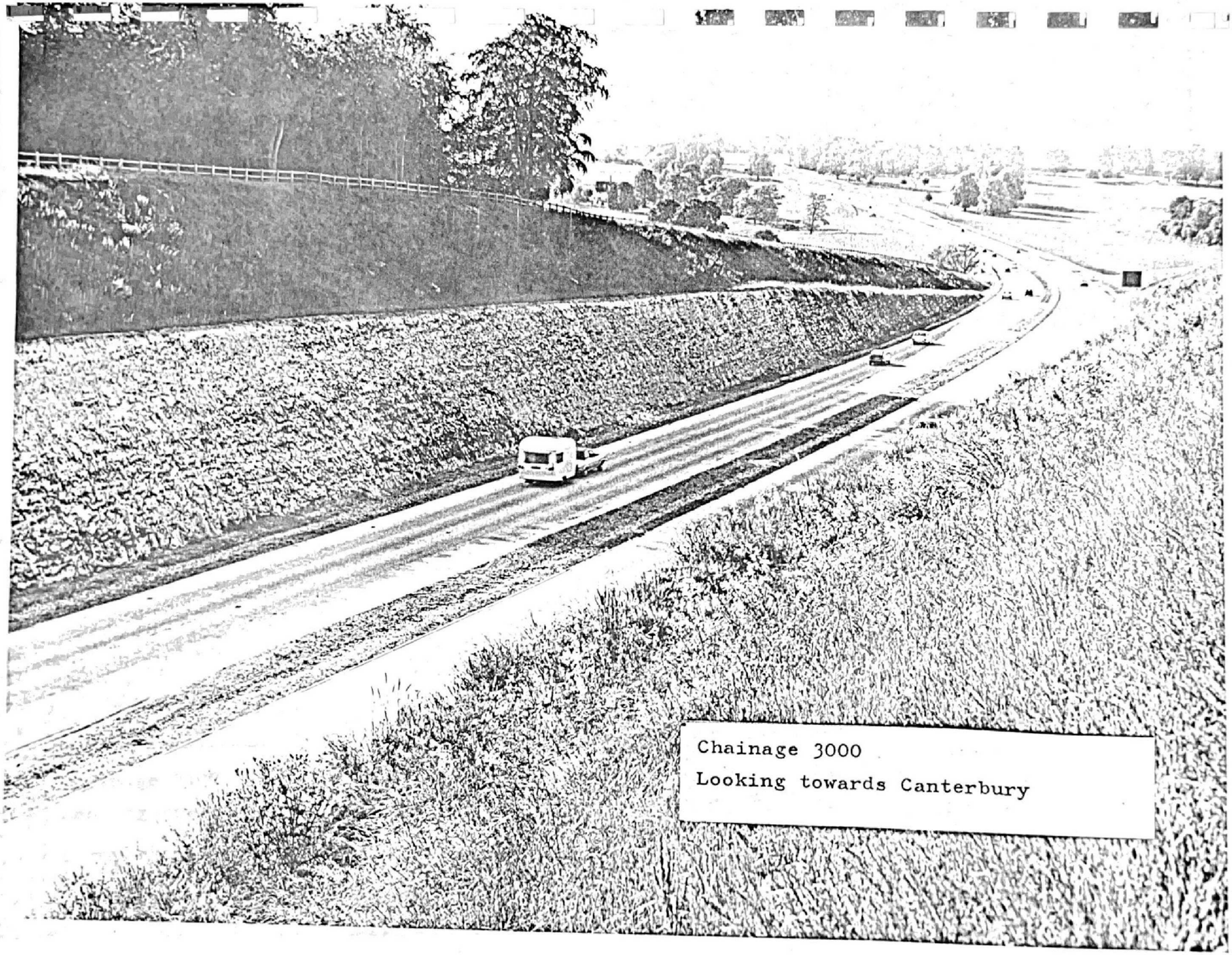
Patrixbourne Road Bridge

29 JUN 1976

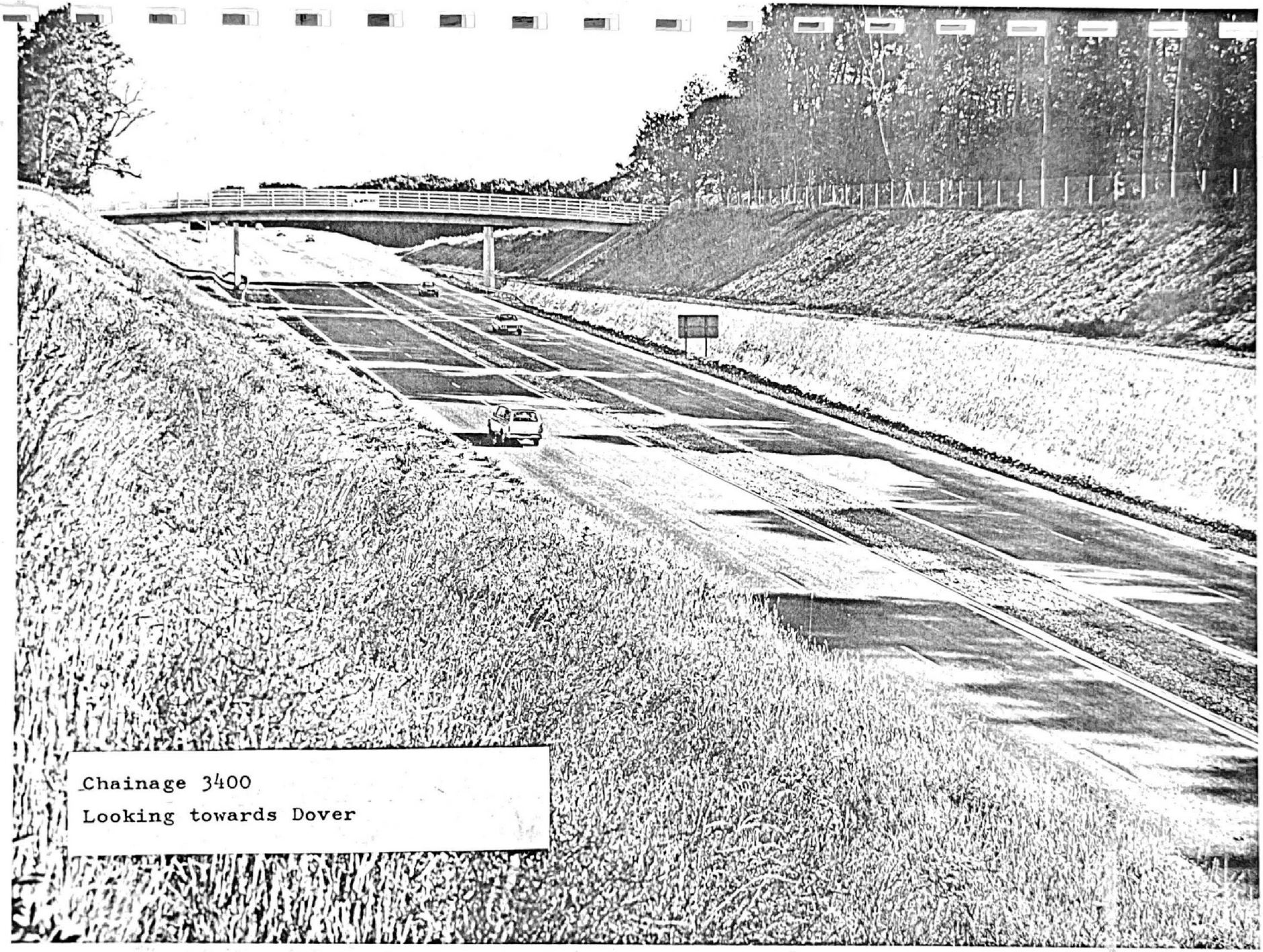


Patrixbourne Road Bridge

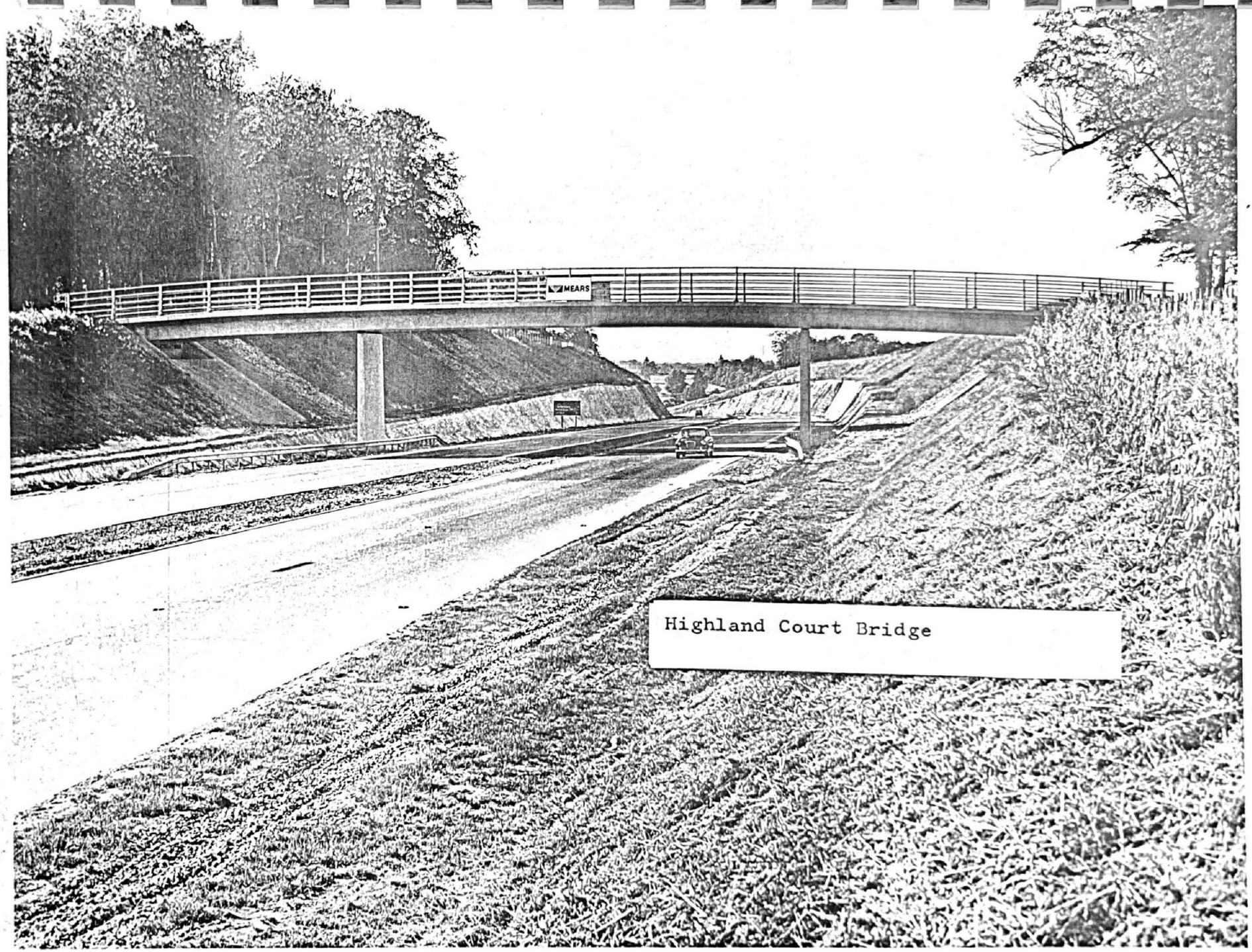
29 JUN 1976



29 JUL 1976



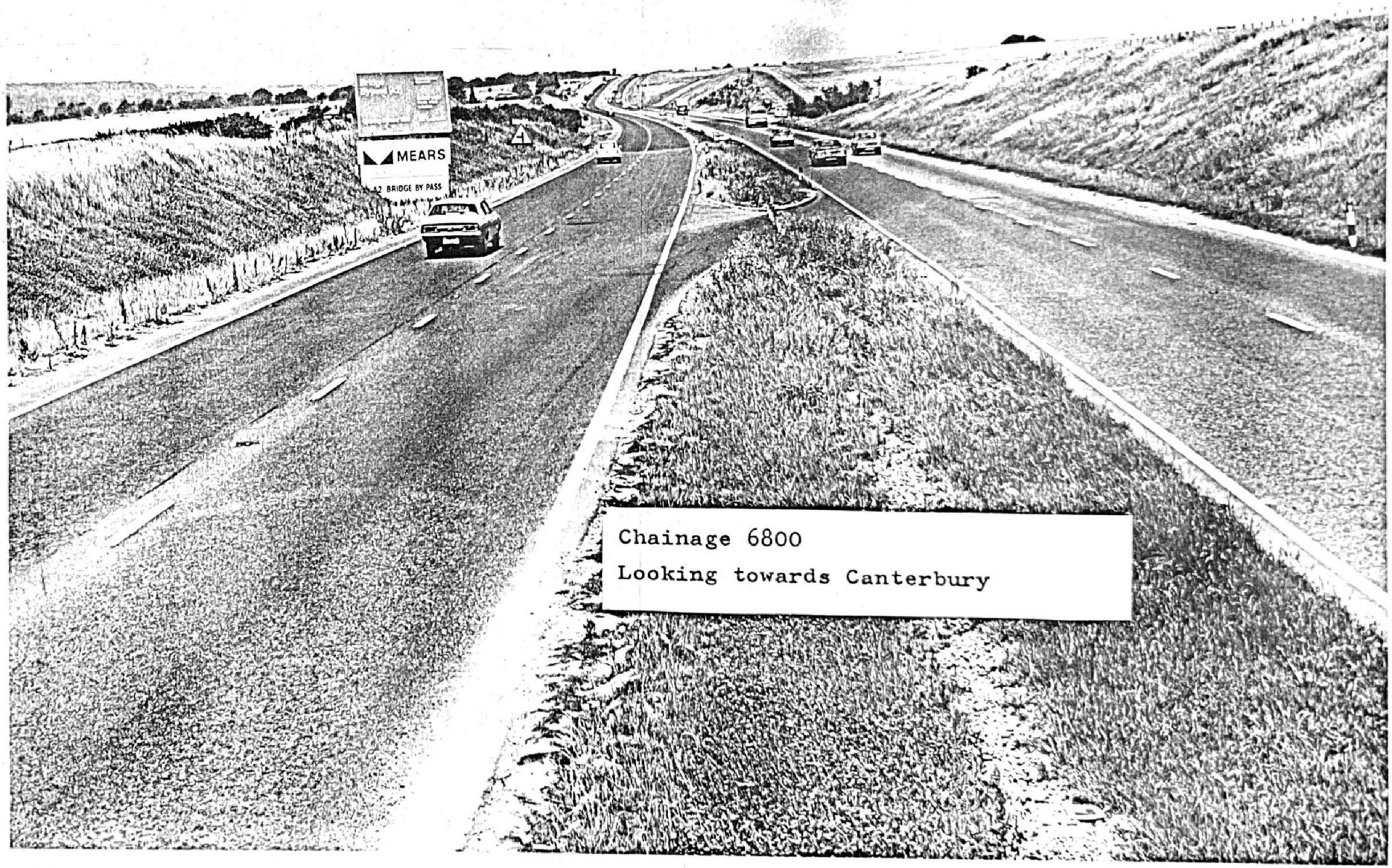
29 JUN 1976



Highland Court Bridge



Coldharbour Lane and
Coldharbour Lane Bridge



Chainage 6800

Looking towards Canterbury

29 JUN 1976