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HIGHWAYS AGENCY

A421 Improvements M1 Junction 13 to Bedford

Environmental Statement

Volume 2B – Detailed Assessment and Supplementary Information

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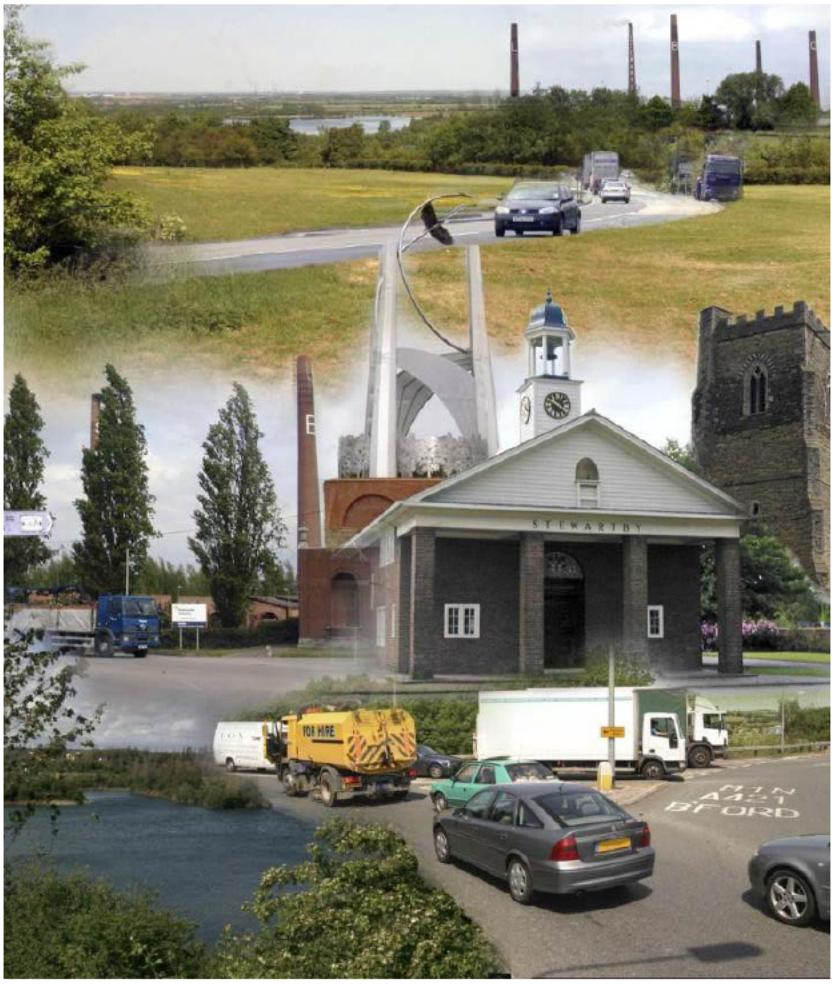

An Executive Agency of the Department for Transport

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10 GEOLOGY AND SOILS

10.1 Introduction

10.1.1 This chapter reports on the predicted effects of the proposed Scheme upon soils and geology. The soils and underlying geology in the vicinity of the Scheme are important factors in determining the physical appearance of an area, and can contain valuable resources, such as fertile land and mineral resources. Potential effects associated with the presence of contaminated land along the route are also addressed. The assessment has been carried out in accordance with the requirements of the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 11.

10.2 Potential Impacts and Effects

Construction Phase

10.2.1 Potential impacts on soils which may arise as a result of the construction of a scheme such as this include the following:

- Loss or destruction of soils in use for agriculture, woodland and forestry or of nature conservation value
- Physical damage to soils, including soil compaction as a result of heavy construction vehicle movements
- Exacerbation of soil erosion
- Contamination of soils adjacent to roads by construction materials, fuels, oil, spray or airborne contaminants
- Exposure of currently contaminated soils
- Exposure of landfill gases to groundworkers within excavations, poorly ventilated areas or structures within close proximity to Brogborough or Stewartby Landfill sites.

Operational Phase

10.2.2 During operation of a new road scheme, adjacent soils may be affected by spray or airborne contaminants generated during routine maintenance and operation of the road, or contaminants released during road accidents/emergency situations. There is also the possibility of increased soil erosion due to poor drainage design, and of cut and embankment slopes being susceptible to erosion or failure.

10.3 Methodology

Evaluation of Receptors

10.3.1 The importance of potentially affected geological/geomorphological features and the sensitivity of receptors that may be affected by land contamination impacts have been evaluated on the basis of a 5-point scale, as illustrated in Table 10.1, below. These criteria have been developed by the Project Team and applied previously to major highway schemes.

Table 10.1 Criteria for Assessing the Importance of Potentially Affected Geological/Geomorphological Features

Value/ Sensitivity	Geology and Soils	Other Receptors Susceptible to Land Contamination Impacts
Very high	• Internationally designated sites • Very high quality agricultural soils (Grade 1) • Soils of very high nature conservation or landscape importance (refer to Chapter 9: Ecology and Nature Conservation and Chapter 8: Landscape and Visual Assessment)	• Residential areas, schools, play areas, within 50m of construction works • Water features deemed to be of very high value (refer to Chapter 11: Road Drainage and the Water Environment) • Ecological features deemed to be of very high value (refer to Chapter 9: Ecology and Nature Conservation)
High	• Nationally designated sites • Regionally important sites with limited potential for substitution • High quality agricultural soils (Grade 2) • Soils of high nature conservation or landscape importance (refer to Chapter 9: Ecology and Nature Conservation and Chapter 8: Landscape and Visual Assessment)	• Residential areas, schools, playing fields, within 200m • Allotments, arable farmland, livestock, market gardens • Water features deemed to be of high value (refer to Chapter 11: Road Drainage and the Water Environment) • Ecological features deemed to be of high value (refer to Chapter 9: Ecology and Nature Conservation)
Medium	• Regionally important sites with potential for substitution • Locally designated sites • Good quality agricultural soils (Grade 3a) • Soils of medium nature conservation or landscape importance (refer to Chapter 9: Ecology and Nature Conservation and Chapter 8: Landscape and Visual Assessment)	• Commercial area or open space (excluding school playing fields and other play areas) • Forestry areas, ornamental plant nurseries • Buildings including services and foundations • Water features deemed to be of medium value (refer to Chapter 11: Road Drainage and the Water Environment) • Ecological features deemed to be of medium value (refer to Chapter 9: Ecology and Nature Conservation)

Value/ Sensitivity	Geology and Soils	Other Receptors Susceptible to Land Contamination Impacts
Low	• Undesignated sites of some local earth heritage interest • Moderate or poor quality agricultural soils (Grade 3b or Grade 4) • Soils of low nature conservation or landscape importance (refer to Chapter 9: Ecology and Nature Conservation and Chapter 8: Landscape and Visual Assessment)	• Industrial areas, car parks, highways, and railways • Water features deemed to be of low value (refer to Chapter 11: Road Drainage and the Water Environment) • Ecological features deemed to be of low value (refer to Chapter 9: Ecology and Nature Conservation)
Negligible	• Other sites with little or no local earth heritage interest • Very poor quality agricultural soils (Grade 5) • Soils of negligible nature conservation or landscape importance (refer to Chapter 9: Ecology and Nature Conservation and Chapter 8: Landscape and Visual Assessment)	• Areas where there are no built structures, no crops, timber, livestock, etc. • Ecological features deemed to be of negligible value (refer to Chapter 9: Ecology and Nature Conservation)

Identification and Assessment of Potential Impacts

10.3.2 The magnitude of potential Scheme impacts has been assessed using the 5-point scale as shown in Table 10.2, below.

Table 10.2 Criteria for Assessing the Magnitude of Impacts upon Geological/ Geomorphological Features

Magnitude	Criteria: Geology and Soils (Earth Heritage)	Criteria: Other Receptors
Major	Loss of feature or attribute	Significant earthworks required in an area of moderately to highly suspected or known contamination
Moderate	Impact on integrity of or partial loss of feature or attribute	Minor disturbance (e.g. excavation of less than 500m^3) of potentially contaminated ground, or desk study or site investigation indicates limited contamination potential

Magnitude	Criteria: Geology and Soils (Earth Heritage)	Criteria: Other Receptors
Minor	Minor impact on feature or attribute	No disturbance of contaminated land, <u>or</u> desk study or site investigation indicates negligible contamination potential
Negligible	Impact of insufficient magnitude to affect use or integrity of feature or attribute	No disturbance of contaminated land and no identified potential for sources of potential contamination within 250m of works location
Positive	New feature or aspect created (e.g. fresh exposure of geological sequence in road cutting)	Removal or treatment of contaminated soil, which reduces adverse effects or potential for adverse effects on sensitive receptors in the area

Identification of Significant Effects

10.3.3 The significance of potential effects has been derived by combining the importance/sensitivity of the attribute/ receptor and the magnitude of the impact using the matrix presented in Table 10.3, below.

Table 10.3 Criteria for Assessing the Significance of Potential Effects upon Geological/Geomorphological Features

	Value/Sensitivity of Feature/Receptor				
Magnitude of Potential Impact	**Very High**	**High**	**Medium**	**Low**	**Negligible**
Major	Very Significant	Highly Significant	Significant	Low Significance	Insignificant
Moderate	Highly Significant	Significant	Low Significance	Insignificant	Insignificant
Minor	Significant	Low Significance	Insignificant	Insignificant	Insignificant
Negligible	Low Significance	Insignificant	Insignificant	Insignificant	Insignificant
Positive	Highly Significant - Benefit	Highly Significant - Benefit	Significant - Benefit	Low Significance - Benefit	Insignificant

10.4 Baseline Conditions

Legislative Framework

National Policy Guidance

10.4.1 Guidance has been taken from the following national sources

- Department of the Environment (1997) Planning Policy Guidance 23, Planning and Pollution Control
- Department of Trade and Industry (2001) Building Research Establishment Special Digest 1: Concrete in Aggressive Ground
- Department for the Environment Transport and the Regions / Defra (2002 – 2003) Contaminated Land Reports 7 to 11
- Office of the Deputy Prime Minister (2004) Planning Policy Statement 7, Sustainable Development in Rural Areas

Regional Policy Guidance

10.4.2 Bedford lies within the East of England region for planning purposes. The draft Regional Spatial Strategy for the East of England (East of England Regional Assembly, 2004) covers the period up to 2021 and is currently being prepared by the East of England Regional Assembly. This should be read in conjunction with the Milton Keynes/ South Midland Sub Regional Strategy (Secretary of State, 2005).

Limitations

10.4.3 A full environmental risk assessment for soil stabilisation could not be undertaken. Further laboratory analysis including bench tests and leachate analysis would be required for a full environmental risk assessment to be completed. No other major limitations were encountered during the compiling of this chapter.

Data Sources

10.4.4 Baseline geological and soil data for the Scheme has been collected by reference to the following sources:

- British Geological Survey Map Sheet 203, Bedford (Drift), 1900, 1:63360, and the associated geological memoirs
- Soils of Eastern England, Sheet 4, 1983, 1:250,000, Soil Survey of England and Wales
- Soils and their Use in Eastern England, Soil Survey of England and Wales, 1984
- Historical Ordnance Survey Maps
- A421 Improvements: M1 J13 to Bedford, Preliminary Sources Study Report, prepared by Hyder Consulting Limited (HCL) for the Highways Agency March 2005, Report No. GD00612/GDR/1006 Rev C
- “www.magic.gov” website for Agricultural Land Classification
- Provisional Agricultural Land Classification of England and Wales, Sheet 147, 1969, Ministry of Agriculture, Fisheries and Food
- Envirocheck report (See 10.4.2, below)
- A421 Improvements: M1 J13 to Bedford, Review of Gas and Groundwater monitoring near Brogborough and Stewartby Landfill Sites, prepared by Scott Wilson for the Highways Agency, March 2005, Report No. D109831-P1A-ENV-R003
- A421 Dualling, Brogborough to Bedford, Prepared by HCL for the Highways Agency, Land Ownership and Concept Design drawings, GD006R/1014-1016.

10.4.5 Key information provided within an Envirocheck report which was completed as part of a Preliminary Sources Study undertaken by HCL is summarised in the following sections. This section of the chapter presents data on the geology, groundwater and surface water conditions at the site together with other environmental data relating to the environmental setting of the site, such as the nearby presence of sensitive environmental habitats (e.g. Sites of Special Scientific Interest) or other potentially major contaminative industries. Figures 10.1.1 and 10.1.2 present the potential sources of contamination that were identified within the Envirocheck report and other sources.

Geology

10.4.6 The underlying geology is that of Jurassic clay, usually referred to as Oxford Clay. These clays are variously covered with drift deposits of river terrace and glacio-fluvial origin. Over the eastern and central parts of the A421 there is an extensive plain at a general elevation of 30-40m Above Ordnance Datum (AOD) which is of Jurassic clay overlain with river terrace, other drift deposits and locally alluvium. The central parts of the site are at a slightly higher elevation and are dominated by chalky boulder clay. At the western end of the site, adjacent to the M1, the parent materials are river terrace deposits and non-calcareous drift.

10.4.7 The alluvium generally follows the line of the watercourses. A band of alluvium is located either side of the M1 Junction 13 (M1 J13) from the western end to Ch.500; this is thought to be associated with Broughton Brook. A continuous band of alluvium is located crossing the site at Ch.4000 and then continues running to the southeast of the Scheme. This is considered to be associated with Elstow Brook. The 1:10,000 Scale Geological maps also indicate an area of Alluvium running along the length of the Scheme from Ch. 5600 - 6800 then Ch.7100 - 8000. A further band of alluvium is indicated crossing the Scheme at Ch.12400.

10.4.8 Head deposits and glacial sand and gravel extend to depths of up to 2m thick as a blanket layer over the Oxford Clay Formation, where the alluvium is not present. The geological mapping shows Brogborough Hill to be underlain by glacial till. The thickness of the Oxford Clay varies between 3 and 20m across the site and generally decreases in thickness with increased chainage to the east. The Oxford Clay Formation is divided into three layers, the Lower, Middle and Upper. The Upper and Middle Oxford Clays are a combination of mudstone and siltstone. The lower Oxford Clay is a bituminous mudstone. The Oxford Clay Formation is underlain by the Kellaways beds, which consist of an upper layer of sand over a lower layer of clay.

Geological Hazards

10.4.9 According to the Envirocheck report, the following geological hazards have been identified on site:

- A moderate to high potential for compressible ground subsidence hazards

  Compressible ground hazards are associated with the presence of 'soft' ground where settlement or subsidence could occur due to the ground conditions.

- No potential for ground dissolution stability hazards

  Ground dissolution refers to the chemical processes that can affect the ground due to water movement, leading to weakening of the ground and breakdown of the composition of the geological strata.

- No potential for Gulls and Cambering subsidence hazards

  The softer ground is more affected by erosion processes. This can lead to subsidence of overlying strata leading to cambers.

- A low to moderate potential for landslip ground stability hazards
- A low to moderate potential for shrinking and swelling clay.

Radon

10.4.10 According to the Envirocheck report less than 1% of homes in the vicinity of the Scheme are above the action level for health protection. No radon measures are necessary in the construction of new buildings.

Groundwater Conditions

Groundwater Vulnerability

10.4.11 The Oxford Clay Formation and glacial till are considered to be non-aquifers. The alluvial soils underlying the Scheme are considered to be a minor aquifer of low leaching potential (variably to negligibly permeable) and the glacial sands and gravels are considered to have an intermediate leaching potential. Although not producing water for abstraction, they are important for local supplies and in supplying base flow to rivers. Negligibly permeable deposits are formations, which are generally regarded as containing insignificant quantities of groundwater. However groundwater flow through such soils and rocks, although imperceptible, does take place and needs to be considered in assessing the risk associated with persistent pollutants.

10.4.12 Soils of low leaching potential are soils in which pollutants are unlikely to penetrate the soil layer because water movement is largely horizontal or they have large ability to attenuate diffuse pollutants. Lateral flow from these soils contributes to groundwater recharge elsewhere in the catchment. Soils of an intermediate leaching potential are soils which can possibly transmit a wide range of pollutants.

Ground Water Quality

10.4.13 Balfour Beatty/Scott Wilson undertook a review of groundwater quality issues around the Brogborough and Stewartby Landfill sites during March 2006 (Report reference number D109831-P1A-ENV-R003). Elevated concentrations of ammonia were encountered in all boreholes considered, with concentrations ranging from 0mg/l to 7.8mg/l at Brogborough and 0mg/l to 30mg/l at Stewartby. 47% of the Brogborough results were found to exceed the environmental quality standards (EQS) of 1mg/l, as were 63% of the Stewartby results.

10.4.14 Elevated concentrations of copper were encountered in one of the boreholes reviewed for the Brogborough site, with concentrations ranging from 0.01mg/l to 2260mg/l, with 25% of the samples exceeding the EQS of 0.02mg/l. All the elevated copper concentrations were identified from groundwater samples taken on 26 January 2004. Further testing in 2005 found the groundwater to be below the threshold levels for copper. Copper concentrations were not found to be elevated at the Stewartby site.

Mining and Mineral Resources

10.4.15 The properties of the Lower Oxford Clay make it perfect for brick making. Historical maps show that small isolated brick pits are located across the Bedford area. Isolated pits for gravel abstraction (within the glacial sands and gravels) are also indicated. Some of the pits have been infilled with made ground of unknown composition or have been left to fill with water. Others have weathered to shallow depressions, or have been obscured by backfilling and subsequent ploughing of the land.

Landfill Gas

10.4.16 There is a potential for landfill gases to be present in the vicinity of the two large landfill sites, Brogborough and Stewartby. Extensive gas monitoring has been undertaken on and outside the landfill sites. Figures 10.2 and 10.3 present gas and groundwater monitoring points located close to the Scheme but outside the boundary of the landfill sites. Scott Wilson undertook a review of gas and groundwater monitoring near the landfill sites (see paragraph 10.4.13).

10.4.17 Over the 5-year monitoring period of results reviewed for the Brogborough site, low levels of carbon dioxide (CO_2) and methane (CH_4) were identified. The threshold value of 1.5% for CO_2 was exceeded in 29 out of the 723 readings taken (4% of the results) with a maximum concentration of CO_2 of 8.7% by volume. CH_4 was recorded above the critical value of 0.5% on 15 occasions (2% of the results) with the maximum concentration recorded of 9.1% by volume.

10.4.18 Over the 5-year monitoring period of results reviewed for the Stewartby site, low levels of carbon dioxide and methane were identified. The threshold value of 1.5% for CO_2 was exceeded in 179 out of the 2199 readings taken (8% of the results) with a maximum concentration of CO_2 of 4.3% by volume. CH_4 was only recorded above the critical value of 0.5% on 2 occasions (0.1% of the results) with a maximum concentration recorded of 18.1% by volume.

10.4.19 The report concluded that monitoring over a 5-year period had indicated that the degree of contamination external to the two landfill sites was not significant in terms of the proposed road construction. Low levels of landfill gases (methane and carbon dioxide) were generally recorded, and these will need to be taken into account in the detailed design of the route in these areas.

Sites of Geological/Geomorphological Importance

10.4.20 There are no geological Sites of Interest for Nature Conservation (SINC) or Regionally Important Geological Sites (RIGS) within 300m of the proposed Scheme alignment.

Soils

Agricultural Land Classification (ALC)

10.4.21 The majority of soils have impeded drainage. The drainage impediment is generally caused by the presence of poorly permeable clayey subsoils, which inhibit the downward movement of excess rainfall. During the winter months, and at times of high rainfall, the subsoils become anaerobic due to water saturation, and therefore exhibit characteristic colouring, gleying and mottling.

10.4.22 Local climatic factors have been interpolated from the Meteorological Office's standard 5km grid point data set for three representative locations along the route. Climatic factors are given in Appendix 10.1. The local climate has lower rainfall than is typical for much of lowland England and the area can be considered dry. Temperatures are moderately warm, to warm. The moisture deficits are relatively large and the Field Capacity Day regime is lower than average and can be considered favourable for arable cultivation. There is no overall limitation in ALC grading due to climate. Definitions of ALC classes are given in Appendix 10.2.

Existing Soils and ALC Data

10.4.23 The 1:250,000 scale soils map shows four soil associations to be present. The most extensive of these is the Evesham 3 Association, which occurs eastwards from Marston

Moretaine. These are mostly slowly permeable clays, usually calcareous, and are seasonally waterlogged.

10.4.24 The next most extensive mapping unit, found on the slightly higher ground south west of Marston Moretaine, is the Denchworth Association, which are mostly slowly permeable clays, occasionally calcareous, and are also seasonally waterlogged.

10.4.25 At Brogborough, there is a small area of Hanslope soils shown. These are slowly permeable, calcareous clayey soils.

10.4.26 At M1 J13 there is an area of Oxpasture Association, which are mostly fine loamy and clayey soils with slight seasonal waterlogging.

10.4.27 Evesham 3 Association covers low ground on Jurassic and Cretaceous clays, mainly in Cambridgeshire and Bedfordshire. The soils are mostly slowly permeable and clayey, usually calcareous and are seasonally waterlogged. They are formed in clay or mudstone bedrock which is patchily covered by thin drift. The Association is formed mainly by soils of the Evesham Series, but with significant amounts of the St Lawrence series, which are slightly coarser textured, and soils of the Denchworth series, which are generally wetter. The soils are variably calcareous, and in places can be very chalky. Evesham and Denchworth soils series have poorly permeable subsoils and are waterlogged in winter (Wetness Class III) (Soil Wetness is classified according to the depth and duration of waterlogging in the soil profile). The principal soils quickly become saturated in winter and rainfall runs off or passes laterally through the topsoil, due to their slowly permeable subsurface layers. The soils mostly have a moderate to high waterholding capacity, so in the dry climate of eastern England are slightly or moderately droughty.

10.4.28 The Denchworth Association is extensive on Jurassic and Cretaceous clays, such as the Oxford Clay, and consists mainly of wet clayey soils belonging to Denchworth and Lawford series, with lesser amounts of Oxpasture and Wickham soils. Denchworth soils are characteristically deep, stoneless, clayey, strongly mottled and waterlogged for long periods in winter. Lawford soils, though similarly clayey throughout, have stones and small inclusions of sand in the topsoil. The other associate soils also have clayey subsoils but have drier soil water regimes, being waterlogged in winter for short periods only. Oxpasture soils have clay loam upper horizons similar to those of Wickham soils, but Evesham soils have stoneless calcareous clayey topsoils. These slowly permeable soils are waterlogged for prolonged periods in winter and occasionally at other times of year after heavy rain, and are typically of Wetness Class IV.

10.4.29 Hanslope Association soils provide some of the most extensive cereal growing land in Midland and Eastern England, and are developed in chalky till on low plateaux and gently to strongly sloping valley flanks. The main soil series (Hanslope and Faulkbourne) are both clayey to the surface and have slowly permeable subsurface horizons, but they are seldom seriously waterlogged. The Hanslope series (which covers most of the Association in Bedfordshire) have a calcareous brownish subsurface horizon which passes downwards into a dense mottled substrate containing many chalk stones. The soils respond well to drainage and are seasonally or occasionally waterlogged (Wetness Class III or II). With moderately permeable upper horizons but restriction at depth, they have a moderate potential for winter rain acceptance. They are moderately or slightly droughty for cereals and moderately or very droughty for potatoes and grass.

10.4.30 Oxpasture Association are fine loamy over clayey, greyed argillic brown earths, accompanied by other greyed soils, such as Denchworth and Wickham series. All the main soils in this association have poorly permeable subsoils and are generally quite clayey, especially in the subsoil. The clayey subsoil inhibits the downward movement of excess rain and the soils are wet in the winter. Drainage in the winter months is by surface runoff or lateral movement through the topsoil, and they are typically Wetness Class II or III. They benefit from artificial underdrainage.

10.4.31 The Provisional ALC map shows all the agricultural land affected by the Scheme as Grade 3, with large areas of non-agricultural land shown for historic, actual and (at that time) potential areas of clay extraction. However, the Provisional map was made at a time when the ALC system was considerably less sophisticated than today (with the system having been revised fundamentally twice in the interim), was based on little direct field observation of soil properties, and provides only a very generalised guide to land quality. The maps do not differentiate between the subgrades in Grade 3, which has important policy implications with Subgrade 3a being amongst the best and most versatile land and Subgrade 3b described as only moderate quality land.

10.4.32 Several detailed ALC surveys have been undertaken in the locality by the Department for Environment, Food and Rural Affairs (Defra) or its predecessor, Ministry of Agricuture Fisheries and Food (MAFF). The locations of these surveys and their ALC gradings are shown on Figures 10.4.1 - 10.4.4. The maps show a preponderance of Subgrade 3b quality land in the area, with some Subgrade 3a.

Soils Survey Methods

10.4.33 159 soil profiles were examined using an Edelman (Dutch) auger and spade, or by examination of exposed soil faces. The locations of observations are indicated on Figures 10.5.1 - 10.5.4. Observation density on the agricultural land is greater than 1 site per ha. At each observation point the following characteristics were assessed for each soil horizon up to a depth of 1.2m or any impenetrable layer:

- Soil texture
- Significant stoniness
- Colour (including local gleying and mottled colours)
- Consistency
- Structural condition
- Free calcium carbonate
- Depth.

10.4.34 Five soil pits were dug to examine subsoil characteristics in detail, or observations made in archaeological trenches. Pit descriptions are given in Appendix 10.3.

10.4.35 Soil Wetness Class (WC) was inferred from the presence or absence of, and depth to, greyish and ochreous gley mottling and/or poorly permeable subsoil layers at least 150 mm thick.

10.4.36 Soil droughtiness was investigated by the calculation of moisture balance equations. Crop-adjusted Available Profile Water (AP) is compared to a calculated Moisture Deficit (MD) for the standard crops of wheat and potatoes. The MD is a function of potential evapotranspiration and rainfall. Grading of the land can be affected if the AP is insufficient to balance the MD. When a profile is found with significant stoniness, sufficient to prevent penetration of a hand auger, then it is assumed, for the purposes of calculating droughtiness, that the stoniness continues to the full 1.2 m depth considered. Droughtiness was not found to be a principal limiting factor in this survey.

10.4.37 Four topsoil samples were subject to laboratory analysis. Results, given in Appendix 10.4, indicate that topsoil textures are of heavy clay loam, or heavy clay. pH is slightly calcareous to neutral, and nutrient levels are typical of intensively farmed soils. Three samples were analysed from Pit 5; from the topsoil, subsoil and lower subsoil. The laboratory results show that calcium carbonate content increases significantly in the subsoil, with the lower subsoil being particularly chalky.

Main Limitations to Agricultural Land Quality

10.4.38 Assessment of quality has been carried out according to the MAFF revised guidelines (MAFF, 1988). The main factors affecting the classification of the land at this site are poor workability due to the clayey and heavy clay loam topsoils in combination with impeded soil drainage. The most commonly found combination is non-calcareous heavy clay loam topsoil with WCIII drainage, which limits the land to Subgrade 3b. In places the drainage may be slightly better, or the topsoil may be calcareous, or both, which then provides a limitation to Subgrade 3a.

10.4.39 Land of the following qualities was found. The distribution is shown on Figures 10.5.1 - 10.5.4 and summarised in Table 10.4, below.

Table 10.4 Agricultural Land Classification

ALC Grade	Definition	Location within Study Area
Subgrade 3a	Good quality land producing moderate yields consistently	Found mostly at the western end of the route in patches around M1 J13, and on Brogborough Hill; and at the eastern end around Elms Farm
Subgrade 3b	Moderate quality land producing moderate yields on a limited crop range	Found throughout the length of the route

Land Use

Existing Land Use

10.4.40 The Scheme would pass predominantly through agricultural land under a variety of agricultural crops and uses.

10.4.41 The main built-up areas through which, or close to which the Scheme would pass are Brogborough, Marston Moretaine, Lower Shelton, Wootton and Kempston.

10.4.42 The Scheme would pass to the south of Brogborough Landfill Site, to the north of Brogborough Lake, and to the north of Stewartby Lake and Landfill Site.

Historic Land Use

10.4.43 Reference to historic Ordnance Survey maps shows that a road was present on the route of the existing A421 prior to 1889. Table 10.5, below, presents the site history.

Table 10.5 Site History

Date	Scale	Significant Features
1889/1891 1901/1902 1927	1:10,560 1:10,560 1:10,560	<u>General</u> The site is dominated by agricultural land uses and mainly consists of fields and small areas of woodland. A road following the approximate line of the present A421 is indicated on the maps. The Cambridge and Bletchley branch of the London and North Western Railway (L&NWR) railway line is shown 700m to the southeast of the Scheme

Date	Scale	Significant Features
		at Ch.100 running in a west-to-east direction. The railway line crosses under the Scheme at approximate Ch.12300. Streams/ drainage channels A stream or drainage channel with a northerly flow direction is shown adjacent to the western boundary of the Scheme. A drainage channel / stream with a north-eastern flow direction is shown crossing under the proposed Scheme at approximate Ch.5700 then running along the same line of the Scheme approximately 100m to the south east of the road alignment. A drainage channel / stream crosses the Scheme at Ch.6700 and a further one at 9300. A stream is shown along the northern side of the proposed Scheme approximately 200m distance, that crosses under the proposed Scheme at approximate Ch.10600 this is then culverted under the road and railway line at Ch.12300. Gravel pits Old gravel pits are indicated 400m to the southeast of the road at a Ch. of 200, and 600m to the southeast of the Scheme at Ch.1800. Clay pits In the 1901 edition a clay pit located approximately 60m to the northwest of the Scheme and an associated brickworks 20m to the southeast of the Scheme are indicated to be present on the outskirts of the village of Lower Shelton at approximate Ch.6800. By 1927 the clay pit and brickworks are not marked, however brickworks with two small clay pits are located in the adjacent village of Caulcott 200m from the Scheme at Ch.7000. This is in the approximate location of Stewartby Lake. In 1902 two brickworks are indicated to be present along the line of the Bedford Branch of the L&NWR railway line approximately 1000m and 800m to the southeast of the site at approximate Ch.8400 and 9000. By 1927 the southern of the two brickworks has expanded massively in size and is labelled at the Pillinge Brickworks. Railway sidings, a tramway and an engine house are indicated to be associated with the brickworks along with large excavations. Two brickworks are located southeast from the proposed Scheme at Ch.13200. The brickworks and associated small pits are located 1000m (Hardwickhill Brickworks) and 800m (Elstow Brickworks) south of the proposed Scheme. By 1927 the brickworks and clay pits have expanded in size
1938 1938/1952 1960	1:10,560 1:10,560 1:10,560	General The farms have changed little over the years but the villages have increased in size. Clay pits A large pit is shown 100m to the south east of the Scheme alignment at Ch.2200 in the 1952 edition. A tramway runs from brickworks approximately 700m to the south east of the Scheme to the pit. Small excavations are indicated in the vicinity of the brickworks. By the 1960 edition the excavations are shown to have dramatically increased in

Date	Scale	Significant Features
		size and cover the area of the present Brogborough Lake. The alignment of the proposed Scheme is indicated to touch the edge of the excavation. Tramways are indicated around the edge of the excavation. Further tramways / railway lines are indicated to the south and east of the village of Marston Moretaine. By 1960 a very large clay pit is present on the northern side of the railway at Ch.7000 - 8000 extending to within 100m of the route of the proposed Scheme. This is the location of the present Stewartby Lake. The Pillinge brickworks have expanded and the village of Stewartby has been constructed between the village of Wootton Pillinge and the L&NWR railway line. The brickworks are now also located on the southern side of the railway line. A large number of chimneys are identified on the maps. A tramway / railway line is indicated between the present line of the A421 and the edge of the pit. Elstow brickworks have expanded in size again and excavations come within 250m of the proposed Scheme and fill the area between the Cambridge and Bletchley branch of the L&NWR railway line and the London and Midland Railway Line, which runs in a north to south direction.
1966/1969 1976/1982	1:10,560 1:10,560	<u>General</u> The M1 Motorway has been constructed adjacent to the west boundary of the Scheme with a motorway junction 400m to the South east of the Scheme. An oil storage depot is indicated 600m to the southeast of the site adjacent to the railway line. No further developments appear to have occurred within the Brogborough area. <u>Clay pits</u> The tramways / railway lines to the south and east of the village of Marston Moretaine are shown to be disused. Parts of the Elstow Clay pits have been backfilled.
1982/1983	1:10,560	<u>General</u> An electrical substation is located 100m to the south of the alignment at Ch.2200. A picnic site is indicated adjacent to the proposed Scheme line at Ch.1600. A number of drains are located across the area and seem to flow into Brogborough lake. An Electrical Substation is located adjacent to the present line of the A421 between Stewartby Lake and the clay pit at Ch.8000. Elstow Brook has been realigned to flow between Pillinge brickworks and Stewartby pit. <u>Clay pits</u> The brick pit at Brogborough has again increased in size and is now labelled as disused. The tramline has been replaced with a conveyor. A further four excavations are located to the north west of the Scheme at Ch.2400 - 3200 with associated tracks and conveyors. This is the present location of Brogborough Landfill Site. The brickworks associated with the Brogborouh clay pits have also expanded with

Date	Scale	Significant Features
		kilns and aerial ropeways noted on the map. The brickworks at Stewartby have again expanded and kilns and tanks are indicated. Stewartby Lake has been filled with water. A further large pit is located adjacent to the western side of the lake at Ch.8000 - 9100 and bounds onto Pillinge brickworks. Further backfilling of the Elstow Brickwork excavations have occurred.
1990 1995/1990 1999	1:10,560 1:10,560 1:10,560	General A sewage works is located 600m to the south of the site from Ch.600. The A421 has been constructed as a bypass to Kempston and is shown to cross over the Cambridge and Bletchley branch of the L&NWR railway line at Ch.12300. Clay pits The Brogborough brickworks area is shown to be disused. The northern part of the Stewartby clay pit is indicated to be backfilled with refuse. The Pillinge Brickworks is still present and has expanded with more kilns. Three pits are located to the southern side of the road, either side of the Cambridge and Bletchley branch of the L&NWR railway line. These are likely to be borrow pits for the construction of the road. Two are shown to be filled with water and one has been backfilled. The Elstow brickworks is shown to be disused and pits are shown to be partially filled with water.

Pollution Controls

10.4.44 According to the Envirocheck report there are two Local Authority Pollution Prevention and Controls (air pollution controls) within 250m of the Scheme alignment. This is for Marston Moretaine Service area and British Petroleum Express Shopping Ltd.

Discharge Consents

10.4.45 There are a number of discharge consents in the vicinity of the Scheme, and these are listed in Chapter 11, Road Drainage and the Water Environment.

Pollution Incidents to Controlled Waters

10.4.46 There have been a number of reported pollution incidents to controlled waters, and these are also listed in Chapter 11, Road Drainage and the Water Environment.

Registered Radioactive Substances

10.4.47 There are five licenses for registered radioactive substances within 250m of the Scheme. These all belong to Casella Cel Ltd and were for the keeping and use of mobile radioactive sources of less than or equal to 4 Terabecquerels, (B19 and B20, on Figure 10.1.2).

Waste Management Facilities Records

10.4.48 The Envirocheck database search revealed that there are two British Geological Survey (BGS) Recorded Landfill sites, three Licensed Waste Management Facilities (Landfill Boundaries) and three Waste Management Facilities (Locations) within 250m of the site. Table 10.6, below, presents the information.

Table 10.6 Landfill Data

Type of landfill	Name	Location	Features and Observations	Distance Chainage and Direction From Scheme	Envirocheck Reference Number
BGS Recorded Landfill Site and Licensed Waste Management Facility	Shanks Waste Services (now Waste Recycling Group Limited) Brogborough Landfill Site	Brogborough Landfill, Woburn Road, Brogborough	Maximum input – Large, equal or greater than 75,000 tonnes per year Co Disposal landfill site	Immediately north of Scheme at Ch.2400 to 700m of Scheme at Ch.4200	A10, A11, A12
BGS Recorded Landfill Sites and Licensed Waste Management Facility	London Brick Land Ltd. Bedfordshire CC – Elstow Landfill Site A6	Elstow Landfill Site, A6, Wilstead Road	Maximum input – Large, equal or greater than 75,000 tonnes per year Household, Commercial and Industrial Waste Landfills	120m Southeast at Ch.13600 to 600m at Ch.13000	B22, B24
Licensed Waste Management Facility	Shanks Waste Services (now Waste Recycling Group Limited): Field Stewartby	L Field, Green Lane, Stewartby	Maximum input – Large, equal or greater than 75,000 tonnes per year Household, Commercial and Industrial Waste Landfills	70m Southeast at Ch.9300 to 250m at Ch.8000	B23
Licensed Waste Management Facility	Universal Salvage Ltd	Acrey Fields, Woburn Road, Wootton	Metal Recycling Sites (Vehicle Dismantlers)	140 Southeast, Ch.8000	B25

Trade Directories and Fuel Station Entries

10.4.49 According to the Envirocheck report there are forty-five contemporary trade directory entries (i.e. potentially polluting facilities) within 250m of the Scheme and two petrol filling stations. Table 10.7, below, presents a list of those within 100m of the site and a selected list of those within 250m.

Table 10.7 Trade directory and fuel station entries

Site Name	Location	Classification	Status	Distance Chainage and Direction from Scheme	Map ID
Total Fina Service Station	Beancroft Road, Marston Moretaine	Garage Services	Active	30m Southeast, Ch.5900	A53/ 60
Reetawse Ltd	53 Lower Shelton Road	Engineers – General	Inactive	130m Northwest Ch.6900	A54
Marston Panel Craft	Unit 1 Beancroft Road, Marston Moretaine	Car Body Repairs	Active	150m Northwest Ch.6000	A55
Highfield Pet Foods	Highfield Bungalow, Bedford Road, Marston Moretaine	Pet Foods and Animal Feeds	Active	170m Southeast Ch.900	A56
J&K Lawnmower	153 Bedford Road, Marston Moretaine	Lawnmowers & Garden Machinery	Active	170m Southeast Ch.6900	A57
NMT Plant Hire	Pylon House, Bedford Road, Marston Moretaine	Crane Hire, Sales and Service	Active	170m Southeast Ch.6900	A58
Shanks	Brogborough Landfill Site	Waste disposal services and gas extraction	Inactive	200m Southeast Ch.1100	A59
Shanks	14 Railton Road, Kempston	Waste Disposal Services	Active	30m Northwest Ch.12000	B168
Arcade UK Ltd	16 Railton Road, Kempston	Temperature Monitoring Systems Manufacture	Active	20m Northwest Ch.11900	B169
M & M International (UK) Ltd	Railton Road, Kempston	Valve Manufacturers and Suppliers	Active	20m Northwest Ch.11900	B169
Instinctive Trade Technology	8-9 Railton Road, Kempston	Medical Equipment Maintenance and Repairs	Active	20m Northwest Ch.11900	B169
RIFD	Wolseley Road, Kempston	Electronic Component manufacturers and Disrupters	Active	40m Northwest Ch.11800	B170

Site Name	Location	Classification	Status	Distance Chainage and Direction from Scheme	Map ID
The Hobart Manufact-uring Co Ltd	Wolseley Road, Kempston	Catering Equipment	Active	70m Northwest Ch.11900	B171
John Arnold Commercial Ltd	Unit 5, Wolseley Road, Kempston	Commercial Vehicle Servicing , Repairs, Parts and Accessories	Active	130m Northwest Ch.11900	B173
Valmet Atlas Plc	Wolseley Road, Kempston	Engineers General	Active	150m Northwest Ch.12300	B175
Class 47 MOT Centre	2 Sunbeam Road, Kempston	MOT Centres	Active	130m Northwest Ch.12100	B176
Cranfield Electrical Ltd	Adams Close, Kempston	Cable & Wire Equipment Manufacturers	Active	180m Northwest Ch.12200	B177
Universal Salvage Ltd	Acrey Fields, Woburn Road, Wootton	Car Dealers	Active	200m Southeast Ch.7900	B178
HA Boyse & Son	Unit 7 Singer Way, Kempston	Road Haulage Services	Active	200m Northwest Ch.11800	B179
Clydesdale Ltd	3 Sunbeam Road, Kempston	Metal Workers	Active	200m Northwest Ch.12200	B183
Bedford Connect	Elstow Junction	Petrol Station	Active	30m Southeast Ch.13400	B193

Known and Potential Sources of Contamination

10.4.50 Potential sources of contamination have been identified during site walkover surveys and by reference to the data sources and documentation listed in Section 10.4. Potentially contaminative land uses are detailed in the sections below.

Landfills

10.4.51 Several landfill sites are located within 250m of the Scheme. The information is summarised in Table 10.6, above.

10.4.52 Brogborough Landfill Site currently receives about 2.0 million tonnes of waste per annum and is operated by planning permission no. 16/2004. This planning permission requires tipping to cease by 31 January 2008, with restoration to be completed by the end of the year. Details of the site history were collected for the purposes of the current Integrated Pollution Prevention and Control (IPPC) permit for the site and are summarised below.

10.4.53 Before development the land was used for agriculture. Clay extraction for brick making was carried out at Brogborough for much of the 20th century and was worked most recently (1956–1981) by London Brick Company Ltd. Excavation took place to depths of about 25 to 30m, mainly through weathered Oxford Clay (Callow), but also into unweathered Oxford Clay (Knotts). Following excavation, some of the areas excavated, especially in the south, were backfilled with spoil, reject bricks and other materials. Some of the ancillary buildings of the brickworks were built over the reclaimed land. Landfilling commenced in January 1983 into an initial void space of $23Mm^3$ Landfill disposal was mainly undertaken by London Brick Landfill Limited. London Brick Landfill Limited was purchased by Shanks McEwan Waste during April 1986 (subsequently Shanks Waste Services Ltd) and, since June 2004 Waste Recycling Group Limited (WRG) have operated the site and the extension.

10.4.54 Historically, Brogborough Landfill Site Waste Management Licenses permitted the deposits of household, commercial and industrial wastes including difficult and special wastes. Under the landfill directive, the site has operated as a landfill taking non-hazardous waste since July 2004. Total waste movements are restricted to a maximum of 700 inward vehicle movements per day.

10.4.55 WRG own and operate all three major non-hazardous waste landfill sites in Bedfordshire (at Brogborough, Stewartby and Arlesey) and a further prospective landfill site at Elstow.

10.4.56 Stewartby Landfill Site suspended operations in 2005, but resumed in 2006. The site was licensed to accept household, commercial and industrial waste. Stewartby had a pre-settlement waste void (as of 01.01.05) of $1.10Mm^3$. There is a possibility of further mineral extraction to be undertaken at Stewartby which would increase landfill capacity by around $1Mm^3$ and defer closure until 2012, depending on the rate of filling.

10.4.57 WRG owns a former clay extraction site at Elstow. This site has been the subject of an application for planning permission to develop a $5Mm^3$ landfill facility, but the application was withdrawn.

10.4.58 Some of the other former clay pits and borrow pits along the line of the Scheme have been partially in-filled with unknown materials or have been turned into lakes. These are located around Marsh Leys and the railway line crossing of the A421.

Petrol Stations and other Trades

10.4.59 With reference to Table 10.7, above, it is considered that, because of the types of business, their distance from the Scheme, and the fact that the Scheme is on embankment when close to the majority of them, that only the two petrol stations (refs A53/60 and B193), below, and the landfills described above are likely to have the potential to be significant sources of contamination. These two petrol stations are located within 250m of the proposed Scheme alignment;

- Total Petrol Station on Beancroft Road, Marston Moretaine, approximately 30m to the south of the Scheme at Ch.6000
- Connect Petrol Station, Elstow Junction with the A6, approximately 30m to the south of the Scheme at Ch.13400.

10.4.60 An enquiry was made to Bedford County Council Trading Standards Office, Petroleum Licensing Officer concerning the age, location, type and capacity of the tanks on site and whether there had been any recorded leaks or spills. The Tables 10.8 and 10.9, below, present a summary of the information received. Copies of the relevant drawings and correspondence is located in Appendix 10.5

Table 10.8 Fuel Tanks at Marston Moretaine Services

Tank Number	Tank Size	Fuel Type	Tank Construction	Date of Installation	Testing
1	26,384 Litres	Unleaded	Double skinned steel	1998	None Recorded
2	17,460 Litres-	Excellium diesel	Double skinned steel	1998	None Recorded
3	26,384 Litres	Unleaded	Double skinned steel	1998	None Recorded
4	17,460 Litres	Diesel	Double skinned steel	1998	None Recorded
5	26,384 Litres	Excellium diesel	Double skinned steel	1998	None Recorded
6	17,460 Litres	Unleaded	Double skinned steel	1998	None Recorded
7	26,384 Litres	Diesel	Double skinned steel	1998	None Recorded

10.4.61 There is one entry on the Petroleum Licensing computer system referring to a problem with a leaking pipe between diesel tanks 5 and 7 at Marston Moretaine having been corrected in 1997..

Table 10.9 Fuel tanks at Elstow Junction Services

Tank Number	Tank Size	Fuel Type	Tank Construction	Date of Installation	Testing
1	47,500 Litres	Unleaded	Double skinned steel	1998 / 1999	None Recorded
2	28,500 Litres	Ultimate Unleaded	Double skinned steel	1998 / 1999	None Recorded
3	19,000 Litres	Ultimate Diesel	Double skinned steel	1998 / 1999	None Recorded
4	47,500 Litres	Diesel	Double skinned steel	1998 / 1999	None Recorded
5	47,500 Litres	Diesel	Double skinned steel	1998 / 1999	None Recorded
6	11,050 Litres	LPG	Double skinned steel	2001 / 2002	None Recorded

10.4.62 The petrol stations represent potential sources of soil and groundwater contamination by hydrocarbons, which could have occurred through historic or recent leakages from underground tanks/ pipework, or spillages of fuel or oil.

Railways/Roads

10.4.63 The Scheme would pass above an active railway line on the southern side of Kempston (the current A421 passes over the railway line on a single carriageway road) and terminates just short of another railway line to the west of the A6 Junction.

10.4.64 Both active and former railway lines may be sources of contamination. Contamination of railway land can occur in two ways: where on embankment, the fill may have already contained contaminants when placed (Intrinsic) or it may have become contaminated by operational railway use. Possible contaminants include heavy metals, phenols, sulphates, Polycyclic Aromatic Hydrocarbons (PAH's). Other general railway operations may have given rise to contamination of the site from the use or disposal of ash, clinker, ballast, timber sleepers, herbicides, transfers, cabling, paints and asbestos. The potential for existing significant contamination beneath the Cambridge and Bletchley branch of the L&NWR railway line operational railway bridge is considered to be unlikely.

10.4.65 It is noted that the existing A421, and any other roads crossed by the Scheme, also have the potential to cause contamination, either due to accidental/emergency spillages, or from heavy metals and the discharge of road runoff.

Landfill Gas

10.4.66 The Brogborough and Stewartby landfill sites are used for the depositing of domestic refuse and, as such, can give rise to large volumes of landfill gas. Extensive gas monitoring has been undertaken at both landfill sites and low levels of landfill gases external to the site were identified during monitoring. Therefore there is a possibility of gas accumulating in confined spaces within the vicinity of both sites.

Future Conditions (2011) – Without the Scheme

10.4.67 The conditions for geology and soils in Planning Year 2011 may differ from current conditions should:

- Any land be designated Contaminated Land under Part IIA;
- Any new locally important geological/geomorphological sites (RIGS/SSSI) be identified; and/or
- The current status of existing landfills in the area changes.

10.4.68 The local authorities are currently implementing their contaminated land strategies, and therefore it is possible that selected sites identified in Section 10.4 may become designated contaminated land sites under Part IIA by 2011.

10.4.69 The Bedfordshire and Luton Geological Group are currently undertaking an inventory of the county as part of the Local Geology Action Plan Audit. This will include identifying new RIGS sites, some of which may fall within the Scheme area.

10.4.70 Brogborough Landfill Site is currently scheduled to close in January 2008. However, a planning application was made to surcharge most of the site by placing another layer of waste on top of the existing landfill to create approximately 4.5 million cubic metres of additional presettlement void. This application was rejected, and an appeal was refused by the Inspector for the Secretary of State in December 2006. Stewartby Landfill Site has a possible completion date of 2010. However closure could be delayed to 2012 by additional mineral extraction, which would increase available void space.

10.4.71 By 2011 the soil resources within the Scheme area may have been impacted by other transport and development schemes in the area. This may result in less available agricultural land within the Scheme area.

Future Conditions (2026) – Without the Scheme

10.4.72 As with the conditions to 2011, the conditions for geology and soils in 2006 may have altered with regard to new contaminated land designations, new RIGS/SSSI sites, changes in the amount of agricultural land, and changes to the status of existing landfill sites.

10.5 Mitigation and Detailed Development of the Scheme Design

Mitigation Measures Included in Scheme Design

10.5.1 Ground investigations were undertaken in November 2005. Results indicate that material generated by the Scheme from the cuttings at Brogborough and Marston Junction could be reused as fill during road construction. It is thought that Oxford Clay could be used for the embankment cores whereas glacial material from the Brogbourgh cutting could be used as a mantle where steeper embankments slopes are required since glacial till has a higher angle of friction than Oxford Clay. Material generated elsewhere (e.g. topsoil) is also considered suitable for reuse on site. Cutting and embankment slopes will be designed such that they are stable.

10.5.2 A further detailed site investigation is to be carried out during 2007/8. The investigation will include contamination testing, targeted at potential sources of contamination, in particular in the vicinity of Stewartby and Brogborough landfill sites (including gas monitoring), Marston Moretaine and Elstow Junction Service Stations, and around Kempston where there could be problems arising due to the proximity of a number of contemporary trades. As is usual, detailed mitigation measures will be designed at the detailed design stage.

Other Mitigation Objectives to be adopted during Scheme Construction

10.5.3 Mitigation objectives would be required during the Scheme construction phase in order to provide measures to address potential impacts on soils and geology, and/or impacts associated with the known or unexpected presence of ground contamination. In particular, the following mitigation objectives would be implemented:

- The minimisation of adverse effects on sensitive receptors associated with excavation and disposal of potentially contaminated material
- The minimisation of adverse effects associated with any potential hydrocarbon contamination, and with any other unexpected contamination from roadside spillages encountered during the works
- The minimisation of potential contamination of underlying soils at construction sites and compounds, for example, during storage of construction materials, fuels, oils or excavated soils; and
- Routine testing of soils during the ground works phase to confirm material suitability.

10.5.4 General mitigation measures are identified within the outline Construction Environmental Management Plan (CEMP). Particular measures relating to the above requirements are identified in the sections below.

Soil Conservation Measures

10.5.5 Topsoil and subsoil would generally need to be removed during construction in order to prevent permanent burial beneath other earthworks. Such soils would be stockpiled and reused for the Scheme's beneficial landscaping, either within or outside the Scheme. In particular, topsoil excavated from areas of known Grade 3a quality agricultural land would be stored separately and, where possible, would be reused on-site in areas to be landscaped, or in areas that would be regraded and returned to agricultural use. The effects on soil resources would be mitigated by employing high standards of soil handling and management during construction, and by avoiding the creation of bare areas of permanently exposed soil that would be vulnerable to erosion processes.

10.5.6 Topsoil stripped during Scheme construction would be reused as soon as practicable, and stored in such a way as to minimise structural damage from weathering, trafficking and multiple handling. Soil would also be stored in a manner that minimises the leaching of nutrients, whilst measures would be taken to protect soils from accidental contamination while in storage or in transit. Prior to the onset of construction activities, a method statement that details methods of soil handling and storage, including measures to prevent erosion by both wind and surface water, would be prepared.

10.5.7 Some land taken during the construction phase would be restored for agricultural uses following the completion of the works. The restoration of these areas would take the guidance provided in MAFF's 'Good Practice Guide for Handling Soils' (2000) into account. In particular, such agricultural areas would be restored to an ALC quality equivalent to, or better than, that before disturbance.

10.5.8 Particular care would be taken with respect to the reuse of topsoil and subsoil stripped from ecologically sensitive areas. Such material may serve as a valuable seed bank.

Handling and Disposal of Potentially Contaminated Material

10.5.9 Should contamination be identified in soils or groundwater, excavated material generated during the construction phase may require, in the absence of a suitable remediation technique, transport off-site for disposal at a suitably licensed landfill site. Potential effects on construction workers, the surrounding land use and on potentially sensitive receptors along the disposal route would be minimised by the adoption of appropriate control measures as follows:

- Use of impermeable ground sheeting and bunding beneath temporary stock-piles in order to prevent contamination of underlying ground, or storage of contaminated material in appropriate containers
- Use of appropriate dust control measures to prevent contamination of surrounding land via wind-blown dust (e.g. use of water [from a raw water source where possible] for dowsing to suppress dust, use of covered skips, and sheeting of lorries used to transfer contaminated soil)
- Use of personal protection equipment to avoid worker contact with contaminated materials.

10.5.10 In areas where there is the potential to encounter ground contamination during excavation, an environmental chemist/scientist would be present on-site to advise on any contamination if encountered during the excavation works, and to arrange for testing of excavated material. Suspected contaminated material would be stored in such a way as to prevent contamination of clean areas. Any waste soil materials, including contaminated material, would be disposed of in accordance with the following legal requirements, where appropriate:

- Waste Management Licensing Regulations 1994 (as amended)
- Control of Pollution (amendment) Act 1989
- Controlled Waste (Registration of Carriers & Seizure of Vehicles) Regulations 1991 (as amended)

- Landfill (England & Wales) Regulations 2002 (as amended)
- Controlled Waste Regulations 1992
- Hazardous Waste (England & Wales) Regulations 2005
- Lists of Wastes (England) Regulations 2005; and
- Environmental Protection (Duty of Care) Regulations 1991 (as amended).

10.5.11 Specific measures to protect water resources and drainage are referred to in Chapter 11: Road Drainage and the Water Environment.

Demolition Works

10.5.12 Two buildings would be demolished during the construction of the Scheme along with some sections of the existing A421 close to Brogborough Lake, near to Marston Moretaine, and between Marsh Leys Junction and the A6. The buildings consist of an old building used as a sheep shed just west of the M1 junction, and a building connected with Brogborough Landfill Site; a bungalow that has been used as an office. Asbestos type 1-3 surveys would be undertaken on a building-by-building basis. Removal of asbestos, if found, would be completed by a licensed contractor and be disposed of at a licensed landfill, prior to demolition of the buildings.

Environmental Management of Construction Compounds

10.5.13 The CEMP details measures that would be undertaken in order to prevent or minimise potential adverse impacts associated with construction compounds. This relates in particular to potential impacts upon surface water, groundwater and local air quality. Activities include appropriate storage of raw materials and excavated material, storage of fuels, oils and other liquid chemicals, refuelling and maintenance of construction vehicles, vehicle movements and waste management practices. Good site practice measures would be adopted in order to control emissions and to minimise the potential for pollution, taking into account, where appropriate, relevant guidance produced by the Environment Agency (EA)

Soil Stabilisation

10.5.14 Soil stabilisation, as a treatment for earthworks, is likely to form part of the Scheme. Soil stabilisation could have the potential to reduce the amount of capping material that would need to be imported to site. Given this potential, the sections below consider some of the actions that would be taken to minimise the potential environmental impacts of soil stabilisation treatment should it be required.

10.5.15 The environmental impacts of soil stabilisation are of particular importance for ecology (including flora and fauna) and groundwater resources. Most of the soils at the site are neutral, or only slightly acidic or alkaline. Contamination of the landscape soils (topsoil and subsoil) by lime or cement dust could cause a rise in pH level, and an increase in calcium concentrations. As such, it is important to ensure that the soil stabilisation process does not allow contamination of soils that are to be used for landscaping or soils in areas surrounding the site. A full environmental risk assessment would need to be performed if soil stabilisation is required. It would incorporate bench trials undertaken by soil stabilisation contractors.

10.5.16 The main pathways for lime/cement dust contamination are considered to be from either:

- Direct contact by lime/cement dust during lime spreading through inhalation of dust, ingestion or dermal contact (short term)

- Release of lime-rich leachate percolating into soils (in both the short and long term).

10.5.17 In order to minimise such potential effects, a range of mitigation measures could be applied during the works (should such works be required). These are detailed in Table 10.10.

Table 10.10 Potential Lime and Cement Stabilisation Mitigation Methods (if required)

Risk	Action
During Construction	
1. Dust generated during mixing causing contamination	• General good construction practice, use of appropriate plant and care in workmanship
2. Contamination of groundwater by leachate from treated materials	• Leaching tests and field trials to fully characterise site materials and their behaviour; selection of appropriate testing • Testing to analyse leachate chemistry both before and after placement of the treated materials • Pre-earthworks drainage construction to be completed prior to stabilisation operations • Rapid earthwork construction • Protection of earthworks from excessive ingress of water during construction (i.e. normal procedure of compaction of layer with cross-fall at end of each day) • Treatment of collected leachate prior to controlled discharge and monitoring
3. Alkaline leachate increasing the alkalinity of the soil and groundwater environment, impacting on local ecology	• As 2 above
4. Leachate causing changes to the groundwater chemistry impacting upon drinking water supplies	• As 2 above

Risk	Action
Long Term	
5. Contamination of groundwater by leachate from treated materials	• Leaching tests and field trials to fully characterise the site materials and their behaviour, selection of appropriate testing • Testing to analyse leachate chemistry both before and after placement of the treated materials • Placement of fill material beneath road pavement and appropriate thickness of more cohesive landscape fill on the embankment shoulders to reduce leachate volume • Treatment of collected leachate prior to controlled discharge and monitoring • Validation of performance of drainage and PRB equivalent by periodical monitoring of discharge
6. Alkaline leachate increasing the alkalinity of the soil and groundwater environment, impacting on local ecology	• As 5 above • Include groundwater monitoring as part of ecological and soil chemistry monitoring
7. Blocking of drainage by precipitation of calcium carbonate from leachate	• Monitoring and maintenance of drainage layers and collection vessels

10.5.18 With regard to dust generation, modern methods of soil stabilisation practice have been developed to minimise, or even eliminate, the problem. In addition, the methods highlighted in Table 10.10, above, mean that the potential for leachate generation would be low.

10.5.19 In addition to the measures to be undertaken in order to minimise dust generation and leachate generation for health and safety and environmental purposes, the following specific measures would be adopted to minimise contamination:

- Lime/cement dust would not be handled or stored on or adjacent to topsoil, subsoil or landscape fill areas or stockpiles, in order to minimise the risk of direct contact
- Waste lime and lime-treated waste soils would not be placed (or temporarily stored) onto any landscape soils, including landscape fill areas or topsoil stockpiles
- Lime-treated soils would not be placed within approximately 1m of the finished levels in all landscape areas (approx. maximum depth of most tree roots).

10.5.20 In conclusion, through the adoption of the methods highlighted above, risks to the environment associated with lime stabilisation are considered to be low. As such, should such a soil treatment technique be deemed applicable, associated adverse environmental effects are not anticipated.

10.6 Environmental Effects

Reuse of Excavated Material

10.6.1 There would be a two main cuttings within the Scheme alignment as follows:

- Brogborough Hill Cutting, Ch.800 - 2000
- Marston Junction, Ch.5700 - 6300.

10.6.2 In addition, there would be cuttings associated with underbridges, slip roads and link roads.

10.6.3 It is estimated that approximately 2.3 million m^3 of material (including topsoil) would be excavated along the route alignment It is anticipated that all of this material would be reused for general fill in embankments and for landscaping/ regrading purposes.

Landfill sites

10.6.4 Based on contamination results from exploratory holes completed in proximity to the landfill sites, but outside the landfill boundary, contamination is not expected to be significant, but further investigation will be completed as identified in paragraph 10.5.2.

Petrol Stations

10.6.5 The petrol filling station at the Elstow junction is located approximately 30m from the line of the proposed Scheme within an area where the Scheme is located on an embankment. It is therefore considered that unless deep excavations are to take place within the vicinity of the petrol station that hydrocarbon contamination is unlikely to be significant. With regard to the petrol filling station at Beancroft Services, which is located approximately 30m from the edge of the Scheme, the new road alignment would be within a cutting in the vicinity of the petrol station where a leak has previously been noted on the site. Therefore there is the potential for fuel or oil to be encountered in the excavations. The likelihood of encountering significant contamination is considered to be minor due to the nature of the subsoil and its ability to attenuate pollutants and the limited water flow to disperse any pollutants present. However, if hydrocarbon contamination is encountered, it could affect the road infrastructure (e.g. through chemical attack on plastic pipes or cabling), affect construction operations (e.g. release of asphyxiative/explosive vapours) or cause pollution of water resources, if not removed. Provided that the mitigation measures described in Section 10.5 are implemented, the magnitude of any residual impacts would be minor. Removal or treatment of contamination to acceptable levels would potentially result in a beneficial effect on soils, geology and water resources. An investigation will be carried out to establish the levels of any contamination as identified in paragraph 10.5.2.

Other Potentially Contaminated Sites

10.6.6 The Scheme passes close to industries, which have the potential to be a source of contamination. Contamination is not expected to be significant but further investigation will be carried out as identified in paragraph 10.5.2, and suitable detailed mitigation proposed, if necessary.

10.6.7 The Scheme passes close to several partially infilled borrow pits. It is thought that these are infilled with reworked clay and are unlikely to be a significant source of contamination. However further investigation will be carried out as identified in paragraph 10.5.2, and suitable detailed mitigation proposed, if necessary

10.6.8 The main construction compounds and site offices would be located in the vicinity of Highfield Farm at Ch.400, and adjacent to Stewartby Landfill Site between Ch.7900 and

9300. Other smaller construction compounds would be located in the vicinity of proposed structures. The storage and maintenance of construction plant on these sites, together with the storage of construction materials, fuels and oils, have the potential to result in localised ground contamination due to spillage or leakage. Stockpiling of excavated material, particularly if contaminated, also has the potential to cause localised ground contamination, and precautions would be necessary to avoid contact of such materials with the natural ground. Movements of construction plant within construction compounds could also compact underlying soils and temporarily destroy any vegetative cover. Potential impacts on soils associated with construction compounds would be minimised by the implementation of mitigation measures defined in the CEMP, as summarised above. Any residual impacts are likely to be no more than minor.

10.6.9 The area of the Main Construction Compound adjacent to Stewartby Landfill Site has the potential to be affected by landfill gas. Limited monitoring has been carried out between the present line of the A421 and the proposed line. Concentrations of CO_2 from BH31 and BH33 (HA Report D1098331-P1A-ENV-R003, paragraph 10.4.13) completed by Fugro show a maximum concentration of 1.9% by volume during gas circulation testing with a maximum initial concentration of 6.8% CO_2 by volume.

10.6.10 Due to the presence of landfill gas there is a possibility of gas accumulating in confined spaces such as buildings and containers placed within this area. A site investigation will be undertaken, including gas monitoring, and subsequently a risk assessment will be completed for this area for its intended use. Detailed design of any gas protection measures for proposed structures to be placed within this area will be completed.

Demolition Works

10.6.11 Two structures would be demolished due to the Scheme. Provided the asbestos surveys are carried out, and, if found, asbestos removal is undertaken prior to demolition there are unlikely to be contamination issues caused by the demolition of the buildings. There are unlikely to be contamination issues caused by the removal of sections of the existing A421. Such work would be carried out in accordance with the CEMP.

Effects on Geological/Geomorphological Features

10.6.12 No geological/geomorphological features of significant interest would be directly or indirectly affected by the Scheme.

Effects on Agricultural Soils

10.6.13 The Scheme would require the loss of predominantly lower quality agricultural soils (Subgrade 3b) though some higher grade soils (Subgrade 3a) would also be affected. Table 10.11, below, shows the predicted impacts on agricultural soils.

Table 10.11 Potential Impacts upon Agricultural Soils (ha)

	Construction Phase Landtake (ha)	Area Restored (ha)	Residual Land Take (ha)
Subgrade 3a	20.1	3.2	16.9
Subgrade 3b	110.2	13.7	96.5
Total	130.3	16.9	113.4

10.6.14 As indicated in Chapter 6: Land Use and Agriculture, the permanent loss of about 17ha of Subgrade 3a land and 96ha of Subgrade 3b land is considered to be a **moderate adverse** effect.

10.6.15 As described in paragraphs 10.5.5 - 10.5.8, during the Scheme construction phase, soil management measures would be adopted such that soil resources would not be damaged through inappropriate handling of in wet conditions.

Effects on Mineral Resources

10.6.16 Several plots of land along the length of the Scheme are designated to be areas of permitted mineral extraction, subject to planning permission. Table 10.12, below, shows the areas affected.

Table 10.12 Areas of Land with Mineral Rights

Chainage	Title Number	Land Owner/ Leaseholder	Distance and direction from Scheme
2100 – 2200	BD209629	St James Property Ltd	40m southeast
2100 – 2400	BD209629 f/h	St James Property Ltd	Onsite
2100 – 4100	BD209629 f/h	St James Property Ltd	20m southeast
3200 – 4100	BD209631 f/h	St James Property Ltd	Onsite
8500 – 8700	BD209619 f/h	St James Property Ltd	Onsite

10.6.17 The Scheme would pass through approximately 1400m of land from which there is the potential for mineral extraction. The Highways Agency would purchase any rights to minerals, with the land.

Effects of Operation

10.6.18 Scheme operation is not anticipated to result in significant effects in terms of geology and soils. Chapter 11: Road Drainage and the Water Environment considers the environmental risks associated with spillages due to road accidents.

Maintenance Issues

10.6.19 Landfill gases have been identified in the vicinity of the Scheme close to the landfill sites. There is the possibility that landfill gas could accumulate within confined spaces where the Scheme is located close to the landfill sites. Any enclosed spaces that require entry within the vicinity of the landfill sites may require gas monitors to be worn by personnel both during construction and subsequent maintenance.

Significance of Effects

10.6.20 The significance of the effects relating to geology and soils have been determined on the basis of the criteria presented in Table 10.1, Table 10.2 and Table 10.3, and are summarised in Table 10.13, below. The magnitude of potential residual effects, and hence their significance, assumes that the mitigation measures described in Section 10.5 are implemented.

Table 10.13 Significance of Residual Effects

Source of Contamination	Feature/ Receptor	Importance/ Sensitivity of Receptor	Magnitude of Impact (without mitigation)	Residual Impact (following implementation of mitigation)	Significance of Residual Effect
Petrol Stations at Beancroft and A6 junction	Road infrastructure Water resources/soils Site workers	Medium/ High	Moderate	Negligible	Insignificant *
Industries	Road infrastructure Water resources/soil Site workers	Medium/ High	Moderate	Negligible	Insignificant *
Brogborough and Stewartby Landfill Sites	Road infrastructure Water resources/soils Site workers	Medium/ High	Moderate	Minor	Insignificant *
Construction compounds, construction sites	Surrounding land uses – rural Water resources/soils	Medium/ High	Moderate	Minor	Insignificant
Infilled clay pits	Road infrastructure Water resources/soils Site workers	Medium/ High	Minor	Minor	Insignificant *
None	Geological / geo-morphological features	N/A	N/A	N/A	N/A
None	Best and most versatile land take (ALC Grade 3a)	Medium	Moderate	Moderate	Moderate Adverse
None	Other agricultural land (ALC Grade 3b)	Low	Moderate	Moderate	Insignificant

Source of Contamination	Feature/ Receptor	Importance/ Sensitivity of Receptor	Magnitude of Impact (without mitigation)	Residual Impact (following implementation of mitigation)	Significance of Residual Effect
None	Mineral resources	Low	Minor	Minor / Negligible	Insignificant

* Potential beneficial residual effect due to contamination removal
N/A not applicable

10.7 Summary

10.7.1 A number of potential impacts that may give rise to environmental effects related to soils and geology have been identified. The main effects are those associated with soil quality and with areas of known or potential ground contamination, particularly from Brogborough and Stewartby landfill sites where there is the potential for soils and groundwater to be contaminated. The magnitude of all potential impacts would be reduced or minimised by the implementation of mitigation measures described in Section 10.5. Residual impacts would largely be of a level between **minor and negligible**. The removal of contaminated material, or the treatment of material on-site using applicable remediation techniques, would not give rise to a significant effect, but would have the potential to result in a **beneficial effect** on surrounding land use.

10.7.2 The Scheme would result in the permanent loss of about 17ha of best and most versatile agricultural land (i.e. Subgrade 3a land) and about 96ha of moderate quality Subgrade 3b land. This is considered to be a **moderate adverse** effect. Further details are provided in Chapter 6: Land Use and Agriculture.

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British Geological Survey Map Sheet 203, Bedford (Drift), 1900, 1:63360, and the associated geological memoirs

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Department of Trade and Industry (2001), *BRE Special Digest 1: Concrete in Aggressive Ground*

DETR / Defra (2002 – 2003), *Contaminated Land Reports 7 to 11*

East of England Assembly (2004), *Regional Spatial Strategy for the East of England*

Appendix 10.1 Agro-Climatic Factors

Appendix 10.1 Agro-Climatic Factors

	Eastern end of route TL026463	Mid point of route TL005430	Western end of route SP960376
Elevation	29m	37m	81m
Average annual rainfall (AAR)	577mm	579mm	602mm
Accumulated temperature > 0°C (AT0)	1,451 day°	1,444 day°	1,397 day°
Field Capacity Day regime (FCD)	101 days	105 days	121 days
Average moisture deficit, wheat (MDw)	119mm	119mm	110mm
Average moisture deficit, potatoes (MDp)	115mm	114mm	103mm

Appendix 10.2 Descriptions of the Grades and Subgrades

Appendix 10.2 Descriptions of the Grades and Subgrades

The ALC grades and subgrades are described below in terms of the types of limitation which can occur, typical cropping range and the expected level and consistency of yield. In practice, the grades are defined by reference to physical characteristics and the grading guidance and cut-offs for limitation factors enable land to be ranked in accordance with these general descriptions. The most productive and flexible land falls into Grades 1 and 2 and Subgrade 3a and collectively comprises about one-third of the agricultural land in England and Wales. About half the land is of moderate quality in Subgrade 3b or poor quality in Grade 4. Although less significant on a national scale such land can be locally valuable to agriculture and the rural economy where poorer farmland predominates. The remainder is very poor quality land in Grade 5, which mostly occurs in the uplands.

Descriptions are also given of other land categories which may be used on ALC maps.

Grade 1 -excellent quality agricultural land

Land with no or very minor limitations to agricultural use. A very wide range of agricultural and horticultural crops can be grown and commonly includes top fruit, soft fruit, salad crops and winter harvested vegetables. Yields are high and less variable than on land of lower quality.

Grade 2 -very good quality agricultural land

Land with minor limitations which affect crop yield, cultivations or harvesting. A wide range of agricultural and horticultural crops can usually be grown but on some land in the grade there may be reduced flexibility due to difficulties with the production of the more demanding crops such as winter harvested vegetables and arable root crops. The level of yield is generally high but may be lower or more variable than Grade 1.

Grade 3 --good to moderate quality agricultural land

Land with moderate limitations which affect the choice of crops, timing and type of cultivation, harvesting or the level of yield. Where more demanding crops are grown yields are generally lower or more variable than on land in Grades 1 and 2.

Subgrade 3a -good quality agricultural land

Land capable of consistently producing moderate to high yields of a narrow range of arable crops, especially cereals, or moderate yields of a wide range of crops including cereals, grass, oilseed rape, potatoes, sugar beet and the less demanding horticultural crops.

Subgrade 3b -moderate quality agricultural land

Land capable of producing moderate yields of a narrow range of crops, principally cereals and grass or lower yields of a wider range of crops or high yields of grass which can be grazed or harvested over most of the year.

Grade 4 -poor quality agricultural land

Land with severe limitations which significantly restrict the range of crops and/or level of yields. It is mainly suited to grass with occasional arable crops (e.g. cereals and forage crops) the yields of which are variable. In moist climates, yields of grass may be moderate to high but there may be difficulties in utilisation. The grade also includes very droughty arable land.

Grade 5 -very poor quality agricultural land

Land with very severe limitations which restrict use to permanent pasture or rough grazing, except for occasional pioneer forage crops.

Descriptions of other land categories used on ALC maps

Urban

Built-up or 'hard' uses with relatively little potential for a return to agriculture including: housing, industry, commerce, education, transport, religious buildings, cemeteries. Also, hard-surfaced sports facilities, permanent caravan sites and vacant land; all types of derelict land, including mineral workings which are only likely to be reclaimed using derelict land grants.

Non-agricultural

'Soft' uses where most of the land could be returned relatively easily to agriculture, including: golf courses, private parkland, public open spaces, sports fields, allotments and soft-surfaced areas on airports/ airfields. Also active mineral workings and refuse tips where restoration conditions to 'soft' after-uses may apply.

Woodland

Includes commercial and non-commercial woodland. A distinction may be made as necessary between farm and non-farm woodland.

Agricultural buildings

Includes the normal range of agricultural buildings as well as other relatively permanent structures such as glasshouses. Temporary structures (e.g. polythene tunnels erected for lambing) may be ignored.

Open water

Includes lakes, ponds and rivers as map scale permits.

Land not surveyed

Agricultural land which has not been surveyed.

Where the land use includes more than one of the above land cover types, e.g. buildings in large grounds, and where map scale permits, the cover types may be shown separately. Otherwise, the most extensive cover type will usually be shown.

In practice, and as used on the ALC maps in this report, the various categories of non-agricultural land are grouped into a single category, ‘Other Land’.

Appendix 10.3 Pit Descriptions

Appendix 10.3 Pit Descriptions

Pit 1

Grid Reference: SP 9599038293

Weather: Dry winter, recent moderate showers

Soil Series: Wickham (calc. variant)

Soil Subgroup: 7.11

Locality: Brogborough

Parent Material: Jurassic clay

Elevation: 92m Slope: 2°

Land Use: Ley grass

Wetness Class: III

Geology: Jurassic clay

ALC grade: 3b

Depth (cm)

0-21 Dark brown (10YR 3/3); heavy clay loam; slightly stony small and medium rounded quartzite; moist; moderate to strong fine and medium subangular in the upper 10cm over moderate fine and medium subangular structure; low to medium packing density; moderately to slightly porous, many fine fibrous and fleshy roots holding structural units together in upper part of the horizon becoming less numerous (still many) in the lower part of the horizon; occasional earthworms; non-calcareous; abrupt smooth boundary to:

21-32 Brown to dark brown (10YR 4/3); clay; slightly stony small and medium rounded quartz and angular flint and occasional large subangular flint; moist; moderate medium and coarse subangular blocky structure, some remnants of old compaction at the base of a plough layer; medium packing density; moderately porous; common fine fibrous and fleshy roots; occasional earthworm channel; very slightly calcareous; few rounded ferri-manganiferous concentrations; abrupt smooth boundary to:

32-50 Olive brown (2.5Y 4/4); clay; common yellowish brown (10YR 5/6) prominent mottles and few greyish brown (2.5Y 5/2) mottles; moist; few very small and small rounded quartz and subangular flints; weak medium prismatic structure breaking to moderate fine and medium angular blocky structure with numerous subangular edges; high packing density; slightly to very slightly porous; moderately calcareous; few small rounded and subrounded ferri-manganiferous concentrations; abrupt smooth boundary to:

50-89 Olive (5Y 4/4); clay; common prominent yellowish brown (10YR 5/6) and very many grey (10yr 5/1) mottles; moist; stoneless; moderate medium prismatic breaking to medium and coarse angular blocky structure; high packing density; very slightly porous; common fine fibrous roots often appear to be concentrated on ped faces; very calcareous with common secondary concentrations of calcium carbonate.

89-120[by auger] At about 95 structure appears to become massive with laminations visible (geological); colours as above.

Pit 2

Grid Reference: SP 624738513

Weather: Dry winter – recent moderate showers

Soil Series: Hanslope

Soil Subgroup: 411

Locality: Brogborough

Parent Material: Chalky boulder clay

Elevation: 106m

Slope: Convex 2º

Land Use: Arable (beans)

Wetness Class: III

Geology: Chalky boulder clay

ALC grade: 3a

Depth (cm)

0-23 Dark greyish brown (2.5Y 5/2) clay; very moist; slightly stony with small and medium rounded quartz, chalk, and subangular flint (12-14%); extremely fine strongly developed crumb structure in upper 5 cm, below moderate medium and coarse subangular; medium packing density, slightly porous; few fine fibrous dead roots from previous crop; occasional earthworm; moderately calcareous; smooth sharp boundary to:-

23-44 Dark greyish brown to olive brown (2.5Y 4/3); few faint yellowish brown (10YR 5/6) mottles; very moist; slightly stony with small and medium rounded quartz, chalk, and subangular flint (12-14%); moderate fine and medium subangular blocky structure; high packing density, slightly porous; few fine fibrous dead roots; occasional earthworm channel; few rounded ferri-manganiferous concentrations; moderately calcareous; abrupt smooth boundary to:-

44-64 Olive (5Y 5/4); many grey (10YR 5/1) and yellowish brown (10YR 5/6) faint and prominent mottles; clay; very moist; common small and very small subrounded chalk, flints and quartz; moderate medium prismatic structure breaking to medium subangular with some fine fragments; high packing density, very slightly porous; common fine fleshy and fibrous roots; very calcareous; abrupt smooth boundary to:-

64-86 Light olive brown (2.5Y 5/4); very many grey (N5) prominent mottles and streaks; moist; high packing density; very slightly porous; apedal – massive; common small and very small subrounded chalk, flints and quartz; few fine fibrous dead roots; very calcareous.

Pit 3

Grid Reference: SP 9934141979

Weather: Dry winter – recent moderate showers

Soil Series: Denchworth

Soil Subgroup: 712

Locality: Marston Moretaine

Parent Material: Jurassic clay

Elevation: 46m

Slope: Level

Land Use: Arable

Wetness Class: III

Geology: Jurassic clay

ALC grade: 3b

Depth (cm)

0-23 Dark greyish brown (10YR 4/2); clay; stoneless with occasional medium rounded quartz; moist; moderately developed coarse clods with visible remnants of subangular structure; medium to high packing density, slightly porous; many very fine and fine fibrous roots, common incorporated stubble; occasional earthworm; non-calcareous; abrupt smooth boundary to:-

23-61 Olive brown (2.5Y 4/4) many medium and coarse prominent yellowish brown (10YR 5/6) mottles and common fine and medium distinct greyish brown (2.5Y 5/2) mottles; clay; stoneless; moist; weakly developed coarse prismatic structure; high packing density, very slightly porous; few fine fibrous roots; non-calcareous; clear smooth boundary to:-

61-84 Dark greyish brown (2.5Y 4/2), very many grey (5Y 5/1) distinct mottles and common brown (10YR 5/4) mottles; clay; stoneless; very moist; weakly developed medium prismatic structure, breaking readily to medium and coarse angular blocky; high packing density, very slightly porous; few fine fibrous roots; non-calcareous;

84-120[by auger] No noticeable change in colour or texture to above.

Pit 4

Grid Reference: SP 9945442004

Weather: Dry winter – recent moderate showers

Soil Series: Wickham

Soil Subgroup: 711

Locality: Marston Moretaine

Parent Material: Jurassic clay

Elevation: 45m

Slope: Level

Land Use: Arable

Wetness Class: III

Geology: Jurassic clay

ALC grade: 3b

Depth (cm)

0-23 Dark brown (10YR 3/3); clay; very slightly stony (5%) medium rounded quartz and subangular flint; moist; weak coarse and medium subangular clods; medium packing density, moderate to slightly porous; many very fine and fine fibrous roots; occasional earthworm; non-calcareous; sharp smooth boundary to:-

23-50 Dark yellowish brown (10YR 4/4); very many greyish brown (10YR 5/2) and yellowish brown (10YR 5/6) distinct mottles; heavy clay loam; very slightly stony (5%) medium rounded quartz and subangular flint; weakly developed coarse subangular blocky structure; moist; high packing density, slightly porous; common fine fibrous roots; occasional earthworm channels; non-calcareous; abrupt smooth boundary to:-

50-69 Light olive brown (2.5Y 5/4) very many light brownish grey (2.5Y 6/2) and yellowish brown (10YR 5/6) prominent mottles; clay; stoneless with occasional small angular flint; moderate medium prismatic structure breaking readily to medium coarse angular structure; high packing density, very slightly porous; common fine fibrous roots, mainly concentrated on ped faces; non-calcareous.

69-90[by auger] Olive (2.5Y 5/4) very mottled olive grey (5Y 5/2); moist; clay; non-calcareous

90-120[by auger] As above except calcareous

Pit 5

Grid Reference: SP9632538410

Weather: Dry winter – recent moderate showers

Parent Material: Jurassic clay

Locality: Brogborough

Slope: 2º SW

Elevation: 105m

Wetness Class: III

Land Use: Arable

ALC grade: 3a

Geology: Jurassic clay

Depth (cm)

0-25 Dark greyish brown (2.5Y 4/2) moist; clay; slightly stony, (5%) 1-5 cm angular flint and 2% 1 cm subangular chalk; moderately well developed medium and coarse angular blocky structure; moderate packing density, slightly porous, few medium and fine roots; common incorporated trash; moderately calcareous; abrupt smooth boundary to:-

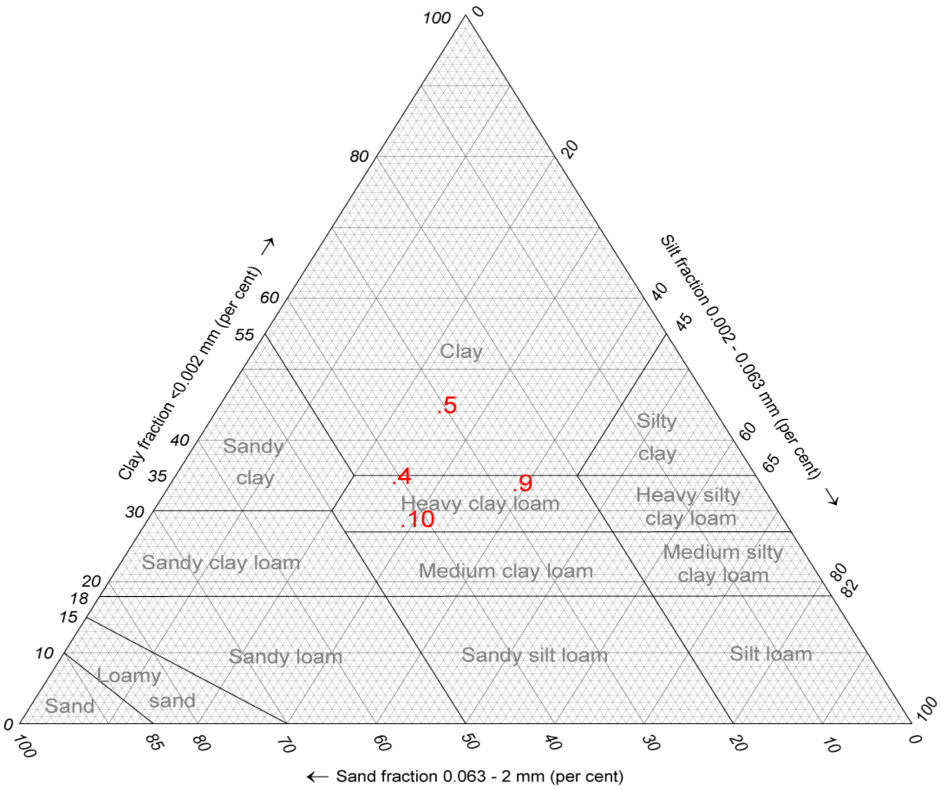
25-40 Dark greyish brown to olive brown (2.5Y 4/3); few medium and fine grey and ochreous (2.5YR 4/8) mottles; moist; clay; weak coarse columnar breaking to weak medium angular blocky; very slightly stony 2% 1-2cm angular flint and 2% 1cm moderately hard subangular chalk; high packing density, very slightly porous; rare fine roots; clear smooth boundary to:-

40-80+ Dark greyish brown to olive brown (2.5Y 4/3) many medium distinct to prominent grey (5GY 5/1) and ochreous (2.5YR 4/8) mottles; moist; heavy clay; weak coarse columnar structure; very slightly stony 2% 1-2cm angular flint and 2% 1cm moderately hard subangular chalk; high packing density, very slightly porous; rootless.

Appendix 10.4 Laboratory Data

Appendix 10.4 Laboratory Data

Limiting percentages of sand, silt and clay fractions for particle-size classes



Sample Site	pH	P (mg/l)	K (mg/l)	Mg (mg/l)
4	7.5	29.6	180	68
5	7.9	17.2	310	83
9	6.2	19.2	138	137
10	7.1	12.2	84	62

Sample Site	Sand (%w/w)	Silt (%w/w)	Clay (%w/w)	Organic matter (Walkley Black %w/w)	Organic Carbon (Wet Oxidation %w/w)
4	41	25	34	3.6	2.1
5	31	25	44	3.8	2.2
9	28	39	33	4.3	2.5
10	43	29	28	2.8	1.6

Sample Site	Sand (%w/w)	Silt (%w/w)	Clay (%w/w)	Neutralising Value as $CaCO_3$ equiv. (%w/w)	Neutralising Value as CaCO equiv. (%w/w)
Pit 5A	34	24	42	7.3	4.1
Pit 5B	32	27	41	8.8	4.9
Pit 5C	27	53	20	39.6	22.2

Appendix 10.5 Petroleum Licensing Details

Emily Peachey

From: Richard Chattaway [Richard.Chattaway@bedscc.gov.uk]
Sent: 23 June 2006 16:15
To: Emily Peachey
Subject: RE: Petroleum Licensing information A421

bean.doc

Emily, further to your request for information on the premises detailed in your e-mail below I can confirm the following, according to the information in the site file for Connect petrol station, Elstow Interchange with the A6, there are 6 exsisting undeground storage tanks.
T1 475000 litres, unleaded
T2 28500, ultimate unleaded
T3 19000 ultimate diesel
T4 47500 diesel
T5 47500 diesel
T6 11050 LPG.

These tankls are of double steel constructionand were installed circa 1998/1999, the LPG tank was installed circa 2001/02. There is no information relating to tank tests or major leaks/spillages available in the site file.

details of location will follow shortly in the post followed by and an invoice for two hours work at £30-35 per hour. I hope this information is of use to you in your course of business.
Richard

-----Original Message-----
From: Emily Peachey [mailto:Emily.Peachey@scottwilson.com]
Sent: 19 June 2006 15:53
To: Richard Chattaway
Subject: Petroleum Licensing information A421

> Hi Richard
>
> As per our earlier telephone conversation please could you undertake a search of the petroleum licensing information for the following sites;
>
> 1) Total Petrol Station on Bean Croft Road, Marston Moretaine
> 2) Connect Petrol Station, Elstow Interchange with the A6
>
> I am interested in the location, capacity, type, fuel storage type of the tanks, the age of the tanks, the dates of any testing and decommissioning details (if relevant) Although any information would be gratefully received. I would also like to know if there have been any recorded pollution incidents or spills at either of the sites.
>
> I understand that an hourly charge will be made of £30 -£35 and that this will be invoiced on completion of the works .In order to process the invoice could you please ensure that the following reference number is used: D109831/EKLP
>
> I would be grateful if you could forward any information to be as soon as possible.
>
> Kind regards
>
> Emily Peachey
>
> Geo-environmentalist
>
> Scott Wilson plc
> * 01256 310 314

> * 01256 310 201
> * Scott House, Basing View, Hampshire, RG21 4JG
> Web: www.scottwilson.com
>
>

Visit our web site at www.scottwilson.com

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Registered office: Scott House, Basing View,
Basingstoke, Hampshire, RG21 4JG. United Kingdom.

****

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Save energy, money and the environment - is it necessary to print this message?

Site Name- Marston Mortaine Service Station
Site Address- A421 Beancroft Road, Marston Mortaine, Bedfordshire, MK43 0PZ

Capacity,
Type, fuel storage type of the tanks,
The age of the tanks,
The dates of any testing and decommissioning details

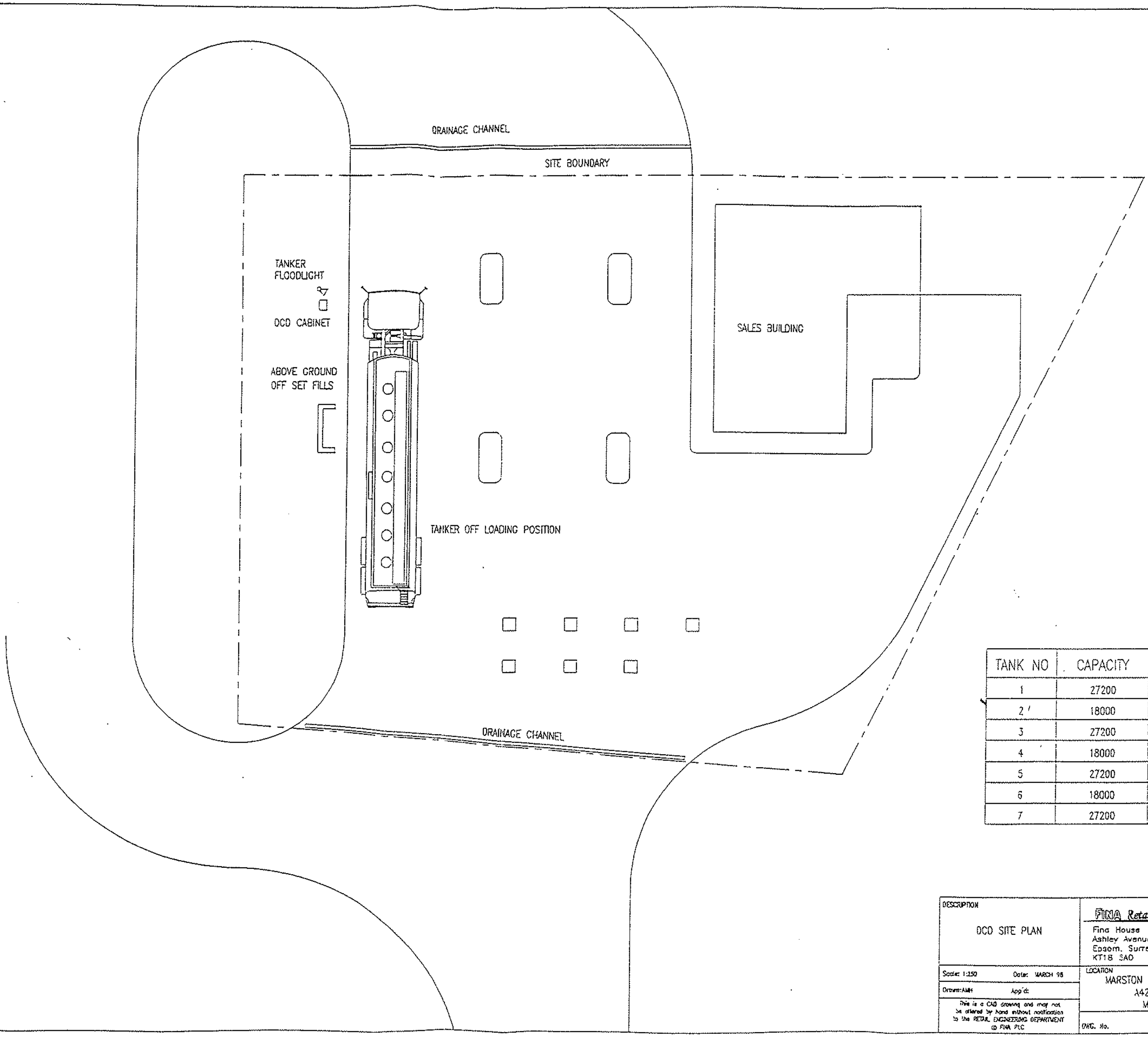
Tank Capacity and Grade

1) 26,384 Litres- Unleaded
2) 17,460 Litres- Excellium diesel
3) 26,384 Litres- Unleaded
4) 17,460 Litres- Diesel
5) 26,384 Litres- Excellium
6) 17,460 Litres- Unleaded
7) 26,384 Litres- Diesel

All of the above tanks were installed in 1998

Pump Type- Euro line

There is no information relating to tank tests or major leaks/ spillages available in the site file. There is one entry on our computer system refering to a problem with a leaking pipe between diesel tanks 5 and 7having been corrected in 1997



TANK NO	CAPACITY	PRODUCT
1	27200	4 *
2	18000	UL
3	27200	UL
4	18000	SUL
5	27200	4 *
6	18000	UL
7	27200	DIESEL

FINA

DESCRIPTION
DCD SITE PLAN

Scale: 1:250 Date: MARCH 98
Drawn: AMH App'd:

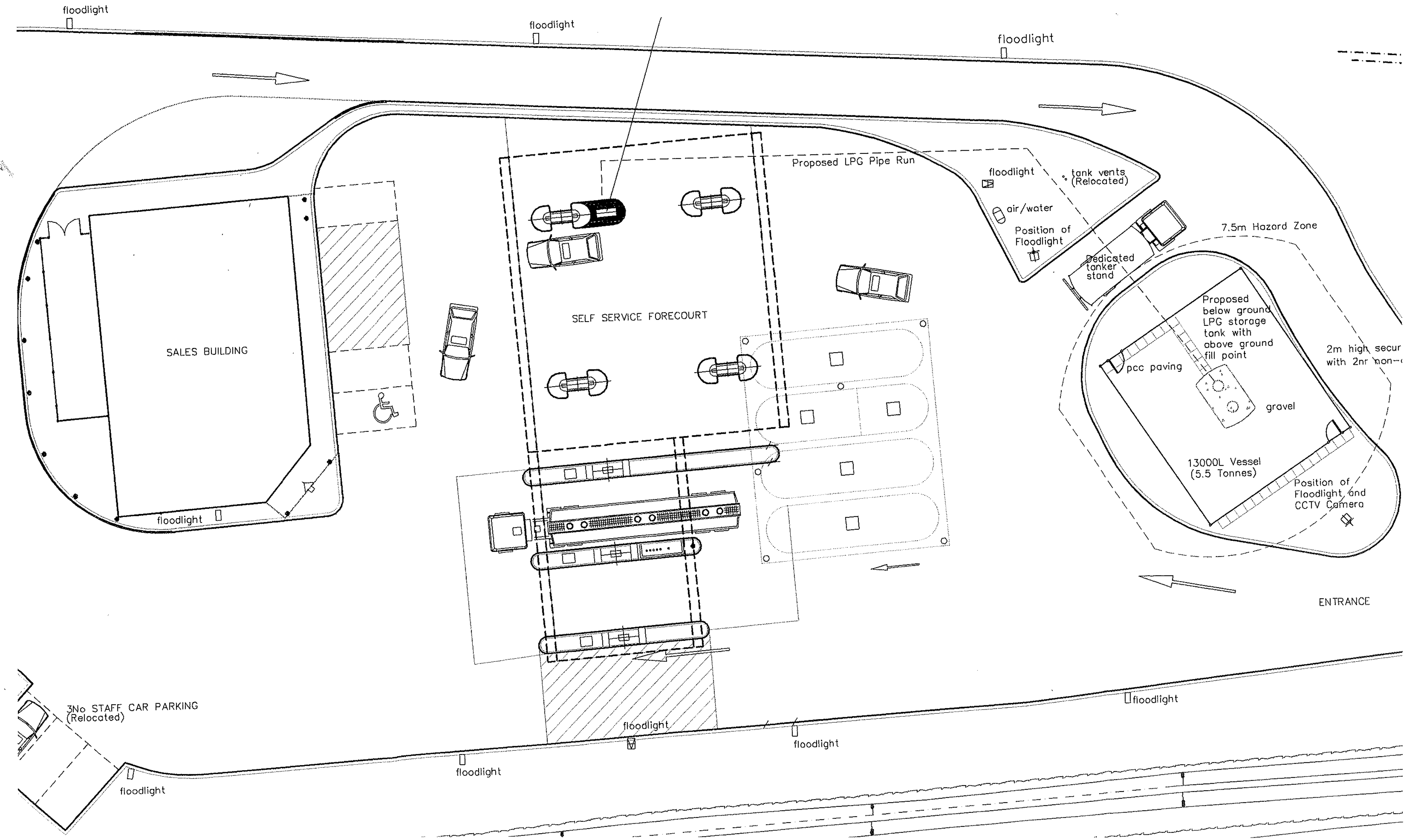
This is a CAD drawing and may not be altered by hand without notification to the RETAIL ENGINEERING DEPARTMENT © FINA PLC

FINA Retail Engineering Department
Fina House
Ashley Avenue
Epsom, Surrey
KT18 5AD
Tel: 01372 726225
Fax: 01372 744520
Telex: 894317

LOCATION
MARSTON MORTAINE SERVICE STATION
A421/BEANCROFT ROAD
MARSTON MORTAINE

DWG. No. Rev:

BP, Elstow interchange.



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11 ROAD DRAINAGE AND THE WATER ENVIRONMENT

11.1 Introduction

11.1.1 This Chapter provides an assessment of the potential effects of Scheme construction and operation on the water environment. These effects include:

- Alterations *in flooding and drainage patterns*
- Changes in the quality and quantity of surface and groundwater resources
- The potential effects on abstractions dependent on those resources.

11.1.2 The water environment is defined as the surface and ground water bodies within the catchments through which the Scheme passes. Cross-reference is made, where appropriate, to Chapter 5: Policies and Plans, Chapter 9: Ecology and Nature Conservation and Chapter 10: Geology and Soils.

11.1.3 The assessment of impacts and effects has been undertaken with regard to the advice and methodologies set out in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 10. This document was revised in May 2006 as HA 216: Road Drainage and the Water Environment. Advice and methodologies in the document relating to flood risk were used in the assessment, as was the advice relating to the assessment of significance criteria. These methodologies are therefore slightly at variance from those described in the Scoping Report.

11.2 Potential Impacts and Effects

11.2.1 The potential impacts from road schemes and their effects on the water environment can be divided into two interrelated categories:

- Effects on water quality
- Effects on surface and groundwater flows, including land drainage and flood risk.

Impacts on Surface Water Quality

11.2.2 Changes to water quality and / or drainage can have an effect on a number of aspects of the water environment. These include biodiversity of aquatic life, water supply, transport and dilution of waste products, fisheries and conveyance of flood flows.

11.2.3 Potential effects on water quality occur during the construction of new roads (i.e. temporary impacts) and from highway operation and maintenance (e.g. chronic effects from routine run-off and accidental spillages). In addition there is the potential for the release of any contaminants that may be present in the material being disturbed, particularly due to the presence of a number of landfill sites close to the Scheme. The assessment of this latter impact is covered in Chapter 10: Geology and Soils. Table 11.1, taken from DMRB 11.3.10, summarises the main potential impacts for each road activity.

Table 11.1 Indication of Potential Pollution Impacts from Roads

	Construction	Operation	Maintenance
Sediment	Major potential	Some potential	Major potential
Metals		Major potential	Major potential
Hydrocarbons	Minor potential	Major potential	Some potential
De-icing compounds		Major potential	

11.2.4 During the construction of new roads the main water quality concern is generally pollution from mobilised suspended solids, but accidental spillages of fuels, lubricants or hydraulic fluids from machines can lead to pollution incidents. Other risks include vandalism, pollution from water abstraction or discharge, and pollution from poor handling of materials.

11.2.5 A broad range of pollutants is associated with the routine run-off from operational roads. These include pollutants from vehicles, as well as those that are deposited on the surface of the road. The pollutants may be soluble, such as zinc or copper, or particulate, such as carbon, rust or plastic. They may also include fuel or lubricants. The effect of these will depend primarily on the sensitivity of the watercourse, and the amount of water available to dilute the pollutant. Watercourses tend to be most vulnerable during the summer when they usually have the lowest flows. They are especially vulnerable when low flow conditions coincide with a heavy rainfall event after a prolonged dry spell, when accumulated pollution on the road surface may be washed into the watercourse.

11.2.6 The risk of accidental spillages occurring is related to the number of heavy goods vehicles (HGVs) on the road and the probability of an accident. A wide variety of vehicle loads can pollute watercourses, including oils, chemicals, milk and foodstuffs.

11.2.7 Maintenance of the roads can lead to pollution from the use of de-icing salts, herbicides and from operations such as gully cleaning, if such activities are poorly controlled.

Impacts on Water flows

11.2.8 The increased area of paved surface created by a new road can lead to a potential increase in flood risk, due to the increased rate of run-off from this surface. A new road embankment, if built in a floodplain can displace water and cause flooding elsewhere.

11.2.9 The diversion of watercourses, of any size, can affect the local hydrology and ecology. Well-established banks and watercourses, which may include habitats, may be affected, and diversions may affect the capacity and flood storage of the watercourse.

Impacts on Groundwater

11.2.10 The increase in paved area can affect the quantity of water infiltrating to ground, leading to a decrease in aquifer recharge. Cuttings and embankments can affect the direction and flow of groundwater and affect the ability of groundwater to support abstractions and watercourse flows.

Other Temporary (Construction) Effects

11.2.11 Other potential effects on the water environment may arise from:

- Temporary vegetation and soil removal, leading to erosion and silty run-off
- Pollution from refuelling facilities, waste storage or handling areas

- Uncontrolled discharges leading to either pollution or flooding
- Temporary drainage crossing and diversions
- Work within floodplains or watercourses.

Benefits

11.2.12 New road schemes may also give rise to beneficial effects on the water environment. For example, whilst run-off from existing roads may have been uncontrolled, the construction of new roads provides opportunities for the incorporation of measures to reduce the risk of both pollution and flooding.

11.3 Methodology

Estimation of the Importance of Water Features

11.3.1 The significance of environmental effects is assessed by considering the importance of the receiving water feature's attributes and the magnitude of the impact. Table 5.3 from HA 216 gives a guide to estimating the importance of water features' attributes and is presented as Table 11.2.

Table 11.2 Estimating the Importance of Water Features' Attributes

Importance	Criteria	Typical Examples	
Very High	Attribute has a high quality and rarity on regional or national scale	**Surface Water:**	European Community(EC) Designated Salmonid/Cyprinid fishery River Quality Objective (RQO) River Ecosystem Class (RE1) Site protected under European Union (EU) or United Kingdom (UK) wildlife legislation (Special Area of Conservation SAC, Special Protection Areas (SPA), Site of Special Scientific Interest (SSSI) Ramsar site)
		Groundwater:	Major aquifer providing a regionally important resource or supporting site protected under wildlife legislation Source Protection Zone (SPZ) I
		Flood Risk:	Flood plain or defence protecting more than 100 residential properties from flooding
High	Attribute has a high quality and rarity on local scale	**Surface Water:**	RQO River Ecosystem Class RE2 Major Cyprinid Fishery Species protected under EU or UK wildlife legislation
		Groundwater:	Major aquifer providing locally important resource or supporting river ecosystem SPZ II
		Flood Risk:	Flood plain or defence protecting between 1 and 100 residential

Importance	Criteria	Typical Examples	
			properties or industrial premises from flooding
Medium	Attribute has a medium quality and rarity on local scale	**Surface Water:**	RQO River Ecosystem Class RE3 and RE4
		Groundwater:	Aquifer providing water for agricultural or industrial use with limited connection to surface water SPZ III
		Flood Risk:	Flood plain or defence protecting 10 or fewer industrial properties from flooding
Low	Attribute has a low quality and rarity on local scale	**Surface Water:**	RQO River Ecosystem Class RE5
		Groundwater:	Non-aquifer
		Flood Risk:	Floodplain with limited constraints and a low probability of flooding of residential and industrial properties

Identification and Assessment of Potential Impacts

11.3.2 The assessment of the effects on the quality of downstream watercourses, as set out in DMRB 11.3.10, is based on two methods. The first approach, originally based on Construction Industry Research and Information Association (CIRIA) Report 142 (1994), assesses the likely effect of routine run-off on watercourses, and is based on the worst case scenario of a storm washing off pollutants that have accumulated on the road into a low flowing watercourse. The second method assesses the risk that a spillage may occur, and the probability that an accident may cause a serious pollution incident within a watercourse.

11.3.3 The assessment of the effects of the Scheme on flood risk is done in two ways, both based on guidance in PPS 25: Development and Flood Risk (2006). The Scheme would create a new paved surface, which would increase the rate of surface water run-off, and may increase the risk of flooding. The Scheme may also occupy space within existing flood plains, thereby displacing flood water, and possibly increasing flood risk elsewhere.

11.3.4 To assess the effects of the Scheme on the Broughton Brook, a hydraulic model was constructed using Hec-Ras software. It was run for the existing situation and for the proposed diversion, using hydrographs for a variety of return periods derived from the Revitalised Flood Hydrograph. This hydrological method is described in HA 216.

11.3.5 Sketch 11.1 shows the plans used. The hydraulic model determined the water levels for an event having a 1% probability of occurring in any one year, which is the event that HA 216 requires to be tested.

11.3.6 The magnitude of identified impacts has been determined using the seven point scale in Table 5.4 of HA 216, which is presented as Table 11.3.

Table 11.3 Estimating the Magnitude of an Impact on an Attribute

Magnitude	Criteria	Typical Example
Major Adverse	Results in loss of attribute and/or quality and integrity of the attribute	**Surface Water:** Potential high risk in Method A (Annex I) and potential failure of Total Zinc and Dissolved Copper in Method B Calculated risk of pollution from an accidental spillage > 2% annually (Method D Annex I) Loss or extensive change to a fishery Loss or extensive change to a Nature Conservation Site **Groundwater:** Loss of an aquifer Potential high risk in Method C (Annex I) of pollution to groundwater from routine run-off- risk score > 250 Calculated risk of pollution from accidental spillages > 2% annually (Method D Annex I) **Flood Risk:** Increase in peak flood level (1% annual probability) > 100mm (Methods E & F Annex I)
Moderate Adverse	Results in effect on integrity of attribute, or loss of part of attribute	**Surface Water:** Potential high risk in Method A (Annex I) and *either* potential failure of Total Zinc *or* Dissolved Copper (Method B Annex I) Calculated risk of pollution from accidental spillages > 1% annually (Method D Annex I) Partial loss in productivity of a fishery **Groundwater:** Partial loss or change to an aquifer Potential medium risk, in Method C (Annex I), of pollution to groundwater from routine run-off - risk score150-250 Calculated risk of pollution from accidental spillages > 1% annually and < 2% (Method D Annex I) **Flood Risk:** Increase in peak flood level (1% annual probability) > 50mm (Methods E & F Annex I)
Minor Adverse	Results in some measurable change in attributes quality or vulnerability.	**Surface Water:** Potential high risk in Method A (Annex I) and no change in Total Zinc and Dissolved Copper in Method B (Annex I) Calculated risk of pollution from accidental spillages >0.5% annually (Method D Annex I) **Groundwater:** Potential low risk, in Method C (Annex I), of pollution to groundwater from routine run-off - risk score <150 Calculated risk of pollution from accidental spillages >0.5% annually and < 1% annually (Method D Annex I) **Flood Risk:** Increase in peak flood level (1% annual probability) > 10mm (Methods E & F Annex I)

Magnitude	Criteria	Typical Example
Negligible	Results in effect on attribute, but of insufficient magnitude to affect the use or integrity.	The proposed Scheme is unlikely to affect the integrity of the water environment. **Surface Water:** Low risk in Method A (Annex I) and risk of pollution from accidental spillages < 0.5% **Groundwater:** No measurable impact upon an aquifer and risk of pollution from accidental spillages < 0.5% **Flood Risk:** Negligible change in peak flood level (1% annual probability) < +/- 10mm
Minor Beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	**Surface Water:** Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is <1% annually) (Method D Annex I) **Groundwater:** Calculated reduction in existing spillage risk by 50% or more to an aquifer (when existing spillage risk <1% annually) (Method D Annex I) **Flood Risk:** Reduction in peak flood level (1% annual probability) > 10mm (Methods E & F Annex I)
Moderate Beneficial	Results in moderate improvement of attribute quality	**Surface Water:** Calculated reduction in existing spillage by 50% or more (when existing spillage risk > 1% annually) (Method D Annex I) **Groundwater:** Calculated reduction in existing spillage risk by 50% or more (when existing spillage risk is >1% annually) (Method D Annex I) **Flood Risk:** Reduction in peak flood level (1% annual probability) > 50mm (Methods E & F Annex I)
Major Beneficial	Results in major improvement of attribute quality	**Surface Water:** Removal of existing polluting discharge, or removing the likelihood of polluting discharges occurring to a watercourse **Groundwater:** Removal of existing polluting discharge to an aquifer or removing the likelihood of polluting discharges occurring Recharge of an aquifer **Flood Risk:** Reduction in peak flood level (1% annual probability) > 100mm (Methods E & F Annex I)

Assessment of the Significance of Potential Effects

11.3.7 The significance of potential effects on the water environment has been estimated by combining the importance of the attribute and the magnitude of the potential impact. Table 5.5 in HA 216 gives guidance on estimating the significance of potential effects and is presented as Table 11.4.

Table 11.4 Estimating the Significance of Potential Effects

IMPORTANCE OF ATTRIBUTE	**Very High**	Neutral	Moderate/Large	Large/Very Large	Very Large
	High	Neutral	Slight/Moderate	Moderate/Large	Large/Very Large
	Medium	Neutral	Slight	Moderate	Large
	Low	Neutral	Neutral	Slight	Slight/Moderate
		Negligible	**Minor**	**Moderate**	**Major**
		MAGNITUDE OF IMPACT			

Assessment of the Effects of Cumulative Impacts

11.3.8 Cumulative impacts may arise as a result of impacts from more than one source combining to produce a greater, overall impact. This Scheme is adjacent to several other schemes (see below) that are likely to have a simultaneous impact. The assessment of this Scheme must therefore consider the possibility of the cumulative effects due to the other schemes.

11.3.9 The possible cumulative impacts from the M1 (J10 to 13) widening scheme, Ridgmont Bypass, the Bedford Western Bypass, Kempston West Development and the development of the land at Wootton are all of particular relevance to assessments in this chapter.

Cumulative impacts are assessed using the same methods as for single impacts, with an assessment of the probability that the separate impacts will coincide. Reference has been made to paragraphs 5.36 - 5.42 of HA (2006) (DMRB 11.3.10), which is the HA's standard advice on the assessment of the effects of cumulative impacts on the water environment.

11.4 Policies and Plans

National Policies and Plans for Water

11.4.1 The study has been undertaken to ensure that current legislation is complied with. The key EU legislation covering the water environment which has a bearing on this Scheme includes:

- The Habitats Directive (92/43/EEC)
- Groundwater Directive (80/68/EEC as amended by 91/692/EEC)
- The Water Framework Directive (2000/60/EC).

11.4.2 The Water Framework Directive came into force in December 2000 and was translated into English law through The Water Environment (Water Framework Directive) (England

and Wales) Regulations 2003, which came into force in January 2004. It has not yet been fully implemented in the United Kingdom and the Government is still in the process of identifying how and who should be responsible for its implementation. The Environment Agency (EA) will be the "Competent Authority" for England and Wales.

11.4.3 The EU legislation is implemented in the UK through various acts and regulations. The key pieces of UK legislation directly regulating the water environment in relation to new roads are:

- Groundwater Regulations 1998
- Water Resources Act 1991 (WRA)
- Highways Act 1980.

11.4.4 Under the Highways Act (Section 100) the HA has a right to discharge run-off from highways into inland, tidal or groundwaters (i.e. controlled waters as defined under the WRA 1991), but is not exempt from prosecution in the event of the pollution of controlled waters (WRA, S.85).

Groundwater Regulations 1998

11.4.5 The Groundwater Regulations protect groundwater in England. Aquifers are protected as being valuable in their own right. The Highways Act does not require a discharge consent under the Groundwater Regulations but must comply with the technical requirements of the regulations. These primarily restrict the discharge of List I and List II substances. Consent is required under these regulations for the construction of outfalls.

Water Resources Act 1991

11.4.6 The HA is exempt from many of the legal obligations relating to obtaining consents etc. Under the WRA and the Groundwater Regulations. However, the HA is legally bound not to break the law with respect to polluting water.

11.4.7 The WRA S.86 makes it an offence to knowingly pollute controlled waters, which includes all groundwaters, lakes, ponds, rivers and streams around the proposed Scheme.

11.4.8 The WRA S.93 provides for the establishment of water protection zones. This is implemented under the Policy and Practice for the Protection of Groundwater of the EA through the definition of SPZ by the EA. The SPZs are defined as:

- Zone I: Inner SPZ – defined as an area bounded by the 50 day travel time of a particle from any point below the water table to the point of abstraction
- Zone II: Outer SPZ – defined as an area bounded by the 400 day travel time of a particle from any point below the water table to the point of abstraction, outside of Zone I, or 25% of the total catchment area, whichever is the larger
- Zone III: Source Catchment – covers the entire catchment area of a groundwater source that eventually discharges from the point of abstraction.

11.4.9 Within the SPZs the EA seeks to restrict certain potentially polluting activities, with the most onerous restrictions applied to Zone I.

A Better Quality of Life – A Strategy for Sustainable Development for the United Kingdom (Cm 4345) (May 1999)

11.4.10 The Strategy contained in this command document recognises the importance of good quality freshwater to public health and the environment. It states that safeguarding resources and ensuring affordable supplies are essential for sustainable development.

"*The UK does not face severe problems of water availability and quality but there are marked regional variations and many pressures. Demand is likely to grow, largely due to increased household use. Parts of the country, notably the south and east, already appear to be experiencing changed weather patterns. New development and urbanisation increase demand and create further pollution pressures. Diffuse inputs, such as run off and leaching from road, agricultural land and urban areas, loss of habitats and pressure on groundwaters all present substantial challenges.*" (Para. 8.29)

Planning Policy Statement (PPS) 25 – Development and Flood Risk (December 2006)

11.4.11 This PPS sets out the importance the Government attaches to the management and reduction of flood risk in the land-use planning process.

"The aims of planning policy on development and flood risk are to ensure that flood risk is taken into account at all stages in the planning process to avoid inappropriate development in areas at risk of flooding, and to direct development away from areas of highest risk." (Paragraph 5)

*"Regional planning bodies and local planning authorities are urged to prepare and implement planning strategies that help to deliver sustainable development by appraising, managing and reducing the risk of flooding. They should work effectively with the Environment Agency and other stakeholders to ensure such plans are effective."(*Paragraph 6*)*

11.4.12 The Government expects local planning authorities to

"apply the sequential approach (Paragraphs 14 - 17) at a site level to minimise risk by directing the most vulnerable development to areas of lowest flood risk, matching vulnerability of land use to flood risk" (Paragraph 8)

11.4.13 Those proposing development are responsible for demonstrating it is consistent with the policies in PPS 25 and providing a FRA to demonstrate it. (Paragraph 22).

11.4.14 Annex F of the Guidance entitled 'Managing Surface Water ' goes on to say that surface water from a developed site should be managed to mimic the surface water flows arising from the site prior to the proposed development, and that climate change should be taken into account. (Paragraph F6) . It further states that:

"The surface water drainage arrangements for any development site should be such that the volumes and peak flow rates of surface water leaving a developed site are no greater than the rates prior to the proposed development, unless specific off-site arrangements are made and result in the same effect" (Paragraph F10)

11.4.15 PPS25 emphasises that the threat of flooding needs to be managed and that development should be constructed so as to be appropriately flood resilient and resistant. (Paragraph 8 and Annex G) The potential Scheme impacts upon water quality and flooding are considered in Section 11.3. Where adverse impacts are identified, mitigation measures are proposed (see Section 11.6).

Regional Policies and Plans for Water

Draft Regional Spatial Strategy for the East of England (December 2004)

11.4.16 Policy RSS14 'development and flood risk' outlines:

"*Coastal and river flood risk is a significant factor in the East of the England. The priority is to defend existing properties from flooding, and where possible locate new development in locations with little or no risk of flooding.*

Local development documents will:

- *Promote the use of strategic flood risk assessments to guide development away from floodplains, areas at risk or likely to be at risk in future from flooding, or where development would increase the risk of flooding elsewhere*
- *Include policies to protect flood plains and land liable to tidal or coastal flooding from development, based on the Environment Agency's flood zone maps, supplemented where necessary by historical and modelled flood data (e.g. Section 105 maps) and indications as to other areas which could be at risk in future (including proposals for 'managed retreat' where appropriate)*
- *Require that all developments and, where subject to planning control, all land uses (including agricultural activities and changes to drainage in existing settlements) should not add to the risk of flooding elsewhere and should reduce flooding pressures by using appropriate sustainable drainage systems*
- *Only propose development in floodplains, areas at flood risk or at risk of flooding in future, or where development would increase the risk of flooding elsewhere, where land at lower risk of flooding is not available, where there is significant overriding need for the development, and the risk can be fully mitigated by design or engineering measures.*"

11.4.17 Policy ENV9 'water supply, management and drainage' states:

"*New development will be located, designed and its implementation planned in such a way to allow for sustainable provision of water supply and enable timely investment in sewage treatment and discharge systems to maintain the required standard of water quality.*

Local authorities will:

- *In preparing local development documents, take account of the Environment Agency's Regional Water Resources Strategy, catchment abstraction management strategies, groundwater vulnerability maps and groundwater source protection zone maps. The protection of water resources and provision for water abstraction should take into account environmental constraints*
- *Ensure that rates of development do not exceed the capacity of existing water supply system or, where relevant, proceed ahead of essential planned improvements that will increase the supply*
- *Maintain ongoing liaison with the Environment Agency, water companies and sewage statutory undertakers in order to ensure timely and sustainable provision of infrastructure for the supply of water and sewage treatment and discharge systems, particularly in connection with major new development*
- *Require the introduction of water conservation measures and sustainable drainage solutions. Local planning authorities should produce detailed supplementary planning guidance to implement water conservation and sustainable drainage solution*
- *Encourage the provision of on-farm winter storage facilities for water where that does not conflict with other planning policies, for use in summer and to provide a resource for wildlife and recreation.*

All relevant agencies and developers should include water conservation measures in new development and promote public awareness of the need to reduce water consumption.

The East of England Regional Assembly and the Environment Agency will work with the water industry and neighbouring regional planning bodies, including the Greater

London Authority, to formulate a sustainable long-term policy relating to inter-regional water provision."

County Policies and Plans for Water

Bedfordshire Structure Plan 2011 (March 1997)

11.4.18 Policy 3 on Water states that:

"*New development will not be permitted when: -*

- *Adequate water resources do not exist or cannot be augmented*
- *There is a risk to existing resources, water quality, amenity or nature conservation*
- *The proposal will lead to a deterioration in the quality of underground or surface water, or will interfere with the flow of ground or surface water*
- *Such development would be at direct risk from flooding or likely to increase the risk of flooding elsewhere. (Development includes the raising of land within areas at risk from flooding.)*"

Local Policies and Plans for Water

Bedford Borough Local Plan Policies (October 2002)

11.4.19 Policy NE16 states that:

"*The Borough Council will not permit development where*

- *It would intensify the risk of flooding; or*
- *It would be at an unacceptable risk from flooding; or*
- *It would prejudice existing flood defences or interfere with the ability to carry out flood control and maintenance work; or*
- *It would adversely affect wildlife habitat in the floodplain.*

Unless, the Borough Council, in consultation with the Environment Agency and Internal Drainage Board as appropriate, is satisfied that developer will provide appropriate mitigation, protection and compensatory measures."

11.4.20 Policy NE24 states:

"*The Borough Council will seek to protect, and where possible, enhance, the water resources in the Borough by:*

- *Not permitting developments which would adversely affect the quality or quantity of water resources or their amenity or nature conservation value*
- *Not permitting development which would unduly restrict assess to the River and other water bodies with recreational potential*
- *Actively negotiating with developers in order to achieve more sustainable methods of surface water management and drainage*"

The Mid Bedfordshire Local Plan First Review (December 2005)

11.4.21 Paragraph 9.7.4 states that:

"*Within the Bedfordshire and River Ivel Internal Drainage Board (IDB) area, developers should also note the byelaws of the Drainage Board, which seeks to retain a 7 metre strip, free from development or landscaping, on one side of the bank top of existing* *watercourses to enable assess for watercourse maintenance. In some circumstances there is a need to maintain the watercourse from both sides.*"

11.4.22 Policy DPS17 states that:

"*Developers must take full account of the impact of their proposals on surface water drainage and infrastructure and incorporate appropriate control as necessary. The council will refuse proposals for development that would:*

- *Intensify the risk of flooding*
- *Be at an unacceptable risk of flooding*
- *Prejudice existing flood control and maintenance works*
- *Adversely affect wildlife habitat in the floodplain.*

Planning applications may be required to include a levels survey of the proposal site. Any compensatory works associated with development proposals will be considered against other Local Plan policies as appropriate."

11.4.23 Paragraph 11.2.2 states that:

"*The potential for new development to cause pollution is just one aspect of the overall environmental impact of that development or the use of land. It may therefore be a material consideration to be taken into account when deciding whether or not to grant planning permission. However, the dividing line between planning and pollution control considerations is not always clear.*"

11.4.24 Policy PHS1 states that:

"*The Council, in considering development proposals that are likely to involve processes or substances that may lead to pollution, will seek advice and maintain close liaison with the appropriate regulatory authorities. Where expert advice indicates that necessary pollution control authorisation is unlikely to be forthcoming, the council will not grant planning permission for the development.*"

11.4.25 Policy PHS2 states that:

"*The Council will encourage development that is likely to result in a material reduction in polluting emissions to the environment. When such proposals are made, the council will seek the advice of the appropriate regulatory authority.*"

11.4.26 Policy PHS3 states that:

"*In considering development proposals, the Council will pay close regard to expert advice from the relevant regulatory bodies and, where appropriate, independent expert advice. Where there is a risk that emissions to the environment will result in an unacceptable reduction in air quality, water quality (ground or surface), soil quality and/or an unacceptable reduction in amenity through noise or odour, permission will not be granted.*"

11.4.27 Paragraph 11.2.5 states that:

"*The risk of pollution can be negated or substantially minimised through appropriate works or modification to development proposals, often at minimal cost. Examples of such works may be the fitting of interceptors and/or simple bunds where there is a risk of chemical spillage onto land or into drainage systems. Whilst other pollution control regulations may require such works, they may also be required as a condition on a planning permission. The NRA, now part of Environment Agency, has published a document entitled 'Policy and Practice for the Protection of Groundwater' which provides advice upon the prevention of groundwater pollution.*"

11.4.28 Policy PHS4 states that:

"*In the determination of planning applications, the Council will, where appropriate, require by condition or Section 106 Agreement the provision of works to minimise or negate the risk of pollution.*"

Non Statutory Policies and Plans

The Surface Waters Plan

11.4.29 The Surface Waters Plan is a non-statutory document published on behalf of the Marston Vale Surface Waters Group, whose membership consists of representatives from:

- Bedfordshire County Council (BCC)
- Bedford Borough Council (BBC)
- Mid-Bedfordshire District Council (MBDC)
- Forest of Marston Vale
- Environment Agency
- Bedford and River Ivel Internal Drainage Board.

11.4.30 Paragraphs 5.19 - 5.22 are general policy statements which state:

"*The Surface Waters Group will promote an integrated approach to flood risk management, surface water drainage and the water environment in response to development pressure in the Marston Vale.*

The Surface Waters Group will promote government guidance contained in PPG25 "Development and Flood Risk". This Surface Waters Plan provides a strategic framework for the site specific Flood Risk Assessments which must be produced in support of planning applications where flood risk is a material consideration, in accordance with PPG25.

The Surface Waters Group will seek support from the Planning Authorities in its efforts to encourage developers to consider and, where appropriate and practicable, implement strategic solutions to surface water drainage and flood risk that are sustainable and offer opportunities for environmental and recreational gains.

The Surface Waters Group will seek to assist developers with co-ordinating negotiations and studies where appropriate, primarily through the offices of the Drainage Board and Environment Agency, particularly where several landowners and developers are involved."

11.4.31 Paragraphs 5.23 and 5.24 refer to watercourse corridors and state:

"*The Surface Waters Group will seek to encourage Planning Authorities and developers to protect watercourse corridors from development that would have an adverse impact on the drainage regime, flood risk and the river environment.*

The Surface Waters Group will support measures to enhance the river system and environment by appropriate channel improvement, planting and other works."

11.4.32 Paragraph 5.25 looks to the long term and states:

"*The Surface Waters Group will seek to take a long-term view of development potential in the Marston Vale and opportunities that may arise to lay down early strategies for serving such development. Such opportunities may arise from continuing extraction of minerals in the area and subsequent restoration of pits and may have the potential to reduce flood risk for existing property in the face of adverse climate change.*"

11.4.33 Paragraph 5.26 considers available powers and funding and states:

"*In light of the deficiencies in present mechanisms for encouraging a strategic approach to surface water issues, particularly those arising from new development, the Surface Waters Group will lobby central government to address funding, adoption and related issues. In the view of the Surface Waters Group, it is essential that improved regulatory and financial mechanisms be introduced to deal with increasing development pressures and ensure that sustainable and environmentally acceptable solutions are implemented.*"

11.4.34 Paragraph 5.27 considers proposals relating to specific developments and states:

"*The Surface Waters Group will from time to time identify potential opportunities for creation of specific strategic surface water facilities that might serve particular developments, or provide enhanced management of the system. The first set of such outline proposals in give in Appendix H. Proposals of this nature will of necessity require review from time to time to accord with the changing planning and development context and will be the subject of future reports by the Surface Waters Group.*"

11.4.35 Paragraphs 5.28 and 5.29 consider technical justification and state;

"*In promoting this approach, the Surface Waters Group recognises that any solution requires technical and economic evaluation and justification. It is generally the responsibility of developers to provide this but the member organisations of the Surface Waters Group will endeavour to provide appropriate guidance and may, in some instances, be able to contribute to preparation of technical justification on behalf of developers.*

Again, in some instance member organisations may assist with technical analysis to further refine the proposals embodies in the Surface Waters Plan and to support the preparation of supplementary planning guidance, for example development briefs for specific major developments. In this respect it is envisaged that the information and policies in the Surface Waters Plan will provide a holistic and consistent approach to surface water and drainage issues across the Forest."

11.4.36 Paragraphs H1.1 and H1.2 consider Stewartby Lake and state:

"*The Surface Waters Group emphasises the importance of flow attenuation provided by Stewartby Lake with the Elstow Brook drainage system. It will endeavour to protect this strategic flood defence function in the long-term.*

The Surface Waters Group supports the transfer of operational responsibility for the outfall from Stewartby Lake to the Internal Drainage Board and will seek the preparation and implementation of a management plan that has regard to the various interests in the operation of the lake."

11.4.37 Paragraphs H1.3 - H1.5 consider developments at Wootton and elsewhere and include:

"*The Surface Waters Group will seek to encourage implementation of a strategic solution for surface water drainage and flood protection for proposed developments at Wootton and south and west of Kempston; as opposed to piecemeal solutions for individual developments.*

Some elements of a strategic scheme have already been implemented in the form of new surface water attenuation and flood storage areas at the Marsh Leys development site. The Surface Waters Group will seek to encourage that further development of this approach, which could include a scheme to harness the potential of existing pits at Kempston Hardwick (Map Ref. KH). Any such scheme should endeavour to provide appropriate environmental gains and recreational opportunities."

11.4.38 Paragraphs H1.8 and H1.9 consider Brogborough Lake and state;

"*The Surface Waters Group will seek the recognition and long-term retention of Brogborough Lake as a facility for water management in the Elstow Brook.*

The Surface Waters Group will seek to encourage the implementation of appropriate organisation of hydrological and hydraulic management of Brogborough Lake, having regard to the various interests in the lake and its potential to assist with management of flood risk and periods of low flow."

11.5 Baseline Conditions

Data Sources

11.5.1 Baseline Data on the existing water environment has been collated from the following sources:

- A421 Improvements M1 J13 to Bedford Stage 2 Environmental Impact Assessment Report, Hyder Consulting Limited (2004)
- The Environment Agency Web-site
- Bedfordshire Group of Internal Drainage Boards: District Plans
- The Surface Waters Plan, Bedfordshire and River Ivel Internal Drainage Board and the Forest of Marston Vale (2002)
- Walkover surveys in Spring 2006
- Environment Agency Groundwater Vulnerability Map Sheet 31, 1:100,000 scale
- Drainage Design Strategy Report No D109831-P1A-DRA-R001
- Topographical survey

Data Limitation

11.5.2 A significant parameter affecting the vulnerability of a surface watercourse to pollution is its "Low Flow", or Q_{95} value, which is defined as the flow in the watercourse exceeded for 95% of a specified period. To ensure reliable values of low flow, this period should be at least 5 years. Unlike flood flow data, this parameter is less widely recorded, especially for watercourses that are not main rivers. There are no recorded data for this parameter for either the Elstow or Broughton Brooks. For the purpose of the assessments in this report, an estimate was made by comparing the characteristics of these catchments with similar catchments having a known value of low flow. The catchments used for comparison were the Wootton Brook (EA gauge 32031) and the Clipstone Brook (EA gauge 33030). A figure of $0.03m^3/s$ was estimated for both watercourses. This compared favourably with the value measured for Broughton Brook in early 2006 as part of the survey work for the adjacent M1 widening scheme. However the lack of any official low flow data for these watercourses means that the reliability of this estimate must be treated with caution.

Surface Water Features

11.5.3 The Scheme runs within two catchments. M1 Junction 13 (M1 J13) and the A421 from that junction to the crest of the proposed cutting at Brogborough would be within the catchment drained by the Broughton Brook. This is a tributary of the River Great Ouse, into which it flows, via the River Ouzel, about 10km northwest of M1 J13. The remainder of the Scheme is within the catchment of the Elstow Brook, which is also a tributary of the River Great Ouse, into which the brook flows about 7 km northeast of the A6 / A421 junction. Ground levels vary from about 78m AOD at the M1 Junction to 106m AOD at the top of Brogborough Hill, and then the land falls to about 50m AOD near Brogborough Lake, and falls more gently to about 24m AOD near Bedford. These catchments are shown in Figures 11.1.1 and 11.1.2.

Surface Watercourses

11.5.4 In the vicinity of the Scheme, Broughton Brook flows from southeast to northwest roughly parallel to the M1. Elstow Brook flows northeast roughly parallel to the A421. Broughton and Elstow brooks both lie within the district of the Bedfordshire Group of Internal Drainage Boards (IDB). The IDB has a duty and permissive powers to exercise general supervision of all land drainage matters within its district (see Figures 11.1.1 and 11.1.2). The district also includes many of the smaller watercourses that flow into the two brooks.

11.5.5 The entire Scheme northeast of the M1 lies within the Forest of Marston Vale. For this area a Surface Waters Plan has been produced by the Marston Vale Surface Waters Group, which is composed of the IDB, EA and local planning authorities. The Plan seeks to promote a range of policies to encourage an integrated and sustainable approach to the management of the surface waters, in the context of major proposed developments in the area. For further details of the Plan's policies, and those of other local authorities, see Chapter 5, Policies and Plans.

11.5.6 Broughton Brook and the Elstow Brook have both been modified significantly over the years, as the land drainage of the area has been improved. The drainage pattern in these catchments comprises small watercourses flowing to the brooks, many of them being culverted beneath the A421. The watercourses drain local fields and have also been modified as land drainage improves.

Broughton Brook February 2006

Elstow Brook June 2006

Water course beneath Beancroft Road February 2006

Stewartby Lake June 2006

Lakes and ponds

11.5.7 There is a legacy of brick making in the area, which has resulted in empty pits being filled by water to create ponds and lakes. Two of the largest lakes within the study area are Brogborough Lake and Stewartby Lake, through both of which Elstow Brook flows. The lakes are located south of the A421 at approximate chainages 3000 and 7000 respectively (see Figures 11.2.1 and 11.2.2). Both lakes are used for amenity purposes. The importance of the lakes as recreational resources is estimated to be medium, as defined in Table 11.2, above. Other disused pits include Coronation pit at Wootton Broadmead and ponds at Kempston Hardwick.

Flood plains

11.5.8 The Broughton Brook rises to the east of Watling Street near Little Brickhill to the south of the A421 and has a catchment of 29.0km^2 when it reaches the A421. It flows in a northerly direction to the west of the M1. Its catchment is shown in Figure 11.1.1. The existing channel is relatively recent, having been constructed when the A421 towards Milton Keynes was built in the 1980s and is a straight uniform trapezoidal channel with little ecological value. The brook passes under the A507 in an in situ concrete arch culvert 3.8m wide and 3.0m high. The IDB has a hydraulic model of the Broughton Brook, constructed by HR Wallingford, as far as Kingston Bridge, about 5km downstream of the A507. An area of indicative flood plain is shown on the EA's web-site in the Broughton Brook catchment and this is shown in Appendix 11.1

11.5.9 A new hydraulic model of the Broughton Brook has been constructed from a downstream boundary at Hulcote Manor, 1km downstream of the A507 to a point upstream of the A507. The existing brook has been modelled to ascertain a baseline, and the resulting floodplain is shown on Sketch 11.1. As can be seen in the figure, most of the flow predicted to occur after an event with an annual probability of 1% (plus an allowance for climate change) is accommodated by the existing channel so the extent of the flood plain outside the channel is very limited.

11.5.10 Two areas of indicative flood plain are shown on the EA's web-site in the Elstow Brook catchment and these are shown in Appendix 11.2. Small parts of one area lie adjacent to the Scheme at Marston Moretaine. No records of flooding exist for these parts. A more extensive area is shown in the Marsh Leys area. Both these areas lie within the region where the Surface Waters Group is promoting an integrated strategic approach to flood risk management, as set out in paragraph 11.4.30.

11.5.11 The Surface Waters Plan proposes that the provision of balancing ponds to control the surface run-off within the Elstow Brook catchment should be co-ordinated by the IDB, to ensure that maximum benefit is made of the existing lakes, to avoid unnecessary piecemeal provision of uneconomic measures and to allow the board to comment on designs for structures which in many cases they would be responsible for managing when built. The importance of the flood plains of the two brooks is estimated to be low, as defined in Table 11.2, above.

Surface Water Quality

11.5.12 Broughton Brook (reach: Birchmoor Green to M1) and Elstow Brook (reach: Stewartby Lake to A421) both have a River Quality Target of RE3, as defined by the River Ecosystem Regulations. Available data on the EA's web-site shows that the measured water quality for both brooks for the last ten years, as defined by the Chemical General Quality Assessment (GQA), has varied between GQA grades B and C. Grade C ("fairly good quality") is needed to meet the River Quality Target of RE3. Details are given in Appendices 11.1 and 11.2. The catchment areas upstream of the point at which these measurements are made are 48km^2 for Broughton Brook and 50km^2 for Elstow Brook. It is at these points that the low flow value is estimated, as required by HA 216. The importance of the water quality for both brooks is estimated as medium, as defined in Table 11.2, above.

Surface Water Abstractions

11.5.13 Several licences are held for surface water abstraction local to the Scheme, for the purposes of agriculture, industry or public water supply. Details are given in Appendix 11.3 and their location is shown on Figures 11.2.1 and 11.2.2.

Discharge Consents

11.5.14 Several discharge consents are located within the study area. Details are given in Appendix 11.4 and their location is shown on Figures 11.2.1 and 11.2.2.

Pollution Incidents to Surface Watercourses

11.5.15 A record of pollution incidents local to the Scheme and recorded by the EA is included in Appendix 11.5 and their location is shown on Figures 11.2.1 and 11.2.2. Incidents with a significant potential or actual impact on the water environment are included.

Groundwater Features

11.5.16 The underlying geology is that of Jurassic clay, usually known as Oxford Clay, which varies in thickness across the site from some 3m to 20m, generally getting thinner towards the Bedford end of the site. These clays are variously covered with drift deposits of river terrace and glacio-fluvial origin, up to some 2m thick. The Oxford Clay and glacial till are considered to be non-aquifers. The alluvial soils underlying the Scheme are considered to be a minor aquifer with low leaching potential. The glacial sands and gravels are considered to have an intermediate (and occasionally high) leaching potential. A fuller description of the local geology and groundwater conditions is given in Chapter 10 Geology and Soils.

Groundwater Vulnerability

11.5.17 The EA classifies aquifers according to their scale and vulnerability to pollution. A series of groundwater vulnerability maps has been produced by the EA to show aquifer classification and the vulnerability of the aquifers from surface activities. Table 11.5 summarises the groundwater vulnerability classifications encountered along the route of the Scheme and their locations are shown on Figures 11.2.1 and 11.2.2. Overall, vulnerability of the groundwater is estimated to be minor to low, as defined in Table 11.2, above.

Table 11.5 Groundwater Vulnerability Classifications

Chainage	Vulnerability class
M1 J13	Minor Aquifer, high soil leaching potential
M1 J13 - 300	Minor Aquifer, intermediate soil leaching potential
300 - 6000	Non-Aquifer
6000 - 7300	Minor Aquifer, intermediate soil leaching potential
7300 - 7900	Minor Aquifer, high soil leaching potential
7900 - 9600	Non-Aquifer
9600 - 13000	Minor Aquifer, low soil leaching potential

Groundwater Abstractions and Discharges

11.5.18 Several licences are held for groundwater abstraction local to the Scheme, for the purposes of agriculture, industry or public service. Details are given in Appendix 11.6 and their location is shown on Figures 11.2.1 and 11.2.2. Other licences are held to permit discharge to groundwater and details of these are given in Appendix 11.7 and their location shown on Figures 11.2.1 and 11.2.2. There are no Source Protection Zones for groundwater abstraction within the study area.

Sites of Ecological importance

11.5.19 Details of sites and species of ecological importance are presented in Chapter 9: Ecology and Nature Conservation. The following County Wildlife Sites (CWS) are located within 250m of the Scheme and are associated with water:

- Brogborough Lake CWS
- Stewartby Lake CWS.

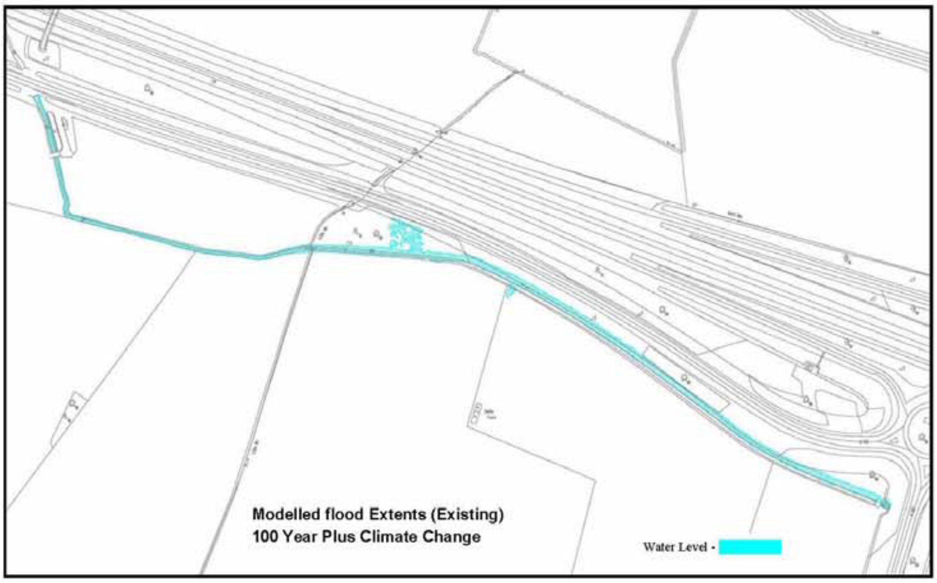
11.5.20 Elstow Brook has been shown to contain the Local Biodiversity Action Plan (BAP) species Spined Loach, with Broughton Brook and Elstow Brook containing Bullhead, which is included on Annex II on the Habitats Directive. There is also evidence to suggest that Elstow Brook supports otter populations, which is on Annex IV of the Habitats Directive and Schedule 5 of the Wildlife and Countryside Act (WCA).

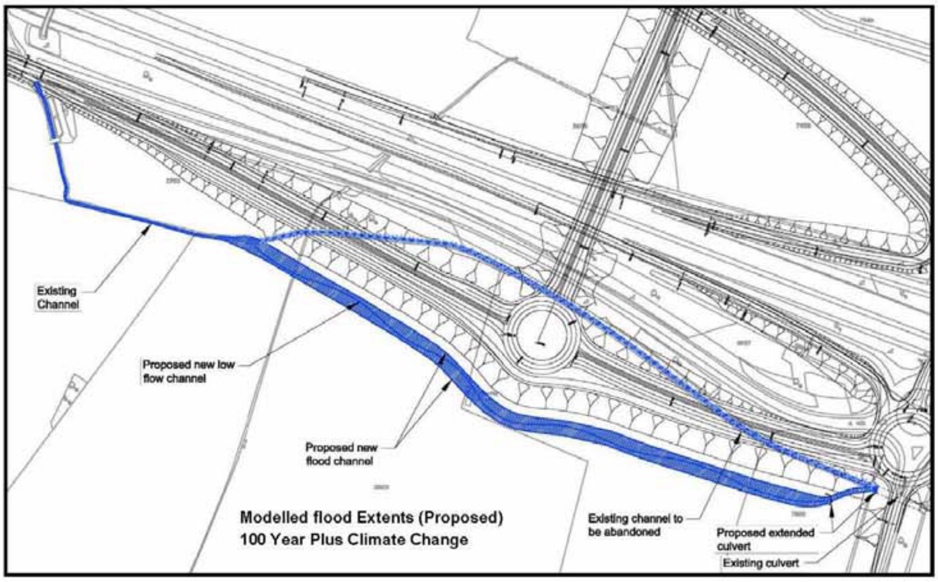
11.5.21 There are also numerous ponds within 500m of the route corridor, which are of little ecological value in their own right; but over half of them support breeding Great Crested Newt populations. Great crested newts are fully protected under European and British legislation. The ditch system that runs at the edge of numerous areas of agricultural land is of negligible ecological interest, although the ditches may act as wildlife ‘corridors’ in certain situations.

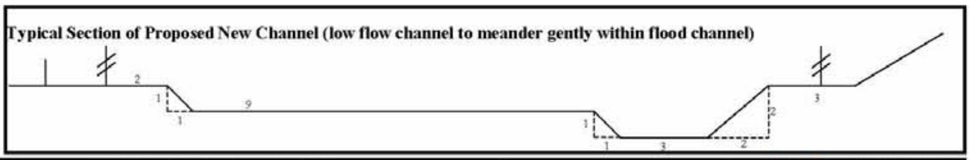
Existing Sources of Contamination of the Water Environment

11.5.22 As indicated previously, the quality of surface watercourses in the area appears to be fair to good. It is likely to be affected by run-off from the surrounding arable land, and to some extent by run-off from the existing roads. As noted in Chapter 10: Geology and Soils, in paragraphs 10.4.13 and 10.4.14, some groundwater samples analysed, from the vicinity of Brogborough and Stewartby landfills had elevated levels of ammonia and copper.

11.5.23 At the existing outfall located within M1 J13 and discharging to Broughton Brook, there are no pollution prevention measures present. Advice from the HA’s Area Maintenance team, following a recent survey and analysis suggests that there is a higher than usual risk of pollution from accidental spillage. Mitigation measures would be installed at this outfall as part of the Scheme. Details of an assessment of the existing risks at this outfall are given in Appendices 11.8 and 11.9. There are no known pollution prevention measures at any of the outfalls on the existing A421, which for most of its length is an unimproved single carriageway road having several junctions. There is therefore likely to be a higher accident rate, and hence pollution incident rate, when compared to the Scheme.







Sketch 11.1 **BROUGHTON BROOK (A421) – FLOOD RISK ASSESSMENT**

MODELLED FLOOD EXTENTS
100 YEAR PLUS CLIMATE CHANGE

D109831/ES/R006/SK11.1		
NOT TO SCALE		
Drw: AW	App: DR	Rev: 0
Chk: MT	Date: Oct 06	

HIGHWAYS AGENCY

Prepared for the Highways Agency by: Balfour Beatty and Scott Wilson
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11.6 Mitigation and Detailed Development of Scheme Design

Scheme Drainage Design

11.6.1 As noted in paragraph 11.5.3 the Scheme would cross two sub-catchments of the River Great Ouse: Broughton Brook to the west of Ch. 1500 and Elstow Brook for the rest of the Scheme. Generally all existing watercourses crossed by the Scheme would be culverted on line, although in a few locations there would be local diversions, either to reduce the number of culverts, or where the road alignment is too low to allow a crossing on line. Both the A421 (Milton Keynes link) and the M1 cross the Broughton Brook, as does the A507. The A421 culvert would need to be extended, as would the A507 culvert. The M1 culvert would not be affected. The capacity of all these culverts has been checked and is satisfactory. Broughton Brook would require to be diverted for about 700m of its length, as shown in Sketch 11.1. Elstow Brook is crossed by the A421, and the culvert, known as Race Meadow Culvert, would be extended. Its existing capacity is satisfactory.

11.6.2 The highway drainage for the Scheme has been designed according to the following principles:

- Highway drainage would be kept separate from existing land drainage
- Highway drainage on embankments would generally consist of surface water channels, except where the gradients are very shallow. Then, run-off would drain either into combined kerb and drainage blocks or over the edge into ditches
- Highway drainage in cuttings would generally consist of combined surface water and groundwater filter drains
- At the cutting at the Marston Moretaine Junction, a pumping station would be installed, as the levels are too low to allow drainage by gravity
- Drainage to the Broughton Brook would be attenuated using balancing ponds to a greenfield rate of 4 litres /sec / hectare
- Drainage to the Elstow Brook catchment would be attenuated by balancing ponds (also to 4 litres /sec / hectare) except where the receiving water course is already attenuated by the strategic facilities established by the Internal Drainage Board
- Kerb and gullies or a combined kerb and drainage system would be used where a kerb is required (for example at bridges, junctions, laybys)
- Subgrade drainage on embankments would consist of fine or narrow filter drains
- On the high sides of cuttings, cut-off ditches would be built to drain into existing water courses
- At the toe of embankments ditches would be constructed. Where these do not receive carriageway drainage, they would drain to water courses. Otherwise they would form part of the highway drainage system
- Spillage containment facilities (to control accidental spillages) would be constructed upstream of balancing ponds or prior to discharge of the highway drainage into the local watercourses.

11.6.3 Locations of balancing ponds, spillage containment facilities and culverts are shown on the Environmental Masterplans (Figures 4.3.1 - 4.3.10).

Mitigation Measures Included in Scheme Design

Mitigation Measures to Reduce Pollution from Routine Run-off

11.6.4 The potential pollution effects of the routine run-off from the carriageways would be mitigated as follows:

- The balancing ponds would facilitate removal of some heavy metal pollutants through settlement of the suspended solids to which they tend to adhere (see HA 216)
- The filter drains would reduce the effect of the suspended solids.

Mitigation Measures to Reduce the Pollution Risk from Accidental Spillages

11.6.5 The effects of potential impacts from accidental spillages would be mitigated by ensuring that spillage containment facilities are located either at locations where run-off outfalls into the local watercourses, or upstream of balancing ponds. These facilities enable the drainage system to be isolated in the event of a spillage, which would be collected in a tank or basin, prior to being disposed of from the area.

11.6.6 The facilities would comprise a chamber into which the run-off flows. Normally the flow would pass unhindered through the chamber to the outfall or balancing pond. In the event of an accidental spillage or other pollution threat, a penstock within the chamber can be lowered to direct the flow to the basin or tank, which is located off line. The polluted flow can be kept there until it can be safely disposed of. The basin or tank will be designed to hold up to 25m^3 of pollutant, which is the maximum volume of pollutant likely to be spilt in an accident. Such arrangements follow the current design guidance in HD33 (DMRB 4.2.3), which advocates these arrangements in favour of oil separators.

Mitigation Measures to Manage the Risk of Flooding

11.6.7 The existing flood plain and channel of the Broughton Brook would be overlaid by the new slip road from the A421 to the A507. This would require a diversion of the brook and compensation for the loss of flood plain, although as discussed above in paragraph 11.5.9 there is only a very small area of floodplain associated with this reach of the brook. It would also be necessary to lengthen the existing culverts under the A507 and A421.

11.6.8 It is proposed that a two stage channel should replace the present oversized trapezoidal channel as shown in Sketch 11.1. The flood channel would provide the necessary compensation for the loss of floodplain, with the low flow channel being designed with sufficient capacity for low flows. The low flow channel would have gentle meanders to create a slightly more natural effect than the existing channel. The existing A507 arch culvert would be extended by an oversized box culvert. The A421 box culvert would be extended using a similar box culvert section.

Mitigation for Changes to the Hydrological Regime

11.6.9 There would be an increase in the impermeable area draining to the Broughton Brook and the run-off from this area would be attenuated to the IDB's greenfield run-off rate (4 litres / second / hectare) using the proposed balancing ponds, thus ensuring that there is no increase in flows in the Broughton Brook or its tributaries.

11.6.10 As noted in paragraph 11.5.11, attenuation of run-off within the Elstow catchment is managed at a strategic level by the IDB. Where run-off from the Scheme would flow to an IDB attenuation facility, such as those planned near the Marsh Leys junction, no attenuation is required as part of the Scheme. In all other locations, attenuation of the run-off to greenfield rate would be achieved using the balancing ponds proposed.

11.6.11 The balancing ponds would generally be designed to be dry basins, filling up after rainfall events and emptying afterwards.

Mitigation Measures to be Adopted during Scheme Construction

11.6.12 The procedures for managing construction of the Scheme so as to minimise the effects on the water environment are defined in the outline Construction Environmental Management Plan (CEMP). This would be reviewed and revised regularly should the Scheme progress to construction.

11.6.13 The potential for adverse environmental effects would be minimised by adhering to the following Pollution Prevention Guidance Notes published by the Environment Agency and readily accessible on its web-site:

- General Guide to the Prevention of Pollution PPG1
- Above Ground Oil Storage Tanks PPG2
- Use and Design of Oil Separators in Surface Water Drainage Systems PPG3
- Works in, Near or Liable to Affect Watercourses PPG5
- Working at Construction and Demolition Sites PPG6
- Refuelling Facilities PPG7
- Safe Storage and Disposal of Used Oil PPG8
- High Pressure Water and Steam Cleaners PPG13
- Managing Fire Water and Major Spillages PPG18
- Pollution Incident Response Planning PPG21
- Storage and Handling of Drums and Intermediate Bulk containers PPG26.

11.6.14 The advice in CIRIA Technical Guidance C648 "Control of water pollution from linear construction projects" would be followed, and copies of this guidance or the associated Site Guide C649 would be readily available to construction personnel.

11.7 Environmental Effects

Effects of Construction

Effects on Surface Water Flows

11.7.1 Construction of the Scheme could lead to effects on the flows in the brooks and ditches. These could be caused by blockages, leading to flooding upstream or drying out downstream, by discharges or by temporary diversions. Broughton Brook would be most likely to be affected, either by the proposed diversion works or works extending the existing culverts. Elstow Brook could be affected where works on the proposed culvert extension are being carried out, or due to works affecting the flows in one of the several ditches that feed into it. There is the potential for minor impacts to cause **slight adverse** effects locally on these watercourses.

11.7.2 There is a risk that construction within the floodplain could affect flows downstream in the River Great Ouse. Deposition of materials within the floodplain could reduce the volume available for storage of floodwaters. However the floodplains areas are relatively small and some distance from the river, so impact of the Scheme is estimated to be negligible and the effects on the river's flood flows are considered to be **neutral**.

11.7.3 During construction of culverts over the ditches, it is possible that storms could cause flooding, if the ditches are temporarily blocked or diverted. However it is considered that any flooding that did occur would be localised, so the effects would be **neutral**.

11.7.4 Adoption of the advice given in the documents listed in paragraphs 11.6.13 and 11.6.14 would further minimise the potential for adverse impacts to occur. Therefore it is considered that the effects on surface water flows would be **neutral**.

Effects on Surface Water Quality

11.7.5 Where works are undertaken on or in close proximity to watercourses, there is a risk that the following impacts could affect the watercourses:

- Spillage or deposition of stored materials, including oil, fuel, hydraulic fluids
- Run-off of silt from exposed ground or stockpiles
- Spillage or release of construction materials such as concrete
- Release of contaminants from disturbed ground (See Chapter 10: Geology and Soils).

11.7.6 These impacts may affect the watercourse directly, or may enter via drains, ditches or run off adjacent ground. The risks are likely to be greatest during construction of the Broughton Brook diversion, and works to culverts crossing that brook, Elstow Brook and other watercourses. Bulk earthworks, such as excavation of the cuttings and filling to the embankments could also give rise to the risk of run-off of silt, particularly where such operations are close to watercourses, as would be the case for much of the Scheme east of Marston Moretaine.

11.7.7 Adoption of the advice given in the documents listed in paragraphs 11.6.13 and 11.6.14 would however minimise the potential for adverse impacts to occur. Therefore it is considered that the effects on surface water quality would be **neutral**.

Effects on Groundwater Flows

11.7.8 Most of the Scheme would be constructed above the water table. Some sections such as the cuttings at Brogborough and Beancroft would intercept the existing water table and de-watering is likely to be required. The effect of construction of these cuttings is likely to lead to localised lowering of the water table. Given the relatively low permeability of much of the underlying ground, the relatively flat terrain and the presence of large water bodies it is considered that any effects on groundwater flow are likely to be very localised. With adoption of the advice given in the documents listed in paragraphs 11.6.13 and 11.6.14, any effects during construction of the works would be minimised and are therefore considered to be **neutral**.

Effects on Groundwater Quality

11.7.9 Wherever construction works are carried out, there is always the risk that spillages or leakages of oil, fuel or hydraulic fluids could contaminate the ground and subsequently leach into the underlying water table; or that contaminants in the ground could be released. The risk would be greatest where works are carried out in cuttings, as described above, or above soils of high permeability. Most of the Scheme would however be protected by the overlying soils and drift deposits and the advice given in the documents listed in paragraphs 11.6.13 and 11.6.14 would be implemented. Given that most of the Scheme would be constructed above soils of low permeability, the absence of any major aquifers and the low number of groundwater abstractions within the Scheme area, the risk that any such impacts would lead to significant effects upon groundwater quality is considered to be **neutral**.

Effects of Road Operation and Maintenance

Effects on Surface Water Quality

11.7.10 The method in DMRB 11.3.10 was used to assess the effect of routine highway run-off on the water quality, by estimating the downstream concentrations of copper and zinc. It was found that the effects on Broughton Brook would be **moderate adverse**. The effects on individual ditches in either catchment would be **neutral**. The effects on Elstow Brook would be **moderate adverse**, if the cumulative impact of all the watercourses flowing into the brook is considered. These effects would be reduced to **slight** when the mitigation measures described in paragraph 11.6.4 are taken into account. The results of the assessment of the worst case for both brooks are given in Appendix 11.8.

11.7.11 An assessment has been made of the risk of a pollution incident occurring as a result of an accidental spillage. The effect would be **slight adverse** for the length of M1 discharging to Broughton Brook, but this would be reduced to **negligible** when the mitigation measures described in paragraph 11.6.7 are taken into account. The risk of a pollution incident affecting Elstow Brook is assessed as **negligible**. The results of the spillage risk assessments are given in Appendix 11.9.

11.7.12 The existing M1 and A421 do not contain any measures at the outfalls to control the risk of pollution due to accidental spillage. As noted in paragraph 11.5.23 above, the existing risk from the length of M1 within the Scheme is considered higher than usual and has been assessed as having a **slight adverse** effect, and includes a location assessed as a "priority outfall" due to the risk of pollution. This means it is one of the locations on the Highways Agency's network where the risk of pollution is considered to be highest. Implementation of spillage control measures would be a **slight beneficial** effect of the Scheme.

11.7.13 Maintenance of the highway when operational would include the use of de-icing salts and herbicides. Both these have the potential to affect water quality, particularly if the maintenance operation is poorly managed. It is considered that the extent of application of these materials within the catchments would not significantly change with implementation of the Scheme, as there would be a significant decrease in the extent of application on the existing A421, once its traffic volume decreases. It is considered that the overall effect would therefore be **neutral**.

11.7.14 The results from the assessments in Appendices 11.8 and 11.9 are summarised in Table 11.6.

Table 11.6 Summary of Potential Pollution Impacts

Catchment	Broughton Brook (Do minimum)	Broughton Brook with Scheme	Elstow Brook
Routine Run-off Assessment	Negligible impact	Possible minor impact on concentration of dissolved copper	Possible minor impact on concentration of dissolved copper
Spillage risk without mitigation	Annual Spillage risk is 0.39%	Annual Spillage risk is 0.52%	Annual Spillage risk is 0.41%
Spillage risk with mitigation	Annual Spillage risk is 0.31%	Annual Spillage risk is 0.17%	Annual Spillage risk is 0.12%
Impact on Spillage risk	Scheme would have minor beneficial impact on spillage risk		Negligible impact

Effects on Surface Water Flows and Flood Risk

11.7.15 The new channel area for the proposed diversion of Broughton Brook described in 11.6.7 and 11.7.8 is in excess of the existing flood plain and the proposed channel therefore contains the flood predicted to occur with an annual probability of 1% (including an allowance for climate change) without overtopping its banks. This is shown in Sketch 11.1. The results of the hydrological and hydraulic analyses show that the proposed culvert extensions would have no effect on water levels upstream and there would be no increase in water levels downstream of the A421. The proposed low flow channel with gentle meanders would encourage greater biodiversity along the brook than with the existing trapezoidal channel. The effect on the wider Broughton Brook catchment would therefore be **neutral**. Tables giving details of similar catchments used as the pooling group in the hydrological analysis described in paragraph 11.3.4 are included in Appendix 11.10.

11.7.16 The rest of the Scheme lies within the Elstow Brook catchment. Strategic management of surface water flows and flood risk is under the control of the Surface Waters Group, as described in paragraphs 11.4.28 - 11.4.37, 11.5.10 - 11.5.11. There was therefore no need to model the effect of the Scheme on the hydrology of Elstow Brook. The highway drainage run-off, as described in paragraph 11.6.10, would be designed to the requirements of the Surface Waters Plan. It is considered therefore that the effects of the Scheme on both surface water flow and the capacity of the existing flood plain would be **neutral**.

Effects on Groundwater Quality

11.7.17 No run-off from the Scheme would be discharged direct to the ground. However, as noted in paragraph 11.6.2, some of the run-off would be discharged via balancing ponds. All these ponds would have outlets discharging to surface watercourses, but some infiltration to ground is likely. There may be times when the receiving surface waters are very low, or even dry, and on these occasions there may also be a degree of infiltration of the run-off via those watercourses. As the polluting potential of the run-off is low and there would be no direct discharge of List 1 substances to groundwater, no special measures (such as impermeable liners) to prevent such infiltration would be implemented, and recharge to the ground is maximised.

11.7.18 As noted in paragraph 11.7.10, the effects on the water quality of individual ditches from routine highway run-off would be neutral. The ground through which the run-off percolates before it reaches the water table would attenuate any pollutants in the run-off. As noted in paragraph 11.5.17 above, the vulnerability of the existing groundwater is not high. Adoption of the measures described in paragraphs 11.6.4 and 11.6.6 would further reduce the risk of pollution of groundwater. It is considered the effects to groundwater quality from routine run-off are **neutral**.

11.7.19 As noted in paragraph 11.7.11, the risk of a spillage impact causing a significant effect on Elstow Brook is considered negligible. Although there remains a risk that a spillage impact could affect the groundwater for the reasons explained in paragraph 11.7.17, the effect on groundwater quality from such an impact is considered **neutral**.

Effects on Groundwater Flows

11.7.20 Two significant cuttings would be constructed as part of the Scheme, at Brogborough and at Marston Junction. The remainder of the Scheme would be constructed above the water table. At Brogborough, the cutting would be mainly through Oxford Clay, which is relatively impermeable. There may be pockets of more permeable material, such as alluvium or gravel, and excavation in these would lead to release of groundwater. The effect of the Scheme would be to lower the water table in the vicinity of the cuttings. At Brogborough, the cutting would be at the top of the catchments, so the impact on groundwater flows would be negligible. At Marston, the cutting would be close to Stewartby Lake, which would act as a buffer to changes in groundwater level caused by the Scheme. The effects of the Scheme on groundwater flows in this area would therefore also be **neutral**.

Significance of Effects

11.7.21 The methodology outlined in paragraphs 11.3.2 - 11.3.7 was used to assess the significance of the effects of the impacts of the Scheme on the water environment. It assumes that the mitigation measures described in Section 11.6 are implemented. The results are summarised in Table 11.7.

11.7.22 Both Broughton Brook and Elstow Brook and associated surface water features have been assessed as features of medium importance, using the definitions in Table 11.2. The groundwater has been assessed as of medium to low importance and Stewartby Lake has been assessed as a feature of medium importance.

Table 11.7 Summary of Potential Impacts and the Significance of their Effects

Feature	Attribute	Quality	Importance	Mitigation	Magnitude	Significance
Construction						
Watercourses Hydrology	Flood plain	Fair	Low	Good planning and management	Negligible	Neutral
Watercourses Water quality	Water quality	Fairly Good	Medium	Good planning and management	Negligible	Neutral
Groundwater	Resource	Fair	Medium / Low	Good planning and management	Negligible	Neutral
Operation						
Broughton Brook	Water Quality Routine run-off	Fairly Good	Medium	Ponds	Minor adverse	Slight adverse
Broughton Brook	Water Quality Spillage risk	Fairly Good	Medium	Ponds, spillage control facilities	Minor beneficial	Slight beneficial
Broughton Brook	Flood plain	Fair	Low	Two stage channel	Negligible	Neutral
Elstow Brook	Water Quality Routine run-off	Fairly Good	Medium	Ponds	Minor adverse	Slight adverse
Elstow Brook	Water Quality Spillage risk	Fairly Good	Medium	Ponds, spillage control facilities	Negligible	Neutral
Elstow Brook	Flood plain	Fair	Low	Balancing ponds and IDB strategic facilities	Negligible	Neutral
Stewartby Lake	Recreation	Fairly Good	Medium	Ponds, spillage control facilities	Negligible	Neutral

Feature	Attribute	Quality	Importance	Mitigation	Magnitude	Significance
Groundwater	Groundwater resource	Fair	Medium/Low	Ponds, spillage control facilities	Negligible	Neutral

11.8 Summary

11.8.1 A number of potential impacts on the water environment have been identified with the Scheme. The magnitude of these impacts would be reduced by mitigation measures incorporated into the Scheme design, as well as actions taken during the construction phase. A number of residual effects have been identified. The majority have been assessed as being **neutral**, though, as can be seen in Table 11.7, above, two have been assessed as being **slight adverse** and one as **slight beneficial**.

11.8.2 The assessment shows that the significance of the effects of the impacts from the Scheme on the hydrology of both Broughton Brook and Elstow Brook would be **neutral**. A hydraulic model shows that the impact on Broughton brook would be negligible. In the Elstow Brook catchment, the arrangement whereby the Surface Water Group, through the offices of the IDB, is planning to manage the impacts of various proposed developments, including this Scheme, is estimated to lead to **negligible** impact on the hydrology of the brook.

11.8.3 The assessment shows that assuming the worst case cumulative impact, the effect of routine run-off on water quality could be **adverse**. It also shows that for Broughton Brook the effect of spillage risk would be **beneficial**.

11.8.4 The overall assessment of the effect of the Scheme on the water environment is that it would have a **neutral** effect.

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Planning Policy Statement (PPS) 25: *Development and Flood Risk (2006)*

Appendix 11.1 Water Quality Data and Indicative Flood Risk for Downstream Watercourses (from Environment Agency Web Site) – Broughton Brook

» How to use the flood map

» What to do in a flood

» Current flood warnings

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River quality targets

Grid reference: X : 492,099.91, Y: 239,163.38

13 results for selected location. Page 1 / 1 :

River name	River stretch	Years	Target	Compliance	
BROUGHTON BROOK	BIRCHMOOR GREEN M1	2002 to 2004	3	Compliant	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	2001 to 2003	3	Compliant	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	2000 to 2002	3	Compliant	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	1999 to 2001	3	Compliant	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	1998 to 2000	3	Compliant	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	1997 to 1999	3	Compliant	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	1996 to 1998	3	Compliant	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	1995 to 1997	3	Compliant	View details
		1994 to			View

BROUGHTON BROOK	BIRCHMOOR GREEN M1	1996	3	Compliant	details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	1993 to 1995	3	Compliant	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	1992 to 1994	3	Compliant	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	1991 to 1993	3	Significant Failure	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	1988 to 1990	3	Marginal	View details

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River quality

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Water

Water Framework Directive (WFD)

River quality (chemistry)

Grid reference: X : 492,020.53, Y: 239,163.38

13 results for selected location. Page 1 / 1 :

River name	River stretch	County	District	Years	Grade	
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	2002 to 2004	B	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	2001 to 2003	B	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	2000 to 2002	B	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	1999 to 2001	B	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	1998 to 2000	B	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	1997 to 1999	C	View details
		Milton	Milton			

BROUGHTON BROOK	BIRCHMOOR GREEN M1	Keynes Council	Keynes Council	1996 to 1998	C	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	1995 to 1997	C	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	1994 to 1996	B	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	1993 to 1995	B	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	1992 to 1994	C	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	1991 to 1993	D	View details
BROUGHTON BROOK	BIRCHMOOR GREEN M1	Milton Keynes Council	Milton Keynes Council	1988 to 1990	D	View details

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River quality targets

Site details:

River name	BROUGHTON BROOK
River stretch	BIRCHMOOR GREEN M1
Years	2002 to 2004
Upstream grid ref.	X:494100, Y:233900
Downstream grid ref.	X:492100, Y:239200
Length	10.5

Sampling results:

	Average	Standard deviation	Percentile 95	Percentile 90	Percentile 10	Number of samples	Compliance
Biochemical oxygen demand (mg/l)	1.27	.82		1.88		36	Compliant
Ammonia (mgN/l)	.023	.030		.036		36	Compliant
Dissolved oxygen	103.89	19.12			85.72	35	Compliant

(percentage saturation)							
Un-ionised ammonia (mgN/l)	0	.00093	.00147			36	Compliant
pH acid	8.11	.462	7.52			36	Compliant
pH alkali	8.11	.462	8.70			36	Compliant
Hardness (mg/l CaCO3)	999						
Dissolved copper (ug/l)	0	0	0			0	Ungraded
Total zinc (ug/l)	0	0	0			0	Ungraded

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Appendix 11.2 Water Quality Data and Indicative Flood Risk for Downstream Watercourses (from Environment Agency Web Site) – Elstow Brook

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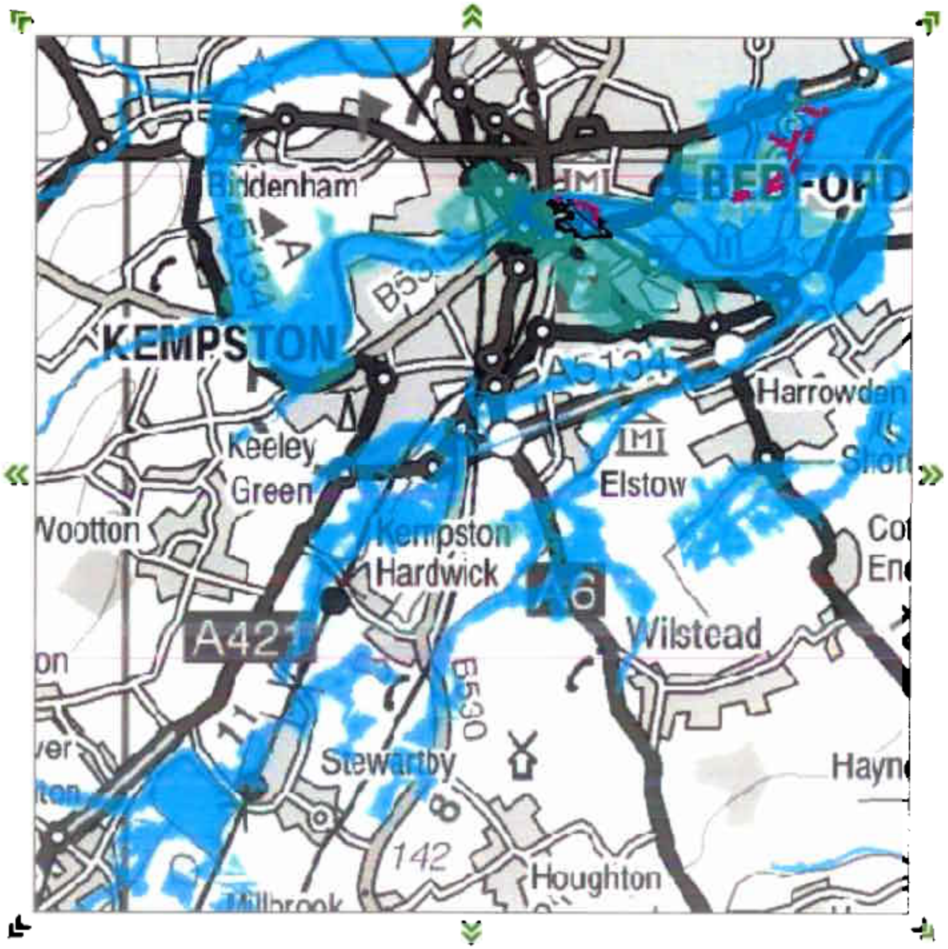

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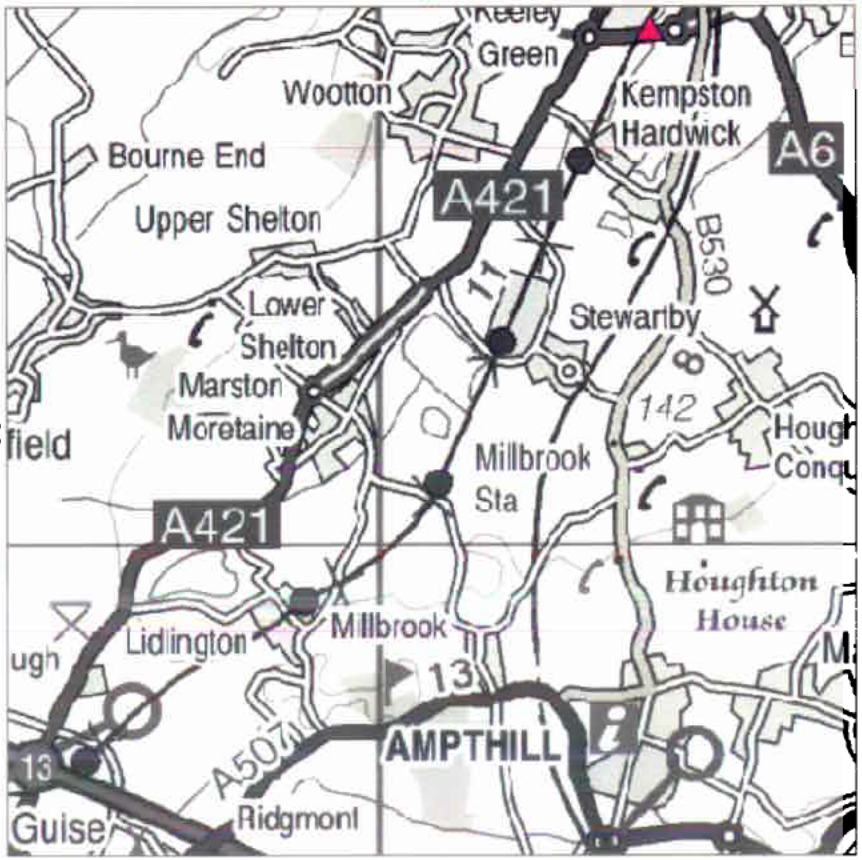

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Hi-flows

River quality

See also...

Water

Water Framework Directive (WFD)

River quality targets

Grid reference: X : 503,461.12, Y: 246,185.42

13 results for selected location. Page 1 / 1 :

River name	River stretch	Years	Target	Compliance	
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	2002 to 2004	3	Compliant	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	2001 to 2003	3	Compliant	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	2000 to 2002	3	Compliant	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	1999 to 2001	3	Compliant	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	1998 to 2000	3	Compliant	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	1997 to 1999	3	Compliant	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	1996 to 1998	3	Compliant	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	1995 to 1997	3	Compliant	View details
	STEWARTBY LAKE	1994 to			View

ELSTOW BROOK	OUTLET A421	1996	3	Compliant	details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	1993 to 1995	3	Compliant	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	1992 to 1994	3	Significant Failure	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	1991 to 1993	3	Significant Failure	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	1988 to 1990	3	Marginal	View details

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River quality (chemistry)

Grid reference: X : 503,355.28, Y: 246,291.25

13 results for selected location. Page 1 / 1 :

River name	River stretch	County	District	Years	Grade	
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	2002 to 2004	C	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	2001 to 2003	C	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	2000 to 2002	C	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	1999 to 2001	B	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	1998 to 2000	C	View details

ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	1997 to 1999	B	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	1996 to 1998	C	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	1995 to 1997	C	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	1994 to 1996	C	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	1993 to 1995	B	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	1992 to 1994	C	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	1991 to 1993	C	View details
ELSTOW BROOK	STEWARTBY LAKE OUTLET A421	Bedford Borough Council	Bedford Borough Council	1988 to 1990	D	View details

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River quality targets

Site details:

River name	ELSTOW BROOK
River stretch	STEWARTBY LAKE OUTLET A421
Years	2002 to 2004
Upstream grid ref.	X:501100, Y:242500
Downstream grid ref.	X:503400, Y:246300
Length	4.5

Sampling results:

	Average	Standard deviation	Percentile 95	Percentile 90	Percentile 10	Number of samples	Compliance
Biochemical oxygen demand (mg/l)	1.97	.91		2.73		36	Compliant
Ammonia (mgN/l)	.186	.607		.244		36	Compliant
Dissolved oxygen	96.11	22.33			74.99	34	Compliant

(percentage saturation)							
Un-ionised ammonia (mgN/l)	0	.01859	.00977			36	Compliant
pH acid	8.22	.396	7.71			36	Compliant
pH alkali	8.22	.396	8.72			36	Compliant
Hardness (mg/l CaCO3)	999						
Dissolved copper (ug/l)	3.01	2.05	5.49			36	Compliant
Total zinc (ug/l)	13.32	10.01	25.08			36	Compliant

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Appendix 11.3 Surface Water Abstraction Licences

Appendix 11.3 Summary of Surface Water Abstraction Licences

Licence No.	Local Name	Licence holder	NGR	Drawing Ref No.	Source	Purpose	Annual Quantity (m^3)	Daily Quantity (m^3)	Hourly Quantity (m^3)	Instant Quantity (l/s)
6/33/12/*S/0012	Stream at Wilstead	H Maskell & Son	TL 0543 4464	1	Surface Water	Spray Irrigation	4545	654.54	27.27	7.57
6/33/12/*S/0027	Flooded Knothole - Kempston Hardwick	Hanson Brick Ltd	TL 0329 4521 TL 0315 4495 TL 0290 4488 TL 0297 4510	2 3 4 5	Surface Water	Industrial, Commerical & Public Services	24836	133.45	25	22.73
	Kempston Hardwick Knothole	Hanson Brick Ltd	TL 029 449	6	Surface Water	Industrial, Commerical & Public Services	850	2.72	-	4.5
	Kempston Hardwick Knothole	Hanson Brick Ltd	TL 029 448	7	Surface Water	Industrial, Commerical & Public Services	4255	13.63	-	7.5
	Kempston Hardwick Knothole	Hanson Brick Ltd	TL 031 449	8	Surface Water	Industrial, Commerical & Public Services	59	0.2	-	1.06
6/33/12/*S/0062	Watercourse at Elstow	S Clark	TL 0520 4550 TL 060 469	9 10	Surface Water	Spray Irrigation	7863	490.9	40.9	11.36
6/33/12/*S/0080	Stream at Stewartby	Hanson Brick Ltd	TL 017 427	11	Surface Water	Industrial, Commerical & Public Services	204570	1636.56	68.19	18.94
	Stream at Stewartby	Hanson Brick Ltd	TL 012 428	12	Surface Water	Industrial, Commerical & Public Services	409140	1309.24	81.82	22.73
6/33/12/*S/0142	Stewartby Pit	Marston Vale Services	TL 004 421	13	Surface Water	Environmental - Non-remedial River/Wetland Support Make Up or Top Up Water	150000	12000	500	138

Appendix 11.4 Discharge Consents

Appendix 11.4 Current Discharge Consents to Surface Watercourse

Reference	Operator	Location	NGR	Drawing Ref. No	Issue Date	Discharge Type	Discharge Environment	Receiving Water	Approx. Distrance from Road Scheme (m)
PRCNF17727		Hungerhill Farm Beancroft road Marston Moreteyne	SP9777042610	1	3/20/2006	Sewage Discharge - Final/Treated Effluent - Not Water Company			2340
PRCNF17296		1 Quest Bungalow Ampthill road Houghton Conquest	TL0368342730	2	5/20/2004	Sewage Discharge - Final/Treated Effluent - Not Water Company			2700
PRCNF14375	[redacted]	The Haven Woburn Road Wootton	TL0050043000	3	7/13/2000	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	A Tributary of Bromham Brook	100
PRCNF17441	Bedfordshire County Council	Elstow Landfill (NE) Wilstead Road Elstow	TL0470046300	4	4/22/2005	Trade Discharges - Site Drainage	Freshwater Stream/River	Tr butary of Elstow Brook	350
PRCNF14381	[redacted]	The Haven Woburn Road Wootton	TL0050043000	5	7/13/2000	Sewage Discharge - Final/Treated Effluent - Not Water Company	Sewage Discharge - Final/Treated Effulent - Not Water Company	Culverted Ditch Stewartby Lake	100
PRCNF14594	[redacted]	Meadow View Cranfields Road Wootton Green	TL0027043980	6	8/15/2001	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Ditch Tributary of Elstow Brook	1058
PRCNF14641	[redacted]	16 Wootton Green Wootton	SP9987143614	7	12/10/2001	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Ditch Tributary of Wootton Brook	1100
PRCNF05515	[redacted]	Berry Farm Off Cranfield Road Wootton	TL0075043770	8	7/20/1995	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Ditch Tributary of Elstow Brook	416
PRCNF05862	[redacted]	Plot 2 ADJ The Croft Cranfield	TL0035043820	9	4/3/1998	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Ditch Tributary of Elstow Brook	840
PRCNF04079	Shanks Waste Service Ltd	Workshop Land ADJ to Rail Terminal.L Stewartby	TL0173043230	10	2/21/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Elstow Brook	920

Reference	Operator	Location	NGR	Drawing Ref. No	Issue Date	Discharge Type	Discharge Environment	Receiving Water	Approx. Distrance from Road Scheme (m)
AW1NF1199	Anglian Water Service Ltd	Sewer at Caulcott Marston Moretaine	TL0010042100	11	11/15/1977	Storm Overflow	Freshwater Stream/River	Elstow Brook	490
PRCNF05128	[redacted]	British Railways Stewartby Halt Stewartby	TL0190043290	12	1/14/1993	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Elstow Brook	1000
AW1NF1585	Anglian Water Service Ltd	Kempson (Hardwick) STW Kempston Hardwick	TL0360043700	13	6/15/1985	Sewage Discharge - Final/Treated Effluent - Water Company	Freshwater Stream/River	Elstow Brook River Great Ouse	2300
PRCNF05805	[redacted]	The Sycamores Bedford Road Marston Moretaine	TL0060043200	14	2/7/1997	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Highway Drain Elstow Brook	20
AWCNF11325	Anglian Water Service Ltd	Station Road PS Marston Moretaine	SP9985041180	15	8/12/1997	Storm Overflow	Freshwater Stream/River	Marston Brook	950
AW1NF3013	Anglian Water Service Ltd	Marston Moretaine STW Marston Moretaine	TL0005842154	16	3/23/2005	Storm Overflow	Freshwater Stream/River	Marston Brook	340
AW1NF3013	Anglian Water Service Ltd	Marston Moretaine STW Marston Moretaine	TL0005842154	17	3/23/2005	Sewage Discharge - Final/Treated Effluent - Water Company	Freshwater Stream/River	Marston Brook	340
AWCNF11325	Anglian Water Service Ltd	Station Road PS Marston Moretaine	SP9985041180	18	8/12/1997	Sewage Discharge	Freshwater Stream/River	Marston Brook	950
PRCNF14024	SITA UK	Rookery N & S Brick PITS Green Lane Stewartby	TL0112041310	19	5/22/1998	Trade Discharge	Freshwater Stream/River	Partly Culverted Ditch Stewart	1700
AWCNF11053	Anglian Water Service Ltd	Walnut Grove SPS Kempston	TL0183047610	20	12/10/1993	Seage Discharge	Freshwater Stream/River	River Great Ouse	1667
AWCNF2139	Anglian Water Service Ltd	Bell End - Kempston Kempston	TL0231047280	21	1/2/1990	Discharge	Freshwater Stream/River	River Great Ouse	1177
AW1NF1320	Anglian Water Service Ltd	Sewers Serving Kempston	TL0160047900	22	6/22/1983	Sewage Discharge	Freshwater Stream/River	River Great Ouse	2000
PR1NF1392	Bedfordshire County Council	Elstow Landfill (NE) Wilstead Road Elstow	TL0480046100	23	4/12/1983	Trade discharges - Process Effluent - Not water	Freshwater Stream/River	Tr butary of Elstow Brook	600

Reference	Operator	Location	NGR	Drawing Ref. No	Issue Date	Discharge Type	Discharge Environment	Receiving Water	Approx. Distrance from Road Scheme (m)
PRCNF03360	London Brick Company Ltd	3 Pillinge Cottages Station Road Millbrook Bedford	TL0080040430	24	1/24/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	2826
PR1NF1781	City & St James Property Ltd	The Elms Woburn Roaf Kempston Hardwick	TL0220045300	25	2/26/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	205
PRCNF05088	[redacted]	Iron House Wood End Marston	SP9779041520	26	9/25/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	666
PRCNF04067	[redacted]	Eschear Farm Buildings Lower End Lidlington	SP9833040340	27	2/6/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	682
PRCNF04495	[redacted]	Kempston Court Kempston Hardwick	TL0334044160	28	1/24/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	1800
PRCNF0956	[redacted]	Moretaine Farm Wood End Marston Moretaine	SP9850041400	29	1/10/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	121
PRCNF00800	Kempston Court Management Co	Kempston Court Kempston Hardwick	TL0334044160	30	1/17/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	218
PR1NF3412	[redacted]	1 Sailors Bridge Road Woburn Road Kempston	TL0272046410	31	2/13/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	218
PR1NF2173	[redacted]	2 Manor Road Kempston Hardwick	TL0340044300	32	3/10/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	1800
PR1NF 2083	[redacted]	Woburn Road Kempston Woburn Road Kempston Hardwick	TL0270046400	33	3/10/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	218

Reference	Operator	Location	NGR	Drawing Ref. No	Issue Date	Discharge Type	Discharge Environment	Receiving Water	Approx. Distrance from Road Scheme (m)
PR1NF 1113	[redacted]	4 Midland Cottages Houghton Conquest	TL0370043700	34	2/26/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Kempston Hardwick Brook	2500
PRCNF03162	[redacted]	Wood End Marston Moreteyne	SP9874041070	35	1/27/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Maston Brook	524
AW1NF448A	Anglian Water Service Ltd	Stewartby STW Broadmead Road Stewarty	TL0210043200	36	9/14/2000	Sewage Discharge - Final/Treated Effluent - Water Company	Freshwater Stream/River	Tr butary of Elstow Brook River Great Ouse	1200
PRCNF17539		West End Cottages Kempston	SP9944147837	37	5/13/2005	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of River Great Ouse	3400
PRCNF17368		Gresford Wood End Wootton	SP9958046220	38	10/14/2004	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of River Great Ouse	2580
PRCNF40077	[redacted]	Tithe Farm Tithe Road Wood End Kempston	TL0006046930	39	2/3/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of River Great Ouse	2420
PRCNF05227	Bedfordshire County Council	Bell Farm Ridge Road Kempston	TL01973046470	40	10/15/1993	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Wootton Brook	851
PRCNF05742	[redacted]	The Croft Cranfield Road Wootton	TL0030043750	41	12/12/1996	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	630
PRCNF14022	London Brick Company Ltd	Broadmead Farmhouse Wootton Broadmead Stewartby	TL0225043360	42	1/28/1998	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	1150
PRCNF05859	Wootton Green Management Ltd	Upper Shelton Road Wootoon Green	SP9982043360	43	5/8/1998	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	883
PRCNF05857	[redacted]	Plot 1 ADJ The Croft Cranfield	TL0032043750	44	3/30/1998	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	630

Reference	Operator	Location	NGR	Drawing Ref. No	Issue Date	Discharge Type	Discharge Environment	Receiving Water	Approx. Distrance from Road Scheme (m)
PRCNF05803	[redacted]	2 Manor Road Kempston Hardwick	TL0340044300	45	2/7/1997	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	1800
PRCNF05802	Pilgrims Housing Associates	Askern House Kempston Hardwick	TL0300044600	46	2/7/1997	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	1316
PRCNF05628	Shanks Waste Service Ltd	Coronation Clay Pit Broadmead Road Stewartby	TL0280043600	47	7/29/1998	Trade Discharge - Site Drainge	Freshwater Stream/River	Tr butary of Elstow Brook	1600
PRCNF04503	Universal Salvage Plc	Acrey Fields Woburn Road	TL0070045010	48	6/29/1998	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Elstow Brook	1210
PRCNF05943	Shanks Waste Service Ltd	Elstow Waste Transfer Elstow Landfill Site Wilstead Road Elstow	TL0489046000	49	7/6/2001	Trade discharges - Process Effluent - Not Water	Freshwater Stream/River	Tr butary of Harrowden Brook	730
PRCNF05944	Shanks Waste Service Ltd	Elstow Waste Transfer Elstow Landfill Site Wilstead Road Elstow	TL0489046000	50	7/6/2001	Trade Discharge - Site Drainge	Freshwater Stream/River	Tr butary of Harrowden Brook	730
PRCNF17442	Bedfordshire County Council	Elstow Landfill (NW) Wilstead Road Elstow	TL0420346300	51	4/22/2005	Trade Discharge - Site Drainge	Freshwater Stream/River	Tr butary of Elstow Brook	200
PRCNF14326	[redacted]	Top Farm Wootton Green Wootton	SP9858044700	52	2/29/2000	Sewage Discharge - Final/Treated Effluent - Water Company	Freshwater Stream/River	Tr butary of Wootton Brook	3000
PRCNF05482	[redacted]	10 & 12 Wootton Green Wootton Green	SP9985043580	53	6/15/1995	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Wootton Green Brook	1100
PRCNF 14257	W Lamb Ltd	Crawley Crossing Bedford Road Husborne Crawley	SP9600037100	54	10/4/1999	Sewage Discharge - Final/Treated Effluent - Water Company	Freshwater Stream/River		244

Reference	Operator	Location	NGR	Drawing Ref. No	Issue Date	Discharge Type	Discharge Environment	Receiving Water	Approx. Distrance from Road Scheme (m)
PRNCF14258	Modo Merchants Ltd	Phase 4B Industrial Estate Bedford Road Crawley Crossing Husborne Crawley	SP9603037080	55	10/4/1999	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Broughton Brook	280
PRCNF14263	S J J Limited	Manor Farm Brogborough	SP9634039090	56	10/7/1999	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Elstow Brook	460
PR1NF3416	[redacted]	Rook Tree Farm Hulcote Milton Keynes	SP9482039110	57	2/14/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Broughton Brook	1950
PRCNF05008	Rogers Hulcote Ltd	Hulcote Farm Hulcote Milton Keynes	SP9508038320	58	1/30/1992	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Broughton Brook	885
PR1NF2148	Millbrook Proving Ground Ltd	MillBrook Bedford	TL0130039400	59	9/17/1985	Discharge	Freshwater Stream/River	Tr butary of Elstow Brook	3600
AW1NF448A	Anglian Water Service Ltd	Stewartby STW Broadmead Road Stewarty	TL0210043200	60	9/14/2000	Sewage Discharge - Final/Treated Effluent - Water Company	Freshwater Stream/River	Tr butary of Elstow Brook River Great Ouse	1120
PRCNF05506	Clifford Packaging Films	Crawley Crossing Bedford Road Husborne Crawley	SP9600037100	61	7/11/1995	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Broughton Brook	244
PRCNF14437	C H Jones Ltd Crawley Crossing	Crawley Crossing Bedford Road Husborne Crawley	SP9603037070	62	11/14/2001	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Broughton Brook	280
PRCNF17668		The Halt Garage Husborne Crawley	SP9576036880	63	11/3/2005	Sewage Discharge - Final/Treated Effluent - Not Water Company	Freshwater Stream/River	Tr butary of Broughton Brook	520
PR1NF1349	Shanks & Mcewan	Site Office Brogborough No. 2 Refuse Reception	SP97163989	64	6/8/1982	Trade Discharges - Process Water	Freshwater Stream/River	Tr butary of Elstow Brook	5

Appendix 11.5 Pollution Incidents

Appendix 11.5 Pollution Incidents to Surface Watercourse

ID	Event No	Reported Date	NGR	Cause Type	Premises Type	Pollutant	Water Env. Impact Level
1	232587	4/26/2004	TL00825 44976	Pipe Failure below ground	Petrol Station	Diesel	Cat 2 (Significant)
2	178197	7/31/2003	TL0106 4267	Algla Activity	Other Natural Source	Algae	Cat 2 (Significant)
3	141292	3/5/2003	TL05139 45467	Pipe Failure below ground	Foul Sewer	Crude Sewage	Cat 2 (Significant)
4	90058	7/8/2002	TL0195 4376	Algal Activity	Other Natural Source	Algae	Cat 1 (Major)
5	77585	5/9/2002	TL0201 4352	Sewer Failure or Overflow	Sewage Treatment Works	Crude Sewage	Cat 2 (Significant)
6	66945	3/27/2002	TL05153 45515	Sewer Failure or Overflow	Rising Main	Crude Sewage	Cat 2 (Significant)
7	45008	11/26/2001	TL03101 44579	Vandalism	Education and Research	Gas & Fuel Oils	Cat 2 (Significant)
8	45008	11/26/2001	TL0260 4782	Vandalism	Education and Research	Gas & Fuel Oils	Cat 2 (Significant)
9	9912	6/18/2001	TL 0225 4265	Septic Tank or Sewage Treatment Plant Failure	Sewage Treatment Works	Sludge	Cat 2 (Significant)
10	9912	6/18/2001	TL0199 4315	Septic Tank or Sewage Treatment Plant Failure	Sewage Treatment Works	Sludge	Cat 2 (Significant)
11	76718	12/16/1998	SP9490 4080	Structural Failure - Pipe Failure (below ground)	Transport, Storage, communicats - Pipelines	Inert - Rocks & Soils Other	Cat 2 (Significant)
12	76456	11/2/1998	TL0190 4370		Waste Management Facilities - Landfill	Inert - Rocks & Soils	Cat 2 (Significant)
13	76292	10/23/1998	TL0250 4520		Waste Management Facilities - Landfill	Inert - Rocks & Soils	Cat 2 (Significant)
14	76076	9/14/1998	TL0250 4520	Other	No premises identified	General Biodegradable - Natural Organic Material - Other	Cat 2 (Significant)
15	74174	2/8/1998	TL 0070 4290	Un-consented Works	No premises identified	Organic Chemicals - Other Organic Wastes - Other	Cat 1 (Major)

ID	Event No	Reported Date	NGR	Cause Type	Premises Type	Pollutant	Water Env. Impact Level
16	74170	2/4/1998	TL 0010 4220	Other	WSC Sewage, Sewage & Supply - Sewage Treatment Works (WSC)	General Biodegradable - Sewage and Sewerage Material - Treated Effluent	Cat 2 (Significant)
17	73915	1/10/1998	SP 9690 3960	Un-consented Works	CB 3998 Brogborough (Beds) Trib Elstow Brooks	Organic Chemicals - Mineral & Synthetic Oils - Reds Gas Oils	Cat 2 (Significant)
18	71502	5/17/1997	TL 0250 4770	Structural Failure - Pipe Failure (below ground)	No premises identified	Organic Chemicals - Mineral & Synthetic Oils - Diesel Fules	Cat 2 (Significant)
19	68370	8/1/1996	TL 0020 4260	Human Actions - Operator error	Agriculture - Arable Farming	General Biodegradable - Sewage and Sewerage Material - Sludge	Cat 2 (Significant)
20	68294	5/28/1996	TL 0510 4550	Drainage Failures - Foul Sewer Failure	Other premises	General Biodegradable - Sewage and Sewerage Material - Crude Sewage	Cat 2 (Significant)
21	63883	2/7/1995	TL 0600 4400		Agriculture - Pig Farm	General Biodegradable - Agricultural - Slurry	Cat 2 (Significant)
22	62320	8/5/1994	TL 0160 4330	Other	Waste Management Facilities - Landfill	General Biodegradable - Biological/non Sewage - Landfill Leachate	Cat 2 (Significant)
23	60432	2/2/1994	TL 0170 4280	Other	Other premises	Organic Chemicals - Mineral & Synthetic Oils - Diesel Fules	Cat 2 (Significant)
24	60430	2/1/1994	TL 0340 4650	Structural Failure - Pipe Failure (below ground)	WSC Sewage, Sewerage & Supply - Sewage Treatment Works (WSC)	Organic Chemicals - Mineral & Synthetic Oils - Reds Gas Oils	Cat 2 (Significant)

Appendix 11.6 Groundwater Abstraction Licences

Appendix 11.6 Summary of Groundwater Abstraction Licences

Licence No.	Local Name	Licence holder	NGR	Drawing Ref No.	Source	Purpose	Annual Quantity (m^3)	Daily Quantity (m^3)	Hourly Quantity (m^3)	Instant Quantity (l/s)
6/33/12/*G/0031	Well - Racemeadow Farm	London Brick Co Ltd	TL 0380 4570	1	Groundwater	General Farming & Domestic	195.5	0.52	-	0.31
6/33/12/*G/0139	Borehole at Kempston Hardwick	Supreme Concrete Ltd	TL 038 454	2	Groundwater	Industrial, Commerical & Public Services	650	2.27	0.22	0.06

Appendix 11.7 Discharge to Groundwater Licences

Appendix 11.7 Current Discharge Consents to Groundwater

Reference	Opoerator	Location	NGR	Drawing Ref. No	Issue Date	Discharge Type	Discharge Environment	Receiving Water	Approx. Distrance from Road Scheme (m)
GWCLF31121	F J Hall & Sons	College Farm Harrowden	TL0498046640	1	4/1/1999	Abstraction	Groundwater	Groundwater	126
GWCLF31226	L E Barnes & Sons Ltd	Roxhill Manore Farm Maston Moreteyne	SP9761043550	2	4/1/1999	Abstraction	Groundwater	Groundwater	3440
GWCLF30824	RJ HA PJ Carter Partnership	Great Thickthorn Farm Houghton Conquest	TL0440042700	3	4/2/1999	Abstraction	Groundwater	Groundwater	4168
GWCLF30242	[redacted]	Beancroft Farm High Street Stagden	SP9865042080	4	3/31/1999	Abstraction	Groundwater	Groundwater	912
GWCLF30036	Sinnot & Partners	Hayfield Farm Aspley Guise Milton Keynes	SP9482037580	5	4/1/1999	Abstraction	Groundwater	Groundwater	772

Appendix 11.8 Worst Case Assessment for Broughton Brook and Elstow Brook

Brougton Brook Catchment with Proposed Scheme
Assessment of Risk of Polluton from Routine Highway Runoff (Using methodology from CIRIA 142)

River flow (Q95)	0 030	m3/s	Assumed
RE class (1 - 6)	3		
Average Hardness	999 00	mg/l	
Motorway Road width (impermeable surface)	15	m	One-way
Motorway Road width (impermeable surface)	30	m	Two-way
Motorway central reserve width	4	m	
Road length drained into river	1900	m	Northbound
Road length drained into river	1900	m	Central Reserve
Road length drained into river	1900	m	Southbound
Road length drained into river	1900	m	Two-way
Trunk Road Road width (impermeable surface)	7.3	m	One-way
Trunk Road Road width (impermeable surface)	14.6	m	Two-way
Trunk Road central reserve width	9	m	
Road length drained into river	2450	m	Northbound
Road length drained into river	2450	m	Central Reserve
Road length drained into river	2450	m	Southbound
Road length drained into river	2450	m	Two-way
Extra for junctions (impermeable surface)	17109 00	m2	
Traffic flow (two-way)	155840	veh/day	
Traffic Flow (northbound one-way)	77920	veh/day	
Traffic Flow (southbound one-way)	77920	veh/day	
Runoff coefficient	0.5		Assumed
Rainfall depth	8	mm/day	
Upstream dissolved copper (95 %ile)	0 071	mg/l	Data from site sampling
Upstream total zinc (95 %ile)	0 037	mg/l	Data from site sampling
Road area upstream contributing to river	0	m2	
Traffic flow upstream contributing to river	0	veh/day	

NO.	DESCRIPTION		NOTES	VALUE
1	River flow (m3/s)	Q_{95}	Obtain from regulator	0.03
2	River flow Daily Volume(m3/day)	V_R	[1] * 3600 *24	2592.000
3	RE class (1-6)	RE	Obtain from regulator	3
4	Hardness (mg/l CaCO3)		Obtain from regulator	999
5i	Motorway Road width (m) - Two way		Width of impermeable surface of new road (Two-way)	30
5ii	Motorway Central Reserve width (m)		Width of cenral reserve of motorway	4
6i	Road Length (m) - Two-way		Length of Motorway to this outfall	1900
6ii	Road Length (m) - Central Reservation		Length of Motorway to this outfall	1900
7i	Road width (m) - Two way		Width of impermeable surface of new road (Two-way)	14.6
7ii	Trunk Road Central Reserve width (m)		Width of cenral reserve of trunk road	9
8i	Trunk Road Length (m) - Two-way		Length of trunk road to this outfall	2450
8ii	TrunkRoad Length (m) - Central Reserve		Length of trunk road to this outfall	2450
9	Extra for junctions (m2)		Allowance for extra impermeable area	17109
10	Road area (m2)		([5i] * [6i] + [5ii] * [6ii] + [7i] * [8i] + [7ii] * [8ii])+ [9]	139529
11	Traffic flow (veh/day) - Two way		Design traffic flow - Two way	155840
12	Runoff coefficient		Use 0.5 unless justification for other value	0 5
13	Rainfall depth (mm)	d	Read from Figure 5.4 in CIRIA Report 142	8
14	Runoff volume (m3)	V_H	[10] * [12] * [13] / 1000	558.116
15	Dilution	V_R/V_H	[2] / [14]	4 644
16	Impact code		From CIRIA Report 142, Table 5 6 for values in [11] & [15]	D O
17	Total road area (m2)		All roads draining to this river reach with traffic flow > 5000	139529
18	Average traffic flow (veh/day)		For roads included in [17]	155840
19	Runoff volume (m3)		[17] * [12] * [13] / 1000	558.116
20	Dilution		[2] / [19]	4 644
21	Impact code		From CIRIA Report 142, Table 5 6 for values in [16] & [18]	D O
22	Overall impact code		Worst case of [16] & [21]	**D O**
22a	Detailed assessment for metals?		Carry out if [20a] includes "D"	YES
23	Annual build up of soluble copper (kg/ha/y)	M	From CIRIA Report 142, Table 5.1 for value in [18]	1 2
24	5 day build-up at studied outfall (kg)		5 * [10] * [23] / (10000 * 365)	0 2294
25	Standard for copper (mg/l)		From Table 5.5 / 1000 for values in [3] & [4]	0.112
26	Upstream conc of copper (mg/l)	C_B	From regulator (95%ile)	0 056
27	Change in conc of copper (mg/l)		1000 * [24] / ([19] + [2])	0 073
28	Downstream conc of copper (mg/l)	C_R	[26] + [27]	0.129
29	Is there an impact?		Yes if [28] > [25]	**YES**
30	Annual build up of total zinc (kg/ha/y)		From CIRIA Report 142, Table 5.1 for value in [18]	5 0
31	5 day build-up at studied outfall (kg)	M	5 * [10] * [30] / (10000 * 365)	0 956
32	Standard for zinc (mg/l)		From Table 5.5 / 1000 for values in [3] & [4]	2 000
33	Upstream conc of zinc (mg/l)	C_B	From regulator (95%ile)	0 037
34	Change in conc of zinc (mg/l)		1000 * [31] / ([19] + [2])	0 303
35	Downstream conc of zinc (mg/l)	C_R	[33] + [34]	0 340
36	Is there an impact?		Yes if [35] > [32]	**NO**

Assessment predicts an impact on dissolved copper, so mitigation is recommended.

Elstow Brook Catchment

Assessment of Risk of Polluton from Routine Highway Runoff (Using methodology from CIRIA 142)

River flow (Q95)	0.030	m3/s	Assumed
RE class (1 - 6)	3		
Average Hardness	999.00	mg/l	
Road width (impermeable surface)	7 3	m	One-way
Road width (impermeable surface)	14 6	m	Two-way
Central Reserve Width	6	m	
Road length drained into river	13200	m	Northbound
Road length drained into river	13200	m	Central Reserve
Road length drained into river	13200	m	Southbound
Road length drained into river	13200	m	Two-way
Extra for junctions (impermeable surface)	232867	m2	
Traffic flow (two-way)	88580	veh/day	
Traffic Flow (northbound one-way)	44290	veh/day	
Traffic Flow (southbound one-way)	44290	veh/day	
Runoff coefficient	0 5		Assumed
Rainfall depth	8	mm/day	
Upstream dissolved copper (95 %ile)	0.056	mg/l	Assumed 1/2 of Table 5.5 values (target values)
Upstream total zinc (95 %ile)	1.000	mg/l	Assumed 1/2 of Table 5.5 values (target values)
Road area upstream contributing to river	0	m2	
Traffic flow upstream contributing to river	0	veh/day	

NO.	DESCRIPTION		NOTES	VALUE
1	River flow (m3/s)	Q_{95}	Obtain from regulator	0.03
2	River flow Daily Volume(m3/day)	V_R	[1] * 3600 *24	2592.000
3	RE class (1-6)	RE	Obtain from regulator	3
4	Hardness (mg/l CaCO3)		Obtain from regulator	999
5i	Road width (m) - Two way		Width of impermeable surface of new road (Two-way)	14.6
5ii	Central Reserve width (m)		Width of central reserve	6
6i	Road Length (m) - Two-way		Length of new road to this outfall	13200
6ii	Road Length (m) - Central Reserve		Length of new road to this outfall	13200
7	Extra for junctions (m2)		Allowance for extra impermeable area	232867
8	Road area (m2)		([5]*[6i]+[5ii]*[6ii])+ [7]	504787
9i	Traffic flow (veh/day) - Two way		Design traffic flow - Two way	88580
10	Runoff coefficient		Use 0.5 unless justification for other value	0 5
11	Rainfall depth (mm)	d	Read from Figure 5.4 in C RIA Report 142	8
12	Runoff volume (m3)	V_H	[8] * [10] * [11] / 1000	2019.148
13	Dilution	V_R/V_H	[2] / [12]	1.284
14	Impact code		From C RIA Report 142, Table 5.6 for values in [9] & [13]	D O
15	Total road area (m2)		All roads draining to this river reach with traffic flow > 5000	504787
16	Average traffic flow (veh/day)		For roads included in [15]	88580
17	Runoff volume (m3)		[15] * [10] * [11] / 1000	2019.148
18	Dilution		[2] / [17]	1.284
19	Impact code		From C RIA Report 142, Table 5.6 for values in [16] & [18]	D O
20	Overall impact code		Worst case of [14] & [19]	**D O**
20a	Detailed assessment for metals?		Carry out if [20a] includes "D"	YES
21	Annual build up of soluble copper (kg/ha/y)	M	From C RIA Report 142, Table 5.1 for value in [16]	1 2
22	5 day build-up at studied outfall (kg)		5 * [8] * [21] / (10000 * 365)	0 8298
23	Standard for copper (mg/l)		From Table 5 5 / 1000 for values in [3] & [4]	0.112
24	Upstream conc of copper (mg/l)	C_B	From regulator (95%ile)	0.056
25	Change in conc of copper (mg/l)		1000 * [22] / ([17] + [2])	0.180
26	Downstream conc of copper (mg/l)	C_R	[24] + [25]	0.236
27	Is there an impact?		Yes if [26] > [23]	**YES**
28	Annual build up of total zinc (kg/ha/y)		From C RIA Report 142, Table 5.1 for value in [16]	5 0
29	5 day build-up at studied outfall (kg)	M	5 * [8] * [28] / (10000 * 365)	3.457
30	Standard for zinc (mg/l)		From Table 5 5 / 1000 for values in [3] & [4]	2.000
31	Upstream conc of zinc (mg/l)	C_B	From regulator (95%ile)	1.000
32	Change in conc of zinc (mg/l)		1000 * [29] / ([17] + [2])	0.750
33	Downstream conc of zinc (mg/l)	C_R	[31] + [32]	1.750
34	Is there an impact?		Yes if [33] > [30]	**NO**

The method predicts an effect on dissolved copper, so mitga ion is recommended.

Appendix 11.9 Spillage Risk Assessment Results

HIGHWAYS AGENCY

Broughton Brook Catchment (Do Minimum)

Method D - assessment of risk from accidental spillage

		A (main road)	B	C	D	E	F	G	H	I	J		
			Additional columns for use if other roads drain to the same outfall										
D1	Water body type	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse		
D2	Length of road draining to outfall *(m)*	1,500	400	1,200	200	332	707	200	200	452	100		
D3	Road Type *(A-road or Motorway)*	M	M	A	A	A	M	A	A	A	A		
D4	If A road, is site urban or rural?			Rural	Rural	Rural	Rural	Rural	Rural	Rural	Rural		
D5	Junction type	No junction	Slip road	No junction	Slip road	Roundabout	Slip road	Roundabout	Side road	Side road	Roundabout		
D6	Location	> 1 hour	> 1 hour	< 1 hour	< 1 hour	< 1 hour	> 1 hour	< 1 hour	< 1 hour	< 1 hour	< 1 hour		
D7	Traffic flow	164,000	164,000	33,000	35,000	50,000	12,000	12,000	12,000	28,508	28,508		
D8	% HGV	16.1	16.1	8	8	8	10	10	10	5.2	5.2		
D8	Spillage factor *(no/10^9 HGVkm/year)*	0.36	0.43	0.29	0.83	3.09	0.43	3.09	0.93	0.93	3.09		
D9	Risk of accidental spillage	0.00520	0.00166	0.00034	0.00017	0.00150	0.00013	0.00027	0.00008	0.00023	0.00017		
D10	Probability factor from Table D.2	0.40	0.40	0.40	0.40	0.40	0.50	0.40	0.40	0.40	0.40		
D11	Risk of pollution incident	0.00208	0.00066	0.00013	0.00007	0.00060	0.00007	0.00011	0.00003	0.00009	0.00007	**Overall annual risk**	**Return Period (years)**
D12	Is risk greater than 0.01?	No	No	No	No	No	No	No	No	No	No		
D13	Return period without pollution reduction measures	0.00208	0.00066	0.00013	0.00007	0.00060	0.00007	0.00011	0.00003	0.00009	0.00007	0.39%	256
D14	Existing measures factor											0.8	
D15	Return period with existing pollution reduction measures											0.0031	320
D16	Proposed measures factor											0.8	
D17	Residual with proposed Pollution reduction measures											0.31%	320

Table 7.1

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

Justification for choice of existing measures factors:

No known existing measures except filter drains in some locations.
Assume reduction factor = 0.8.

Justification for choice of proposed measures factors:

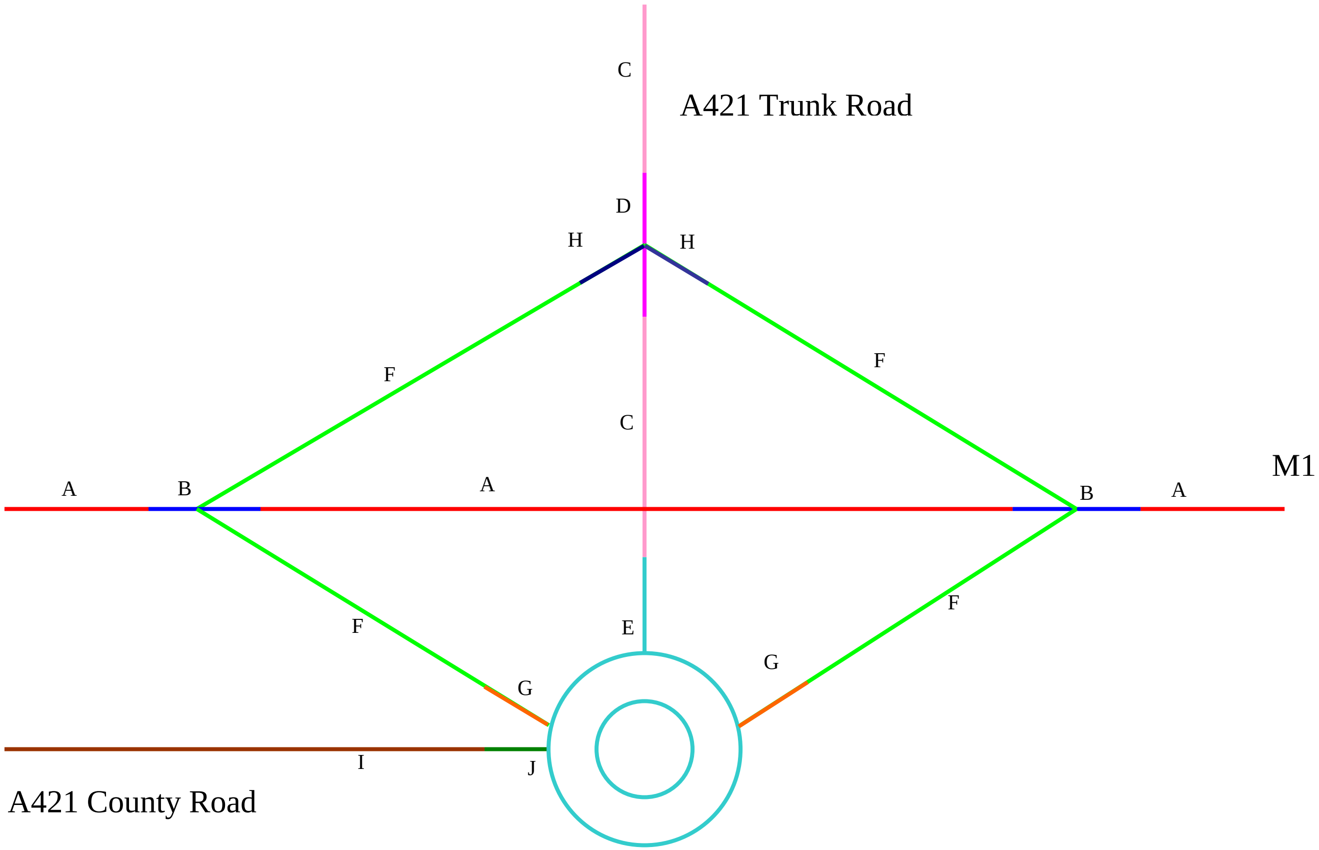
Table D1

	Serious Accidental Spillages *(Billion HGV km / year)*	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	-	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Table D2

Water Quality Objective of Receiving Watercourse	Urban (response time to site < 20 min)	Rural (response time to site < 1 hour)	Remote (response time to site > 1 hour)
RE1 watercourse	0.45	0.60	0.75
RE2 watercourse	0.45	0.60	0.75
RE3 watercourse	0.30	0.40	0.50
RE4 watercourse	0.30	0.40	0.50
Aquifer	0.30	0.30	0.50

Broughton Brook Catchment (Do Minimum)



NOT TO SCALE

Cat.	Type and Length of the road	Junction type
A	Length of Motorway > 100m away from slip road junctions and roundabouts (1500m)	No Junction
B	Length of Motorway < 100m away from slip road junctions (400m)	Motorway Slip Road
C	Length of trunk road > 100m away from slip road junctions and roundabouts (850m)	No Junction
D	Length of trunk road < 100m away from slip road (200m)	Slip Road
E	Length of trunk road < 100m away from roundabout (332m)	Roundabout
F	For the M1 slip road > 100m away from roundabout and side road junction (707m)	Motorway Slip Road
G	For the M1 slip road < 100m away from roundabout (200m)	Roundabout
H	For the M1 slip road < 100m away from side road junction (200m)	Side Road
I	For the side road (A421 county road) > 100m away from roundabout (452m)	Side Road
J	For the side road (A421 county road) < 100m away from roundabout (100m)	Roundabout

HIGHWAYS AGENCY

Broughton Brook Catchment with Proposed Scheme

Method D - assessment of risk from accidental spillage

		A (main road)	B	C	D	E	F	G	H	I		
			Additional columns for use if other roads drain to the same outfall									
D1	Water body type	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse		
D2	Length of road draining to outfall *(m)*	1,500	400	1,750	200	1,198	1,785	400	870	200		
D3	Road Type *(A-road or Motorway)*	M	M	A	A	A	M	A	A	A		
D4	If A road, is site urban or rural?			Rural	Rural	Rural	Rural	Rural	Rural	Rural		
D5	Junction type	No junction	Slip road	No junction	Slip road	Roundabout	Slip road	Roundabout	Slip road	Roundabout		
D6	Location	> 1 hour	> 1 hour	< 1 hour	< 1 hour	< 1 hour	> 1 hour	< 1 hour	< 1 hour	< 1 hour		
D7	Traffic flow	168,000	168,000	60,258	60,258	60,258	25,476	25,476	11,646	11,646		
D8	% HGV	16.2	16.2	3.9	3 9	3.9	10.6	10 6	4.4	4.4		
D8	Spillage factor *(no/10^9 HGVkm/year)*	0 36	0.43	0.29	0 83	3.09	0.43	3.09	0.83	3 09		
D9	Risk of accidental spillage	0 00536	0.00171	0.00044	0 00014	0.00318	0 00076	0.00122	0.00014	0 00012		
D10	Probability factor from Table D.2	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40		
D11	Risk of pollution incident	0 00215	0.00068	0.00017	0 00006	0.00127	0 00030	0.00049	0.00005	0 00005	**Overall annual risk**	**Return Period (years)**
D12	Is risk greater than 0.01?	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**No**		
D13	Return period without pollution reduction measures	0 00215	0.00068	0.00017	0 00006	0.00127	0 00030	0.00049	0.00005	0 00005	0.52%	192
D14	Existing measures factor										0.8	
D15	Return period with existing pollution reduction measures										0.00418	239
D16	Proposed measures factor										0.4	
D17	Residual with proposed Pollution reduction measures										0.17%	599

Table 7.1

System	Optimum Risk Reduction Factor
Filter Drain	0 6
Grassed Ditch / Swale	0 6
Pond	0 5
Wetland	0.4
Soakaway / Infiltration basin	0 6
Sediment Trap	0 6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0 6
Oil Separator	0 5

Justification for choice of existing measures factors

No known existing measures, except filter drains in some locations.
Assume reduction factor = 0 8.

Justification for choice of proposed measures factors

Penstocks in manholes to contain spillage, assume reduction factor = 0.5.
Overall reduction factor = 0.4.

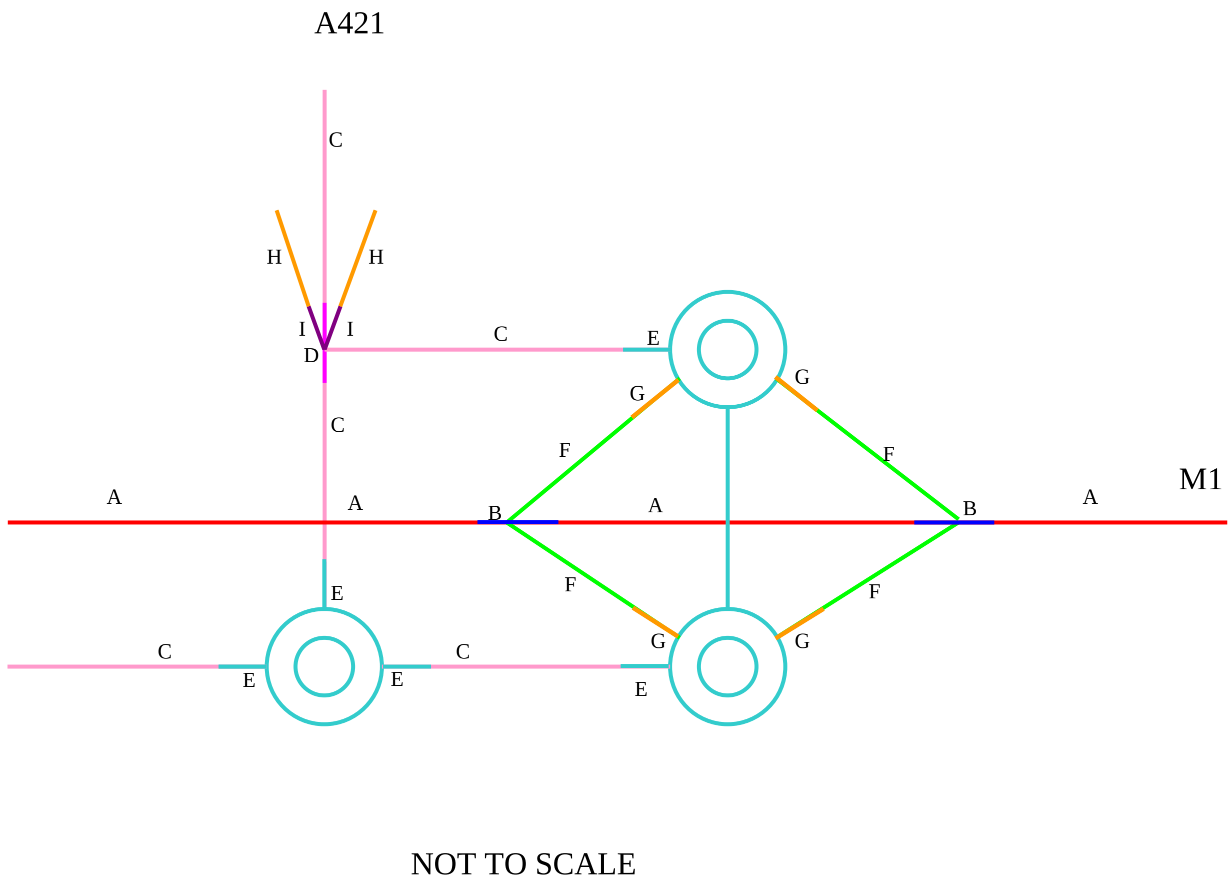
Table D1

	Serious Accidental Spillages *(Billion HGV km / year)*	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	-	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Table D2

Water Quality Objective of Receiving Watercourse	Urban (response time to site < 20 min)	Rural (response time to site < 1 hour)	Remote (response time to site > 1 hour)
RE1 watercourse	0.45	0 60	0.75
RE2 watercourse	0.45	0 60	0.75
RE3 watercourse	0.30	0.40	0.50
RE4 watercourse	0.30	0.40	0.50
Aquifer	0.30	0 30	0.50

Broughton Brook Catchment with Proposed Scheme



Cat.	Type and Length of the road	Junction type
A	Length of Motorway > 100m away from slip road junctions and roundabouts (1500m)	No Junction
B	Length of Motorway < 100m away from slip road junctions (400m)	Motorway Slip Road
C	Length of trunk road > 100m away from slip road junctions and roundabouts (1750m)	No Junction
D	Length of trunk road < 100m away from slip road (200m)	Slip Road
E	Length of trunk road < 100m away from roundabout (1198m)	Roundabout
F	For the M1 slip road > 100m away from roundabout and side road junction (1785m)	Motorway Slip Road
G	For the M1 slip road < 100m away from roundabout (400m)	Roundabout
H	For the A421 slip road > 100m away from side road junction (870m)	Slip Road
I	For the A421 slip road < 100m away from side road junction (200m)	Side Road

HIGHWAYS AGENCY

Elstow Brook Catchment

Method D - assessment of risk from accidental spillage

			Additional columns for use if other roads drain to the same outfall						
		A (main road)	B	C	D	E	F	Overall annual risk	Return Period (years)
D1	Water body type	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse	RE3 watercourse		
D2	Length of road draining to outfall *(m)*	12,000	1,200	3,000	3,267	1,000	200		
D3	Road Type *(A-road or Motorway)*	A	A	A	A	A	A		
D4	If A road, is site urban or rural?	Rural	Rural	Rural	Rural	Rural	Rural		
D5	Junction type	No junction	Slip road	Slip road	Roundabout	Side road	Roundabout		
D6	Location	<1 hour	< 1 hour	< 1 hour	< 1 hour	< 1 hour	< 1 hour		
D7	Traffic flow	67,758	67,758	16,383	16,383	9,550	9,550		
D8	% HGV	4 5	4.5	5.9	5 9	15.3	15.3		
D8	Spillage factor *(no/10^9 HGVkm/year)*	0 29	0.83	0.83	3 09	0.93	3 09		
D9	Risk of accidental spillage	0 00387	0 00111	0.00088	0 00356	0.00050	0 00033		
D10	Probability factor from Table D.2	0.40	0.40	0.40	0.40	0.40	0.40		
D11	Risk of pollution incident	0 00155	0 00044	0.00035	0 00142	0.00020	0 00013		
D12	Is risk greater than 0.01?	No	No	No	No	No	No		
D13	Return period without pollution reduction measures	0 00155	0 00044	0.00035	0 00142	0.00020	0 00013	0.41%	244
D14	Existing measures factor							1	
D15	Return period with existing pollution reduction measures							0.41%	244
D16	Proposed measures factor							0 3	
D17	Residual with proposed Pollution reduction measures							0.12%	813

Table 7.1

System	Optimum Risk Reduction Factor
Filter Drain	0.6
Grassed Ditch / Swale	0.6
Pond	0.5
Wetland	0.4
Soakaway / Infiltration basin	0.6
Sediment Trap	0.6
Unlined Ditch	0.7
Penstock / valve	0.4
Notched Weir	0.6
Oil Separator	0.5

Justification for choice of existing measures factors

New road - does not apply.

Justification for choice of proposed measures factors

Ponds designed as balancing ponds, assume reduction factor = 0 6.
Penstock in manhole, assume reduction factor = 0.5.
Overall reduction factor = (0 6 * 0 5) = 0 3.

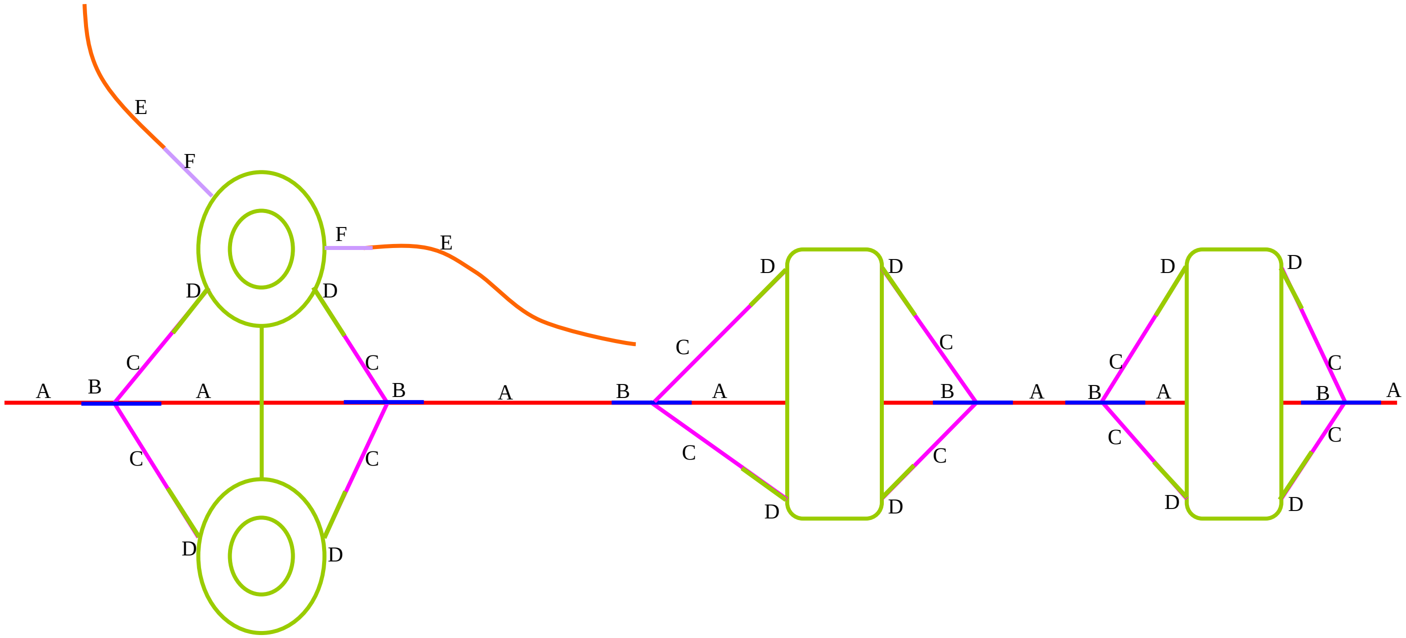
Table D1

	Serious Accidental Spillages *(Billion HGV km / year)*	Motorways	Rural Trunk	Urban Trunk
Location	No junction	0.36	0.29	0.31
	Slip road	0.43	0.83	0.36
	Roundabout	-	3.09	5.35
	Cross road	-	0.88	1.46
	Side road	-	0.93	1.81
	Total	0.37	0.45	0.85

Table D2

Water Quality Objective of Receiving Watercourse	Urban (response time to site < 20 min)	Rural (response time to site < 1 hour)	Remote (response time to site > 1 hour)
RE1 watercourse	0.45	0.60	0.75
RE2 watercourse	0.45	0.60	0.75
RE3 watercourse	0.30	0.40	0.50
RE4 watercourse	0.30	0.40	0.50
Aquifer	0.30	0.30	0.50

Elstow Brook Catchment



Cat.	Type and Length of the road	Junction type
A	Length of trunk road > 100m away from slip road junctions and roundabouts (12000m)	No Junction
B	Length of trunk road < 100m away from slip road junctions (1200m)	Slip Road
C	For the slip road > 100m away from roundabouts (3000m)	Slip Road
D	For the slip road < 100m away from roundabouts (3267m)	Roundabout
E	For the side road > 100m away from roundabouts (1000m)	Side Road
F	For the side road < 100m away from roundabouts (200m)	Roundabout

NOT TO SCALE

Appendix 11.10 Catchment Areas Used for Hydrological Analysis

Appendix 11.10

Data Used for Hydrological Analysis

Catchment Characteristics

The Ordnance Survey maps for the catchment were consulted and a number of tributaries of the Broughton brook in the area of interest were identified. The Flood Estimation Handbook (FEH) CDRom which includes catchment data for the whole of the UK was interrogated to determine the catchment characteristics of each tributary and this data is summarised in Table 1.

Table 1 - Catchment Characteristics

Stream name	Apsley Hall North	Apsley Hall South	Winter Wood	Charity Farm	Brog-borough	Broughton Brook	Ridgmont
NGR Easting	494250	494350	494850	495250	495350	496700	496800
NGR Northing	238350	237900	237950	237350	237550	236700	236700
AREA (km^2)	2.99	2.9	1.45	0.82	1.64	24.07	3.27
FARL	0.966	1	1	1	1	0.978	1
PROP WET	0.32	0.32	0.32	0.32	0.32	0.32	0.32
ALTBAR	96	93	94	89	86	124	109
ASPBAR	30	353	200	2	227	19	296
ASPVAR	0.31	0.58	0.65	0.72	0.55	0.24	0.32
BFI HOST	0.547	0.518	0.344	0.469	0.349	0.709	0.506
PLBAR	2.6	2.02	1.29	0.88	1.41	5.89	2.12
DPSBAR	36.1	42.9	28.9	29.2	21.6	42	32.7
LDP	5.02	4.05	2.21	1.75	2.71	10.22	4.14
RMED-1Hour	10.5	10.6	10.6	10.5	10.6	10.5	10.6
RMED-1Day	29.2	29.2	28.5	29.2	29	29.9	29.5
RMED-2Day	37.5	37.6	37	37.6	37.6	38.4	38.5
SAAR	633	636	632	632	628	651	627
SAAR 41-70	625	624	598	619	604	645	615
SPR HOST	41.1	44.1	49.5	48	51.8	25.9	42.5
URB CONC	0.558	0.394	N/A	0.505	N/A	0.52	0.417
URBEXT1990	0.04	0.028	0	0.009	0.002	0.009	0.008

Median Flow (Qmed)

The FEH method uses an index flood, Q median (the annual maximum flow that is exceeded in 50% of years), and applies growth factors to this to obtain the flow/return period relationship. The growth factors are derived from an analysis of a group of hydrologically similar sites (the pooling group) that is obtained from the Winfap software. The Winfap-FEH software was used to calculate the median flow at the site, from the catchment descriptors, for each tributary. The Winfap database was then searched for gauges with similar hydrological characteristics to the various tributaries and it was found that there is a gauge on the Broughton Brook at Broughton, some 7 km downstream of the A421. This gauge is very hydraulically similar to the various tributaries of interest and so it has been used for data transfer using the formula:

$$Q_{med}\text{ (site, adjusted)} = Q_{med}\text{ (CD, site)} \times Q_{med}\text{ (data, donor)} / Q_{med}\text{ (CD, donor)},$$

which in this instance gives an adjustment factor of 8.81/8.42 = 1..046.
The results are summarised below.

Table 2 - Q_{med}

Stream name	Apsley Hall North	Apsley Hall South	Winter Wood	Charity Farm	Brog-borough	Broughton Brook	Ridgmont
Q_{med} from CDs	0.376	0.416	0.352	0.128	0.362	1.751	0.480
Q_{med} adjusted	0.393	0.435	0.368	0.134	0.379	1.832	0.502

The adjusted Q_{med} is then used with growth factors derived as described below to produce flood frequency curves for the tributaries.

Flood Frequency Curves

A group of hydrologically similar gauging stations (a pooling group) were selected for each site using the Winfap-FEH software. The selected groups were generally strongly heterogeneous so the data sets were reviewed. One of the sites that featured in some of the groups was station no 41026, the Cockhaise Brook at Holywell Farm, had a very low value of FARL (which indicates a significant proportion of the catchment passing through a reservoir). As the sites of interest have a FARL of 1, i.e. there are no reservoirs in the catchments, this station was removed from the pooling groups in which it appeared. No other stations were removed from the pooling groups.
Data analysis revealed suitable flood frequency distributions for the various sites and these were used to produce flood growth curves for each site. The distributions used are shown in Table 3.

Table 3 – Chosen Distributions

Stream name	Apsley Hall North	Apsley Hall South	Winter Wood	Charity Farm	Brog-borough	Broughton Brook	Ridgmont
Distribution(s) used	GL[1] and GEV[2]	GEV	GL and GEV	GEV and P3[3]	GL and GEV	GL and GEV	GL and GEV

[1] GL = Generalised Logistic
[2] GEV = Generalised Extreme Value
[3] P3 = Pearson Type III

For the purposes of modelling the Broughton Brook as it passes the A421, the 100-year return period (1% probability) flow was abstracted from the flood frequency curve and the results are shown in Table 4.

Hydrographs

The catchment data was analysed using the Revitalised Flood Hydrograph (ReFH) spreadsheet to generate hydrograph profiles for each stream. ReFH is a new lumped conceptual rainfall-runoff model developed by CEH Wallingford on behalf of DEFRA and the EA. The ReFH model has been developed for modelling flood events based on robust hydrological modelling techniques and is considered to be an improvement over the existing rainfall/runoff model. It enables a more direct and transparent description of flood-generating mechanisms and introduces the concept of seasonal variation in soil moisture content, design rainfall and baseflow.
Using the ReFH model, design flood hydrographs can be generated for a specified initial soil moisture content and a design rainfall event of the required return period. Both soil moisture and rainfall are specified on a seasonal basis depending on the degree of urbanisation of the catchment under consideration (summer conditions for urbanised catchments and winter conditions for rural catchments). Hydrographs were generated using ReFH for the 100yr return period flows and durations and these are included in Appendix C and summarised in Table 4 with the statistical values shown for comparison.

Table 4 – 100-year Flows

Location name (starting upstream)	Statistical Flow	ReFH peak flow	% change
Ridgmont Stream	1.957	2.30	-16.3
Broughton Brook @ Mill Road	7.337	5.67	27.5
Brogborough Brook	1.369	1.82	-26.4
Charity Farm	0.514	0.85	-40.5
Winter Wood	1.340	1.71	-23.2
Apsley Hall South	1.543	2.24	-32.3
Apsley Hall North	1.496	1.93	-23.8
Total	15.303	16.520	-7.4

It can be seen that the flows generated by the statistical method are lower than those generated by ReFH except for the main Broughton brook catchment where the statistical flow is 27.5 % higher. The difference between the totals flows generated by the two methods is only 7.4 % however. The hydrograph shapes generated from ReFH have been used in the model but with the ordinates scaled to the statistical flows.

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List of Figures (See Volume 3)

12 NOISE & VIBRATION

12.1 Introduction

12.1.1 This Chapter assesses the predicted noise and vibration impacts of the Scheme in accordance with the requirements of the Design Manual for Roads and Bridges, Volume 11, Section 3, Part 7, 1994 (DMRB).

12.1.2 Improvement to the A421 would affect the noise and vibration levels due to road traffic experienced by residents of properties along the route of both the existing A421 and the Scheme. In addition, the Scheme would have an impact on traffic flows on a number of surrounding roads and, therefore, may affect the traffic noise and vibration levels experienced at residential properties adjacent to such roads.

12.1.3 Noise and vibration impacts arising from demolition and construction works associated with the Scheme are also considered.

12.2 Methodology

Construction Noise

Impact Assessment Methodology

12.2.1 The noise levels generated by construction activities and experienced by nearby sensitive receptors such as residential properties, depend upon a number of variables, the most significant of which are:

- The noise generated by plant or equipment used on site, generally expressed as sound power levels (Lw)
- The periods of operation of the plant on the site, known as its ‘on-time’
- The distance between the noise source and the receptor
- The attenuation due to ground absorption, air absorption and barrier effects

12.2.2 Construction noise predictions are based on the methodology outlined in British Standard (BS) 5228: ‘Noise and vibration control on construction and open sites’ (1997). Construction noise levels are predicted as an equivalent continuous noise level averaged over a one-hour period (dB $_{LAeq,1h}$).

12.2.3 In order to evaluate the noise from construction, it is necessary to define the various activities to be undertaken and the equipment to be used, based upon the anticipated programme of work over the construction schedule.

12.2.4 The magnitude of the impact of construction noise is then quantified by predicting likely construction noise levels at a selection of the closest residential properties to the various construction activities.

12.2.5 Other factors to be considered when setting the criteria include the scheduled duration of exposure and the existing ambient noise level, prior to any construction.

Assessment of Construction Noise Significance

12.2.6 Noise levels generated by construction activities are regulated by guidelines and subject to local authority control.

12.2.7 In 1963, the Wilson Committee report on noise recommended that outside the windows of the nearest occupied dwelling in an urban area a noise level of 75 dB (A), and in suburban or rural areas a level of 70 dB (A), should not be exceeded by noise from construction work. This serves as a useful general guideline, but is not sufficiently definite on whether the quoted levels can be exceeded at all, or whether a construction project taking one or two days should be treated differently from one taking one or two years or even longer.

12.2.8 The original BS Code of Practice on 'Noise Control on Construction and Demolition Sites' (BS 5228: 1975, now revised to BS 5228: 1997) originally suggested noise reference levels for construction work based on the original Wilson report recommendations but was more precise, recommending that generally at one metre outside the nearest noise sensitive building the equivalent continuous sound level over a 12-hour period (07.00 to 19.00 hours) should not exceed 75 dB (A). This gave some flexibility, allowing periods at a high level (exceeding 75 dB (A)) compensated by extended quieter periods. The suggested level was not mandatory and no longer forms part of the updated 1997 BS.

12.2.9 In terms of the duration sensitive receptors may be exposed to higher noise levels, reference is made to the Noise Insulation Regulations 1995 which states (in terms of construction noise) that the responsible authority may carry out or make a grant in respect of sound insulation to sensitive buildings when noise is at a level which seriously affects an eligible building "for a substantial period of time". A more specific time period (or noise level) is not prescribed. Further guidance can be found in Minerals Policy Statement (MPS) 2: "Controlling and Mitigating the Environmental Effects of Minerals Extraction in England Annex 2: Noise" (ODPM, 2005). This provides advice regarding short-term noisy activities carried out on mineral sites such as soil stripping, earth bund construction, earthworks and road construction. It suggests a limit of 70 dB $_{LAeq,1h}$ for a period up to eight weeks in a year, with a further statement suggesting that higher levels with shortened periods should be considered in order to complete temporary operations as quickly as possible.

12.2.10 Based on the above discussion, a construction noise limit of 70 dB $LA_{eq,1h}$ is recommended at the nearest noise sensitive properties with some flexibility for more transient and therefore shorter term construction activities. This is an approach which has been employed for the assessment of construction noise for other road schemes.

12.2.11 Exceedance of the suggested limit indicates a negative impact due to the construction works. The significance of the effect depends on the amount by which the limit is exceeded, the duration of the noisy works and the prevailing ambient noise level.

12.2.12 With regard to this particular project, existing ambient levels along the proposed length of the Scheme have been monitored and recorded within the separate document entitled 'Ambient Noise Monitoring Report' (Highways Agency (2006)).

12.2.13 The construction noise assessment is considered to be a worst-case, in that noisy operations are assumed to be at their closest approach to sensitive receptors. In practice, the mean distance to any sensitive receptor during these operations would be greater than this.

Construction Vibration

Impact Assessment Methodology

12.2.14 The magnitude of the construction vibration impact is determined by estimating the vibration peak particle velocity (ppv) due to piling and other activities at a selection of the closest sensitive receptors to the proposed construction works, using example measured source data and the propagation relationship taken from BS 5228: 1992 Part 4: "Code of practice for noise and vibration control applicable to piling operations".

12.2.15 The calculated peak particle velocity at sensitive receptors is employed to derive the estimated Vibration Dose Value (eVDV) using the procedure given in BS 6472: 1992 “Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)”.

Assessment of Construction Vibration Significance

12.2.16 Vibration can be both a source of nuisance to occupiers of affected properties and a source of building damage. The significance of vibration levels generated during Scheme construction has been assessed by comparison of the estimated vibration levels with guideline levels for annoyance and the onset of building damage.

12.2.17 Ground vibrations may cause reactions ranging from ‘just perceptible’, through ‘concern’ to ‘alarm’ and ‘discomfort’. The subjective response varies widely and is a function of situation, information, time of day and duration.

12.2.18 BS 6472: 1992 ‘Guide to evaluation of human exposure to vibration in buildings (1 Hz to 80 Hz)' gives base curves of vibration for minimal adverse comment, and also vibration dose values (VDVs) at which complaints are likely.

12.2.19 The potential for the predicted construction vibration levels to cause annoyance is assessed by comparison of the predicted VDV with the ‘probability of adverse comment’ specified in BS 6472 - refer to Table 12.1 below.

Table 12.1 Vibration Dose Values above which Various Degrees of Adverse Comment may be expected in Residential Buildings (from BS 6472: 1992)

Building Classification	Vibration Dose Values ($ms^{-1.75}$)		
	Low Probability of Adverse Comment	**Adverse Comment Possible**	**Adverse Comment Probable**
Residential buildings, 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings, 8h night	0.13	0.26	0.54

12.2.20 Those situations where adverse comment is possible or probable are considered to be significant.

12.2.21 Buildings are reasonably resilient to ground-borne vibration and vibration-induced damage is rare. Guidance on acceptable vibration levels in structures is provided in BS 5228: 1992 Part 4 'Code of practice for noise and vibration control applicable to piling operations'. This Standard recommends that a conservative threshold for minor or cosmetic damage should be taken as a ppv of 10mm/s for intermittent vibration and 5mm/s for continuous vibration to determine whether there is any risk of building damage, particularly from construction works involving piling.

12.2.22 The likelihood of the estimated construction vibration levels to cause building damage is based on the criteria shown in Table 12.2 (compiled from paragraph 8.4.2, page 24 of BS 5228: 1992 (Part 4)). Vibration levels above these thresholds would be considered to be significant.

Table 12.2 Vibration Limits Relating to Minor or Cosmetic Damage to Buildings from Piling Operations (from BS 5228: 1992 Part 4)

Building Classification	Intermittent Vibration (ppv, mm/s)	Continuous Vibration (ppv, mm/s)
Residential in generally good repair	10	5
Residential where preliminary survey reveals significant defects	5	2.5
Industrial/commercial - light and flexible structure	20	15
Industrial/commercial – heavy and stiff structure	30	15

12.2.23 Surface plant such as cranes, compressors and generators are not recognised as sources of high levels of environmental vibration and reference to Figure 1 of 'Control of Vibration and Noise during Piling' confirms that even at a closest distance of 10m, ppv significantly less than 5mm/s are generated by such plant. For example, the indication is that a bulldozer would generate a ppv of approximately 0.6mm/s and a 'heavy lorry on poor road surface' a ppv of less than 0.1mm/s at 10m. These values are well below limits at which even cosmetic building damage becomes likely (5mm/s).

Operational Noise

Impact Assessment Methodology

12.2.24 Noise from a flow of road traffic is generated by both vehicles' engines and the interaction of tyres with the road surface. The traffic noise level at a receptor, such as an observer at the roadside or residents within a property, is influenced by a number of factors including traffic flow, speed, composition (% Heavy Goods Vehicle (HGV)), gradient, type of road surface, distance from the road and the presence of any obstructions between the road and the receptor.

12.2.25 Noise from a stream of traffic is not constant. Therefore, to assess the noise impact a single figure estimate of the overall noise level is necessary. The index adopted by the Government (in 'The Calculation of Road Traffic Noise' (CRTN) (1988, first issued in 1975)) to assess traffic noise is $L_{A10,18h}$, which is the arithmetic mean of the noise levels exceeded for 10% of the time in each of the eighteen 1-hour periods between 06.00 and 24.00. A reasonably good correlation has been shown to exist between this index and residents' perception of traffic noise over a wide range of exposures.

12.2.26 CRTN provides a standard methodology for predicting the $L_{A10,18h}$ road traffic noise level. Noise levels are predicted at 1m (horizontally) external to the façade of the worst-affected external window or door of a habitable room (generally taken as being 4m above ground level, a first floor bedroom).

12.2.27 DMRB guidance requires that the Study Area for the traffic noise impact assessment includes all properties within a 300m corridor each side of the centreline of the Scheme and any roads that are predicted to experience a significant change in traffic flow. DMRB defines a significant change in traffic flow as an increase in the 18-hour traffic flow of equal to or greater than 25%, or a decrease equal to or greater than 20%.

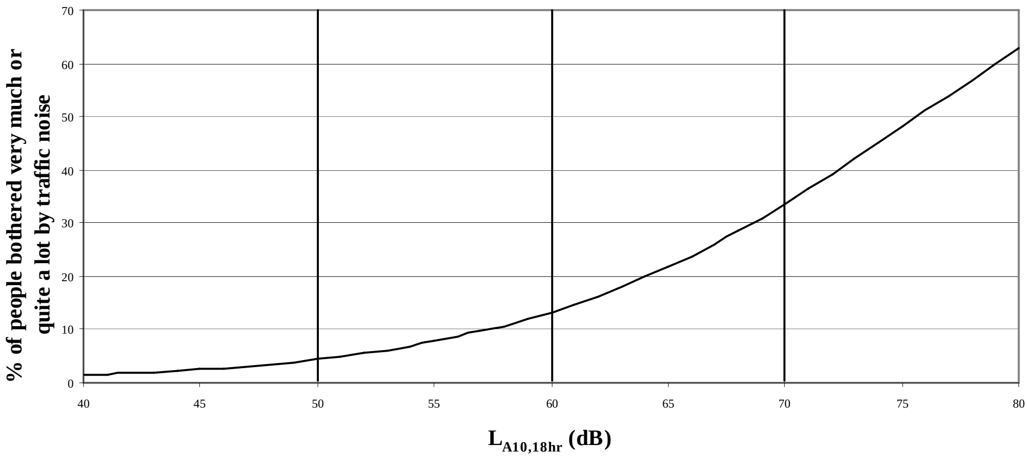
12.2.28 Traffic noise levels have been calculated herein at properties for five scenarios:

- Existing Baseline (2005)
- Year of Scheme Opening (2010/11) – Baseline (no Scheme)
- Year of Scheme Opening (2010/11) – Operational (with Scheme)
- 15 years after Scheme Opening (2025/26) – Baseline (no Scheme)
- 15 years after Scheme Opening (2025/26) – Operational (with Scheme).

12.2.29 For the Scheme corridor, façade noise levels have been calculated for every residential property within 300m of the Scheme and the existing A421. For significant road links outside of the Scheme corridor, façade noise levels have been calculated for every residential property within 50m of those links. For residential properties along these links within the distance bands 50 – 100m, 100 – 200m and 200 – 300m, representative calculated noise levels and band property numbers have been employed to estimate the numbers of people bothered by traffic noise. This approach was agreed with the HA prior to the assessment being carried out, due to the large number of links outside the Scheme corridor.

12.2.30 To assess the magnitude of the impact of a predicted traffic noise level on residents, the annoyance caused by varying levels of traffic noise must be quantified. Individuals vary widely in their response to the same level of traffic noise. However, since the average or community response from a large number of people to a level of traffic noise is fairly stable, a community average degree of bother caused by traffic noise can be related to the long-term steady state noise level. The relationship between the steady state traffic noise level and the estimated annoyance experienced, expressed as the percentage of people 'bothered very much or quite a lot', is illustrated in Plate 12.1 (as taken from DMRB). This shows, for example, that approximately 13% of all residents would be 'bothered very much or quite a lot' at a road traffic noise level of 60dB.

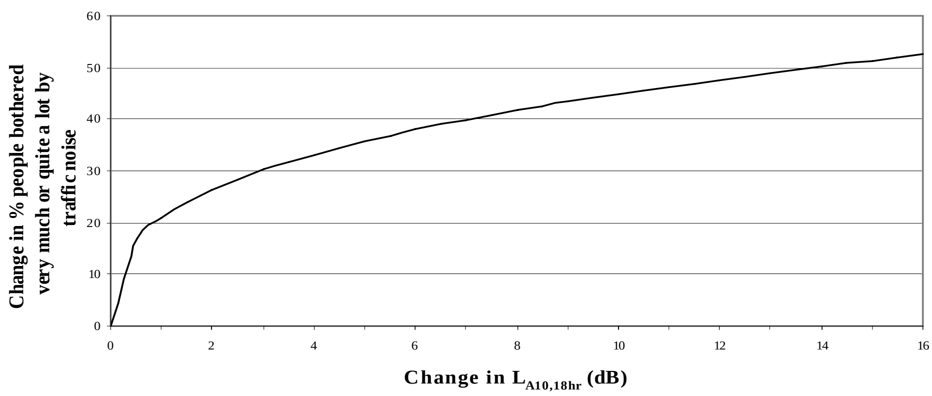
Plate 12.1: Steady State - Estimated Traffic Noise Nuisance



12.2.31 Research has shown that people are more sensitive to abrupt changes in traffic noise, for example following the opening of a new road, than would be predicted from the steady state relationship between traffic noise and annoyance (described above). While the effects of an abrupt change could last for a number of years, in the longer term the perceived noise nuisance tends towards the steady state level due to familiarisation. The percentage change in the traffic noise annoyance due to an abrupt change in the traffic noise is illustrated in Plate 12.2 (taken from DMRB).

12.2.32 Plate 12.2 shows, for example, that with an abrupt increase of 7 dB(A) there would be a net change of 40% residents ‘bothered very much or quite a lot’ by road traffic noise. If the initial noise level was 60 $dB_{LA10,18h}$ (14% bothered) then there would be 54% bothered immediately after the increase to 67 $dB_{LA10,18h}$. This would eventually diminish in the long term due to familiarisation to become approximately 25% bothered (Plate 12.1).

Plate 12.2: Immediate Impact - Change in % people bothered very much or quite a lot by traffic noise



12.2.33 These relationships between traffic noise and the level of nuisance experienced by occupants of residential properties are used to calculate the number of people likely to be bothered by road traffic noise for each scenario. The benefits of proposed noise mitigation are taken into account in all predictions.

12.2.34 The DMRB methodology includes an estimation of the number of people likely to be bothered by traffic noise using population data and applying the relationships between traffic noise and annoyance given in Plate 12.1 or 12.2 as appropriate. In the absence of comprehensive local data for the Study Area, it is assumed that the national average household of 2.4 people resides in each property (TAG Noise Sub Objective, June 2003).

Assessment of Operational Noise Significance

12.2.35 The Noise Insulation Regulations 1975, amended 1988, allow provision of noise attenuation measures in the form of secondary glazing and mechanical ventilation to habitable rooms of residential properties affected by road traffic noise from a ‘new or altered highway’ which meet the following criteria:

- The combined expected maximum traffic noise level, i.e. the relevant noise level, from the new or altered highway together with other traffic in the vicinity must not be less than the specified noise level, 68 $dB_{LA10,18h}$
- The relevant noise level is at least 1.0 dB(A) more than the prevailing noise level, i.e. the total traffic noise level existing before the works to construct or improve the highway were begun
- The contribution to the increase in the relevant noise level from the new or altered highway must be at least 1.0 dB(A).

12.2.36 The results of the traffic noise impact assessment are used to determine whether any properties within 300m of the Scheme are likely to meet the criteria. Additionally, the Noise Insulation Regulations allow discretionary provision of noise insulation for properties adversely affected by demolition and construction noise.

12.2.37 The significance of predicted traffic noise impacts is assessed in two ways; firstly by consideration of whether the provisions of the Noise Insulation Regulations 1975 apply at any properties, and secondly by the changes in traffic noise and nuisance levels at all noise sensitive receptors due to the opening of the Scheme.

12.2.38 Generally, increases in noise level up to 1 dB are not perceptible and are considered negligible in any assessment. Noise level increases of 3 dB are generally required for a perceivable change in a steady noise. A noise level increase of 10 dB is perceived as a doubling in loudness by a representative sample of people. Based on these perceptions and the Draft Guidance of the Institute of Acoustics/Institute of Environmental Management and Assessment (IEMA) Working Party issued in April 2002, Table 12.3 presents criteria for assessing the significance of changes in traffic noise levels as a result of the Scheme.

Table 12.3 Criteria for Significance Assessment of Changes in Noise Level

Change in Noise Level (dB)	Subjective Response	Significance
< 1	None	Negligible
1 < 3	Perceptible	Slight
3 < 5	Noticeable	Moderate
5 < 10	Up to a doubling in loudness	Substantial
≥ 10	More than a doubling in loudness	Severe

12.2.39 At properties that would experience an increase in traffic noise, the greatest increases would usually be 15 years after opening. Therefore, the increase in traffic noise between the baseline in the year of Scheme opening and the operation of the Scheme 15 years after opening is normally used to determine the change in noise levels.

12.2.40 At properties that would experience a reduction in noise levels, the smallest reduction would usually be 15 years after opening. Therefore, the decrease in traffic noise between the baseline in the year of Scheme opening and the operation of the Scheme 15 years after opening is normally used to determine the change in noise levels.

12.2.41 At properties that would experience an immediate increase in traffic noise, the greatest annoyance would usually be immediately after the Scheme opens. Therefore, the abrupt increase in traffic noise between the baseline and the operation of the Scheme in the year of opening is normally used to determine the change in annoyance, based on the relationship illustrated in Plate 12.2.

12.2.42 At properties that would experience a reduction in noise levels, the greatest annoyance would usually be 15 years after opening, as determined by the relationship in Plate 12.1. This approach does not highlight the immediate reduction in annoyance experienced by occupants of properties where traffic noise reduces immediately after the Scheme is opened.

Operational Vibration

Impact Assessment Methodology

12.2.43 Traffic vibration can be transmitted through the air or through the ground. Airborne vibration is produced by the engines and exhausts of road vehicles, with dominant frequencies typically in the range 50 – 100Hz. Ground borne vibration is produced by the interaction of the vehicle tyres and the road surface with dominant frequencies typically in the range 8 – 20Hz. The passage of vehicles over irregularities in the road surface is a source of ground borne vibration.

12.2.44 Traffic vibration can have an effect on buildings and cause disturbance to occupiers. Air borne vibration is noticed by occupiers more often than ground borne vibration as it may result in detectable vibrations in building elements such as windows and doors.

12.2.45 Traffic vibration becomes perceptible to people at a ppv of around 0.5mm/s in the vertical direction. However, vibration levels of above approximately 5mm/s are required before the onset of even cosmetic structural damage to buildings. In the structure of buildings close to busy roads ppvs are typically well below 1mm/s and rarely exceed 2mm/s. Extensive research on a wide range of buildings has found no evidence of traffic induced ground borne vibration being a source of damage to buildings.

12.2.46 To assess the magnitude of the impact of traffic induced vibration on residents, a parameter is needed which reflects a person's subjective rating of vibration disturbance. DMRB recommends the use of the $L_{A10,18h}$. The relationship between the $L_{A10,18h}$ and bother due to vibration is similar to that for bother due to steady state traffic noise, as described in Plate 12.1, except that the percentage of people bothered by vibration is lower. For a given level of noise exposure, the percentage of people bothered very much or quite a lot by vibration is 10% lower than the corresponding figure for annoyance due to traffic noise. Below 58 dB(A) the percentage of people bothered by traffic induced vibration is assumed to be zero.

Assessment of Operational Vibration Significance

12.2.47 The significance of the predicted traffic vibration impact is assessed by consideration of the difference in nuisance levels experienced by residents in the long term, with and without the Scheme in operation, as prescribed in DMRB.

12.3 Baseline Conditions

Existing Baseline Conditions

12.3.1 Baseline noise levels in the vicinity of the existing A421 have been monitored. The monitoring took place at intervals over the period 23 March to 11 May 2006 at 13 locations, which are shown in Figure 12.1. The detailed monitoring procedure, measurements and results are given in the Ambient Noise Monitoring Report (Highways Agency (2006)). A summary of the monitoring results is provided in Table 12.4.

Table 12.4 Summary of Noise Monitoring Results

Identifier	Location	Average Daytime Noise Level		
		$L_{Aeq,16h}$	$L_{A10,18h}$	$L_{A90,18h}$
1	'Omega' Salford Road	59.4	60.6	56.2
2	Highfield Farm (Hedgehog Cottage)	54.4	55.3	52.4
3	15 Hill Crescent, Brogborough	56.3	57.8	51.3
4	(Brogborough) Manor Farm	52.0	50.7	43.2
5	The Woodlands, Wood End	60.6	50.2	40.9
6	Moreteyne Farm	50.3	49.1	42.5
7	Beancroft Farm	57.3	59.3	41.7
8	9 Burridge Close, Marston Moretaine	62.6	65.0	51.9
8B	Hoolane Farm	62.5*	62.9*	56.6*
8D	Haycroft, Wootton	62.8*	65.2*	47.9*
9	Elms Farm	56.0	56.1	48.9
9A	32 Dennis Road, Kempston	49.5*	50.9*	43.3*
9B	1 Manor Road, Kempston Hardwick	61.0*	57.2*	40.3*

***** Short Term Measurement Period

12.3.2 The results obtained are in accordance with what may be expected for the types of locations where monitoring was carried out. L_{Aeq} levels range from approximately 50 dB to the low sixties.

12.3.3 The relevant local authority environmental health departments were consulted prior to baseline noise monitoring and monitoring locations were agreed. It is considered that representative noise levels of the current ambient noise climate have been gathered at locations that may be expected to experience a change in noise levels as a result of the Scheme.

12.3.4 The study area, including the Scheme and all significant road links, is shown in Figure 12.2. Also shown in Figure 12.2 is the defined Scheme Corridor. It should be noted that the Scheme has an impact on traffic levels over a particularly large area; hence the large number of properties affected. Noise levels at all residential properties within the study area have been calculated for the existing baseline. The numbers of residential properties, and therefore the numbers of people likely to be bothered by noise and vibration, within each noise band (<50, 50<60, 60<70, ≥70 dB $L_{A10,18h}$) for the existing baseline are provided in Table 12.5 for the Scheme Corridor and in Table 12.6 for the wider road network (outside the Scheme Corridor) in the study area. Numbers are based on the steady state relationship between traffic noise and nuisance and an average household size of 2.4 (TAG Noise Sub Objective, June 2003). The figures take account of all properties within 300m of the Scheme and all significant links. A standard Hot Rolled Asphalt (HRA) road surface has been assumed for the existing A421 in 2005.

Table 12.5 Predicted Noise and Vibration Impact (Within Scheme Corridor) – Current Baseline (2005)

Noise Band $L_{A10,18h}$ (dB)	No. of Residential Properties	No. of People Bothered by Noise (2005)	No. of People Bothered by Vibration (2005)
<50	156	15	0
50 < 60	1286	235	8
60 < 70	873	426	216
≥70	155	157	120
Total	**2470**	**833**	**344**

Table 12.6 Predicted Noise and Vibration Impact (Outside Scheme Corridor) – Current Baseline (2005)

Noise Band $L_{A10,18h}$ (dB)	No. of Residential Properties	No. of People Bothered by Noise (2005)	No. of People Bothered by Vibration (2005)
<50	21999	1242	0
50 < 60	18683	3142	77
60 < 70	5754	2989	1608
≥70	1642	1623	1229
Total	**48078**	**8996**	**2915**

12.3.5 Tables 12.5 and 12.6, above, indicate that a total of 2,470 properties were included in the scheme corridor and a total of 48,078 properties were included outside the scheme corridor. This equates to a total population of 121,315 assuming an average household size of 2.4.

12.3.6 The total number of people likely to be bothered by traffic noise is 9,829, which is just over 8.1% of the total population. The total number of people likely to be bothered by traffic vibration is estimated as 3,259, just under 2.7% of the total population.

12.3.7 Free field noise contour plots (at a height of 4m above ground level) for the 2005 baseline are presented in Figures 12.3.1 - 12.3.4.

Year (2010/11)

12.3.8 Noise levels at all residential properties within the study area have been calculated for 2010/11 baseline without the Scheme. The numbers of residential properties, and therefore the numbers of people likely to be bothered by noise and vibration, within each noise band (<50, 50<60, 60<70, ≥70 dB $LA_{10,18h}$) for the 2010/11 baseline are provided in Table 12.7 for the Scheme Corridor and in Table 12.8 for the wider road network (outside the Scheme Corridor) in the study area. Numbers are based on the steady state relationship between traffic noise and nuisance and an average household size of 2.4 (TAG Noise Sub Objective, June 2003). A standard Hot Rolled Asphalt (HRA) road surface has been assumed for the existing A421 in 2010/11.

Table 12.7 Predicted Noise and Vibration Impact (Within Scheme Corridor) – 2010/11 Baseline

Noise Band $L_{A10,18h}$ (dB)	No. of Residential Properties	No. of People Bothered by Noise (2010/11)	No. of People Bothered by Vibration (2010/11)
<50	29	3	0
50 < 60	1327	239	7
60 < 70	960	478	248
≥70	154	162	125
Total	**2470**	**882**	**381**

Table 12.8 Predicted Noise and Vibration Impact (Outside Scheme Corridor) – 2010/11 Baseline

Noise Band $L_{A10,18h}$ (dB)	No. of Residential Properties	No. of People Bothered by Noise (2010/11)	No. of People Bothered by Vibration (2010/11)
<50	19678	1256	0
50 < 60	20235	3445	90
60 < 70	6457	3378	1829
≥70	1708	1702	1292
Total	**48078**	**9781**	**3211**

12.3.9 For the 2010/11 baseline, the numbers of people estimated to be bothered by traffic noise and vibration are slightly higher than the numbers for the 2005 baseline, due to changes in traffic flows.

12.3.10 The total number of people likely to be bothered by traffic noise is estimated as 10,663 which is just under 8.8% of the total population in the study area. The number of people likely to be bothered by traffic vibration is estimated as 3,592 which is just under 3.0% of the total population in the study area.

12.3.11 As a result of discussions with the respective developers, it has been assumed that proposed developments in Kempston West and to the north and south of Fields Road, Wootton, would provide an additional 925 residential properties within the study area for 2010/11. No detailed layouts are available, but a worst case estimate is that an additional 267 people would be bothered by traffic noise, out of a total population of 2,220 in these three developments.

12.3.12 Free field noise contour plots (at a height of 4m above ground level) for the 2010/11 baseline are presented in Figures 12.4.1 - 12.4.4.

Trends to Assessment Year (2025/26)

12.3.13 Noise levels at all residential properties within the study area have been calculated for the 2025/26 baseline without the Scheme. The numbers of residential properties, and therefore the numbers of people likely to be bothered by noise and vibration, within each noise band (<50, 50<60, 60<70, ≥70 $LA_{10,18h}$) for the 2025/26 baseline are provided in Table 12.9 for the Scheme Corridor and in Table 12.10 for the wider road network (outside the Scheme Corridor) in the study area. Numbers are based on the steady state relationship between traffic noise and nuisance and an average household size of 2.4 (TAG Noise Sub Objective, June 2003). The 2025/26 baseline scenario assumes that a low-noise road surface would be laid throughout the length of the existing A421.

Table 12.9 Predicted Noise and Vibration Impact (Within Scheme Corridor) – 2025/26 Baseline

Noise Band $L_{A10,18h}$ (dB)	No. of Residential Properties	No. of People Bothered by Noise (2025/26)	No. of People Bothered by Vibration (2025/26)
<50	142	14	0
50 < 60	1355	236	8
60 < 70	808	407	213
≥70	165	154	114
Total	**2470**	**810**	**335**

Table 12.10 Predicted Noise and Vibration Impact (Outside Scheme Corridor) – 2025/26 Baseline

Noise Band $L_{A10,18h}$ (dB)	No. of Residential Properties	No. of People Bothered by Noise (2025/26)	No. of People Bothered by Vibration (2025/26)
<50	15844	1094	0
50 < 60	23292	3857	103
60 < 70	7124	3796	2086
≥70	1818	1757	1320
Total	**48078**	**10503**	**3509**

12.3.14 For the 2025/26 baseline, the numbers of people bothered by traffic noise and vibration are higher than the numbers for the existing baseline, due to changes in traffic flows.

12.3.15 The total number of people likely to be bothered by traffic noise is estimated as 11,313, just over 9.3% of the total population in the study area. The number of people likely to be bothered by traffic vibration is estimated as 3,844, just under 3.2% of the total population in the study area.

12.3.16 Proposed developments in Kempston West and to the north and south of Fields Road, Wootton, are assumed to provide an additional 2,300 residential properties within the study area for 2025/26. A worst case estimate is that an additional 642 people would be bothered by traffic noise, out of a total population of 5,520 in these three developments.

12.3.17 Free field noise contour plots (at a height of 4m above ground level) for the 2025/26 baseline are presented in Figures 12.5.1 - 12.5.4.

12.4 Mitigation and Detailed Development of Scheme Design

12.4.1 There is no official guidance reporting at what final noise level, or for what noise level change, it is appropriate to consider introducing environmental noise mitigation (primarily in the form of noise barriers).

12.4.2 For this Scheme it was decided to propose noise mitigation (most practicably in the form of carriageway-edge noise barriers) where calculations indicated that road traffic noise levels at properties along the route of the Scheme would be increased to exceed 68 dB $L_{A10,18h}$, the criterion level for entitlement under The Noise Insulation Regulations.

12.4.3 Additionally, bunding was included where estimated noise increases as a result of the Scheme were shown to be substantial, although the resultant With-Scheme noise level was below 68 dB $L_{A10,18h}$,

12.4.4 Features that have been included in the Scheme design to provide noise mitigation are:

- 3 metre landscaping bund, south of Scheme (Ch.800 – 1100)
- 3 metre landscaping bund, north of Scheme (Ch.4850 – 5320);
- 3 metre landscaping bund, south of Scheme (Ch.5000 – 5330)
- 3 metre absorbent noise fence, north of Scheme, between new A421 and Lower Shelton link road (Ch.6800 – 7200)
- 3 metre absorbent noise fence, south of Scheme, between new A421 and remaining existing A421 (Ch.6700 – 7250)
- 3 metre reflective noise fence, south of Scheme (Ch.7250 – 7500)
- 1 metre landscaping bund, south of Scheme (Ch.7500 – 8100)
- 3 metre reflective noise fence, north of Scheme (Ch.10050 – 10400).

12.4.5 The Scheme would be surfaced with a low-noise road surface, which meets the specification required by the Highways Agency to be classified as a 'quiet running surface'. CRTN allows for a road traffic noise reduction of 3.5dB(A) at road speeds above 75km/h for quiet road surfaces compared to noise from conventional hot rolled asphalt, such as used for the existing A421. A low-noise road surface along the whole of the existing A421 has been assumed for the 2025/26 baseline scenario.

12.4.6 It has been assumed that the M1 would have a standard HRA surface for the current year and the opening year, and a low-noise surface for the design year; that the Ridgmont Bypass would have a standard HRA surface within the study area for the opening year and the design year; and that Bedford Western Bypass would have a low-noise surface for the opening year and the design year.

Mitigation Measures to be adopted during Scheme Construction

12.4.7 A range of good site practices would be adopted in order to mitigate construction phase noise and vibration (as detailed in the Construction Environmental Management Plan (CEMP)). Such measures, and other good site practice mitigation techniques include:

- Proper use of plant with respect to minimising noise emissions and regular maintenance. All vehicles and mechanical plant used for the purpose of the works to be fitted with effective exhaust silencers and to be maintained in good efficient working order
- Selection of inherently quiet plant where appropriate. All major compressors to be 'sound reduced' models fitted with properly lined and sealed acoustic covers which are kept closed whenever the machines are in use, and all ancillary pneumatic

percussive tools to be fitted with mufflers or silencers of the type recommended by the manufacturers

- Machines in intermittent use to be shut down in the intervening periods between work or throttled down to a minimum
- All ancillary plant such as generators, compressors and pumps to be positioned so as to cause minimum noise disturbance. If necessary, acoustic barriers or enclosures to be provided. A well constructed 3m high barrier of 10mm softwood can reduce noise levels by 5–10dB
- Adherence to the codes of practice for construction working and piling given in British Standard BS 5228:1992 and the guidance given therein for minimising noise emissions from the site
- Where appropriate, provision of close-boarded wooden fencing to sensitive receptors when estimated construction noise levels exceed the adopted criterion for particular activities.

12.5 Environmental Effects

Effects of Construction

12.5.1 Construction noise levels have been calculated at 21 receptors along the Scheme alignment, chosen to reflect their proximity to the mainline, the cut and embankment areas, and main structures.

12.5.2 The calculations were based upon the indicative plant roster provided, and the proposed construction programme.

12.5.3 Reference sound power noise levels for plant and equipment have been sourced from BS 5228, 1997: 'Noise and Vibration Control on Construction and Open Sites', the Department for Environment, Food and Rural Affairs (DEFRA) update produced in 2005, Scott Wilson internal database and information from previous assessments.

12.5.4 The receptor locations, along with their closest distances to the main structure locations and other nearest working phase are detailed in Table 12.11.

12.5.5 Noise levels have been calculated at the receptor locations for the works of site clearance, earthworks and drainage, roadwork, finishings, and the main structure works of foundations, substructure and superstructure. For the majority of the initial works, it was assumed that the receptors have direct line-of-sight to the works, with all plant working at its closest approach.

12.5.6 Consequently noise levels are predicted on a worst-case basis. The predicted worst-case construction noise levels ($dB_{LAeq,1hr}$) at the chosen receptors are shown in Table 12.12.

Table 12.11 Construction Noise Receptor Locations

Ref.	Approx Chainage	Property	Approx closest approach to area of nearest works (m)	
			Earthworks, Roadwork & Finishings.	Main Structures
1	400	'Omega', Salford Road	80	120
1A	400	'Llanberis', Salford Road	60	100
2	950	Highfield Farm (Hedgehog Cottage)	70	260
3	1400	1 Hill Crescent	150	380
4	1800	(Brogborough) Manor Farm	260	260
4A	2300	North Common Farm	200	200
5	5000	The Woodlands	60	60
6	5100	Moreteyne Farm	60	60
7	6000	Beancroft Farm	60	130
8	6350	9 Burridge Close	90	90
8B	7850	Hoo Lane Farm	180	660
8D	9700	51 Fields Rd, Haycroft	220	300
9	9800	The Elms (and adjacent Elms Farm)	55	55
9A	11850	32 Dennis Road, Kempston	300	300
10	450	1 Salford Road	60	60
11	5900	Travelodge Motel at junction of Beancroft and existing A421	50	50
12	7000	45 Lower Shelton Road (and other side of road, no 14)	50	420
13	9825	CP Farm, Woburn Rd	50	180
14	1750	Brogborough Manor Cottages	40	40
15	12800	71 The Silver Birches	290	290
16	7800	'The Sycamores' (nr. Green Lane)	80	650

Distances obtained from drawings: GD00612/2021, GD00612/2022, GD00612/2023, GD00612/2024

Table 12.12 Predicted Construction Noise Levels (LAeq, 1 hour dB)

Ref.	Location	Site clearance	Earthworks & Drainage	Main structures - Foundations	Main structures - Substructure	Main structures - Superstructure	Roadworks	Finishings
1	'Omega', Salford Road	66	69	66	66	65	70	69
1A	'Llanberis', Salford Road	69	**71**	68	68	67	**72**	**71**
2	Highfield Farm (Hedgehog Cottage)	67	70	59	59	58	**71**	70
3	1 Hill Crescent	61	70	56	56	55	64	63
4	(Brogborough) Manor Farm	56	59	59	59	58	54	58
4A	North Common Farm	58	61	62	62	61	62	61
5	The Woodlands	69	**71**	**72**	**72**	**71**	**72**	**71**
6	Moreteyne Farm	69	**71**	**72**	**72**	**71**	**72**	**71**
7	Beancroft Farm	69	**71**	65	66	64	**72**	**71**
8	9 Burridge Close	**78**	**81**	69	69	68	**82**	**81**

Table 12.12 (continued)

Ref.	Location	Site clearance	Earthworks & Drainage	Main structures - Foundations	Main structures - Substructure	Main structures - Superstructure	Roadworks	Finishings
8B	Hoo Lane Farm	59	62	51	51	50	62	62
8D	51 Fields Road, Haycroft,	58	60	58	58	57	61	60
9	The Elms (and adjacent Elms Farm)	70	**72**	**73**	**73**	**72**	**73**	**72**
9A	32 Dennis Road, Kempston	55	57	58	58	57	62	60
10	1 Salford Rd	66	70	**72**	**72**	**71**	**72**	**71**
11	Travelodge Motel at junction of Beancroft and existing A421	70	**73**	**74**	**74**	**73**	**74**	**73**
12	45 Lower Shelton Road	**78**	**81**	55	55	54	**82**	**81**
13	CP Farm	70	**73**	63	63	62	**74**	**73**
14	Brogborough Manor Cottages	**72**	**75**	**75**	**76**	**75**	**76**	**75**
15	71 The Silver Birches	55	58	58	59	57	58	58
16	'The Sycamores' (nr. Green Lane)	69	63	51	52	50	54	58

12.5.7 The 70dB $L_{Aeq,1h}$ criterion is predicted to be exceeded at twelve of the selected receptors, at some stage during the construction works (as shown in bold in Table 12.9, above).

12.5.8 Distances from construction activities, within which receptors are predicted to experience noise levels exceeding 70dB $_{LAeq,\ 1hr}$ are given below in Table 12.13. Also included are estimates of the time the particular activities are within these critical distances of the selected receptors. Durations of activities have been taken from the Construction Time Location Programme, and a percentage in terms of area of works determined. The same percentage of time has been taken to estimate the duration of activities within the critical distances of the selected receptors.

12.5.9 The process of site clearance, using chainsaws, an excavator and a mechanical mulcher is a relatively fast moving operation (8 weeks in total for the complete length of the Scheme). Current predictions assume that all plant would operate simultaneously at the closest approach to the receptors. In the case of Burridge Close (receptor 8) and properties on Lower Shelton Road (either side of the main line, receptor 12) this distance is 20 metres. When the plant is operating further than 50 metres from the receptors, noise levels drop below 70dB $L_{Aeq,\ 1hr}$. At Brogborough Manor Cottages (receptor 14), predictions have been carried out using a distance of 40 metres. Again, at distances greater than 50 metres, noise levels are predicted to drop below 70dB. Therefore, due to the short-term nature of this activity occurring within critical distances of receptors it is concluded that the noise levels would be acceptable.

12.5.10 Earthworks and Drainage activities would result in noise levels above the 70dB criterion at 10 receptor locations. At receptors 11 and 12, the duration of noise levels above the criterion level for these activities is of the order of 7 to 9 weeks.

12.5.11 Main structures foundations activities would result in noise levels above the 70dB criterion at 6 receptor locations. At receptor 9, the duration of noise levels above the criterion level for these activities is of the order of 15 weeks.

12.5.12 Main structures substructure activities would result in noise levels above the 70dB criterion at 6 receptor locations. At receptor 9, the duration of noise levels above the criterion level for these activities is of the order of 16 to 17 weeks.

12.5.13 Main structures superstructure activities would result in noise levels above the 70dB criterion at 6 receptor locations. At receptor 9, the duration of noise levels above the criterion level for these activities is of the order of 13 to 14 weeks.

12.5.14 Roadworks activities would result in noise levels above the 70dB criterion at 12 receptor locations. The maximum time that the noise level would be above the criterion level is of the order of 3 weeks at any receptor.

12.5.15 Finishings activities would result in noise levels above the 70dB criterion at 11 receptor locations. The maximum time that the noise level would be above the criterion level is of the order of 2 weeks at any receptor.

12.5.16 The above estimates are based on a worst-case approach, assuming activities carried out at the closest approach to the receptors. For much of the time, activities would be at significantly greater distances and noise levels consequently reduced below the 70dB criterion.

12.5.17 Based on the estimated worst-case noise levels in Table 12.9, above, and the estimated duration of exceedances of the 70dB criterion level, the significance of the construction noise levels at the receptors has been assessed as follows. Receptors 9, 11 and 12 experience the most significant effect. Receptors 5, 6, 8, 10 and 14 experience the next most significant effect. Receptors 1A, 2, 7 and 13 experience the least significant effect. The significance of construction noise at these receptors, in the absence of any specific mitigation, is assessed as slight to moderate adverse.

Compounds

12.5.18 The location of the main compound is proposed to be between the existing A421 and the proposed A421 to the north of Green Lane in Wootton Green. This area of approximately 90,000m^2 would be the site of the main contract offices, car parking, welfare facilities, workshops, temporary storage of materials, batching plant, recycling centre and accommodation for the workforce.

12.5.19 A secondary compound for the M1 works is proposed at the north of Salford Road and to the west of the proposed A421. Offices, car parking, welfare facilities, workshops, temporary storage of materials and a plant yard would be situated here.

12.5.20 Although activities within the compounds are not considered excessively noisy, it is understood that certain activities could continue on a 24-hour basis.

Haul Routes

12.5.21 It is proposed to establish a haul route (in part or in whole) along the length of the Scheme from east of the M1 J13 area to just west of Marsh Leys junction. The majority of deliveries to the site would enter from the M1 J13 or from the A421/A6 junction.

12.5.22 In order to assess a worst-case situation, receptors at both ends of the Scheme and at a closest approach to the anticipated location of the haul routes have been selected. Calculations in accordance with BS 5228 have been undertaken at these receptors using estimated vehicle numbers.

12.5.23 Employing the maximum estimate of 346 deliveries on site per day, assuming all deliveries are from the M1 J13 or the A421/A6 Junction entry points, and assuming a twelve-hour day, a maximum of 58 HGVs would pass by any given point on the haul routes during one hour. At a distance of 30 metres to the nearest receptor which experiences the maximum amount of HGV traffic, and assuming a speed of 48km/hr, a vehicle sound power level of 105dB, no screening, and an 180^o angle of view, the 1 hr L_{Aeq} at a receptor location is calculated at 58dB(A). Other construction traffic on the haul routes (excavators moving location, water bowsers etc.) would make a lesser contribution to the noise at nearby receptors. It is estimated that the worst-case noise level at the nearest receptor to the haul routes would be less than 60dB(A).

12.5.24 Therefore, the contribution of haul road traffic to the noise level at any receptor location is expected to be minimal, and is not considered a contributory factor for the possibility of noise levels exceeding the adopted limit at any of the receptors.

Construction Traffic on Public Roads

12.5.25 The majority of construction traffic would access the site via the M1 J13 Junction or the A6/A421 Junction. As a worst case, an additional 692 HGV’s per day were assumed on the M1, the A421 and the A6 during the construction phase (equivalent to 346 two-way trips). Employing the supplied traffic data for the current situation on these links, the increases in road traffic noise on these links, due to this additional HGV traffic, were calculated using the method provided in CRTN. Increases on all three links were below 1dB (0.2dB for the M1, 0.5dB for the A421, 0.8dB for the A6). Consequently, the significance of the effect of construction HGV traffic on public roads is assessed as negligible.

Table 12.13 Estimated Duration of Activities within Critical Distance of Receptor Locations (In days)

Activity	Distance Within Which $L_{Aeq, 1h}$ exceeds 70 dB	Receptor Location											
		1A	**2**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Site Clearance	50						1				1		1
Earthworks/Drainage	70	14		19	19	14	28	10		41	55	10	10
MS Foundations	70			9	9			90	9	23			9
MS Substructure	75			11	11			99	11	27			11
MS Superstructure	65			7	7			81	7	18			7
Roadworks	80	16	6	3	3	2	4	4	21	8	8	4	3
Finishings	70	12		3	3	2	3	3	10	2	6	3	2
Total Days		**42**	**6**	**52**	**52**	**18**	**36**	**287**	**58**	**119**	**70**	**17**	**32**

Car Traffic on Public Roads

12.5.26 The estimated peak number of personnel working on the A421 is 395. As a worst case, each employee would arrive separately by car. This assumes that all works would be carried out concurrently, while in reality, works would be phased over a period of two years. Employing the supplied traffic data for the current situation on the M1, A421 and A6, the increases in road traffic noise on these links, due to this additional car traffic, was calculated using the method provided in CRTN. Increases on all three links were well below 1dB. Consequently, the significance of the effect of construction car traffic on public roads is assessed as negligible.

Working Hours and Night-Time Working

12.5.27 Current proposed working hours are as follows:

- 0700–2000 Monday to Saturday, with occasional works on Sundays and Bank Holidays for the earthworks operation
- 0700–1900 Monday to Friday and 0700–1300 Saturday for most other operations

12.5.28 The following locations are possible sites of working outside the above proposed hours (including night-time working) due to traffic volumes and rail possessions:

- M1 J13
- Alignment past Brogborough Landfill
- Marston Junction
- Fields Road Bridge
- Marsh Leys to A6 junction
- Kempston Railway Bridge

12.5.29 It should be noted that all locations where out of hours working may be required have yet to be finalised.

12.5.30 In general, the hours for construction work accepted by the relevant local authorities are 0800–1800 Monday to Friday, and 0800–1300 Saturday. Current proposed working hours would therefore need to be agreed with the Local Authorities. It is expected that a degree of flexibility regarding times would be available due to the nature of the Scheme, in order to minimise congestion, and ensure the safety of construction workers.

12.5.31 Close liaison between the contractors, the Local Authority Environmental Health Departments and local residents would be necessary to successfully manage any night-time working.

Effects of Construction – Vibration

12.5.32 At present, it is anticipated that all piling associated with the structures along the length of the Scheme would be undertaken using the 'rotary-bored' method as opposed to driven piling. However, driven piles would be employed between chainages 2400 to 3000 to cope with soft ground adjacent to Brogborough Lake.

12.5.33 A typical rotary bored piling rig generates a ppv of the order of 0.4mm/s at10m from the operation (ref: BS 5228 Pt 4, Table 8). This equates to approximately 0.1mm/s at 40m, the distance to the nearest sensitive receptor from any piling works. Employing the procedure given in BS 6472, for a 12-hour working day, this equates to a VDV value of $0.06ms^{-1.75}$ at the nearest sensitive receptor.

12.5.34 A typical driven piling rig generates a ppv of the order of 4mm/s at 10m from the operation (ref: BS 5228 Pt 4, Table 11). This equates to approximately 0.17mm/s at 250 m, the distance to the nearest residential receptor from driven piling works (North Common Farm), and 0.53mm/s at 80 m, the distance to the nearest non-residential receptor (Waste Recycling buildings). Employing the procedure given in BS 6472 for a 12-hour working day, this equates to a VDV of 0.12 $ms^{-1.75}$ at North Common Farm and a VDV of 0.36 $ms^{-1.75}$ at the Waste recycling buildings.

12.5.35 Surface plant are not recognised as sources of high levels of environmental vibration and reference to Figure 1 of 'Control of Vibration and Noise during Piling' confirms that even at a closest distance of 10m, ppv significantly less than 5mm/s would be generated by such plant. For example, the indication is that a bulldozer would generate a ppv of approximately 0.6mm/s and a 'heavy lorry on poor road surface' a ppv of less than 0.1mm/s at 10m. These values are well below limits at which even cosmetic building damage becomes likely (5mm/s).

Mitigation Measures to be Adopted During Scheme Construction

12.5.36 Best practicable means as already outlined in paragraph 12.4.7 would be employed by the contractors to reduce the noise and vibration impact upon nearby sensitive receptors during construction work.

12.5.37 Furthermore, and in order to minimise the likelihood of complaints the Local Authorities and affected residents should be kept informed of the works to be carried out and of any proposed work outside normal hours. Residents would be provided with a point of contact for any queries or complaints.

12.5.38 Further temporary mitigation measures may be required at several locations where the adopted noise limit is expected to be exceeded for a period of time considered significant (generally considered to be over 6 weeks). These locations, in order of significance, are as follows:

- The Elms (Receptor 9)
- Travelodge (Receptor 11)
- Lower Shelton Road (both sides of A421) (Receptor 12)
- Burridge Close (Receptor 8)
- The Woodlands (Receptor 5)
- Moretyne Farm (Receptor 6)
- 1 Salford Road (Receptor 10)
- Brogborough Manor Cottages (Receptor 14)
- "Llanberis", Salford Road (Receptor 1A)

12.5.39 Employment of temporary noise barriers or bunds at these locations, combined with sensible use of plant and equipment should provide attenuation to reduce incident noise levels to below the criterion level during most construction phases.

12.5.40 It is recommended that temporary noise barriers or bunds be erected along the perimeter of the M1 compound between the site and the closest receptors ('Omega' and 'Llanberis' on Salford Road), should noisy operations or significant night time working be proposed at the compound. Similarly, a temporary noise barrier or bund should be erected along the perimeter of the main compound in the vicinity of the closest residential property ("Belmont", on the existing A421) to provide shielding should noisy operations or significant night time working be proposed at the compound.

"The Sycamores", the next nearest residential property to this compound, benefits from a greater separation distance and shielding provided by intervening buildings, and does not require additional mitigation.

Effects of Operation

12.5.41 Noise levels at all residential properties within the study area have been calculated for 2010/11 with the Scheme. The numbers of residential properties, and therefore the numbers of people likely to be bothered by noise and vibration, within each noise band (<50, 50<60, 60<70, ≥70 $LA_{10,18h}$) for the 2010/11 With-Scheme scenario are provided in Table 12.14 for the Scheme Corridor and in Table 12.15 for the wider road network (outside the Scheme Corridor) in the study area. Numbers are based on the abrupt change relationship between traffic noise and nuisance and an average household size of 2.4 (TAG Noise Sub Objective, June 2003). The figures take account of all properties within 300m of the Scheme and all significant road links.

Table 12.14 Predicted Noise and Vibration Impact (Within Scheme Corridor) – 2010/11 With-Scheme

Noise Band $L_{A10,18h}$ (dB)	No. of Residential Properties	No. of People Bothered by Noise (2010/11)	No. of People Bothered by Vibration (2010/11)
<50	35	5	0
50<60	1659	501	15
60<70	726	442	194
≥70	50	58	34
Total	**2470**	**1006**	**243**

Table 12.15 Predicted Noise and Vibration Impact (Outside Scheme Corridor) – 2010/11 With-Scheme

Noise Band $L_{A10,18h}$ (dB)	No. of Residential Properties	No. of People Bothered by Noise (2010/11)	No. of People Bothered by Vibration (2010/11)
<50	20688	2340	0
50<60	19863	6067	80
60<70	6213	3925	1734
≥70	1314	1445	969
Total	**48078**	**13777**	**2783**

12.5.42 For 2010/11 With-Scheme, the numbers of people bothered by traffic noise are significantly higher than the numbers for the baseline scenarios. This is a consequence of employing the nuisance statistics for abrupt noise increases in DMRB. Conversely, the numbers of people bothered by vibration are lower than the numbers for the baseline scenarios. This is a consequence of there being fewer properties in the ≥70dB band and the upper end of the 60 < 70dB band for the With-Scheme scenario.

12.5.43 The number of people likely to be bothered by traffic noise is estimated to be 14,783 which is just under 12.2% of the total population in the study area. The number of people likely to be bothered by traffic vibration is estimated to be 3,026, just under 2.5% of the total population in the study area.

12.5.44 Proposed developments in Kempston West and to the north and south of Fields Road, Wootton, would provide an additional 925 residential properties (see para 12.3.11) within the study area for 2010/11. A worst case estimate is that an additional 827 people would be bothered by traffic noise, out of a total population of 2,220 in these three developments.

12.5.45 Free field noise contour plots (at a height of 4m above ground level) for the 2010/11 With-Scheme scenario are presented in Figures 12.6.1 - 12.6.4.

12.5.46 Noise levels at all residential properties within the study area have been calculated for 2025/26 With-Scheme. The numbers of residential properties, and therefore the numbers of people likely to be bothered by noise and vibration, within each noise band (<50, 50<60, 60<70, ≥70 $L_{A10,18h}$) for the 2025/26 With-Scheme scenario are provided in Table 12.16 for the Scheme Corridor and in Table 12.17 for the wider road network (outside the Scheme Corridor) in the study area. Numbers are based on the steady state relationship between traffic noise and nuisance and an average household size of 2.4 (TAG Noise Sub Objective, June 2003).

Table 12.16 Predicted Noise and Vibration Impact (Within Scheme Corridor) – 2025/26 With-Scheme

Noise Band $L_{A10,18h}$ (dB)	No. of Residential Properties	No. of People Bothered by Noise (2025/26)	No. of People Bothered by Vibration (2025/26)
<50	9	1	0
50<60	1604	315	15
60<70	752	377	196
≥70	105	93	68
Total	**2470**	**786**	**279**

Table 12.17 Predicted Noise and Vibration Impact (Outside Scheme Corridor) – 2025/26 With-Scheme

Noise Band $L_{A10,18h}$ (dB)	No. of Residential Properties	No. of People Bothered by Noise (2025/26)	No. of People Bothered by Vibration (2025/26)
<50	17132	1167	0
50<60	22190	3777	87
60<70	6954	3604	1935
≥70	1802	1729	1297
Total	**48078**	**10276**	**3319**

12.5.47 For the 2025/26 With-Scheme scenario, the total number of people bothered by traffic noise is slightly lower than the number for the 2025/26 baseline scenario. The total number of people bothered by vibration is also lower than the number for the baseline scenario. This is a consequence of there being fewer properties in the ≥ 70dB band and the upper end of the 60<70dB band for the With-Scheme scenario.

12.5.48 The total number of people likely to be bothered by traffic noise is estimated to be 11,062 which is just over 9.1% of the total population in the study area. The number of people likely to be bothered by traffic vibration is estimated to be 3,598, just under 3.0% of the total population in the study area.

12.5.49 Proposed developments in Kempston West and to the north and south of Fields Road, Wootton, would provide an additional 2,300 residential properties (see para 12.3.16) within the study area for 2025/26. No detailed layouts are available, but a worst case estimate is that an additional 854 people would be bothered by traffic noise, out of a total population of 5,520 in these three developments.

12.5.50 Free field noise contour plots (at a height of 4m above ground level) for the 2025/26 With-Scheme scenario are presented in Figures 12.7.1 - 12.7.4.

12.5.51 Calculated façade noise levels at a selection of properties along the Scheme are given in Table 12.18 for the baseline scenarios and the With-Scheme scenarios. These selected properties are a subset of those employed in the construction noise and vibration assessment.

12.5.52 Some individual properties, and small groups of properties, experience significant noise increases as a result of the Scheme, whilst others experience significant decreases. Relatively large areas of residential development in Brogborough, Lower Shelton and Marston Moretaine experience significant decreases in noise level.

Table 12.18 Calculated Façade Noise Levels at Selected Properties

Ref.	Location	Approx. Chainage	Façade $L_{A10,18\ hour}$			2025/26 With Scheme minus 2025/26 Base
			2005 Baseline	2025/26 Baseline	2025/26 With Scheme	
1A	‘Llanberis’, Salford Road	400	68.6	65.9	68.7	+ 2.8
2	Highfield Farm	950	63.9	61.2	62.4	+ 1.2
3	1 Hill Crescent	1400	74.0	73.0	71.1	- 1.9
5	The Woodlands	5000	48.3	47.3	60.0	+ 12.7
6	Moreteyne Farm	5100	50.3	50.5	59.1	+ 8.6
7	Beancroft Farm	6000	70.9	73.6	62.5	- 11.1
8	9 Burridge Close	6350	74.1	71.1	68.6	- 2.5
8B	Hoo Lane Farm	7850	56.6	57.9	61.7	+ 3.8
9	The Elms	9800	69.6	71.6	68.2	- 3.4
10	1 Salford Road	450	71.9	70.6	67.6	- 3.0
11	Travel Lodge Motel	5900	65.3	64.6	67.0	+ 2.4
12	45 Lower Shelton Road	7000	71.1	68.6	65.8	- 2.8
14	Brogborough Manor Cottages	1750	57.0	55.1	58.2	+ 3.1

Ref.	Location	Approx. Chainage	Façade $L_{A10,18\ hour}$			2025/26 With Scheme minus 2025/26 Base
			2005 Baseline	2025/26 Baseline	2025/26 With Scheme	
16	'The Sycamores' (nr. Green Lane)	7800	73.5	75.8	71.9	- 3.9

Significance of Effects

Construction Noise and Vibration – Significance of Effects

12.5.53 Where construction noise levels are predicted to exceed the suggested criterion level of 70dB $L_{Aeq,1h}$ at the chosen receptors, this is not generally expected to continue for a significant period of time at most receptors. There may be some locations, however, where exceedances above the 70dB criterion prevail for a significant number of days.

12.5.54 Where the criterion level would be exceeded for some construction activities, the employment of temporary barriers and considerate work practices should bring noise levels to below the criteria level.

12.5.55 The resulting predicted noise levels should prove acceptable for the proposed daytime working hours, and are unlikely to result in justifiable complaint from residents. Works proposed for Sundays, bank holidays and night-time, would need to be by prior agreement with the Local Authority and would require liaison with residents affected by the construction of the Scheme. The significance of the effect of construction noise at sensitive receptors is assessed as **moderate adverse**, taking into account the estimated noise levels and the short-term nature of the work.

12.5.56 Estimated vibration levels from rotary bored piling work at the nearest sensitive receptors (40 metres) are of the order of 0.1 mm/s ppv, with an eVDV of 0.06 $ms^{-1.75}$ for a 12-hour working day. Reference to Tables 12.1 and 12.2, above, indicates that the estimated ppv and eVDV values are well below the suggested damage and annoyance criteria (even for night time working). Estimated vibration levels from driven piling work at the nearest residential receptor (250 m) are of the order of 0.17 mm/s ppv, with an eVDV of 0.12 $ms^{-1.75}$ for a 12-hour working day. Estimated vibration levels from driven piling work at the nearest non-residential receptor (80 m) are of the order of 0.53 mm/s ppv, with an eVDV of 0.36 $ms^{-1.75}$ for a 12-hour working day. The estimated ppv and eVDV values are well below the suggested damage and daytime annoyance criteria for residential and non-residential properties. Consequently it is considered that it is unlikely that vibration from construction of the Scheme would give rise to onset of cosmetic building damage or justifiable vibration complaints at local residential property. Overall, the significance of construction vibration is rated as **negligible**.

Operation

12.5.57 Based on this assessment, one property would qualify for treatment under the Noise Insulation Regulations as a result of the Scheme, and it is recommended that a detailed assessment should be carried out during the detailed design of the Scheme. This property is:-

- 'Llanberis', Salford Road, Hulcote, Milton Keynes, MK17 8BS

12.5.58 Table 12.19 shows the changes in numbers of people bothered by traffic noise due to the opening of the Scheme in 2010/11, for properties within the Scheme Corridor. Table 12.20 shows the changes in numbers of people bothered by traffic noise due to the opening of the Scheme in 2010/11, for properties outside the Scheme Corridor. It is estimated that there would be a total increase of 4,120 in the number of people bothered by traffic noise, due to the employment of the "abrupt change" nuisance relationship detailed in Plate 12.2. This would change the percentage of people in the study area bothered by traffic noise from 8.8% to 12.2% and is considered to be an **adverse** effect of **moderate** significance.

Table 12.19 Noise Impact for Baseline and Operation (Within Scheme Corridor) – 2010/11

Road Traffic Noise dB $L_{A10,18h}$	Scheme Year and Descriptor		
	2005 Baseline	2010/11 Baseline	2010/11 With-Scheme
	No. of residents bothered 'very much or quite a lot' by road traffic noise		
<50	15	3	5
50<60	235	239	501
60<70	426	478	442
≥70	157	162	58
Total	**833**	**882**	**1006**
Net		**Increase of 124**	

Table 12.20 Noise Impact for Baseline and Operation (Outside Scheme Corridor) – 2010/11

Road Traffic Noise dB $L_{A10,18h}$	Scheme Year and Descriptor		
	2005 Baseline	2010/11 Baseline	2010/11 With-Scheme
	No. of residents bothered 'very much or quite a lot' by road traffic noise		
<50	1242	1256	2340
50<60	3142	3445	6067
60<70	2989	3378	3925
≥70	1623	1702	1445
Total	**8996**	**9781**	**13777**
Net		**Increase of 3996**	

12.5.59 Table 12.21 shows the changes in numbers of people bothered by traffic vibration due to the opening of the Scheme in 2010/11, for properties within the Scheme Corridor. Table 12.22 shows the changes in numbers of people bothered by traffic vibration due to the opening of the Scheme in 2010/11, for properties outside the Scheme Corridor. It is estimated that there would be a total decrease of 566 in the number of people bothered by traffic vibration. This would change the percentage of people in the study area bothered by traffic vibration from 3.0% to 2.5% and is considered to be of **negligible significance**.

Table 12.21 Vibration Impact for Baseline and Operation (Within Scheme Corridor) – 2010/11

Road Traffic Noise dB $L_{A10,18h}$	Scheme Year and Descriptor		
	Existing Baseline	**2010/11 Baseline**	**2010/11 With-Scheme**
	No. of residents bothered 'very much or quite a lot' by road traffic vibration		
<50	0	0	0
50<60	8	7	15
60<70	216	248	194
≥70	120	125	34
Total	**344**	**381**	**243**
Net		**Decrease of 138**	

Table 12.22 Vibration Impact for Baseline and Operation (Outside Scheme Corridor) – 2010/11

Road Traffic Noise dB $L_{A10,18h}$	Scheme Year and Descriptor		
	Existing Baseline	**2010/11 Baseline**	**2010/11 With-Scheme**
	No. of residents bothered 'very much or quite a lot' by road traffic vibration		
<50	0	0	0
50<60	77	90	80
60<70	1608	1829	1734
≥70	1229	1292	969
Total	**2915**	**3211**	**2783**
Net		**Decrease of 428**	

12.5.60 Table 12.23 shows the number of people estimated to be bothered by traffic noise for the 2025/26 baseline and with the Scheme, for properties within the Scheme Corridor. Table 12.24 shows the number of people estimated to be bothered by traffic noise for the 2025/26 baseline and with the Scheme, for properties outside the Scheme Corridor. It is estimated that there would be a total decrease of 251 in the number of people bothered by traffic noise over the 2025/26 baseline. This would change the percentage of people in the study area bothered by traffic noise from 9.3% to 9.1% and is considered to be of **negligible significance**.

12.5.61 Proposed developments in Kempston West and to the north and south of Fields Road, Wootton, would provide an additional 2,300 residential properties within the study area for 2025/26. With the Scheme, a worst case estimate is that an additional 854 people would be bothered by traffic noise, approximately 15% of the total population of 5,520. For the 2025/26 baseline, a worst case estimate is that an additional 642 people would be bothered by traffic noise, approximately 12% of the total population of 5,520.

Table 12.23 Noise Impact for Baseline and Operation (Within Scheme Corridor) – 2025/26

Road Traffic Noise dB $L_{A10,18h}$	Scheme Year and Descriptor		
	Existing Baseline	2025/26 Baseline	2025/26 With-Scheme
	No. of residents bothered 'very much or quite a lot' by road traffic noise		
<50	15	14	1
50<60	235	236	315
60<70	426	407	377
≥70	157	154	93
Total	**833**	**810**	**786**
Net		**Decrease of 24**	

Table 12.24 Noise Impact for Baseline and Operation (Outside Scheme Corridor) – 2025/26

Road Traffic Noise dB $L_{A10,18h}$	Scheme Year and Descriptor		
	Existing Baseline	2025/26 Baseline	2025/26 With-Scheme
	No. of residents bothered 'very much or quite a lot' by road traffic noise		
<50	1242	1094	1167
50<60	3142	3857	3777
60<70	2989	3796	3604
≥70	1623	1757	1729
Total	**8996**	**10503**	**10276**
Net		**Decrease of 227**	

12.5.62 Table 12.25 shows the number of people estimated to be bothered by traffic vibration for the 2025/26 baseline and with the Scheme, for properties within the Scheme Corridor. Table 12.26 shows the number of people estimated to be bothered by traffic vibration for the 2025/26 baseline and with the Scheme, for properties outside the Scheme Corridor. It is estimated that there would be a total decrease of 246 in the number of people bothered by traffic vibration over the 2025/26 baseline. This would change the percentage of people in the study area bothered by traffic vibration from 3.2% to 3.0% and is considered to be of **negligible significance**.

Table 12.25 Vibration Impact for Baseline and Operation (Within Scheme Corridor) – 2025/26

Road Traffic Noise dB $L_{A10,18h}$	Scheme Year and Descriptor		
	Existing Baseline	**2025/26 Baseline**	**2025/26 With-Scheme**
	No. of residents bothered 'very much or quite a lot' by road traffic vibration		
<50	0	0	0
50<60	8	8	15
60<70	216	213	196
≥70	120	114	68
Total	**344**	**335**	**279**
Net		**Decrease of 56**	

Table 12.26 Vibration Impact for Baseline and Operation (Outside Scheme Corridor) – 2025/26

Road Traffic Noise dB $L_{A10,18h}$	Scheme Year and Descriptor		
	Existing Baseline	**2025/26 Baseline**	**2025/26 With-Scheme**
	No. of residents bothered 'very much or quite a lot' by road traffic vibration		
<50	0	0	0
50<60	77	103	87
60<70	1608	2086	1935
≥70	1229	1320	1297
Total	**2915**	**3509**	**3319**
Net		**Decrease of 190**	

12.5.63 In addition, the DMRB methodology requires a worst-case assessment of the significance of the changes in traffic noise levels and nuisance levels by considering the greatest levels of traffic noise and nuisance experienced in the first 15 years after Scheme opening.

12.5.64 Table 12.27 illustrates the results of this assessment for the number of properties in each of the four noise bands relative to the baseline scenario in 2010/11, as required by DMRB, for the whole of the study area. Properties which experience no change in noise level, and hence nuisance, are not included in the table.

Table 12.27 Significance of the Predicted Traffic Noise Impact (table is to the requirements of DMRB)

		Baseline 2010/11 Traffic Noise Band $L_{A10,18h}$ dB									
		<50		50<60		60<70		≥70		Total	
		Operation	Baseline	Operation	Baseline	Operation	Baseline	Operation	Baseline	Operation	Baseline
Increase in traffic noise level is based on worst-case, i.e. comparison between 2010/11B to 2025/26WS for operation, 2010/11B to 2025/26B for baseline.											
Increase in Traffic Noise $L_{A10,18h}$ Properties	<1	4207	3802	5714	6458	1525	2180	341	880	11787	13320
	1<3	7748	6811	4780	4093	1488	1898	123	67	14139	12869
	3<5	1100	5408	1155	1598	238	728	0	7	2493	7741
	5<10	890	896	429	446	138	141	0	0	1457	1483
	10<15	1	0	1	0	1	0	0	0	3	0
	≥15	0	0	0	0	0	0	0	0	0	0
Increase in nuisance is based on worst-case i.e. comparison between 2010/11B to 2010/11WS for operation, 2010/11B to 2025/26B for baseline.											
Increase in Nuisance Level percentage points, Properties	<10%	17	16917	259	12513	174	4806	39	954	489	35190
	10<20%	1018	0	1873	82	621	141	179	0	3691	223
	20<30%	1612	0	3738	0	621	0	58	0	6029	0
	30<40%	1	0	245	0	107	0	0	0	353	0
	≥40%	1	0	6	0	4	0	0	0	11	0
Decrease in traffic noise is based on worst-case (least benefit) i.e. 2010/11B to 2025/26WS for operation, 2010/11B to 2025/26B for baseline.											
Decrease in Traffic Noise $L_{A10,18h}$	<1	2888	973	4496	3480	1395	889	610	186	9389	5528
	1<3	1330	1370	3606	4777	1853	743	568	238	7357	7128
	3<5	0	98	239	246	388	693	119	449	746	1486

Properties	5<10	0	1	0	2	20	20	70	0	90	23
	10<15	0	0	0	0	0	0	0	0	0	0
	≥15	0	0	0	0	0	0	0	0	0	0
Decrease in traffic nuisance is based on worst-case (least benefit) i.e. 2010/11B to 2025/26WS for operation, 2010/11B to 2025/26B for baseline.											
Decrease in Nuisance Level percentage points, Properties	<10%	4218	2442	8341	8505	3628	2343	1225	831	17412	14121
	10<20%	0	0	0	0	28	2	138	42	166	44
	20<30%	0	0	0	0	0	0	4	0	4	0
	30<40%	0	0	0	0	0	0	0	0	0	0
	≥40%	0	0	0	0	0	0	0	0	0	0

.

Discussion of Results

12.5.66 Noise difference contour plots (2025/26 Baseline minus 2010/11 Baseline) are presented in Figures 12.8.1 -12.8.4.

12.5.67 Noise difference contour plots (2010/11 With-Scheme minus 2010/11 Baseline) are presented in Figures 12.9.1 - 12.9.4.

12.5.68 Noise difference contour plots (2025/26 With-Scheme minus 2010/11 Baseline) are presented in Figures 12.10.1 - 12.10.4.

12.5.69 The noise difference contour plots in Figures 12.8.1 - 12.8.4 show negligible to minor noise decreases and increases along the length of the existing A421 due to a combination of changes in traffic flow from 2010/11 Baseline to 2025/26 Baseline and the incorporation of a low-noise road surface on the existing A421 for the 2025/26 scenario.

12.5.70 The noise difference contour plots in Figures 12.9.1 - 12.9.4, and in Figures 12.10.1 - 12.10.4, show significant noise increases in those areas adjacent to the Scheme where it goes off-line, as would be expected. Areas adjacent to the existing A421 in these off-line regions experience complementary significant noise decreases.

12.5.71 Where the Scheme is on-line there are noise increases and decreases to adjacent properties depending on the combination of changes in traffic flow from 2010/11 Baseline, the incorporation of a low-noise road surface for the Scheme and the employment of noise barriers.

12.5.72 Table 12.28 provides a summary of the significance of the long term noise changes (2010/11 Baseline to 2025/26 With-Scheme) as a result of the Scheme for the main areas of population, based on the scale given in Table 12.3, above. The table should be read in conjunction with the noise difference contour plots of Figures 12.10.1 - 12.10.4.

Table 12.28 Significance of Long Term Noise Changes

Location	Noise Change (dB)	Significance
Brogborough	-4 < 0	Slight / Moderate Beneficial
Marston Moretaine (adjacent to A421)	-5 < 0	Slight / Moderate Beneficial
Marston Moretaine	0 < 2	Negligible / Slight Adverse
Lower Shelton (adjacent to A421)	-5 < -2	Slight / Moderate Beneficial
Lower Shelton	-2 < 0	Negligible / Slight Beneficial
Wootton (area along Fields Road)	0 < 3	Slight / Moderate Adverse

12.5.73 Within the Scheme corridor, the 2025/26 With-Scheme scenario is an improvement on the 2010/11 Baseline scenario (as is the 2025/26 Baseline scenario). There are decreases in the numbers of people bothered by noise and vibration. The 2025/26 With-Scheme scenario is an improvement on the 2025/26 Baseline scenario.

12.5.74 Outside of the Scheme corridor, the 2025/26 With-Scheme scenario is slightly worse than the 2010/11 Baseline scenario (as is the 2025/26 Baseline scenario). There are increases in the numbers of people bothered by noise and vibration. The 2025/26 With-Scheme scenario is an improvement on the 2025/26 Baseline scenario.

12.5.75 The assessment as reported here is considered to be a worst case – as required by DMRB. In particular the assessment assumes a low-noise road surface for the existing A421 in the future 2025/26 baseline.

12.6 Summary

12.6.1 A construction noise and vibration assessment has been carried out for 21 representative "worst-case" receptors along the length of the Scheme.

12.6.2 Construction noise levels would not generally exceed the suggested criterion level of 70dB $_{LAeq}$, 1h at the chosen receptors. Where the criterion level would be exceeded for some construction activities, the employment of temporary barriers and considerate work practices should bring noise levels to below this criterion level. Overall it is considered that the significance of construction noise is **moderate adverse**.

12.6.3 Estimated construction vibration levels are well below the suggested damage and annoyance criteria (even for night time working). Consequently it is considered that it is unlikely that vibration from construction of the Scheme would give rise to onset of cosmetic building damage or justifiable complaint from local residents. Overall, it is considered that the significance of construction vibration effect is **negligible**.

12.6.4 On opening of the Scheme, it is estimated that there would be a short term increase of 4,120 in the number of people bothered by traffic noise over the future baseline, in a total population of 121,315. This would change the percentage of people in the study area bothered by traffic noise from 8.8% to 12.2% and is considered to be a **moderate adverse** effect.

12.6.5 In the long term, it is estimated that, with the Scheme, there would be a decrease of 251 in the number of people bothered by traffic noise over the future baseline, in a total population of 121,315. This would change the percentage of people bothered by traffic noise from 9.3% to 9.1% and is considered to be a **negligible** effect.

12.6.6 In the long term, it is estimated that, with the Scheme, there would be a decrease of 246 in the number of people bothered by traffic vibration over the future baseline. This would change the percentage of people in the study area bothered by traffic vibration from 3.2% to 3.0% and is considered to be a **negligible** effect.

12.6.7 The assessment undertaken herein is considered to be a worst case as based upon DMRB guidance. In particular the assessment assumes a low-noise road surface for the existing A421 in the future 2025/26 baseline.

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13 AIR QUALITY

13.1 Introduction

13.1.1 This chapter reports on the predicted effects of the proposed Scheme on air quality. The Scheme would potentially affect air pollution levels due to changes in traffic flows, as experienced by residents of properties along the route of the Scheme, as well as residents in the vicinity of affected surrounding roads.

13.1.2 Individual or groups of residential properties and potentially sensitive properties such as schools within 200m of the route of the existing A421, the Scheme and surrounding affected roads have been identified as the most significant receptors potentially affected, and have been used to assess the local air quality impact of the proposals. In addition, any internationally designated nature conservation sites and Site of Special Scientific Interest (SSSI) located within 200m of the existing A421, the Scheme or affected side roads are also considered as potentially sensitive receptors. Beyond 200m from these roads, the contribution of vehicle emissions to local pollution levels is not generally considered significant (IAN 61/05, Highways Agency (HA) 2005).

13.1.3 Four assessments have been carried out as follows:

- At the local scale, this assessment focuses on concentrations of the pollutants: nitrogen dioxide (NO_2), fine particulate matter (PM_{10}), carbon monoxide (CO), benzene and 1,3 butadiene
- A more generalised local appraisal is also carried out, focussing on the total number of properties affected is based on NO_2 and PM_{10} concentrations
- At the regional scale, the total quantity of oxides of nitrogen (NOx), PM_{10}, CO and total hydrocarbons (THC) produced with and without the Scheme has been calculated. The total quantity of carbon dioxide (CO_2) that would be produced by the Scheme has been used as an indicator of the impact on climate change
- The impact of concentrations of NOx and the deposition of oxides of nitrogen is considered at designated nature conservation sites.

13.1.4 The four assessments defined above (local, generalised local, regional and nature conservation) have been undertaken and are described in paragraph 13.2.10 below.

13.1.5 The significance of the localised air quality impact is based on the change in the predicted pollution concentrations at each receptor, with and without the Scheme, and by comparison with the relevant air quality assessment criteria. The significance of the generalised local air quality impact is based on the change in overall exposure of residents to road traffic pollution with and without the Scheme. The significance of the impact at a regional scale and on climate change is based on the change in the predicted total quantity of pollutants emitted with and without the Scheme in operation.

13.2 Methodology

Limitations

13.2.1 The assessment of effects on local air quality sensitive receptors has been subject to the following limitations:

- The air quality assessment has considered all links addressed within the transport assessment modelling. No links that lie outside this area have been considered.
- In excess of 69,000 receptors have been identified as being located within 200m of the existing A421, the Scheme and surrounding road links that would experience a significant change in Annual Average Daily Traffic (AADT) traffic flows as a result

of the Scheme. In order to process this volume of data, a manual house count has only been carried out for the Scheme corridor. An automated house count procedure has been used for the wider study area (including the Scheme corridor) based on the use of geographical information system software.

- The automated house counting procedure assigns each receptor to the closest road link. It does not take account of the fact that receptors could be located within 200m of more than one road link. Therefore, the automated procedure used in the generalised local assessment is less robust than the manual count procedure. However, this method has only been used for the calculation of the assessment value for the whole study area, the assessment value for the Scheme corridor has been calculated using manual house counts.

13.2.2 There have been no significant limitations on the assessment of effects on regional air quality or on the assessment of construction phase effects at air quality sensitive receptors.

Construction Emissions

Impact Assessment Methodology

13.2.3 Site preparation and construction works can generate dust emissions. Dust is defined in British Standard (BS) 6069 (BS, 1994) as particulate matter in the size range 1–75 μm in diameter, and is produced through the action of abrasive forces on materials. Fine dust or Particulate Matter (PM_{10}) is defined as particles less than 10 μm in diameter, and are of the most concern regarding health effects. Large and intermediate size particles with a diameter greater than 10 μm make up the greatest proportion of dust generated by activities such as soil stripping, handling and storage of materials, and the movement of equipment on unsurfaced areas (Minerals Planning Policy Statement 2, Annex 1: Dust, Office of the Deputy Prime Minister (ODPM) 2005). Therefore construction dust does not necessarily increase existing levels of PM_{10}. Larger particles of dust are rapidly deposited from the air onto surfaces such as window ledges, cars and plants located in the vicinity of the source of dust.

13.2.4 It is very difficult to quantify likely emissions of construction dust as it depends on such a wide range of variables including ground conditions, weather conditions, method of working etc. Therefore, it is not possible to accurately predict likely rates of dust deposition. In addition, there are no statutory United Kingdom (UK) or European Community (EC) standards relating to deposition rates which impact on amenity or vegetation growth, though various guideline dust deposition rates of between 100–200 $mg/m^2/day$ to define the onset of ‘complaints possible’ have been proposed and used for mineral sites (Vallack and Shillito, 1998). Significant impacts on vegetation are unlikely to occur at deposition rates of less than $1000 mg/m^2/day$. A qualitative assessment of the likely magnitude of construction dust emissions has been carried out by associating the potential magnitude of the dust impact of various activities with a distance beyond which significant impacts are unlikely to occur.

13.2.5 Construction road traffic generates the main pollutants associated with road traffic, namely Nitrogen Dioxide (NO_2), PM_{10}, Carbon Monoxide (CO), and hydrocarbons including benzene and 1,3 butadiene. An estimate of the magnitude of the impact on air quality of the addition of construction traffic to the A421 and adjacent roads has been made by determining the likely increase in traffic flow and the percentage of heavy goods vehicles (HGV) on the A421.

Significance Assessment Methodology

13.2.6 The significance of the impact of construction dust has been assessed based on the proximity of the works to potentially sensitive receptors, the magnitude of the likely dust emissions and the likely duration (see Table 13.1, below). The criteria are qualitative estimates based on the collective experience of many practitioners, as presented in an extensive body of environmental assessment reports, and expert evidence (Scott Wilson, 2005). The criteria assume that standard best practice dust mitigation measures are in place.

Table 13.1 Qualitative Construction Dust Assessment Criteria – with standard mitigation

Source		Potential Distance for Significant Adverse Effects (Distance from source)	
Scale	**Description**	**Soiling**	**PM_{10} ***
High	Large construction sites, with high use of haul routes	100m	25-50m
Medium	Moderate sized construction sites, with moderate use of haul routes	50m	15-30m
Low	Minor construction sites, with limited use of haul routes	25m	10-20m

* Based on 35 permitted exceedences of 50 µg/m^3 in a year

13.2.7 The construction of the Scheme has been categorised as a high scale development, due to the large size of the works and the high level of use of haul routes over a period of many months. Potentially sensitive construction dust receptors will be considered within a 100m radius of the works.

Road Traffic Emissions

Impact Assessment Methodology

13.2.8 The incomplete combustion of fuel in vehicle engines results in the presence of hydrocarbons (HC) such as benzene and 1,3 butadiene, and CO and PM_{10} in the exhaust emissions. In addition, at the high temperatures and pressures found in vehicle engines, some of the nitrogen in the air and the fuel is oxidised to form Oxides of Nitrogen (NOx,) mainly in the form of nitric oxide (NO), which is then converted to NO_2 in the atmosphere. Only NO_2 is associated with adverse effects on human health. CO_2 is produced by vehicle engines, as in any combustion process. Whilst CO_2 is not considered a pollutant at a local scale, it is significant on a larger scale due to its importance as a greenhouse gas, which contributes to the phenomenon of global warming. Better emission control technology and fuel specifications are expected to reduce emissions per vehicle over time.

13.2.9 The concentration of pollutants at a sensitive receptor, and the total quantity of pollutants produced by traffic on a road, is influenced by a number of factors including traffic flow, traffic composition and speed. A relatively large change in traffic flow, 10% or more, is often considered necessary to have a significant impact on pollutant concentrations (WebTAG, 2004). Therefore, the Study Area of the local air quality impact assessment includes the existing A421, the Scheme and surrounding roads which are predicted to experience a change in traffic flow of 10% or more due to the operation of the Scheme. Surrounding roads with an AADT flow of less than 1000 vehicles in all assessment years are not included in the local air quality Study Area as the impact on local air quality from such low traffic flows is negligible.

13.2.10 The detailed assessment of the air quality impacts of the Scheme has been carried out following the approach set out in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 1, and the subsequent Interim Advice Notes 54/04 and

61/05. The DMRB methodology requires that the magnitude of the air quality impacts are predicted in four ways as follows:

- Local impact assessment: predicts actual concentrations of NO_2, PM_{10}, CO, benzene and 1,3 butadiene at individual sensitive receptors in the existing year (2005) and the year of opening (2010/11) with and without the Scheme
- Generalised local impact assessment: estimate the overall change in exposure to NO_2 and PM_{10} at properties due to the Scheme. The estimates are done for the year of opening (2010/11)
- Regional impact assessment: predict the total quantity of NOx, PM_{10}, CO, CO_2 and THC (Total Hydrocarbons) produced in the existing year (2005), year of opening (2010/11) with and without the Scheme and the project design year (2025/26 - 15 years after opening) with and without the Scheme
- Nature Conservation Sites assessment: predict concentrations of NOx and rates of nitrogen deposition at designated nature conservation sites for the existing year (2005) and year of opening (2010/11) with and without the Scheme.

13.2.11 The DMRB procedures outlined above are a screening technique which was developed to indicate whether more complex and sophisticated modelling of air quality is required. A number of features of the DMRB procedures are designed to overestimate road traffic impacts on air quality. Therefore, it can be assumed with some confidence that a road Scheme will not result in air quality problems if none are predicted using the DMRB methodology.

Local Impact Assessment

13.2.12 The local air quality impact assessment has been carried out for the years 2005 and 2010/11, using traffic data for 2005 and 2011 respectively. Pollution concentrations have been predicted at thirteen individual receptors using the latest version of the DMRB prediction spreadsheet (v1.02). The choice of sensitive receptors considered locations close to the existing A421, the Scheme and surrounding affected roads, where members of the public might reasonably be expected to be exposed to air quality impacts over the averaging time of the relevant air quality objectives. Therefore the selected receptors illustrated in Figure 13.1 are representative of residential properties in their vicinity.

Generalised Local Impact Assessment

13.2.13 The generalised local air quality impact assessment has been carried out for the year of Scheme opening (2010/11), using traffic data for 2011, both with and without the Scheme. The number of properties in four distance bands 0-50m, 50-100m, 100-150m and 150-200m from the centre of each affected road were counted. The corresponding average NO_2 and PM_{10} concentration in each band was determined by predicting the concentration at a distance of 20m, 70m, 115m, and 175m from the road using the DMRB methodology. Total 'exposure' to each pollutant was determined by multiplying the average concentration in each band by the number of properties and summing the total across the four distance bands and across all road links. The road links included in the assessment are illustrated in Figure 13.2.

13.2.14 The total exposure to each pollutant without the Scheme is subtracted from the total exposure with the Scheme. A positive number indicates an increase in exposure due to the Scheme and a negative number a decrease in exposure.

Regional Impact Assessment

13.2.15 The regional air quality impact assessment has been carried out for the years 2005, 2010/11 and 2025/26. Traffic flow data has been used for 2005, 2011, 2026 and emissions factors have been used for 2005, 2011 and 2025. CO_2 is included to enable the contribution of the Scheme to climate change to be assessed. The magnitude of the impact, in terms of the total quantity of pollution generated by the affected roads in the Traffic Model Study Area, has been predicted using the DMRB methodology.

Nature Sites Assessment

13.2.16 An assessment of the impact of a road Scheme on nature conservation sites is required if an internationally designated site or a SSSI is located within 200m of the Scheme or other significantly effected road which undergoes a change in traffic flow of 10% or more due to the Scheme (IAN 61/05, HA 2005). The ecology assessment has identified one SSSI within the traffic model study area. This is the Marston Thrift SSSI, which is approximately 750m from the new alignment of the A421, and the closest other affected link is within Cranfield and is approximately 960m from the SSSI. There are no other such sites within 200m of any of the other significantly affected roads. Therefore, as there are no SSSIs within 200m of the Scheme or any other significantly affected roads, the nature conservation site air quality assessment method has not been continued beyond this initial site identification step.

Significance Assessment Methodology

Local Impact Assessment

13.2.17 The significance of the predicted change in traffic pollution levels at the thirteen selected sensitive receptors due to the operation of the Scheme, has been assessed by consideration of the magnitude of the change, improvement or worsening, between baseline and operational scenarios, and comparing the predicted levels with the current local air quality objectives and limit values.

13.2.18 Air quality objectives and target dates for the five main road traffic pollutants are prescribed in the Air Quality (England) Regulations 2000 (DETR, 2000), and the Air Quality (England) (Amendment) Regulations 2002 (DEFRA 2002) (see Table 13.2, below). The responsibility for reviewing and assessing whether the objectives will be achieved lies with Local Authorities.

13.2.19 The Limit Values are prescribed under the Air Quality Limit Values (England) Regulations (DETR, 2000), the most recent version of which was implemented in 2003 (see Table 13.2, below). The Limit Values Regulations transfer EU Directives on ambient air quality into UK law. Unlike the air quality objectives the Limit Values are legally binding on central government.

13.2.20 The value of the objectives and limit values are generally the same and it is often only the compliance date that differs. A suggested replacement for the annual mean PM_{10} objective of 20μg/m^3, and a reduction in the allowed number of exceedances of the 24 hour mean PM_{10} objective to 7 per year, in England outside London, to be achieved by 2010, was announced by the government in August 2002. However, these changes are currently provisional and were not prescribed in the Amendment Regulations.

13.2.21 The CO objective and limit value is specified as a maximum daily running 8 hour mean, this is not directly comparable with annual mean CO concentrations, as predicted by the DMRB. However, if the annual mean is less than 2mg/m^3 it is unlikely the 8 hour mean objective would be exceeded (Highways Agency, 2003).

Table 13.2 Current Air Quality Objectives and Limit Values (England)

Pollutant	Limit Value / Objective	Air Quality Statistic	Objective Target Date	Limit Value Target Date
Nitrogen Dioxide (NO_2)	40 μg/m^3	Annual mean	31/12/05	01/01/10
	200 μg /m^3 not to be exceeded more than 18 times per year	1hr mean	31/12/05	01/01/10
Fine Particles (PM_{10})	40 μg /m^3	Annual mean	31/12/04	01/01/05
	50 μg /m^3 not to be exceeded more than 35 times per year	24hr mean	31/12/04	01/01/05
Carbon Monoxide (CO)	10 mg/m^3	Max daily running 8hr mean	31/12/03	1/1/2005
Benzene	16.25 μg/m^3	Running annual mean	31/12/03	-
	5 μg/m^3	Running annual mean	31/12/10	1/1/10
1,3-Butadiene	2.25 μg/m^3	Running annual mean	31/12/03	-

13.2.22 The significance of the magnitude of the predicted change in pollution concentrations due to the Scheme is assessed based on the change in annual mean NO_2 concentrations. Table 13.3, below, illustrates the scale of significance used where NO_2 concentrations are below the air quality objective and limit value.

Table 13.3 Significance of Changes in Pollution Concentrations

Magnitude of change in annual mean NO_2 concentration due to the Scheme (µg/m^3)	Significance
5 or more	Substantial
2 to less than 5	Moderate
1 to less than 2	Minor
Less than 1	Negligible

Generalised Local Impact Assessment

13.2.23 The significance of the generalised local impact assessment is based on the change in the calculated total ‘exposure’. A positive value indicates an increase in pollution exposure, while a negative value indicates a decrease. The larger the value (positive or negative), the greater the change in pollution levels and the greater the number of properties affected.

13.2.24 In addition, DMRB suggests that the following increases in pollution concentrations at a distance of 20m from the road centre should be considered as significant:

- An increase in annual mean PM_{10} levels of at least 1 µg/m^3
- An increase in annual mean NO_2 levels of at least 2 µg/m^3.

Regional Impact Assessment

13.2.25 The significance of the impact of the Scheme at the regional scale has been determined by comparing the total tonnes/year of NOx, PM_{10}, CO and THC produced by the baseline and operation scenarios in 2010/11 and 2025/26.

13.2.26 The significance of the impact of the Scheme on climate change has been determined in the same way as for the regional impact assessment, using the total tonnes/yr of CO_2 produced following the introduction of the Scheme in 2010/11 and 2025/26.

13.3 Baseline Conditions

Existing Ambient Air Quality Data

Existing Ambient Air Quality

13.3.1 A desk study of the following existing sources of information and monitoring data, relating to the pollutants NO_2, PM_{10}, CO, benzene and 1,3 butadiene, has been carried out:

- Local authority air quality assessment reports (BBC 2003, BBC 2005, BBC 2005a, MBDC, 2004))
- Pollution monitoring results from existing relevant monitoring sites
- Estimated UK background pollution levels.

13.3.2 Ambient concentrations of NO_2, PM_{10}, CO, benzene and 1,3 butadiene in the local air quality Study Area are discussed with reference to the relevant air quality objectives and limit values (refer to Table 13.2, above).

13.3.3 The total pollution level at a receptor or a distance from the road centre includes a contribution from background pollution levels. The assessment of existing ambient air quality identifies relevant background pollution levels to be used in the local, generalised local and nature conservation sites DMRB predictions.

Local Authority Review & Assessments of Air Quality

13.3.4 The study area is located within the areas covered by Mid Bedfordshire District Council (MBDC), Bedford Borough Council (BBC), Aylesbury Vale District Council, Milton Keynes Council, North Hertfordshire District Council and South Bedfordshire District Council. Under the Environment Act 1995 all local authorities in the UK are required to undertake periodic ‘Review and Assessments’ of air quality within their area to determine if the air quality objectives are at risk of being breached. If any breaches are predicted the affected areas must be declared an Air Quality Management Area (AQMA) and an Action Plan drawn up to determine how pollution levels can be reduced.

13.3.5 MBDC completed the first Review and Assessment of air quality in the district in 2001. It was concluded that it was unlikely that any breaches of the air quality objectives would occur anywhere in the study area from traffic related sources. However consideration was given to declaring an AQMA for sulphur dioxide based on emissions from an industrial source. The AQMA was declared in March 2005 for SO_2 emissions from the Stewartby Brickworks and includes the villages of Marston Moretaine and Houghton Conquest.

13.3.6 In 2003 MBDC’s Updating and Screening Assessment (MBDC, 2004) concluded that further detailed assessment of NO_2 and PM_{10} was only required around the A1/A603/B1042 junction. It can therefore be concluded that MBDC do not currently consider any breaches of the relevant air quality objectives are likely at receptors in the vicinity of the A421.

13.3.7 BBC have reviewed the air quality at the eastern end of the Scheme corridor. In 2003, BBC's updating and screening assessment (BBC 2003) confirmed that there is not a significant risk of the objectives for carbon monoxide, benzene, 1,3 butadiene or lead being breached within the borough. The potential for exceedances of the objectives for NO_2 and PM_{10} was identified and subsequently (2005) a revised detailed assessment resulted in AQMA's being declared for the A421 at Great Barford (North East of Bedford) and for two narrow, busy roads within Bedford. Within the rest of the borough NO_2 is reported as, not being likely to exceed the objective, where there is relevant exposure.

13.3.8 In their 2005 Air Quality Progress Report, BBC confirmed that the recently constructed Great Barford Bypass would greatly reduce the impact of road traffic emissions at receptors that were identified as being at risk of exceeding the annual mean objective for NO_2 before the opening year of this (A421) Scheme.

13.3.9 Potentially significant changes in traffic flows have been identified on surrounding roads located away from the Scheme corridor in Aylesbury Vale District Council., Milton Keynes Council, North Hertfordshire District Council and South Bedfordshire District Council. As the respective local authorities have not identified any of these roads as being air quality sensitive areas, it can be concluded that relevant air quality objectives are currently likely to be met at receptors in the vicinity of these roads.

Monitoring Data

13.3.10 Various pollutants are monitored automatically across the UK as part of the Automatic Urban and Rural Network (AURN), operated by the Department for Environment Food & Rural Affairs (DEFRA). There are no AURN sites close to the Scheme, but there are a number of automatic monitoring stations in the area operated as part of the Hertfordshire and Bedfordshire Air Pollution Monitoring Network (Environmental Research Group, 2006). None of these sites provides data that is specifically relevant for use in this study as they have been sited to monitor rural ozone levels, industrial SO_2 impacts or local air quality at a single junction on the A1 in Sandy.

13.3.11 MBDC carries out NO_2 monitoring using simpler and less accurate diffusion tubes at a number of sites across the district. Data for these sites is published on the Hertfordshire and Bedfordshire Air Pollution Monitoring Network website (Environmental Research Group, 2006). However as MBDC have not identified the Scheme corridor as being at risk of exceeding air quality objective values for traffic derived pollutants, the network only provides a minimal level of coverage within the study area.

Archive Background Data

13.3.12 The UK National Air Quality Information Archive (DEFRA, 2006) provides annual mean background NO_2, NOx, PM_{10}, CO, benzene and 1,3 butadiene concentrations for 2001 and a variety of future years. Background concentrations for the current baseline year of 2005 and the year of opening 2011 have been calculated where required, using the year adjustment factors provided by the UK National Air Quality Information Archive. The average background concentrations for the 1189 1km x 1km grid squares in which the existing A421, the Scheme and surrounding affected roads are located are provided in Table 13.4, below.

Table 13.4 Average Annual Mean Background Pollution Concentrations in the Local Air Quality Study Area

Year	2005	2011
NOx (µg/m^3)	18.0	14.0
NO_2 (µg/m^3)	13.8	11.1
PM_{10} (µg/m^3)	20.4	18.5
CO (mg/m^3)	0.2	0.2
Benzene (µg/m^3)	0.3	0.3
1,3-butadiene (µg/m^3)	0.1	0.1

13.3.13 Technical Guidance Local Air Quality Management (LAQM) TG(03) (DEFRA 2003) recommends an approach for determining the background concentration for receptors close to major roads in rural areas. This method involves averaging the background concentrations from the grid squares up to 4km either side of the road and is designed to avoid double counting of road traffic emissions. For the local air quality study area, background concentrations in the UK National Air Quality Information Archive (DEFRA, 2006) have been used to calculate background contributions to pollutant levels at each selected receptor. For the generalised local air quality impact assessment, the average of all 1189 grid squares in the local air quality study area has been used.

Local Air Quality Impact

13.3.14 The predicted baseline pollutant concentrations in 2005 and 2011 at the 13 selected receptors in the vicinity of the A421 Scheme and surrounding affected roads are presented in Table 13.5, below. The locations of the selected receptors are shown on Figure 13.1. The background pollution levels assumed at each receptor are provided in Appendix 13.1 and the road traffic links considered at each receptor are provided in Appendix 13.2.

Table 13.5 Baseline Air Quality Levels (No Scheme)

Location	Year	NO_2 (µg/m^3)	PM_{10} (µg/m^3)		CO (mg/m^3)	Benzene (µg/m^3)	1,3 butadiene (µg/m^3)
		Annual Mean	Annual Mean	No. days/ yr 24hr mean >50	Annual Mean	Annual Mean	Annual Mean
R1:	2005	24.1	25.2	12.9	0.3	0.4	0.3
	2011	17.6	21.2	5.0	0.3	0.3	0.2
R2:	2005	21.1	23.8	9.7	0.3	0.3	0.2
	2011	15.7	20.6	4.1	0.3	0.3	0.2
R3:	2005	24.9	25.3	13.1	0.3	0.4	0.2
	2011	18.0	21.3	5.2	0.3	0.4	0.2
R4:	2005	22.4	24.1	10.5	0.3	0.4	0.2
	2011	16.5	20.8	4.4	0.3	0.3	0.2
R5:	2005	23.0	24.5	11.3	0.3	0.4	0.2

Location	Year	NO_2 (µg/m^3)	PM_{10} (µg/m^3)		CO (mg/m^3)	Benzene (µg/m^3)	1,3 butadiene (µg/m^3)
		Annual Mean	**Annual Mean**	**No. days/ yr 24hr mean >50**	**Annual Mean**	**Annual Mean**	**Annual Mean**
	2011	17.2	21.1	4.9	0.3	0.3	0.2
R6:	2005	25.3	25.8	14.3	0.3	0.4	0.2
	2011	16.0	20.9	4.5	0.3	0.3	0.2
R7:	2005	25.5	25.4	13.3	0.3	0.4	0.3
	2011	16.7	20.8	4.5	0.3	0.3	0.1
R8:	2005	20.5	23.3	8.7	0.3	0.3	0.2
	2011	18.0	21.3	5.1	0.3	0.3	0.2
R9:	2005	17.5	22.1	6.5	0.3	0.3	0.1
	2011	15.2	20.3	3.8	0.3	0.3	0.1
R10:	2005	-	-	-	-	-	-
	2011	13.4	19.5	2.8	0.3	0.3	0.1
R11:	2005	14.7	20.9	4.6	0.2	0.3	0.1
	2011	11.8	19.0	2.3	0.2	0.3	0.1
R12:	2005	21.0	23.2	8.5	0.3	0.3	0.2
	2011	15.5	20.1	3.5	0.3	0.4	0.2
R13:	2005	13.8	20.4	3.9	0.2	0.3	0.1
	2011	11.1	18.5	1.8	.0.2	0.3	0.1
Objective (provisional)		40	40 (20)	35 (7)	<2*	5	2.25

* Annual mean CO concentration equivalent to meeting the running 8 hour mean objective

13.3.15 The baseline pollution concentrations at all the selected receptors in both assessment years are calculated to be below the current air quality objectives. The predicted pollution concentrations decline from 2005 to 2010/11 as emissions per vehicle are reduced and the background levels fall.

13.3.16 The provisional annual mean PM_{10} objective of 20 µg/m^3 is unlikely to be achieved in 2005 at any of the thirteen selected receptors. The trend of improving background levels of PM_{10} is predicted to result in lower annual mean concentrations of PM_{10} in 2010/11, than for the baseline year of 2005. However the provisional objectives for PM_{10} will remain at risk of being exceeded in 2010/11, due to the magnitude of the background contribution from sources located in southeast England and continental Europe.

Generalised Local Air Quality Impact

13.3.17 The calculated total baseline 'exposure' to NO_2 and PM_{10} pollution is provided in Table 13.6, below. The assessment score provides a measure of the communities overall level of exposure to a pollutant, as experienced within 200m of the existing A421 and surrounding affected roads,

Table 13.6 Baseline Total 'Exposure' to NO_2 and PM_{10} (No Scheme)

	Total Exposure Assessment Score (See paragraph 13.2.13)	
	NO_2	PM_{10}
Scheme Corridor Only	22,354	36,824
Whole Study Area	773,229	1,282,912

13.3.18 In the baseline scenario a total of approximately 69,068 properties are located within 200m of the existing A421 or the Scheme or surrounding affected side roads.

Regional Impact Assessment

13.3.19 The total quantities of NOx, PM_{10}, CO_2, CO and THC produced by baseline traffic on the existing A421 and surrounding affected side roads in 2005, 2011 and 2026 are presented in Table 13.7, below.

Table 13.7 Baseline Total Traffic Emissions (No Scheme)

	Total Quantity of Pollutants tonnes/yr				
Year	**NOx**	PM_{10}	CO_2	**CO**	**THC**
2005	6,010	184	918,994	4,552	700
2011	4116	112	997,941	3,565	556
2026*	3,061	89	1,117,418	4,260	614

* based on emission factors for 2025

13.3.20 The net variation in the quantity of baseline pollution emissions from 2005 to 2011 and 2026 is determined by the combination of the increase in vehicle kilometres travelled, which increases emissions over time, and the introduction of controls on the magnitude of emissions per vehicle, which reduces emissions over time.

13.3.21 As a result of the removal of older vehicle models from the national fleet a trend of reduced emissions is predicted for emissions of NOx and PM_{10}. Over the same time period increasing numbers of vehicle kilometres travelled will result in increasing emissions of CO_2. For the pollutants CO and THC, the benefits achieved by the removal of older vehicle models from the national fleet by 2011 are offset in the longer term by the increased number of vehicle kilometres travelled and changes in the mix of petrol and diesel vehicles in operation.

13.4 Mitigation and Detailed Development of Scheme Design

Mitigation Measures included in Scheme Design

13.4.1 The only practical mitigation measures that can be incorporated into the design are to ensure that the minimum number of properties are located within 200m of the Scheme, that traffic flows are smooth without large changes in speed, and any increase in traffic flows on surrounding roads are minimised.

13.4.2 The proximity of the Scheme to sensitive receptors including residential properties was a primary factor affecting the design of the horizontal and vertical alignment of the Scheme. The greater the distance between the road and a receptor, the lower the pollution levels. In addition, design measures were included which allow traffic to flow freely, minimising pollutant emissions e.g. gentle gradients, minimum potential number of junctions, and grade separated junctions.

13.4.3 The Scheme design also aims to achieve a materials balance which minimises the requirement for material import and export. A knock-on benefit is the minimisation of construction traffic required for material haulage.

Mitigation Measures to be Adopted During Scheme Construction

13.4.4 Mitigation has been incorporated into the design of the Scheme through the choice of the main construction compound location and the topsoil storage locations. The main compound would be situated between chainages 7900 and 8900. There are only a small number of residential properties located within 100m of the construction site boundary and the adoption of best practice mitigation measures would be essential to minimise the frequency and magnitude of adverse dust impacts at these receptors.

13.4.5 Standard best practice mitigation measures to be adopted during Scheme construction, as defined in the outline Construction Environmental Management Plan (CEMP) (and as recommended in the latest CIRIA C502 (CIRIA 1999) and BRE (BRE 2003) guidance), would be employed during the construction process, including:

- Minimising the handling of materials such as soil
- Minimising drop heights
- Immediate clearance of spillages of dusty material
- Use of water bowsers during dry and/or windy conditions to damp down material stockpiles and unsurfaced areas e.g. haul roads
- Avoid overfilling of lorries
- No burning of materials on site
- Locate construction compounds and material stockpiles away from sensitive receptors where possible
- Restricting vehicle speeds on unsurfaced haul routes and all unsurfaced areas to 20mph
- Regular use of road sweepers, mechanical brushes or similar as appropriate on local off-site roads, to remove any material tracked out of the site
- Regular maintenance of site access / egress points to ensure cleanliness and safe standards
- Careful location of haul routes to keep vehicles as far as possible from sensitive locations.

13.4.6 The use of such best practice measures should minimise the potential for dust to be generated by the majority of construction activities.

13.4.7 The site manager would have responsibility on a day to day basis for determining if either the nature of the activities on site or the weather conditions are likely to result in the transfer of dust off site. If so, remedial action would be taken to minimise emissions, including the temporary suspension of works.

13.4.8 Best site management measures including keeping local residents informed and providing a point of contact for any concerns would also encourage a positive relationship with the local community and minimise the likelihood of complaints. The Public Liaison Officer would co-ordinate communication with the public via newsletters, exhibitions, letter drops, project helpline, website etc. Any complaints regarding dust emissions from the works would be recorded and investigated.

13.5 Environmental Effects

Effects of Construction

13.5.1 Large and intermediate size particles with a diameter greater than 10 µm make up the greatest proportion of dust generated by activities such as soil stripping, handling and storage of materials, and the movement of equipment on unsurfaced areas (ODPM, 2005). Therefore, construction dust does not necessarily increase existing levels of PM_{10} considerably. Particles between 10 µm and 75 µm in diameter are not normally associated with adverse effects on human health. The main potential effects are:

- The visible soiling of surfaces such as window ledges, car bodywork, agricultural crops
- Increased levels of airborne dust at sensitive industrial facilities.

13.5.2 Impacts on amenity at residential properties along the Scheme and dust impacts on agricultural land are considered to be the main potentially significant construction dust impacts.

13.5.3 During construction works, the most significant potential source of fugitive dust emissions would be activities involving the excavation and movement of potentially dusty materials such as soil and hardcore.

13.5.4 The removal of topsoil and the construction of the embankments and cuttings requires the excavation and movement of considerable quantities of soil. Therefore, these activities have been ranked as having a severe potential to generate dust in the absence of mitigation. Smaller scale earthworks to construct balancing ponds have been ranked as moderate.

13.5.5 Topsoil for reuse would be stored in stockpiles adjacent to the main construction areas in windrows. The height of the stockpiles would be limited to three metres.

13.5.6 Material to construct the sub-base of the new road may also need to be stored on site. It would be imported to the site, and efforts would be made to deliver it on a just in time basis so that the need for stockpiles would be minimised.

13.5.7 The potential for stockpiles of materials to generate dust largely depends on the nature of the material. Earth is soft and friable compared to hardcore. However, hardcore generally has a lower moisture content than soil, and consequently they can both be a potentially significant source of dust.

13.5.8 A haul route would run from the east of M1 J13 to the west of the Marsh Leys Junction. The regular movement of vehicles and equipment on unsurfaced areas can generate dust both from the surface and from debris picked up by the vehicles on the wheels and underside of the vehicle while on site. In wet weather this can be transferred off site as mud.

13.5.9 To cause annoyance outside the construction site, dust must become airborne and reach a potentially sensitive receptor. The potential for dust to be lifted from the surface depends in part on the wind speed and the size of the dust particles. This potential is considerably reduced when the surface is moist, either from artificial dust suppression or from rainfall. Once airborne, the location of the impact of the dust depends on the direction of the wind.

13.5.10 The main construction compound would have an available area of 90,000m^2 and contain contract offices, welfare facilities, car parking, workshops, temporary storage of materials, batching plant, recycling centre, and accommodation area for the workforce. There are a small number of properties located within 100m of the compound boundary. Therefore it is possible that significant dust impacts would occur at these receptors. These impacts are likely to be short-term and infrequent in nature and to take the form of increased soiling rates.

13.5.11 A compound for the M1 works would be located between the proposed A421, Salford Road and Llanberis. The available area of the site is approximately 15,000m^2 and it would contain offices, car parking, welfare facilities, workshops, temporary storage of materials, and a plant yard. The Llanberis property is located to the west of the compound. Therefore care should be taken to locate storage of potentially dusty materials away from this edge of the site.

13.5.12 Other satellite office sites would be reviewed closer to commencement on site. These would be located considerately.

13.5.13 The main haul route would run from M1 J13 to just west of the Marsh Leys Junction. Graders and tractor towed water bowsers would be used to maintain the haul route and for dust suppression. Where the haul route intersects with existing highways mechanical sweepers would be used.

13.5.14 There are new bridges and underpasses being built along the route. These are:

- M1 J13 Brogborough Interchange North and South. There are no properties within 100m of the works so no potential for dust impacts
- Salford Road Underbridge. There are a small number of residential properties within 100m of the works so there may be potential for dust impacts
- Manor Farm Bridleway 1 Overbridge. There are no properties within 100m of the works so no potential for dust impacts
- North Common Farm Underpass. There are no properties within 100m of the works so no potential for dust impacts
- Vale Farm Bridleway 31 Overbridge. There are no properties within 100m of the works so no potential for dust impacts
- Wood End Overbridge. There are no properties within 100m of to the works so no potential for dust impacts
- Marston Overbridge. There is a Motel located approximately 40m from the construction works so there may be potential for dust impacts
- Lower Shelton Subway. There are residential properties within 100m of the works so there may be potential for dust impacts
- Berry Farm Underpass. There are no properties within 100m of the works so no potential for dust impacts
- Fields Road North and South Overbridges. There is a residential property located at a distance of slightly more than 100m from the boundary of the works, so there may be potential for dust impacts to occur in very adverse weather conditions
- Manor Road Bridleway 23 Overbridge. There is a residential property within 100m of the works so there may be potential for dust impacts
- Marsh Leys Junction West and East Underbridges. There are residential properties within 100m of the works so there may be potential for dust impacts
- Marsh Leys Railway Bridge South. There are no properties within 100m of the works so no potential for dust impacts
- Marsh Leys Railway Bridge North. There are no properties within 100m of the works so no potential for dust impacts.

13.5.15 Construction of the Scheme would give rise to potential dust impacts at properties within 100m of the Scheme, of which there are some 150.

13.5.16 During the construction process the prediction for the number of vehicles required is shown in Table 13.8, below. The construction process is expected to increase the baseline AADT flow of approximately 30,000 vehicles per day, on the existing A421, by approximately 336 vehicles per day. The impact of an increased traffic flow of less than 3%, due to construction vehicle movements, on pollution concentrations at receptors close to the existing A421 is considered to be **negligible**.

Table 13.8 Construction Phase HGV Traffic on Public Roads

Material Type	Deliveries per Day	Duration (weekdays)
Road haulage of embankment fill	200	250
Deliveries to satellite office establishments	5	350
Deliveries to main office establishment	20	550
Piling works (excluding concrete supply)	5	100
Concrete (average)	20	450
Drainage materials (aggregate, pipe-work, geotextile, etc.) (average)	10	410
Road construction (granular sub-base, cement, bituminous pavement materials) (average)	70	450
Construction materials (pre-cast concrete, beams, lights, fencing, barriers, manholes, pipes, kerbs etc)	5	500
Traffic Management (averaged over contract)	1	550

Effects of Operation

Local Air Quality Impact Assessment

13.5.17 The predicted operational pollutant concentrations in the year of opening 2010/11 at the 13 selected receptors in the vicinity of the A421 and surrounding affected roads are presented in Table 13.9. The locations of the selected receptors are shown on Figure 13.1. The background pollution levels assumed at each receptor are provided in Appendix 13.1 and the road traffic links considered at each receptor are provided in Appendix 13.2.

Table 13.9 Operational Air Quality Levels (With Scheme)

Location	Year	NO_2 (µg/m^3)	PM_{10} (µg/m^3)		CO (mg/m^3)	Benzene (µg/m^3)	1,3 butadiene (µg/m^3)
		Annual Mean	Annual Mean	No. days/ yr 24hr mean >50	Annual Mean	Annual Mean	Annual Mean
R1:	2011	14.3	20.0	3.4	0.2	0.3	0.1
R2:	2011	14.7	20.4	3.9	0.3	0.3	0.2

Location	Year	NO_2 (µg/m^3)	PM_{10} (µg/m^3)		CO (mg/m^3)	Benzene (µg/m^3)	1,3 butadiene (µg/m^3)
		Annual Mean	Annual Mean	No. days/ yr 24hr mean >50	Annual Mean	Annual Mean	Annual Mean
R3:	2011	13.9	20.0	3.4	0.3	0.3	0.1
R4:	2011	14.1	20.0	3.4	0.3	0.3	0.1
R5:	2011	17.2	21.1	4.9	0.3	0.3	0.2
R6:	2011	16.9	21.2	5.	0.3	0.4	0.2
R7:	2011	18.8	21.5	5.5	0.3	0.3	0.2
R8:	2011	18.0	21.2	5.0	0.3	0.3	0.2
R9:	2011	15.6	20.5	4.0	0.3	0.3	0.1
R10:	2011	14.1	19.6	3.0	0.3	0.3	0.1
R11:	2011	11.8	19.0	2.3	0.2	0.3	0.1
R12:	2011	15.8	20.2	3.7	0.3	0.3	0.2
R13:	2011	14.4	21.3	5.1	0.2	0.3	0.1
Objective (provisional)		40	40 (20)	35 (7)	<2*	5	2.25

* Annual mean CO concentration equivalent to meeting the running 8 hour mean objective

13.5.18 The operational pollution concentrations at all the selected receptors are below the current air quality objectives for CO, Benzene, 1,3 butadiene, NO_2, and PM_{10}. The provisional 24-hour objective for PM_{10} is also predicted to be met at all receptors. However, as in the baseline scenario, the provisional annual mean PM_{10} objective of 20µg/m^3 to be achieved by 2011, is at risk of being widely exceeded. .

Generalised Local Air Quality Impact Assessment

13.5.19 The calculated total operational ‘exposure’ to NO_2 and PM_{10} pollution is provided in Table 13.10, based on a count of all residential properties located within 200m of the existing A421, the Scheme and surrounding affected roads, see Figure 13.2.

Table 13.10 Operational total ‘exposure’ to NO_2 and PM_{10} (With Scheme)

	Total Exposure Assessment Score (See paragraph 13.2.13)	
	NO_2	PM_{10}
Scheme Corridor Only	22,246	36,782
Whole Study Area	772,435	1,282,576

13.5.20 In the operational scenario a total of approximately 69,068 properties are located within 200m of the existing A421, and/or the Scheme and/or surrounding affected side roads. 1957 properties are located within 200m of the Scheme corridor.

Regional Impact Assessment

13.5.21 The total quantities of NOx, PM_{10}, CO_2, CO and THC produced by operational traffic in the Traffic Model Study Area in 2011 and 2026 are presented in Table 13.11.

Table 13.11 Operational Total Traffic Emissions (With Scheme)

	Total Quantity of Pollutants tonnes/yr				
Year	**NOx**	**PM_{10}**	**CO_2**	**CO**	**THC**
2011	4,138	115	1,106,634	3,618	554
2026*	3,202	93	1,161,881	4,364	631

* based on emission factors for 2025

13.5.22 The variation in the quantity of operational pollution emissions from 2011 to 2026 is determined by the combination of the increase in vehicle kilometres travelled, which increases emissions over time, and the decline in emissions per vehicle, which reduces emissions over time.

Significance of Effects

Effects of Construction

13.5.23 Construction dust can only have a significant impact on sensitive receptors if a receptor is located in fairly close proximity to the activity. The potential for dust to be transferred off site, to affect PM_{10} levels or cause a nuisance, is likely to be limited to around 100m, from a construction process such as this, which involves considerable earthworks. A total of approximately 150 residential properties have been identified within 100 m of the boundary of the works.

13.5.24 Topsoil for re-use and other stockpiles, including excess arisings for removal off site, would be located adjacent to the main compound. They would be limited in height, normally to around three metres and stored, where possible, in a windrow. It is proposed that excess topsoil would be spread on adjacent fields.

13.5.25 Due to the nature of construction works, construction dust impacts are temporary.. The construction process is estimated to be completed in around 110 weeks between late 2008 and 2010. A summary of the approximate duration of the main construction activities is provided in Table 13.12.

Table 13.12 Summary of Construction Activity Durations

Location	Chainage	Activity (Weeks)						
		Structure	Culverts	Cut	Fill	Topsoil Strip	Drainage	Finishes
M1 Junction 13 Brogborough Interchange North	100	54						
Salford Road Underbridge	350	21			2.5	1	3	
Manor Farm Bridle Way 1 Overbridge	1750	31		5			1	

Location	Chainage	Activity (Weeks)						
		Structure	Culverts	Cut	Fill	Topsoil Strip	Drainage	Finishes
North Common Farm Underpass	2400	33			4	1	1	
Vale Farm Bridleway 31 Overbridge	3630	32			14		2	
Wood End Overbridge	4750	31				1		
Marston Overbridge	6025	38		6			1	
Lower Shelton Subway	6750/6960	23			1	1	1	
Berry Farm Underpass	8540/8520	25					1	
Fields Road Overbridges	9990	34			2	1		
Manor Road Bridleway 23 Overbridge	10640	29			1			
Marsh Leys Junction West	11400	38					1	
Marsh Leys Junction East	11480	38				1		
Marsh Leys Railway Bridge South	12280	27			4	1	1	
Marsh Leys Railway Bridge North	12300	26			2	1	1	
A421	0-150		4		55		44	12
A421	400-600				3		3	
A421	400-2500				11	4	8	13
A421	2100-3600				5		10	9
A421	2500-3100				4	3	7	8
A421	3100-6000				30	6	12	8
A421	6000-11400				11	6	22	11

Location	Chainage	Activity (Weeks)						
		Structure	Culverts	Cut	Fill	Topsoil Strip	Drainage	Finishes
A421	11500-13100						14	12
A421	11500-13500				14	6		

13.5.26 The construction of structures such as bridges are the most time consuming activities. Activities with the greatest potential to generate dust such as topsoil stripping and earthworks(cut and fill) are generally of more limited duration.

13.5.27 Based on the number of receptors close to the works and the likely duration of works such as topsoil stripping in close proximity to the identified receptors, the significance of the construction dust impact is ranked as moderate adverse.

13.5.28 The incorporation of effective site management procedures and the mitigation measures to control dust as outlined in paragraphs 13.4.4 - 13.4.8 would ensure that the impact of the construction works on nearby sensitive receptors would be minimised.

Effects of Operation

Local Air Quality Impact Assessment

13.5.29 The significance of the predicted operational pollution concentrations at the thirteen selected sensitive receptors has been assessed by comparison with the current air quality objectives and limit values, and consideration of the magnitude of the change in concentration compared to the baseline for the same year.

13.5.30 No exceedances of the current air quality objectives or limit values for NO_2, PM_{10}, CO, benzene and 1,3 butadiene are predicted at any of the selected receptors due to the operation of the Scheme.

13.5.31 The predicted change in pollutant concentrations due to the Scheme in the year of opening 2010/11 at the thirteen selected receptors in the vicinity of the Scheme and surrounding affected roads are presented in Table 13.13.

Table 13.13 Change in Air Quality Levels (With Scheme-No Scheme)

Location	Year	NO_2 (µg/m^3)	PM_{10} (µg/m^3)		CO (mg/m^3)	Benzene (µg/m^3)	1,3 butadiene (µg/m^3)
		Annual Mean	Annual Mean	No. days/ yr 24hr mean >50	Annual Mean	Annual Mean	Annual Mean
R1:	2011	-3.3	-1.2	-1.6	<0.1	+0.1	0.1
R2:	2011	-1.1	-0.2	-0.2	<0.1	<0.1	<0.1
R3:	2011	-4.2	-1.3	-1.8	<0.1	0.1	0.1
R4:	2011	-2.4	-0.8	-1.0	<0.1	<0.1	<0.1
R5:	2011	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R6:	2011	+1.0	+0.4	0.6	<0.1	<0.1	<0.1
R7:	2011	+2.0	+0.7	+1.0	<0.1	<0.1	<0.1

Location	Year	NO_2 (µg/m^3)	PM_{10} (µg/m^3)		CO (mg/m^3)	Benzene (µg/m^3)	1,3 butadiene (µg/m^3)
		Annual Mean	Annual Mean	No. days/ yr 24hr mean >50	Annual Mean	Annual Mean	Annual Mean
R8:	2011	-0.1	-0.1	-0.1	<0.1	<0.1	<0.1
R9:	2011	+0.4	+0.1	+0.2	<0.1	<0.1	<0.1
R10:	2011	+0.7	+0.1	+0.2	<0.1	<0.1	<0.1
R11:	2011	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
R12:	2011	+0.3	+0.2	+0.2	<0.1	0.02	0.01
R13:	2011	+3.4	+2.8	+3.3	<0.1	<0.1	<0.1
Objective (provisional)		40	40 (20)	35 (7)	<2*	5	2.25

Annual mean CO concentration equivalent to meeting the running 8 hour mean objective

13.5.32 Receptors located within 200m of the existing A421 and the Scheme between M1 J13 and Caulcott (R1–R6) are predicted to experience a minor or moderate improvement in air quality as a result of the Scheme, with the exception of the northern edge of Marston Moretaine (R5) where there is a negligible change.. Annual mean concentrations of NO_2 are predicted to reduce by between 1.1–4.2 µg/m^3, with the greatest benefit experienced near to Brogborough and the western end of Marston Moretaine. Reductions in annual mean concentrations of PM_{10} are predicted to be smaller in magnitude but decreases in the order of 0.8–1.3 µg/m^3 would still result in a **minor beneficial** effect at these receptors.

13.5.33 In the vicinity of the Fields Road Overbridge the Scheme is predicted to increase annual mean concentrations of NO_2 and PM_{10} at CP Farm (R7) by 2/0 µg/m^3 and 0.7 µg/m^3 respectively. However the number of exceedances of the 24-hour objective is predicted to increase slightly. For receptors located further from the Scheme in Wootton (R8) and the proposed Wootton development (R9) the predicted increases are negligible and would **not result in a significant effect**.

13.5.34 At the south western side of the proposed Kempston development (R10) the Scheme is predicted to have a negligible adverse effect as a result of increases in the annual mean concentrations of NO_2 and PM_{10} by 0.7 µg/m^3 and 0.1 µg/m^3 respectively. However at the south eastern side of the proposed Kempston development (R11), the annual mean concentrations of both NO_2 and PM_{10} due to the Scheme are predicted to change by less than 0.1 µg/m^3.

13.5.35 There is a predicted increase in NO_2 and PM_{10} levels by 3.4µg/m^3 and 2.8µg/m^3 respectively at Moreteyne Farm (R13) as the new A421 alignment will pass closer than the existing A421 does. This will result in a **moderate adverse** impact.

13.5.36 The Scheme would increase annual average daily total traffic flows on Woburn Road (A5134) between Marsh Leys Junction and Kempston. Receptors in the vicinity of the A5134 (R12) are predicted to experience an increase in annual mean concentrations of NO_2 and PM_{10} by 0.3 µg/m^3 and 0.2 µg/m^3 respectively. The effect on local air quality at receptors in the vicinity of R12 would be **negligible**.

Generalised Local Impact Assessment

13.5.37 The change in the calculated total 'exposure' to NO_2 and PM_{10} pollution is provided in Table 13.14.

Table 13.14 Change in Total 'Exposure' to NO_2 and PM_{10} (With Scheme-No Scheme)

	Total Exposure Assessment Score (See paragraph 13.2.13)	
	NO_2	PM_{10}
Scheme Corridor	- 108	-42
Wider Study Area	-794	-336

13.5.38 The magnitude of the reduction in total exposure to NO_2 and PM_{10} suggests a **minor beneficial** effect to the community as a whole due to the Scheme.

13.5.39 Of the total of 69,068 properties located within 200m of the existing A421 and/or the Scheme and/or surrounding affected roads, 43,371 (63%) would experience an improvement in NO_2 exposure and 25,697 (37%) a worsening of NO_2 exposure and 43,463 (63%) would experience an improvement in PM_{10} exposure and 25,605 (37%) a worsening of PM_{10} exposure. This suggests a **minor beneficial** effect.

Regional Impact Assessment

13.5.40 The change in the total emissions of NOx, PM_{10}, CO_2, CO and THC produced by traffic in the Traffic Model Study Area in 2011 and 2026 due to the Scheme are presented in Table 13.15.

Table 13.15 Change in Total Traffic Emissions (With Scheme-No Scheme)

	Total Change in Quantity of Pollutants tonnes/yr				
Year	**NOx**	**PM_{10}**	**CO_2**	**CO**	**THC**
2011	+22(0.5%)	+3(2.7%)	+18,693(1.9 %)	+52(1.5%)	-2(-0.4%)
2026*	+140(4.6%)	+4(4.5%)	+44,463(1.0 %)	+104(2.4%)	+17(2.8%)

* based on emission factors for 2025

13.5.41 The increase in number of vehicle kilometres travelled in the traffic Model Study Area due to the operation of the Scheme (ie the percentage difference between the with Scheme and without Scheme traffic) is predicted to be 2% in 2011 and 3% in 2026. The increased number of vehicle kilometres travelled and the increase in average speed on the A421 is reflected in the increase in emissions. The magnitude of the increase in emissions of NO_x, PM_{10}, CO_2, CO and THC incorporates the benefits gained from the introduction of a greater proportion of cleaner vehicles into the national fleet and the effect of predicted growth in the proportion of diesel vehicles.

13.6 Summary

13.6.1 This chapter reports on the predicted effects of the proposed Scheme on air quality. Dust generated during construction, and emissions from road traffic with and without the Scheme are considered.

13.6.2 A qualitative impact of the potential dust impacts of the construction works has been carried out. Based on the type and scale of the construction works, totalling around 2 years, impacts within 100m of the works have been considered. Approximately 150 potentially sensitive receptors have been identified within 100m of the works. Based on the number of receptors close to the works and the likely duration of works such as topsoil stripping in close proximity to the identified receptors, the significance of the construction dust impact is ranked as **moderate adverse.**

13.6.3 Concentrations of the main road traffic pollutants with and without the Scheme in place have been predicted at a selection of residential properties along the existing A421, the Scheme and surrounding affected side roads. Both baseline and operational pollution levels at all the selected residential properties are below the current air quality objectives and limit values.

13.6.4 Overall the Scheme has a **minor beneficial** impact on community exposure to road traffic pollution. A total of approximately 69,068 properties are located within 200m of the existing A421 and/or the Scheme and/or surrounding affected side roads. Of these, 63% experience an improvement in air quality and 37% a worsening, in 2011, the year of Scheme opening.

13.6.5 The total quantity of road traffic pollutants and the greenhouse gas CO_2 has been predicted with and without the Scheme in operation. The increase in total vehicle kilometres travelled in the Traffic Model Study Area and the increase in average speed on the A421 with the Scheme in place results in a **moderate increase** in total emissions from road traffic.

13.6.6 Finally, the impact of road traffic emissions on the Marston Thrift SSSI has been assessed. As the only site within the study area is located more than 200 m from any road affected by the Scheme it is concluded that the operation of the Scheme would have no significant impact on nature conservation sites due to changes in road traffic emissions.

13.6.7 The air quality impact assessment concludes that the Scheme would not result in any significant air quality problems due to changes in road traffic emissions. As the DMRB procedures used are designed to over predict traffic emissions, it can be assumed with confidence that no such problems would occur.

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Appendix 13.1 Background Levels at Receptors

Appendix 13.1 Background Levels at Receptors

Location	Year	NO_2 (µg/m^3)	PM_{10} (µg/m^3)	CO (mg/m^3)	Benzene (µg/m^3)	1,3 butadiene (µg/m^3)
		Annual Mean	Annual Mean	Annual Mean	Annual Mean	Annual Mean
R1:	2005	13.8	21.2	0.2	0.3	0.1
	2011	11.5	19.4	0.2	0.2	0.1
R2:	2005	13.8	21.2	0.2	0.3	0.1
	2011	11.5	19.4	0.2	0.2	0.1
R3:	2005	15.2	21.5	0.3	0.3	0.1
	2011	12.3	19.6	0.3	0.3	0.1
R4:	2005	15.2	21.5	0.3	0.3	0.1
	2011	12.3	19.6	0.3	0.3	0.1
R5:	2005	15.2	21.5	0.3	0.3	0.1
	2011	12.3	19.6	0.3	0.3	0.1
R6:	2005	15.2	21.5	0.3	0.3	0.1
	2011	12.3	19.6	0.3	0.3	0.1
R7:	2005	17.2	21.2	0.3	0.3	0.1
	2011	15.0	20.3	0.3	0.3	0.1
R8:	2005	17.2	21.2	0.3	0.3	0.1
	2011	15.0	20.3	0.3	0.3	0.1
R9:	2005	17.2	21.2	0.3	0.3	0.1
	2011	15.0	20.3	0.3	0.3	0.1
R10:	2005	14.4	20.1	0.2	0.3	0.1
	2011	11.6	19.0	0.2	0.3	0.1
R11:	2005	14.4	20.1	0.2	0.3	0.1
	2011	11.6	19.0	0.2	0.3	0.1
R12:	2005	14.4	20.1	0.2	0.3	0.1
	2011	11.6	19.0	0.2	0.3	0.1
R13:	2005	13.8	21.2	0.2	0.3	0.1
	2011	11.5	19.4	0.2	0.3	0.1
Objective (provisional)		40	40 (20)	<2*	5	2.25

Annual mean CO concentration equivalent to meeting the running 8 hour mean objective

Appendix 13.2 Links for Each Receptor

Appendix 13.2 Links for Each Receptor

Receptor	Year	Scenario	Link	Road Type	Distance to Receptor (m)	AADT (Veh/day)	Speed (km/h)	% LDV	%HDV
R1	2005	DM	7028_7027	C	56	1073	41.1	87	13
			7025_7027	A	20	22005	60.2	86	14
	2011	DM	7028_7027	C	56	896	42.4	87	13
			7025_7027	A	20	26615	55.7	90	10
		DS	7028_7027	C	56	1356	46.3	79	21
			7025_7027	A	20	4327	67.0	80	20
R2	2005	DM	7027_7007	A	36	22508	59.9	86	15
	2011	DM	7027_7007	A	36	27180	55.2	90	10
		DS	7027_7007	A	36	4297	67.6	82	18
			9826_9825	A	79	49711	105	94	6
R3	2005	DM	7031_9358	A	19	21385	61.1	87	13
	2011	DM	7031_9358	A	19	25717	56.7	91	9
		DS	7031_9358	A	19	3327	67.8	85	15
R4	2005	DM	603_7006	A	40	20926	59.3	83	17
	2011	DM	603_7006	A	40	25871	55.2	88	12
		DS	603_7006	A	40	4936	65.1	79	21

Receptor	Year	Scenario	Link	Road Type	Distance to Receptor (m)	AADT (Veh/day)	Speed (km/h)	% LDV	%HDV
R5	2005	DM	603_7006	A	45	20926	59.3	83	17
			603_8010	C	23	4247	43.8	92	8
	2011	DM	603_7006	A	45	25871	55.2	88	12
			603_8010	C	23	5600	42	93	7
		DS	603_7006	A	45	4936	65.1	79	21
			603_8010	C	23	8257	43.4	94	6
			9822_9821	A	62	17042	52.5	91	9
R6	2005	DM	7016_7004	C	23	7373	28.5	91	9
			7004_7005	A	45	12120	104.3	85	15
			7038_7037	A	46	13878	104.0	86	15
			7004_7037	A	39	823	29.4	93	8
	2011	DM	7016_7004	C	23	1407	27.7	92	8
			7004_7005	A	45	0	0	100	0
			7038_7037	A	46	19062	101.7	91	10
			7004_7037	A	39	997	26.5	94	6
		DS	7016_7004	C	23	326	29.1	93	7
			7004_7005	A	45	6353	67.8	89	11
			9820_8042	A	54	59737	99.4	94	6

Receptor	Year	Scenario	Link	Road Type	Distance to Receptor (m)	AADT (Veh/day)	Speed (km/h)	% LDV	%HDV
R7	2005	DM	357_9011	C	39	4044	37.6	88	12
			604_357	A	30	25910	56.0	89	11
	2011	DM	8040_9011	C	39	6015	31.9	89	11
			604_8040	A	30	2055	68.1	97	3
		DS	9011_9954	C	39	7220	46.9	91	9
			9819_9814	A	82	59137	99.4	94	6
			604_8040	B	30	5867	67.0	94	6
R8	2005	DM	357_9011	C	16	4044	37.6	88	12
			9011_9012	C	23	1603	40.0	91	9
	2011	DM	8040_9011	C	16	6015	31.9	89	11
			9011_9012	C	23	1719	38.0	92	97
		DS	9011_9954	C	16	7220	46.9	91	9
			9011_9012	C	23	2609	37.3	94	6
R9	2005	DM	604_357	A	190	25910	56.0	89	11
			357_9011	C	193	4044	37.6	88	12
	2011	DM	8040_7011	B	190	36052	71.9	92	8
			8040_9011	C	193	6015	31.9	89	11
		DS	8040_7001	B	190	9180	65.9	93	7

Receptor	Year	Scenario	Link	Road Type	Distance to Receptor (m)	AADT (Veh/day)	Speed (km/h)	% LDV	%HDV
			9011_9954	C	193	7220	46.9	91	9
			9819_9814	A	136	59137	99.4	94	6
R10	2005	DM	-	-	-	-	-	-	-
	2011	DM	8035_354	A	51	18416	75.8	96	4
			9555_8035	A	150	14607	60.0	93	7
		DS	8035_354	A	51	26122	68.4	94	6
			9555_8035	A	150	26184	60.0	92	8
R11	2005	DM	3559_359	A	142	18204	57.9	94	6
	2011	DM	9552_359	A	142	13093	61.7	93	7
			8035_354	A	240	18416	75.8	96	4
		DS	9552_359	A	142	19776	52.7	95	5
			8035_354	A	240	26122	68.4	94	6
R12	2005	DM	358_359	A	17	18207	70.9	94	6
	2011	DM	358_359	A	17	13094	72.5	93	7
		DS	358_359	A	17	19094	72.6	95	5
R13	2011	DS	9824_9823	A	180	49720	105	94	6

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14 PEDESTRIANS, CYCLISTS, EQUESTRIANS AND COMMUNITY EFFECTS

14.1 Introduction

14.1.1 This chapter reports the predicted effects of the Scheme upon non-motorised local movements and journeys made in the locality by people as pedestrians, equestrians or cyclists. It also considers amenity and community severance.

14.2 Methodology

14.2.1 Non-motorised users (NMUs) have been classified and categorised under the headings shown in Table 14.1. Average journey speeds are given as defined in the Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 8 Chapter 3.

Table 14.1 Categories of Non-Motorised Users

Category of Non-Motorised User	Description
Pedestrians	A variety of users with a wide range of abilities undertakes walking. Walking is used for gaining access to a number of facilities up to a distance of about 3km, as a leisure activity over longer distances and in combination with public transport for commuting. Average journey speed of 5km/hr. Journey speeds for the aged and children is reduced to 3km/hr.
Cyclists	A variety of users with a wide range of abilities undertakes cycling. Cycling is used for gaining access to a number of facilities up to a distance of about 8km, as a leisure activity over longer distances and in combination with other forms of transport for commuting. Average journey speed of 20km/hr.
Equestrians	Horse riding and carriage driving is undertaken by a variety of users, mainly for recreational purposes. Journeys normally involve a circuit of about 1 km. Average journey speed of 10km/hr.
Disabled People	The term covers people having a range of physical, sensory or mental impairments. Under the Disability Discrimination Act 1995, Design Organisations should ensure that where possible, accessibility for disabled people is equal to that of other NMUs. Average journey speed of 3km/hr.

14.2.2 The effects on NMU movements and journeys have been predicted using a methodology based upon the guidance provided in DMRB Volume 11, Section 3, Part 8. This chapter also considers the effects of the Scheme in terms of changes in local travel patterns, amenity and community severance. All distances quoted in this chapter have been rounded to the nearest appropriate figure, and are thus approximate.

14.2.3 The sections below define the methods that have been used to assess the following:

- Effects of new severance caused by the new A421
- Relief from existing severance associated with the existing A421
- Effects of the Scheme on community facilities and community severance.

New Severance Effects

14.2.4 In order to assess the effects of the Scheme in terms of new severance, the guidelines set out in DMRB Volume 11 have been applied, as described in Table 14.2.

14.2.5 These guidelines apply specifically to pedestrians. Guidance in the DMRB states that "*cyclists and equestrians are less susceptible to severance due to the fact that they can travel more quickly than people on foot, although they may still be deterred from making journeys which require them to negotiate additional roads and especially junctions."* (DMRB Volume 11, Section 3, Part 8, paragraph 6.1c). The assessment does however take other non motorised users into account, as appropriate.

Table 14.2 Scale of Significance of New Severance Effects (Pedestrians)

Scale of Significance	Description
Slight	Current journey pattern likely to be maintained but some hindrance to movement, for example: • Pedestrian at-grade crossing of new road carrying <8,000 vehicles per day Annual Average Daily Traffic (AADT) • New bridge will need to be climbed or a subway traversed • Journeys will be increased by up to 250m
Moderate	Some residents, particularly children and elderly people, likely to be dissuaded from making trips. Other trips will be made longer or less attractive, for example: • 2 or more of hindrances set out under 'Slight' applying to single trips • Pedestrian at-grade crossing of new road carrying 8,000 – 16,000 vehicles per day (AADT) in opening year • Journeys increased by 250–500m
Severe	People likely to be deterred from making trips to an extent sufficient to induce a re-organisation of their habits, which would lead to a change in the location of centres of activity or in some cases to permanent loss to a particular community. Considerable hindrance will be caused to people trying to make existing journeys, brought about by, for example: • Pedestrian at-grade crossing of a new road carrying >16,000 vehicles per day (AADT) in opening year • Increase in length of journey of >500m • 3 or more of hindrances set out under 'Slight' or 2 or more set out under 'Moderate'

Relief from Existing Severance

14.2.6 DMRB Volume 11 Section 3.8.7 indicates that relief from severance can be categorised by considering reductions in existing traffic levels. Categorisations for rural areas are set out in Table 14.3 below.

Table 14.3 Significance of Reduction in Existing Community Severance

Level of Relief	General Rural Area	Rural Area where Existing Road Bisects Village
	% Reduction in Traffic	
Substantial	>90%	>60%
Moderate	75-90%	30-60%
Slight	60-75%	<30%

Community Severance Effects

14.2.7 Community severance is defined by the DMRB Volume 11 Section 3 Part 8 as *"the separation of residents from facilities and services they use within their community caused by new or improved roads or by changes in traffic flows."* Services and facilities within a community can include shops, doctors' surgeries, pubs, schools, community centres and community land including public open space. The criteria set out in Table 14.4 have been used to define the Scheme effects upon local communities. These criteria have been developed since the Stage 3 Scoping Report by the Project Team and have drawn upon Environmental Impact Assessments carried out for previous major highway schemes.

Table 14.4 New Community Severance Effects

Significance	Definition
Major adverse	• A major reduction in accessibility to important community facilities (reduction in accessibility includes additional distances to routes and the introduction of structures which may affect ability/desire to travel particularly for those with mobility difficulties) • Demolition or loss of a community facility or land resulting in increased difficulty accessing an alternative or replacement facility • A substantial increase in traffic flow in the vicinity of, or severance of, important routes used by NMUs likely to lead to loss of access to the route or reduced amenity for such users
Minor adverse	• A minor reduction in accessibility to important community facilities • A minor increase in traffic flow in the vicinity of, or severance of, important routes used by NMUs likely to lead to loss of access to the route or reduced amenity for such users
Neutral	• A potential change that it unlikely to result in a net positive or negative effect relative to the current situation
Minor beneficial	• Improved access to important community facilities • A minor reduction in traffic flow in the vicinity of important routes used by NMUs potentially leading to reduced severance or improved amenity for such users
Major beneficial	• Significantly improved access to community facilities • A substantial reduction in traffic flow in the vicinity of important routes used by NMUs potentially leading to reduced severance or improved amenity for such users

14.2.8 A baseline was established using desk-based assessment techniques including the use of Ordinance Survey maps and Stages 1 and 2 of the Environmental Impact Assessment. NMU count surveys were also commissioned to gauge the level of usage of the definitive Public Rights of Way (PRoW) in the area.

14.3 Baseline Conditions

14.3.1 This section describes the existing routes for pedestrians, equestrians and cyclists between the start and end points of the proposed A421 Improvements. It also outlines the public facilities located in the area, including local businesses.

Existing Baseline Conditions

Public Rights of Way

14.3.2 PRoW in the vicinity of the Scheme are shown on Figures 14.1.1 - 14.1.4 using information supplied by Bedfordshire County Council and OS mapping. The Scheme would affect PRoW in two districts, Mid-Bedfordshire District and Bedford Borough, whilst the Scheme would be based entirely within the county of Bedfordshire.

14.3.3 The following existing PRoW in the vicinity of the Scheme, from M1 Junction 13 (M1 J13) to Bedford, are described below. The Scheme is broadly described as running from west to east. However the footpaths and bridleways are described using more accurate compass directions notwithstanding the west-east Scheme approach. This is to facilitate clarity in consultation.

- Footpath 10 on the Brook Farm side of the A421 runs north-to-south from Salford Road, crossing the M1 where it becomes Footpath 32, which meets Footpath 6, which runs to Husborne Crawley. Footpath 10 on the Ridgmont Station side of the A421 runs southwest to northeast to the Amazon industrial units where it meets Footpath 4
- Footpath 4 runs in a northwesterly direction from Footpath 10 towards the A421, finishing at the existing A421
- Footpaths 12, 13 and 8 on the eastern side of Brogborough form a circular route, from which FP8 winds away from the A421 in an easterly direction
- Bridleways 1 and 2 are known as the John Bunyan Trail and National Trail Bridleways, they run from northwest to southeast from the northern side of the existing and proposed A421 to Brogborough and beyond on the southern side
- Bridleway 10 runs northwards towards the A421 from Brogborough and traverses the A421 using the existing “Clayway Underpass”. The bridleway reaches the edges of Brogborough Spinney where it turns through almost 180 degrees and finishes near the A421 at the track that leads to Brogborough Hill
- Footpath A6 runs west to east from North Common Farm crossing the existing and proposed A421 to Sheeptick End. The footpath is not currently in use as the route leads across the edge of the landfill site, which is not open to the public
- Bridleway 29 runs south-to-north from the existing A421 to meet Bridleways 36 and 30, which run west to east from Holcot Wood to meet Bridleway 31, which in turn runs from the existing A421 northwards to meet Bridleway 25
- Footpaths 5, 38 and 37 run from the existing A421 in a westerly and northwesterly direction
- Footpath A5 runs from the existing A421 in a northerly direction, meeting FP5 at its northernmost point

- Bridleway 25 runs west-to-east from Aspley Guise Clay Pit to Sun Valley, crossing the proposed A421 and terminating near the existing A421
- Bridleway 27 runs from Bridleway 25 in a north-westerly direction away from the proposed A421
- Footpath 3 runs from Bridleway 25 southwards across the existing A421 finishing at Escheat Farm where it becomes Footpath 4 and continues in a south-easterly direction
- Footpath 24 runs from Glendale Village north-eastwards then south-eastwards in a semi-circular manner to the existing A421 near Rock Villa
- Footpath 32 runs from north of Moreteyne Farm in a north-westerly direction away from the A421
- Footpath 35, which becomes Footpath 33, runs from Marston Thrift in an easterly, then north-easterly and then easterly direction, and crosses the proposed A421 before arriving in Marston Moretaine
- Bridleway 33 is a short section of bridleway, which crosses the existing A421 using the same overbridge as Footpath 33
- Footpath 34 runs from Footpath 33 in a north-easterly direction before joining Footpath 54 which leads to Lower Shelton
- Footpath 56 runs south-eastwards from Footpath 54 (which runs in a north-easterly direction) and crosses the proposed and existing A421 before terminating at Bedford Road
- Footpath 55 runs from Footpath 56 to the north of the existing A421 northwards to Lower Shelton
- Footpath 16 runs from Bedford Road to the south of the existing A421 south-eastwards past the sewage works
- Footpath 17 runs from Bedford Road to the south of the existing A421 south-eastwards past the sewage works
- Footpath 1 runs from Church End on the north side of the A421 past Berry Farm and southwards to the existing A421 where it finishes
- Footpath 1 also runs in a north-westerly to south-easterly manner from the existing A421 at Fields Road to Manor Road, Kempston Hardwick
- A new section of Bridleway 23 runs along Manor Road to the existing A421. It crosses at Manor Road where the older section of BW23 continues northwest past the sewage works to Bott End
- Footpath A3 is on the north side of the A421 and runs from Bridleway 23 at Bott End in a north-easterly direction to the sports ground
- Footpath 33 is on the north side of the A421 and runs from Bridleway 23 from the same point as Footpath A3 following a parallel course into Kempston
- Footpath 8 runs from the B530 on the south side of the A421 northwest then west before joining Footpath A1. Footpath A1 runs north and then northwest to the railway where it crosses the tracks and continues for a short way as Footpath 1
- Bridleway 2 runs from Woburn Road on the north side of the A421 northwards past the police headquarters and Hoo Farm
- The Sustrans cycle route runs from Moreteyne Farm to the north of the A421 in a north-easterly direction for approximately 400m where it turns southeast and runs

into Marston Moretaine using the bridge crossing on FP33. The route forms a circuit around Stewartby Lake in Stewartby Lake Country Park. There is a further section of on-road national cycle route that runs through Lower Shelton towards Upper Shelton.

Future Changes to the Network

14.3.4 Bedfordshire County Council has stated that the following changes are likely to be made to the existing Rights-of-Way network:

- The County Council proposes a new Bridleway, which would run from Bridleway 29 at the Brogborough Landfill Site parallel with the existing A421 in a south-westerly direction until it meets Footpath A6. The new Bridleway would then head in a westerly direction past North Common Farm where it would bend north and continue out of the study area.
- A proposed new Sustrans route would run from Footpath A3 near Marsh Leys junction in a south-westerly direction until it met Bridleway 23. It would follow Bridleway 23 past the sewage treatment works but veers off in a south-westerly direction just before the existing A421. The proposed route would continue in a south-westerly direction crossing Fields Road until it reaches Footpath 1 / Footpath 5 which crosses the existing A421. The proposed Sustrans route would then continue in a south-westerly direction on the east side of the A421 where it meets the existing Sustrans route skirting Stewartby Lake and Marston Vale Millennium Park.

14.3.5 The above changes, whilst documented in this chapter, have not been included in the impact assessment, which considers the existing situation at the time of assessment only.

Land Used by the Community

14.3.6 Land used by the community includes common land, town and village greens and general public open spaces. The following sites are used by the public for informal recreation, and public access is available to them:

- The picnic site at Brogborough Hill on the edge of the Marston Vale Community Forest has views over Marston Vale and gives access to woodland walks through Reynolds Wood and Holcot Wood. A permanent orienteering course is set up through these woods. The picnic site has a formal designation as Public Open Space.
- Brogborough Lake is one of the few large lakes in the county (89ha) that is totally dedicated to windsurfing. No other craft are allowed on the lake with the exception of the rescue boat and on windless days a few kayaks.
- Marston Thrift is situated near Wood End and covers 56 hectares on the east slope of the clay ridge. The Thrift was historically managed by coppicing. The County Council’s planning department manages the woodland in a sympathetic manner as a Local Nature Reserve and Site of Special Scientific Interest.
- Reynolds Wood is a large area of semi-natural habitat situated on part of the northern clay ridge of Marston Vale Community Forest area. The site broadly consists of two large blocks of mixed broadleaved planting, a substantial area of created meadow and one section of ancient woodland. All these elements are interconnected by many kilometres of hedgerow, some of which are of ancient origin. Within this mosaic are several ponds and watercourses. Holcot Wood is a large area of woodland planting based on the old woodland community type situated at the northern end of the site. Holcot Wood is owned and managed by the Woodland Trust.

- Stewartby Lake is sited at the heart of the Marston Vale Millennium Country Park and this former clay pit is now managed as a Country Park. The lake attracts a rich variety of birds, particularly in winter. Water sports also take place on the lake.
- Berry Farm Wood is an area of young, mixed broadleaved and coniferous plantation with open rides transecting and allowing access through it.
- Van Diemans Land is an area of improved unmanaged neutral grassland with adjoining areas of young broadleaved plantation woodland.
- Kempston Wood straddles a clay ridge in the Marston Vale with gravel/loamy soils at its northern and southern extremities. It is one of the few ancient semi-natural woods of any size left in the Marston Vale Community Forest area. Kempston Wood is predominantly oak, ash and field maple with much of the ash of ancient coppice origin.

Non-Motorised User Survey

14.3.7 A Non-Motorised User (NMU) survey to measure the use of the local network for pedestrians, cyclists and equestrians was undertaken for the Stage 2 Environmental Impact Assessment Report in 2004. The survey considered perceived existing use, from on-site investigation into how well trodden the paths were and the level of signage provided. Paths that were poorly maintained, overgrown and not signed were considered 'low use'. Paths maintained and sign-posted with evidence of use were described as moderate or high use at the discretion of the environmental consultant carrying out the survey. Table 14.5 presents the results from the Stage 2 Assessment.

Table 14.5 The Condition and Use of PRoW in the Study Area

PRoW	Description	Location	Existing Use	Traverses existing A421
BW1 BW2	John Bunyan Trail National Trail Bridleway	North of Brogborough	High Use	✓
FPA6	Footpath	North Common Farm – Brogborough Lake	Low to moderate use Located in agricultural field, signed from road	✓
FPA5 FP5	Footpaths	Parallel footpaths leading to Brogborough Lake from agricultural field	Low use although other non – PRoW nearby appeared to be used. Located in agricultural field signed from road but not visible on ground	✓ **X**

PRoW	Description	Location	Existing Use	Traverses existing A421
BW30 BW31 BW30 BW29	Bridleways	Aspley Guise Clay Pit – Moat – Sun Valley Crosses new A421 route at one location	BW31 Low to moderate use signed but overgrown	✓
BW25 BW27	Bridleways	Aspley Guise Clay Pit – Moat Sun Valley	BW25 moderate use wide pathway with hedgerows either side	✓
FP24	Footway	Wood End – Marston Moretaine	Used by residents of Wood End to reach Marston Moretaine facilities	✓
BW67	Bridleway	Sun Valley – Marston Moretaine	Signed Used by residents of Wood End to reach Marston Moretaine facilities	✓
FP33	Footway	Links Wood End Farm and Beancroft Road with Marston Moretaine	Signed. Moderate to high use	✓
BW33	Bridleway	Links to Wood End Farm and Beancroft Road with Marston Moretaine	Moderate to high use	✓
FP35 FP37	Footpaths	Lower End Farm joins up with FP33	No results provided for Stage 2 assessment	**X**
FP34	Footway	Marston Moretaine Moat Farm – northwest direction	Moderate to high use	**X**
Sustrans Route 51	Cycleway	Wood End – Marston Moretaine – Marston Millennium Country Park	High use. Signed and paved cycle, foot and bridleway	✓
FP1	Footway	Wootton – Berry Wood – Stewartby Landfill Site	Low to moderate use. Sign at entrance. Path appears overgrown	✓
BW2 BW9 link to BW23	Bridleway	Eastern Wootton – Van Diemans Land	No results provided for Stage 2 assessment	✓

PRoW	Description	Location	Existing Use	Traverses existing A421
FP3	Footway	Lidlington – Vale Farm – Sun Valley	Low use Though agricultural field not perceived to be problem if diverted	✓
FPA1	Footway	Bedford – Woburn Rd Industrial Estates	Low use	✓
FP55 FP56 FP58	Footways	Lower Shelton – Marston Moretaine	No results provided for Stage 2 assessment	✓

14.3.8 In addition to this survey, in August and September 2004 a pedestrian, cycle and equestrian count was carried out. The counts were undertaken on the weekends of 21-22 August and 25-26 September and Friday 10 September between the hours of 0700 and 2100. Three sites were surveyed and the results can be viewed in Table 14.6 (times are shown after each NMU movement):

- Site 1: Intersection of BW25 and BW27
- Site 2: Intersection of BW30 and 31
- Site 3: Intersections of FP5, BW30 and FPA5.

Table 14.6 Pedestrian, Cycle and Equestrian Count

Date and weather	Site 1	Site 2	Site 3
21 August 2004 Dry and warm with sunny spells	No activity	No activity	No activity
22 August 2004 Dry and warm with sunny spells	1 pedestrian 0841 1 pedestrian 0905 2 pedestrians 1459	No activity	No activity
10 September 2004 Cloudy until 09.52, then light rain. Wet until 10.33 thereafter dry sunny intervals	1 pedestrian 1235	No activity	No activity
25 September 2004 Started bright soon clouded over light rain started 11.44 lasting until 11.59, heavy shower 12.48 lasting until 13.32. Thereafter dry with a hint of sunshine	2 pedestrians 1515 1 equestrian 1516 1 equestrian 1713	No activity	No activity

26 September 2004 Dry throughout with variable cloud and sunshine, quite warm	2 pedestrians 1255 2 pedestrians 1440	2 pedestrians 0839 2 pedestrians 1105 2 pedestrians 1229	2 pedestrians 2131

14.3.9 In summary the survey recorded some 21 NMU movements. Of the total number of movements recorded, 90% were made by pedestrians, with the remaining 10% of the movements being made by equestrians. Of the NMUs recorded, 62% were observed at Site 1 - the intersection of Bridleway 25 and 27; 28% were observed at Site 2 - the intersection of Bridleway 30 and 31; and 10% were observed at Site 3 - the intersection of Footpath 5, A5 and Bridleway 30. There were no cyclists recorded during the survey.

14.3.10 As part of the Stage 3 Environmental Impact Assessment, Scott Wilson commissioned an NMU survey at 14 sites along the route. The surveys were undertaken on Sunday 4 June and Thursday 8 June 2006 between 0700 and 2100 and identified the times and direction of bridleway and footpath users. Survey locations comprised all points along the route where the Scheme would intersect PRoW and, as a result of consultation, Salford Road (due to NMU access to the railway station) and Hoo Lane (due to NMU access to and from Wootton Green). A map showing all 14 survey locations can be viewed in Figure 14.2.

14.3.11 There were no known special events taking place in the area on either of the two days that would lead to atypical or unusual results.

14.3.12 Both survey days enjoyed hot and dry weather.

14.3.13 The following observations were recorded with respect to the condition and use of the PRoW at each site:

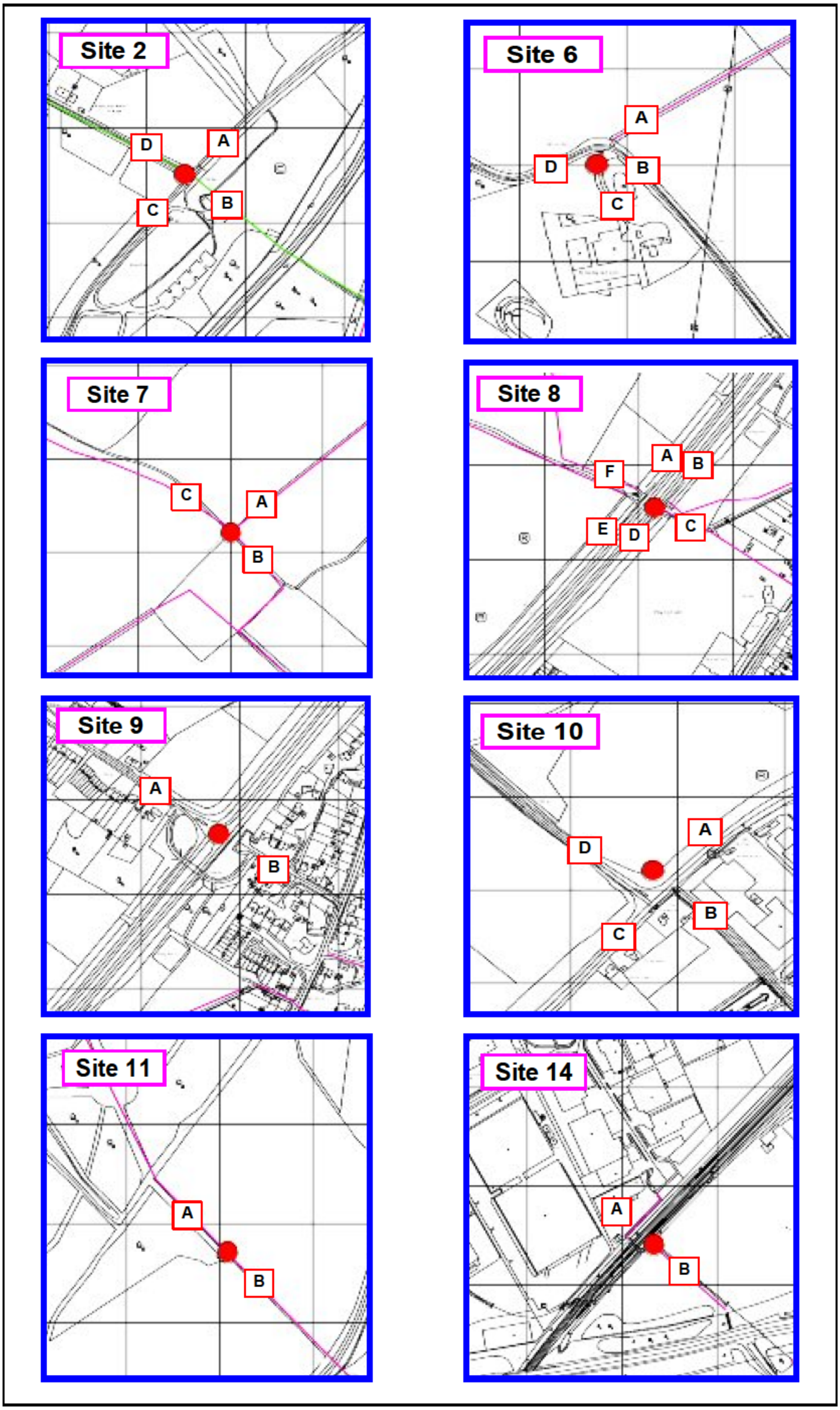
- Site 1: This site was not used throughout the day and did not appear to be used much at all as the long grass was undisturbed
- Site 2: A well-used three-way junction near to Brogborough Picnic Site
- Site 3: Difficult path to trace due to very overgrown grass from non-use. Nobody observed using it throughout the day
- Site 4: Nobody observed using this location but evidence of limited use by pedestrians and horses
- Site 5: Nobody seen using this location but evidence of light usage through long grass
- Site 6: Easy access concreted road, not overgrown
- Site 7: Evidence of some light use through field with easy access
- Site 8: Crossing of A421. There was only evidence of light use at this location
- Site 9: Underpass of A421, well maintained road surface
- Site 10: Only minor use of footpath here throughout the day
- Site 11: Footpath shows no sign of recent use with very overgrown nettles/grass
- Site 12: Access to footpath through industrial premises
- Site 13: Path with two strips of concrete along it and a horse gate. Little evidence of use by foot, but evidence of motorbike tyre tracks. Leads to sewage works; and

- Site 14: The southern part of this path does not show any recent usage for anything other than fly tipping. All pedestrians cross the railway line then exit via the Interchange Retail Park or visa versa.

14.3.14 There was no NMU activity recorded at the following sites:

- 1, 3, 4, 5, 12, 13 on Sunday 4 June
- 1, 3, 4, 5, 7, 8, 11, 12, 13 Thursday 8 June.

14.3.15 Activity was recorded at the sites shown below in Box14.1 and the direction of movements has been recorded in accordance with the labels A – F.



Box 14.1 Active Survey Locations with movement labels

14.3.16 The following tables detail the results of the surveys by day and by site and the observations of the condition/use of sites.

Sunday 4 June 2006

Site 2 Bridleway 1 and Access to Manor Farm Condition/use: well used				
Time	**A/C**	**A/B**	**B/C**	**B/D**
0700-1000	6 pedestrians	1 pedestrians	4 pedestrians	
1000-1400	22 pedestrians 2 cyclists 1 motorcycle	5 pedestrians	3 pedestrians	4 pedestrians
1400-1800	54 pedestrians 1 motorcycle	13 pedestrians	9 pedestrians	2 pedestrians
1800-2100	21 pedestrians	3 pedestrians	7 pedestrians	-

Site 6 Footpath 32 Wood End and Access to Moreteyne Farm Condition/use: easy access concreted road	
Time	**A/D**
1211	1 pedestrian

Site 7 Footpath 33 near Beancroft Condition/use: easy access light use	
Time	**B/C**
1237	1 pedestrian

Site 8 Footpaths 55 & 56 and A421 Condition/use: light use		
Time	**A/B**	**A/C**
0831	1 pedestrian	
1510	-	2 pedestrians
1625	1 pedestrian	

Site 9 Lower Shelton Underpass Condition/use: good condition	
Time	**A/B**
1102	1 pedestrian

Site 10 A421 / Hoo Lane Condition/use: minor use		
Time	**A/D**	**B/D**
0935	10 cyclists	-
1000	-	1 pedestrian
1125	-	2 cyclists

Site 11 Footpath 1 Berry Farm Condition/use: very overgrown no sign of use	
Time	**A/B**
1120	2 pedestrians
1525	1 cyclist

Site 14 Footpath* Kempston Interchange Retail Park Condition: southern part no sign of use	
Time	**A/B**
0700-1000	2 pedestrians 2 cyclists
1000-1400	6 pedestrians
1400-1800	10 pedestrians 2 cyclists
1800-2100	4 pedestrians

*South side footpath not used, people walk along side of railway line to the east and exit retail park

Thursday 8 June

Site 2 Bridleway 1 and Access to Manor Farm				
Time	**A/C**	**A/B**	**B/C**	**A/D**
0700-1000		1 pedestrian		
1000-1400	12 pedestrians	6 pedestrians	7 pedestrians	2 pedestrians
1400-1800	22 pedestrians	5 pedestrians 3 equestrians	1 pedestrian	3 equestrians
1800-2100	14 pedestrians 1 cyclist	3 pedestrians 1 cyclists	-	3 equestrians

Site 6 Footpath 32 Wood End and Access to Moreteyne Farm		
Time	**A/B**	**B/D**
0830	-	3 pedestrians
0900	-	1 pedestrian
0902	1 pedestrian	-

Site 9 Lower Shelton Underpass	
Time	**A/B**
1000-1400	4 pedestrians 6 cyclists
1400-1800	9 pedestrians 2 cyclists

Site 9 **Lower Shelton Underpass**	
Time	**A/B**
1800-2100	3 pedestrians 3 cyclists

Site 10 **A421 / Hoo Lane**			
Time	**A/D**	**C/D**	**B/D**
1145	1 cyclist	-	-
1417	-	1 cyclist	-
1450	-	1 cyclist	-
1515	-	3 cyclists	-
2040	-	-	2 pedestrians

Site 14 **Footpath* Kempston Interchange Retail Park**	
Time	**A/B**
1000-1400	14 pedestrians
1400-1800	11 pedestrians 7 cyclists
1800-2100	11 pedestrians

*South side footpath not used, people walk along side of railway line to the east and exit retail park

14.3.17 In summary, the additional survey recorded 372 NMU movements of which 55% were observed on the Sunday and 45% were recorded on the Thursday. Of the total number of movements recorded 85.5% were made by pedestrians, 12% by cyclists and 2.5% were made by equestrians. The equestrians were recorded at Site 2 Bridleway 1 the John Bunyan National Trail and access to Manor Farm.

Community Facilities

14.3.18 The A421 has several settlements along the route. Brogborough, Lidlington, Marston Moretaine, Lower and Upper Shelton, Wootton Green, Kempston Hardwick and Wootton all lie within approximately 1km of the Scheme. The community facilities associated with these settlements are described below from west to east.

- Brogborough: There are some shops in Brogborough but no schools. A bus stop is located on the A421. Recreational facilities (Brogborough Club and Brogborough Picnic Site) are located on one side of the A421 and residents on the other, so residents must cross the road to reach these facilities
- Lidlington: There are facilities located within the village including shops, newsagents, restaurants, public houses, as well as the Thomas Johnson Lower School (Lidlington Lower School) and playing fields. Lidlington Railway Station provides public transport. The nearest main settlement is Marston Moretaine. There is a Public Right-of-Way (Footpath 1/21) through fields linking Lidlington with Marston Moretaine
- Marston Moretaine: This is the largest village within the study area. The school located in Marston Moretaine is Church End Lower School. There are also bus stops, public houses, a village hall, a sports field, tennis courts, a restaurant, a church, a post office, shops, a retirement home and a doctor’s surgery. A service station, which includes a motel, is located on the opposite side of the A421 to the

village. A completed section of the Sustrans Route 51 crosses the A421 and passes through Marston Moretaine, ending at the Marston Vale Millennium Country Park. This is a cycle route that forms part of the National Cycle Network. As important community facilities are located in the village of Marston Moretaine, residents do not need to cross the existing A421 to reach these facilities. However, they do need to cross the A421 in order to reach other recreational facilities in the Marston Vale Forest such as Reynolds Wood and Berry Wood

- Lower Shelton, Upper Shelton: The main amenities for Lower and Upper Shelton are located in Upper Shelton. Shelton Lower School is also located in Upper Shelton. There is a public footpath in Lower Shelton leading to Wootton Green. Amenities at Upper Shelton include a butcher's shop and a public house. Bus stops are provided for those using public transport. There are PRoW linking the two villages
- Wootton Green: This is a small village with approximately 20 residential properties and no community facilities. It is located along Hoo Lane off the A421 between Lower Shelton and Wootton
- Kempston Hardwick: There are limited community facilities in this small village
- Wootton: This is one of the larger villages within the study area where there are important community facilities. They include the village hall, library, a church, Wootton Upper School, Wootton Lower School, a post office, a supermarket, three public houses, shops, a petrol filling station and a bus stop.

Existing Community Severance Issues

14.3.19 Given that the existing A421 passes directly through Brogborough, Marston Moretaine and Lower Shelton, the local communities are at present affected by severance. In addition, the existing A421 passes between Wootton and Kempston Hardwick, where again it has a severance effect.

14.3.20 The severance experienced at Brogborough concerns the amenities situated adjacent to the A421, Brogborough club and the picnic site on the northern side and the general stores and Chinese takeaway on the southern side. Residents need to cross the A421 in order to reach the club and picnic site and there is currently no safe crossing facility. Whilst residents do not need to cross the A421 to reach amenities on the southern side the amenities are situated very close to the road where noise and volume of road traffic can form psychological barriers recognised as a measure of community severance.[1] Bedfordshire County Council intends to close the picnic site and has concerns about inappropriate behaviour on this site. Local parish councils, Mid Bedfordshire District Council and the Marston Vale Trust are understood to support the picnic site's closure. There is an alternative area of open space with playing facilities and picnic tables in Brogborough away from the road on the southern side, but this does not afford the same views as the picnic site.

14.3.21 Marston Moretaine and Lower Shelton may experience severance in the form of road noise due to the proximity to the A421, but the physical barrier of crossing the road is not as severe as in Brogborough due to an underpass linking the two settlements. The underpass is suitable for all types of pedestrians including those with restricted mobility (pushchairs and wheelchairs) and cyclists.

14.3.22 The A421 acts as a physical barrier between Kempston Hardwick and the much larger village of Wootton, which provides important community facilities. There is a new bridleway, which runs adjacent to Manor Road, and a bridleway that begins directly on

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[1] Department for Transport / TRL Severance Study Part 1 Views of Practitioners and Communities
http://www.renewal.net/Documents/RNET/Research/Comseverancepartone.pdf

the opposing side of the A421 to Manor Road and continues on to Wootton. There is no crossing facility in place to allow residents of Kempston Hardwick safe access to the bridleway on the north side of the A421.

Planning Year (2010/11 No Development)

14.3.23 The sections above highlight that traffic using the A421 causes severance effects upon communities and NMUs. By 2010/11, it is anticipated that the situation would be similar to that currently experienced, although traffic flows are predicted to increase, which would exacerbate severance effects.

Future Baseline (2025/26 No Development)

14.3.24 By 2025/26 residential developments including the Wootton Development Land North and South of Fields Road, Land West of Kempston Development and the Stewartby Development are likely to have been completed. Such developments may result in more pedestrian and vehicular movements in the Wootton, Kempston and Stewartby areas. In addition, severance effects are predicted to be worse than those currently experienced due to significant increases in traffic flows.

14.4 Workshops and Consultations

14.4.1 Consultations with the district/borough and county councils and NMU groups have been carried out (refer to Chapter 1). In March 2004 a Public Consultation event was held to present the proposed improvements developed during the Stage 2 Assessment. The purpose of the Public Consultation was to seek views on the outline proposals from the general public, local authorities and non-statutory bodies.

14.4.2 Comments received during these consultations have been considered during the Scheme design process. Comments received during the March 2004 consultation are presented below in Table 14.7. Some references are not related to the current Scheme, but are included as they are still valid and relevant.

Table 14.7 Summary of Comments from Consultees and Interested Parties

Consultee	Comments
Wootton Parish Council	Encourage journeys to schools in Wootton and Stewartby by foot or cycle.
CTC Right to Ride Network – Mid Beds	Government policy to treble or quadruple the quantum of cycling. Safe crossing for cyclists needs to be provided between Station Road and Salford Road. Station Road links with the proposed MBDC Regional Cycle Route R4 from Woburn.
Sustrans	• Suggests the following required: - • A new cycle track beside the realigned Beancroft Road to the west • A link from this track to the existing farm accommodation bridge over the existing A421 on the west side • A link from Beancroft Road (local access to serve area) to the above path at the new Beancroft Road Bridge • A new bridleway between Moreteyne Farm and the next proposed bridleway bridge • New cyclepath/bridleway to the north of the new road linking Lower Shelton Road, Hoo Lane and Berry Farm • A new bridleway underpass on the line of Hoo Lane would

Consultee	Comments
	also be very beneficial • Concerned about traffic volumes on new link to Cranfield road. Suggests a subway under this road near Stewartby junction (this would link Lower Shelton underpass with the new Wootton development) • Welcome the new bridge at Fields Rd but it needs to continue over the existing A421. This junction needs to allow for cyclists and pedestrians - it is important to link up Kempston, the Interchange Retail Park and Marsh Leys.
CTC Right to Ride Network - Bedford	• A cyclepath segregated from the carriageway should be provided on the south side of the carriageway from Station Road to the far side of the south side of the M1, connecting the A507 to Husborne Crawley • Safe provision should be made for crossing the M1 slip roads and the Ridgmont bypass. Cycle facilities should be provided between Station Road and Salford road • Agree with the proposals of Mid. Beds CTC Right to Ride Network (regarding the closure of Beancroft Road). Wants Marston Moretaine junction, to west of Beancroft Road, to resolve issues with traffic for Millbrook and Cranfield. Shares concerns of Mid. Beds CTC Right to Ride Network (regarding Stewartby Junction).
The Ramblers Association	What will happen to FP54 FP1 or BW23? The map suggests that FP1 will continue under the new A421 although a BW/FP bridge will be provided at Manor Road. This could become important as a link between new developments and Kempston. Would this be of interest to Sustrans?
Aspley Guise Parish Council	Concerned that the proposals will affect FP6 (Aspley Guise No. 32). The route is located between the M1 and A421 and there is a crossing to the north of the proposed A421 south-western roundabout.
Bedfordshire County Council - Environmental	The County Cycling Forum (meeting of 18/5/2004) supported the detailed responses sent to HA from CTC Right to Ride Network - Mid Beds (31/3/2004) and CTC Right to Ride Network - Bedford (7/4/2004). Concerned that the Junction 13 proposals will create an unsafe environment for cyclists.
Cycling Campaign for North Bedfordshire	Agrees with comments made by CTC Right to Ride Representatives. Would like to see underpass on line of Wood End Lane to maintain Sustrans route. Wants fourth slip road to be constructed - removing HGVs and making existing A421 safer for cyclists.
Bedfordshire County Council – Planning and Transport	• Request for new footway link from opposite FP6 to follow new road scheme across M1 to join with the proposed bridleway link at Salford Road - 4m wide bridleway adjacent to new road from Salford to the proposed bridge on BW1 at Brogborough Manor Cottages – NMUs could then access BW2 and connect to Station Road via Brogborough Middle Farm - circuitous but safer • Requests new bridleway link from Manor Farm Bridge to

Consultee	Comments
	Sustrans link and bridge on BW25 and BW27 • Suggests upgrade to FP11, FP14 and a section of FPA6 to bridleway and connection to the proposed underpass to North Common Farm and to the proposed bridleway along the new road from Salford Road to Marston • Current proposal to divert to North Common Farm underpass is commendable but suggests that underpass is extended under the existing A421. Also suggests alternative to divert FPA6 as shown and upgrade to bridleway • Proposed bridge for BW31 is not necessary as this path is seldom used because it terminates at the A421 • Suggest new footpath alongside new road to bridge for BW25 and BW27. Currently proposed diversion of FP33 and Sustrans alongside the realigned routes of Beancroft Road and Wood End is not acceptable as roads will be too busy for Sustrans standard • Divert BW25 and BW27 via Woburn Road to bridge crossing (with additional bridge for existing A421 crossing) • Use existing route (bridleway bridge (Moat Farm)) to Moreteyne Farm, Wood End to Rock Villa then divert to BW25 and BW27 (proposed bridge crossing) • New bridleway alongside existing A421 to join BW67 off Wood Lane then continue along BW25 and BW27 • Footpath FP34 and FP54 should remain aligned (connected) with at-grade crossing at Beancroft Road to maintain link from Lower Shelton to Wood End. Suggests that FP34 is diverted beside ditch (off FP33) or alongside proposed road and Beancroft Road • Suggest additional diversion of FP58 to provide circular path around playing field • A multi-user path (NMUs), alongside Manor Road, will be constructed in conjunction with flood defence measures (part of the Surface Waters Plan). Suggests relocating bridge to connect to the multi-user path and extending it to cross the existing A421 • Design of Marsh Leys Junction needs to consider cyclists and pedestrians accessing the industrial estate • Proposed FPA1 diversion is circuitous and along main routes to Bedford. Suggests diverting underneath current railway bridge and round the lake to rejoin the path to Ampthill Road.
The British Horse Society	• BW1 should be connected to BW2 and BW10 (part of Clay way) • Wants BW10 connected to Sheep Tick End by upgrading FP11 and FP41 • Bridge in this location (Marston Moretaine Bridleways 25 and 27) is welcome. Wants grade separated crossing, at existing A421, for BW25 as roundabout is not suitable (or diversion to

Consultee	Comments
	existing Moat Farm bridge) • Any cycleway grade separated crossing should also be made suitable for horses. Wants horse track with equestrian parapets and tie-in to Wootton development proposals • Concerned at Fields Road closure. A bridge here could replace bridge opposite manor road (with suitable bridleway diversions).
The Forest of Marston Vale	Forecast traffic on Beancroft Road makes it unsuitable for Sustrans route. Suggests route from Marston Moretaine along Woburn Road with crossing at proposed roundabout then follow BW25 and BW27. Routes proposed by Beds CC PRoW officer are also suitable.
Bedfordshire & Luton Joint Local Access Forum	• The new bridges across the M1 and Salford Road present an opportunity to create an additional bridleway link from FP6 to BW1. Provision should be made for the safety of NMUs at the Station Road/Salford Road crossing place • Supports Beds CC request to extend the underpass for FPA6. Prefers Beds CC option 1 for the Sustrans route 51 - existing Moat Farm bridge could be used if required linked to a bridleway • Supports Beds CC proposals for footpaths 55, 56 and 58. Wants an NMU facility for horses as well as cyclists and pedestrians at Wootton FP1 and Stewartby Bridge/Junction. Wants facilities to include a segregated surfaced path for all types of user with parapets for additional safety and ease of use • Wants grade separated crossing to connect FP1 and Fields Road • Wants FPA1 diverted under the railway bridge.
Bedfordshire Rights of Way Association	• Support Beds CC request for extension of FP6 over M1 bridge • Section of Salford Road from the existing A421 to the proposed new roundabout retained for NMUs with an underpass provided north of Salford Road roundabout and segregated link to the stopped up section of Salford Road to Station Road junction • Welcome Manor Farm Bridge but request extension over existing A421 (or signal crossing) • Support Beds CC proposal to upgrade FP11, FP41 and FP6 to bridleway • Welcome the proposed underpass (North Common Farm) but would like it extended to include the existing A421 (or signal crossing) • Support Beds CC request to upgrade the bridleway at Brogborough Landfill Site • If bridge were not provided for BW31, then would suggest bridge for FPA5 (preferable) or FP5

Consultee	Comments
	• Do not see need to stop up FP38 • Welcome the bridge for Lidlington Bridleway 31 – allows access from FPA5 • Prefers Beds CC option 1 for the Sustrans route 51 - gives circular route • If FP34 is diverted to link to FP54, would like to see link to Wood End link • Would like grade separated (or signal) crossing for BW67 at proposed Woburn Road roundabout • Request footpath along redundant section of Beancroft Road with at-grade crossing to Sustrans route • Accepts Beds CC proposals for footpaths 55, 56 and 58. Welcome crossing for NMUs at Stewartby Junction • Welcome bridge crossing at Manor Road but would prefer it to be located further north to link in to the proposed multi-use path along Manor Road • Would like to see FPA1 accommodated close to its present line by an underpass.
Bedford Borough Council	• NMU facilities should be improved in the area and alternative provision should be made for NMUs during the construction period • Provision for cyclists should be made at Salford Road where it becomes part of the new road layout around J13 • The proposed/existing SUSTRANS National Cycle Route 51 crosses the route of the A421 and the new road should ensure that crossing points are provided where necessary • Cycle routes from Wootton to the Kempston Hardwick rail station, The Wixams and leisure sites should be in place • A crossing point in the vicinity of Fields Road would be ideal • Provision for cyclists crossing the A421 at Marsh Leys Junction should be improved.
Mid-Bedfordshire District Council	• BW2 has not been diverted and will need to share Brogborough Manor Farm bridge • FPA6 is to be diverted through North Common Farm underpass, which will be used by lorries for the landfill site. Careful consideration is needed to ensure the safety and protection of pedestrians and horse riders • It would be preferable for FPA6 and FPA5 to be diverted to link up and provide a much-needed circular path around the lake. The path could join and use the crossing for BW31 or the underpass at North Common Farm • It is essential that an underpass be provided for FP33 and 34. Ensure that FP55, 56 and 58 are diverted to the existing subway.

14.4.3 In February 2006 an NMU meeting was held to update the NMU consultation group on Scheme developments. The meeting, hosted by the Highways Agency, gave details of the project timetable, scheme review and design plans for the PRoW in the area. Discussions were then opened to the floor and the following points were raised:

- The need to keep the future development of the area in mind when designing PRoW routes and structures – co-ordination with Local Development Framework team at Mid-Bedfordshire District Council
- Highways Agency confirmed that no changes to FP32 and Husborne Crawley FP6 are planned
- Riders expressed concerns regarding height of bridge parapets, and the need for an extra crossing point in the central area of the Scheme (west of Wood End)
- Need for pedestrian/cyclist crossings at Junction 13 and slip roads
- Traffic management at Marsh Leys junction – Highways Agency confirmed that signalling would be installed for 2011 conditions during the interim period.

14.4.4 A pre-draft Orders Exhibition was held in Marston Moretaine on 11, 12 and 13 May 2006. The aim of this exhibition was to present to the local and wider community, local authorities and statutory consultees the Scheme as it had been developed at that time, showing junction and side-road alignments in more detail than at the proposed Preferred Route exhibition in December 2004, and to identify those issues that cause most concern and/or approval. The exhibition also provided the opportunity to inform the community of the progression of the statutory processes and associated timescales. The following issues concerning NMUs were raised by residents in the vicinity of the Scheme:

- M1 Junction 13 requires adequate provision for cyclists to cross slip roads
- HA Response: The roundabouts either side of the motorway would be partially signal controlled ensuring a degree of safety when crossing the slip roads
- Bridleway 25 needs a facility to cross the proposed A421, as this is the main route to Marston Thrift SSSI and Cranfield, diversion along proposed Scheme would not be acceptable
- HA Response: Diversion increases total length by 415m – no longer adjacent to the Scheme. On the south side, realignment would occur along field boundaries directly towards Wood End Bridge
- Concern about stopping up PRoW 31, 5 and A5
- HA Response: Proposed new bridge at BW31 so PRoW no longer need to be stopped up and short diversions for FP5 and A5 to cross using BW31 Bridge would be provided
- Footpath 33 between Cranfield and Marston Moretaine would be diverted to Marston Junction. It would be inconvenient to use the new footpath
- HA Response: The bridleway/footpath link between Marston Moretaine and Cranfield would be via the proposed Wood End Bridge, Footpath 32 incurring a diversion of 800m and Bridleway 25 incurring a total diversion of 415m. Crossing Beancroft Road and the detrunked A421 would be comparable to crossing normal side roads on foot, with caution required on pavements
- Berry Farm Underpass – need this to be suitable for equestrians
- HA Response: suitable for dismounted equestrians.

14.5 Mitigation and Detailed Development of the Scheme Design

14.5.1 During the development of the Scheme design, the requirement for local traffic movements has been taken into account. This has affected the junction strategy as detailed in Chapter 3: Scheme History and Solutions Considered. In addition the design has taken into account NMU movements/patterns. Overall the aim has been to retain/enhance PRoW including the reinstatement and relocation of footpaths, bridleways and cycleways where possible.

14.5.2 For safety reasons, the Scheme design does not include at-grade crossings. In order to remove the conflict between NMUs and vehicular traffic on the new A421, the Scheme design encourages the use of safe grade-separated NMU crossing points, and removes possible alternative at-grade routes by stopping up linking PRoW. All crossing structures would have ramped access to facilitate not only cycle and equestrian access but also access for those with mobility difficulties and those with pushchairs.

14.5.3 The proposals for PRoW provisions are shown in the Environmental Master Plan Figures 4.3.1 - 4.3.10. The NMU crossing facilities in the Scheme design include the following measures to retain/enhance the PRoW network:

- Manor Farm Bridleway 1 Overbridge – an overbridge would be constructed to carry Bridleways 1 and 2. Equestrians would benefit from 1.8m high parapets, which are screened, to protect riders in case of fall
- North Common Farm underpass –an underpass would be constructed as access for North Common Farm and to carry the diverted BW10 and FPA6 across the Scheme. During construction it is likely that traffic bound for the landfill site would need to use this underpass. This would make it significantly less accessible for NMUs, equestrians particularly. A new bridleway is planned between Brogborough Manor Farm Bridleway 1 Overbridge and the underpass on the northern side of the Scheme to alleviate potential impacts during construction by providing an alternative route of similar distance
- Vale Farm Bridleway 31 Overbridge – provision of an overbridge carrying a 4m private road for NMUs and farm access where holdings have been severed by the Scheme. The bridge would be fitted with 1.8m high, screened parapets
- Wood End overbridge – an overbridge carrying a 4m public road and a separate 2m footpath. The overbridge would be fitted with 1.8m high, screened parapets
- Marston Overbridge – a single 3m footway would be provided along one side of the new road bridge crossing between the Scheme and existing A421. Cyclists would be required to use the road and there would be no provision for equestrians given there are no bridleways in the area
- Lower Shelton Subway – existing underpass to be extended to cross the Scheme providing a separate footpath and cycleway. It would be suitable for use by equestrians provided riders dismounted
- Berry Farm underpass – solely a NMU underpass so no motorised traffic. Provision consists of one track for all NMUs – equestrians would need to dismount
- Manor Road Bridleway 23 Overbridge – solely a NMU crossing. A 3m wide single-track facility for pedestrians, cyclists and equestrians with 1.8m high, screened parapets
- Marsh Leys Railway Bridge– proposals would provide a safe NMU crossing away from the road under the Railway Bridge next to the railway, which would be fenced from the footpath.

14.5.4 The downgrading of the existing A421 would provide local access to cyclists, equestrians and pedestrians though detail regarding the provision of road marking of segregated facilities would be subject to agreement with the local highway authority – Bedfordshire County Council.

14.5.5 The sections above highlight the features included in the Scheme design to maintain PRoW movements. In addition, actions will be taken during the construction phase to minimise disruption and severance issues. These will include the implementation of a Traffic Management System (refer to Chapter 4: Scheme Description) together with temporary footpath/bridleway diversions. These issues are discussed in Section 14.6 below.

14.6 Environmental Effects

Effects of Construction

14.6.1 Construction activities required for the Scheme would potentially have two types of severance effect:

- The temporary severance of PRoW and disruption to other rights of way and minor roads
- Potential effects on traffic movements through surrounding settlements as a result of construction activity.

14.6.2 With regard to the latter, traffic effects would be minimised through the implementation of a Traffic Management System (refer to Chapter 4: Scheme Description and Chapter 16: Disruption Due to Construction). This system aims to minimise disruption to passing traffic and thus limit disruption of the use of community facilities.

14.6.3 With regard to PRoW, during the construction phase the PRoW that traverse the Scheme would be kept open where possible. In some cases temporary closures may be necessary on safety grounds - the duration of closures/diversions would be kept to the minimum possible. During construction, users of PRoW in the vicinity of the Scheme would experience a range of visual impacts. Visual impacts are discussed in Chapter 8: Landscape and Visual Assessment.

14.6.4 The points below detail the actions that would be taken during the Scheme construction phase to minimise disruption to users of PRoW:

- FP6/FP32 – footpath to be temporarily diverted during construction. At-grade crossing to be provided across realigned A421 to Milton Keynes with steps up embankments
- Salford Road – existing road to be kept open for NMUs during construction with a temporary diversion around the structure until the permanent location is completed
- BW2 – bridleway to be temporarily diverted during construction until new bridge is complete. Bridleway to be diverted over new bridge once the bridge is opened
- BW10 – bridleway through “Clayway” underpass to be closed at commencement of construction works
- FPA6 – footpath to be temporarily diverted during construction. Footpath to be diverted to its permanent route once North Common Farm Underpass is opened
- FPA6 – footpath to be stopped up at boundary of proposed A421 once a permanent diversion along the highway boundary to BW31 is established
- FP5 – footpath to be stopped up at boundary of proposed A421 once a permanent diversion along the highway boundary to BW31 is established
- BW31 – bridleway and diverted footpaths FPA6 and FP5 to be temporarily diverted during construction. Bridleway and footpaths to be diverted to permanent location over bridge once bridge is opened

- BW30 – bridleway to be temporarily diverted during construction to cross proposed A421 at same location as BW31, FP5 and FPA6. Bridleway to be diverted to permanent location over bridge once bridge is opened
- BW27 – bridleway to be temporarily diverted during construction.
- BW25 – bridleway to be temporarily diverted during construction. Bridleway to be diverted to permanent location over bridge once new bridge is opened
- Wood End (Sustrans Route 51) – road to be kept open for non-motorised users until new bridge and roads are opened
- FP33 – footpath to be stopped up once permanent diversion to Beancroft Road has been established. A section of this diversion adjacent to Beancroft Road will be in a temporary location until completion of the realignment of Beancroft Road
- FP54 – footpath to be temporarily diverted at Beancroft Road until completion of the realignment of Beancroft Road
- FP55 – footpath to be temporarily diverted until proposed Lower Shelton Link Road is completed. Footpath is then to be diverted to a permanent location along Lower Shelton Link Road
- FP56 – footpath to be temporarily diverted until proposed Lower Shelton Link Road is completed. Footpath then diverted to permanent location along Lower Shelton Link Road
- Lower Shelton subway – footway and cycleway to be kept open for NMUs during construction. A short section of temporary diversion will occur during construction of the extension to the subway
- Hoo Lane – road to be stopped up once proposed footpath diversion is completed. Alternative routes for NMUs exist via Fields Road or Lower Shelton Road and subway
- FP1 – footpath to be temporarily closed during construction until completion of the proposed A421 and reinstatement of the construction compound area
- Fields Road - existing road to be kept open for NMUs during construction until new bridge and road is opened
- BW23 – bridleway to be temporarily diverted during construction. Bridleway to be diverted to permanent location over bridge once new bridge is opened
- Marsh Leys Interchange – a footway and cycleway to be kept open for NMUs during construction with the aid of temporary diversions as necessary
- FP1/FPA1 – footpath to be temporarily closed during construction works. Footpath to be diverted to permanent location alongside railway line and under A421 once new A421 is completed.

14.6.5 The overall level of construction effects is judged to be **slight adverse**. The majority of effects would be temporary closures and diversions during the construction period.

Effects of Operation

New Severance Effects

14.6.6 The proposed permanent PRoW network provisions are shown in Figures 4.3.1 - 4.3.10. These proposals are discussed in the sections below. Table 14.8 details the significance of effects resulting from these provisions.

14.6.7 Footpath 10 crosses the M1 where it becomes Footpath 32; the route of Footpath 32 would be diverted from its course heading eastwards. In the first instance the new route would travel in a westerly direction a short way where pedestrians would need to cross the Scheme before travelling in an easterly direction again to meet Footpath 6 heading to Husborne Crawley. The length of diversion would be approximately 280m, which is considered a **moderate adverse** effect.

14.6.8 Bridleways 1 and 2, the John Bunyan National Trail, would cross the new A421 with an overbridge at Manor Farm north of Brogborough. There would be no additional distance to travel or diversion imposed by this crossing.

14.6.9 Bridleway 10 currently terminates shortly after crossing the A421. The last 50m of this bridleway leading to the Clayway Underpass would be stopped up, resulting in no future access along Bridleway 10 to cross the A421 and reach Brogborough Spinney. Instead users would take Bridleway 2 at the Bridleway 10 interchange and cross the A421 using the proposed Manor Farm Bridleway 1 Overbridge and new bridleway on the north side of the Scheme to get to Brogborough Spinney, which would involve a slight diversion of about 150m, resulting in a **slight adverse effect**.

14.6.10 Footpath A6 would be stopped up at its current intersection with the A421 and follow a slight (140m) diversion to cross at North Common Farm underpass resulting in a **slight adverse effect**.

14.6.11 Bridleway 29 does not cross the existing A421 and no provision is proposed for a crossing facility at this point. Users of this route, as a means of access to Brogborough Lake, would no longer be able to do so. (Bedfordshire County Council has plans to extend Bridleway 29 to meet Footpath A6 (and its underpass crossing) and form a circular route around the landfill site. These proposals could only progress once the landfill site is closed and made suitable for public access.)

14.6.12 An overbridge would be provided at the intersection of Bridleway 31 with the Scheme. Users travelling along Bridleway 31 from Bridleway 25 would incur a short diversion of 180m (**slight adverse effect**) to use the overbridge. Users of Bridleway 30 would incur no diversion to use the overbridge.

14.6.13 Footpath 38 that runs to Footpath 5 would be stopped up from Bridleway 30 and diverted a total distance of 180m (**slight adverse** effect) over the bridge at Bridleway 30 to rejoin Footpath 5.

14.6.14 Footpath A5 would be stopped up at its intersection with Bridleway 30 and diverted a total of 220m (**slight adverse** effect) over the bridge at Bridleway 30 before rejoining its course on the southern side of the Scheme.

14.6.15 Footpath 5 would be stopped up at its intersection with Bridleway 30 and diverted a total distance of 250m (**moderate adverse** effect) over the bridge at Bridleway 30 before rejoining its course on the southern side of the Scheme.

14.6.16 Bridleway 25 would be stopped up at its intersection with the Scheme and diverted via the Wood End overbridge 415m (**moderate adverse** effect) to rejoin its course on the southern side of the Scheme. Pedestrians wishing to use Footpath 3, which runs from Bridleway 25 on the southern side of the Scheme would incur a total diversion of 695m (**severe adverse** effect).

14.6.17 The overbridge at Wood End would provide a crossing for the Sustrans route, which currently terminates at Wood End but is proposed to continue further.

14.6.18 Pedestrians using Footpath 33 leading to Footpath 54, which runs into Lower Shelton, would not incur a diversion. Users of Footpath 33 which runs into Marston Moretaine would incur a diversion via Marston Junction of 510m (**severe adverse** effect).

14.6.19 Bridleway 33, comprising a small section of bridleway crossing the existing A421using the same overbridge as Footpath 33 and Sustrans, would not be affected.

14.6.20 Footpaths 35 and 37 would not be affected by the proposals.

14.6.21 Footpath 54 would not be affected by the proposals.

14.6.22 Footpaths 56 and 55 would be stopped up where they intersect the A421 and a diversion of 470m (**moderate adverse** effect) extends the footpaths and they will pass through the existing subway at Lower Shelton.

14.6.23 Footpaths 16, 17, 18 and 19 would not be affected by the proposals.

14.6.24 Footpath 1 on the north side on the A421 would be unaffected by the proposals as a new crossing (subway suitable for pedestrians, equestrians and cyclists) would be provided at the intersection with the new A421. The proposed Sustrans route would be able to use this same crossing facility.

14.6.25 Footpath 1 on the south side of the A421 would be unaffected by the proposals as it currently terminates at the existing A421.

14.6.26 Manor Road overbridge at Bridleway 23 would require pedestrians to incur a diversion of 110m (**slight adverse** effect) to cross the Scheme and continue along Bridleway 23.

14.6.27 Footpaths 1 (north side of A421) and A1 (south side of A421) at the Kempston junction would be stopped up and a diversion of about 370m (**moderate adverse** effect) necessary to use the new crossing underneath the railway bridge.

14.6.28 As detailed above, the proposed Scheme would result in the diversion of some footpaths, bridleways and byways. Using the criteria detailed in Table 14.4, above, Table 14.8 illustrates the significance of new severance effects caused by the Scheme. It refers to pedestrians and hence footpaths given that DMRB guidance states that cyclists and equestrians are less susceptible to severance as they can travel more quickly. It should be noted that this table does not take into account the number of new footpath links provided by the Scheme as listed in Table 14.9.

Table 14.8 Significance of New Severance Effects

Footpath	Main Use	Diversion Length (m)	Scale of Effects
FP10 FP32	Recreational Access to Husborne Crawley	280m	Moderate adverse
BW1 BW2	Recreational (High use)	0m	Negligible
BW10	Recreational	150m	Slight adverse
FPA6	Recreational	140m	Slight adverse
FPA5 FP5	Recreational Recreational	220m 250m	Slight adverse Moderate adverse
BW30 BW31	Recreational Recreational	0m 180m	Negligible Slight adverse
BW25 BW27	Recreational Access to Marston Moretaine (joins BW25)	415m 0m	Moderate adverse Moderate adverse
FP32 FP24	Access between Wood End and Marston Moretaine	800m	Severe adverse

Footpath	Main Use	Diversion Length (m)	Scale of Effects
FP33-54 FP33-34	Recreational/access Lower Shelton Access to Marston Moretaine	0m 570m	Negligible Severe adverse
BW33 Sustrans	Access to Marston Moretaine Access to Marston Moretaine	0m 0m	Negligible Negligible
FP54	Recreational Access between Lower Shelton and Marston Moretaine	0m	Negligible
FP56 FP55	Recreational Access between Lower Shelton & Marston Moretaine	470m	Moderate adverse
FP16 FP17 FP18 FP19	Recreation (Marston Vale Millennium Country Park)	0m	Negligible
FP1 (Berry Farm)	Recreational	0m	Negligible
BW23	Recreational Access between Wootton and Kempston Hardwick	110m	Slight adverse
FP1	Access to Kempston	370m	Moderate adverse

14.6.29 In addition to the effects upon existing public footpaths noted above, lengths of new footpath, bridleway and cycleway would be created along the Scheme. The provision of footways and road markings in sections for non-motorised users would be subject to agreement with the local councils and landowners.

14.6.30 During the development of the Scheme, the provision of NMU facilities has been considered along with the consultation responses from the local councils, statutory bodies, residents and interested parties. Therefore, footpath closures and diversions have been kept to a minimum and opportunities to extend the existing network have been taken. Table 14.9 shows the overall gain of new (not diverted) footpaths, bridleways, cycleways and byway networks as a result of the Scheme. In addition to those new NMU facilities shown in Table 14.9, approximately 11km of downgraded A421 would be available to pedestrians, cyclists and equestrians due to reduced traffic flows and improved amenity.

Table 14.9 Overall Gain of New Non-Motorised User Facilities provided by the Scheme

Feature	New Length Provided by the Scheme (approx)*
Footpath	New length along Salford Rd, below and to the south side of the Scheme 390m
Bridleway	New length along Salford Road 330m New length between Salford Road and Manor Farm 1350m New length between BW1 and BW29 1080m New length between BW25 and BW31 600m New length between Hoo Lane and FP1 at Berry Wood 820m New length from Footpath1 on the southern side of the proposed Berry Farm Wood underpass heading south-west and then south-east to join the existing A421 470m
Cycleway	-
Byway	-
Total	5040m

* Excludes downgraded sections of the existing A421

Relief from Existing Severance

14.6.31 The sections below consider relief from existing severance using the criteria as detailed in Table 14.3, above.

14.6.32 Severance is likely to be reduced within and between the villages on the south-eastern side of the new A421 including Brogborough, Lidlington, Marston Moretaine, Stewartby and Kempston Hardwick. As the reduced volume of traffic would increase accessibility along the detrunked A421, pedestrians and others from these settlements may be encouraged to use the community facilities, recreational and educational centres on the south-eastern side of the old A421 such as Brogborough Lake, Lake View Wood and Marston Vale Millennium Country Park.

14.6.33 It would be easier for residents at Wood End to cross the old A421 in order to reach the community facilities at Marston Moretaine, as there would be less traffic along the old A421.

14.6.34 The reduction in traffic flows for the existing A421 would be approximately 70%, which in accordance with DMRB Volume 11 Section 3.8.7 would be considered to give rise to a slight reduction in community severance for a general rural area.

Community Severance Effects

14.6.35 The sections below consider community effects using the criteria as detailed in Table 14.7, above.

14.6.36 Due to the predicted reduction in traffic along the detrunked A421 and the provision of several crossing facilities over the new A421, community severance is likely to be reduced within the villages on the southern side of the A421 including Brogborough and Marston Moretaine and between the communities of Kempston Hardwick and Wootton.

14.6.37 The alignment of the road is such that it necessitates the removal of the existing Brogborough Picnic Site, situated to the northeast of Brogborough and immediately north of the existing A421. There is no viable alternative that would enable the picnic site to remain. Discussions between the Highways Agency and Bedfordshire County

Council have been held and have concluded that a like for like replacement in this locality is not desirable due to problems experienced at the existing site, and consequent lack of use by the public. Instead, it has been agreed that appropriate funding would be made available for similar facilities in the area, to be provided in response to identified local needs. The effects of this are therefore considered to be **minor adverse**.

14.6.38 The proposed Scheme would sever the John Bunyan Trail (BW1 and 2), which provides access to Reynolds Wood in Brogborough, but Manor Farm Bridleway 1 Overbridge would be provided to mitigate this impact. Journey length would not be increased. Therefore there would be **neutral** effects.

14.6.39 Brogborough Lake is most easily accessed by car. Pedestrians may gain access via Footpaths A6, A5 and 5 and Bridleways 29 and 31. All these routes currently require crossing the existing A421. Under the Scheme FPA6 would be severed and diverted at minimal extra length to North Common Farm underpass in order to cross the A421 and continue its course; this would result in a minor beneficial effect. Bridleway 29 would have no crossing facility and would not be a suitable option for access to Brogborough Lake resulting in a minor adverse effect. Footpaths A5 and 5 would be subject to diversions to cross the Scheme, resulting in a minor adverse effect. However, ability to cross the detrunked A421 would increase due to reduced traffic flow along this route resulting in minor beneficial effects. It may be considered that the impacts on Footpaths A5 and 5 balance out to result in **neutral** community effects.

14.6.40 NMUs accessing the lake via Bridleway 31 would incur a slight diversion where the bridleway crosses the Scheme; though their ability to cross the detrunked A421 would increase due to reduced traffic flow along this route, resulting in a **minor beneficial** effect.

14.6.41 The new A421 would sever FP33/34, which links Lower Wood End Farm with Marston Moretaine, where there are important community facilities. This footpath would be diverted to Marston Overbridge leaving pedestrians at the current roundabout near the services some 450m from FP33 but nearer to facilities in Marston Moretaine. This would result in **minor adverse** effects.

14.6.42 Alternatively Footpath 32 could be taken from Lower Wood End Farm. This would link into the proposed Wood End overbridge where the journey could then be completed using the Sustrans link to Marston Moretaine entering the village at the same point as Footpath 33 currently does. This route would incur no additional length to the journey and would therefore result in **neutral** effects.

14.6.43 The underpass adjoining Lower Shelton and Marston Moretaine would be extended to cross the new A421 so it is considered there would be **neutral** effects from the Scheme at this location.

14.6.44 Marston Vale Millennium Country Park and Forest Centre: under the Scheme the existing subway below Lower Shelton would be maintained thus journey times would not be increased for NMUs from Wootton Green, Upper Shelton and Lower Shelton. Pedestrians would still be able to use the existing bridleway bridge at Marston Moretaine to reach the Forest of Marston Vale Country Park. In general, journey times to the park would not be affected and **neutral** effects would be likely.

14.6.45 Footpath 1 runs from Wootton southwards past Berry Farm into Berry Wood and on to the existing A421. It would be severed by the Scheme but a pedestrian subway would be provided at the point of intersection, therefore there would be no diversion incurred, resulting in **neutral** community severance effects.

14.6.46 Bridleway 23, which runs southwards from Wootton to the existing A421 and continues along Manor Road, would cross the Scheme via a bridleway and pedestrian footbridge. There would be a need to cross the less busy detrunked A421 but this should provide a better link than the existing link between Wootton and Kempston Hardwick, as there are currently no crossing facilities linking the two sections of bridleway. This would result in **minor beneficial** effects.

14.6.47 Footpath A1 at Kempston junction currently requires pedestrians to cross a busy section of the A421 to reach the adjoining Footpath 1 that runs into Kempston. The Scheme would deliver a three-lane dual carriageway at this location and Footpath A1 would be diverted a substantial distance to cross the A421 at the railway bridge. The current crossing arrangements are unsafe for pedestrians and the new crossing would provide safe access to Kempston. In terms of effects, even though pedestrians incur a diversion, the safety of access is considered more important and therefore **minor beneficial** effects are predicted.

14.6.48 The existing level of community severance is considered moderate as NMUs have to cross or come in close contact with the current A421 in order to reach community and recreational facilities and there is currently little provision for crossing the A421. The level of community severance following the Scheme's implementation is likely to be reduced, as even though NMUs would be subject to diversions, the crossings provided would improve the safety of the PRoW network overall. The crossing facilities would all have ramped access not only to facilitate equestrian and cycle access but also to ensure safe access for those with mobility difficulties and those with pushchairs.

14.6.49 Taking these factors into account the impact of the Scheme on community severance would be **minor beneficial.**

Land Used by the Community

14.6.50 Although Brogborough Picnic Site would be lost to the Scheme, it has been agreed that appropriate funding would be made available for similar facilities in the area, to be provided in response to identified local needs.

14.6.51 An underpass at North Common Farm would improve access to Brogborough Lake from the northwest side but access from the northeast would be affected due to the stopping up of Footpaths 5 and A5 and their diversion to use the overbridge at Bridleway 31.

14.6.52 Accessibility to Reynolds Wood would be unaffected due to Manor Farm Bridleway 1 Overbridge and North Common Farm underpass.

14.6.53 Rights of Way to Marston Thrift SSSI near Wood End would be unaffected by the Scheme.

14.6.54 NMU routes to Marston Vale Millennium Country Park from within Marston Moretaine are unaltered; the two routes that approach Marston Moretaine from the northern side of the A421, FP33 and FP55/56 would experience short diversions in crossing the new A421.

14.6.55 The Scheme would run close the boundary of the Berry Farm Wood community land but would not require any landtake. NMU access to Berry Wood would be provided through an underpass.

14.6.56 Van Diemans Land would by bisected by the Scheme and this would result in the loss of some 2ha of community land.

14.6.57 Access to Kempston Wood via NMU routes would be improved from the southern side of the A421 where severance is currently high due to no safe crossing facility at this location. However the Scheme would run through the southern section of the site. This would result in some direct loss of land from the site and increased traffic and elevated noise levels.

14.6.58 Therefore the overall effects on public open space are considered to be **neutral** even though there would be some direct loss, access by PRoW to some sites would be improved.

Effects on Future Changes to the Network

14.6.59 The BCC proposal for extension to BW 29 and the proposed Sustrans route would be unaffected by the Scheme proposals. The extension to BW 29 does not cross the Scheme though it would run adjacent to the Scheme for a short length from Brogborough Landfill Site to North Common Farm. This section of BW would also run adjacent to the existing A421 without the Scheme so the effects are considered to be neutral. The proposed Sustrans route crosses the Scheme and would use the intended underpass at Berry Farm Wood to do so, thereby incurring no diversions and the effects are considered to be **neutral**.

14.7 Summary

14.7.1 This Chapter considers the effects of the Scheme on pedestrians, cyclists, equestrians and the local community, in terms of severance.

14.7.2 The Scheme would disrupt local footpath use during the construction phase, although footpath diversions and closures would be kept to a minimum. A proposed Traffic Management System would aim to minimise disruption to traffic and community severance.

14.7.3 The Scheme would result in the diversion of some local footpaths. However, the Scheme design aims to retain the existing footpath network through the provision of overbridges and underpasses (some of which are solely for NMUs) and new footpath diversions. The provision of overbridges and underpasses would provide safe points to cross the new A421 and thus allow north-south movement by users, an amenity which does not currently exist in a safe manner as many users have to cross the busy A421. As the majority of routes are used for leisure purposes only, it is considered that the diversions would contribute to a safer, improved PRoW network. However, for some users, the physical aspects such as bridges and diversions and increased noise levels in the area may make journeys less attractive.

14.7.4 The Scheme would deliver an extra 5040m of new PRoW strategically linking certain Rights of Way and forming circular routes.

14.7.5 The downgrading of the existing A421 to provide local access and the provision of a cycleway and equestrian route would increase the network in the Scheme vicinity for cyclists, equestrians and pedestrians, although the creation of footways and segregated road markings for non-motorised users would be subject to agreement by Bedfordshire County Council.

14.7.6 Introduction of the Scheme would reduce community severance through safer crossings for PRoW in the network.

References

Highways Agency, *Design Manual for Roads* and Bridges: Volume 11, Section 3, Part 8.

Department for Transport (2003), *TAG Unit 3.6.2 Severance,* Transport Analysis Guidance (TAG)

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Highways Agency (2005), *A421 Improvements M1 J13 to Bedford, Stage 2 Environmental Impact Assessment Report*, Report No 1014_GD00612_LNR_RE

Woodland Trust, *Reynolds Wood* http://www.wt-woods.org.uk/reynoldswood/description.asp

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15 VEHICLE TRAVELLERS

15.1 Introduction

15.1.1 This Chapter reports on how the Scheme would affect vehicle travellers, in terms of their view from the road and levels of driver stress. The impact assessment has been undertaken in accordance with the guidance given in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 9.

15.2 Methodology

View from the Road

15.2.1 The assessment of travellers' views is based on the method laid out in DMRB. Traveller views from the road are defined as the extent to which travellers (including drivers), are exposed to the different types of scenery through which a route passes. The route is described as running west to east, although views from both directions are noted where applicable. The methodology set out in the DMRB suggests the following should be considered:

- The types of scenery or the landscape character as described and assessed for the baseline studies
- The extent to which travellers may be able to view the scene
- The quality of the landscape as assessed for the baseline studies
- Features of particular interest or prominence in the view.

15.2.2 The travellers' perception of the landscape through which they are travelling would vary with the road level, design, the surrounding ground level, season, time of day and vegetation. The DMRB categorises the view from the road as being:

- No view: where the route is in a deep cutting or surrounded by earth bunds, environmental barriers or adjacent structures
- Restricted view: where there are frequent cuttings or barriers blocking the view
- Intermittent view: road generally at ground level, where there are shallow cuttings or barriers at intervals
- Open view: where the route is at grade or on embankment and where the view extends over many miles or is only restricted by landscape features.

15.2.3 Views from the road can be divided into general views based on the area through which the traveller is passing, and specific views directed to a particular feature or point of interest.

15.2.4 In assessing travellers' views, it is relevant to understand the sensitivity of travellers to changes in the landscape and views from the road. This relates, not only to the speed at which the landscape is viewed, but also the need to concentrate on the road itself.

15.2.5 There are no established criteria for defining the level of impact (or the significance of resulting effects) that a road scheme has on traveller views. Effects upon traveller views have been described in this report as being High, Moderate, Low, or Neutral and have been applied to both construction and operational phases. Effects can be either beneficial or adverse.

15.2.6 As part of the landscape and visual assessment included in this Environmental Statement (ES), vehicle travellers are considered to be low sensitivity visual receptors because they tend to have low duration and degree of exposure to views.

Driver Stress

15.2.7 Using the method laid down in DMRB, an assessment of traveller stress has been carried out along the existing and proposed routes.

15.2.8 Driver stress is defined in DMRB for the purposes of environmental assessment as "*the adverse mental and physiological effects experienced by a driver traversing a road network"*. A variety of factors including traffic speed and flow, number of junctions, evenness of road surfacing and road layout can influence stress levels and induce *"feelings of discomfort, annoyance, frustration or fear culminating in physical and emotional tension that detracts from the value and safety of a journey*". The extent of stress induced in drivers depends upon the individual's skill, experience, state of health, knowledge of the route, and temperament. Increased stress results in decreased driving standards, although this varies between individuals.

15.2.9 Driver stress has three main components:

- Frustration
- Fear of potential accidents
- Uncertainty relating to the route being followed

15.2.10 The definition of these terms as stated in DMRB is detailed in the paragraphs below.

15.2.11 "*Frustration is caused by a driver's inability to drive at a speed consistent with his or her own wishes in relation to the general standard of the road.*" Frustration increases as speed falls and may be due to roadworks, congestion or difficulties in overtaking slower traffic.

15.2.12 Fear of potential accidents results from the presence of other vehicles, inadequate sight distances, and the likelihood of pedestrians stepping out into the road. Additional factors such as inadequate lighting, roadworks, narrow roads and poorly maintained surfaces are also contributing factors. DMRB indicates that fear is highest where traffic speeds, flows and the percentage of heavy goods vehicles (HGVs) are all high and these factors are of more importance during adverse weather conditions. A new scheme may increase driver stress because of increased traffic speeds and flows, although this is often offset by the superior geometrical standards of a new scheme.

15.2.13 Uncertainty is defined within DMRB as being primarily caused by signing where it is inadequate to the individual's purposes.

15.2.14 To provide an indicator of driver stress, the DMRB tabulates the relationship between average peak hourly vehicle flow per lane and average journey speed in kilometres per hour to describe levels of driver stress on a three-point descriptive scale: Low, Moderate or High. The two tables relevant to this Scheme are, firstly, stress on single carriageway roads, which represents the existing situation. And, secondly, stress on dual carriageway roads, which represents the Scheme. These are set out in Tables 15.1 and 15.2.

Table 15.1 Stress on Single Carriageway Roads

Average peak hourly flow per lane, in flow Units/ 1 hour	Average Journey Speed Km/hr		
	Under 50	**50 - 70**	**Over 70**
Under 600	High[1]	Moderate	Low
600 – 800	High	Moderate	Moderate
Over 800	High	High	High

A car or light van equals one flow unit. A commercial vehicle over 1.5 tonnes unladen weight or a public service vehicle equals 3 flow units.

[1]"Moderate" in urban areas

Table 15.2 Stress on Dual Carriageway Roads

Average peak hourly flow per lane, in flow Units/ 1 hour	Average Journey Speed Km/hr		
	Under 60	**60 - 80**	**Over 80**
Under 1200	High[1]	Moderate	Low
1200 - 1600	High	Moderate	Moderate
Over 1600	High	High	High

A car or light van equals one flow unit. A commercial vehicle over 1.5 tonnes unladen weight or a public service vehicle equals 3 flow units.

[1] "Moderate" in urban areas

15.2.15 The potential effects that physical features have on driver stress have also been considered – again using a three point descriptive scale of High, Moderate or Low (refer to Table 15.3). These criteria have been used previously for assessing driver stress related to major highway schemes.

Table 15.3 Significance of Effects on Driver Stress

Significance of Effects	Description
High	• Heavily congested roads, resulting in a great deal of stopping and starting, and queuing • Numerous junctions • High road usage by slow agricultural vehicles and HGVs • Lack of clear signage • Cars parked on the side of the road, restricting access • Cyclists on the road • Pedestrians crossing the road away from official crossing points • Winding, confusing roads • Poor road surfacing • No laybys and/or driver facilities • No street lighting

Significance of Effects	Description
Moderate	• Congested roads, particularly during rush hours • Moderate road usage by slow agricultural vehicles and HGVs • Limited signage • Some pedestrians and cyclists using/crossing the road • Some car parking on the side of the road • Fairly frequent junctions • Variable quality surfacing • Limited number of laybys and/or driver facilities • Variable street lighting
Low	• Straight roads with few bends and even surfacing • Low road usage by slow agricultural vehicles and HGVs • Separation of pedestrians and cyclists from motorists • Any pedestrian crossings marked clearly • Few junctions • Low numbers of vehicles • Clear signage • Provision of laybys and/or driver facilities • Provision of street lighting

15.2.16 DMRB requires an assessment to be made for the existing situation and also for the worst case in the 15 years after opening. Traffic data for the year 2005 has been used to assess the degree of driver stress in the existing situation, and predicted traffic flows and speeds for 2025/26 have been used to assess the situation in year 15 after Scheme opening, the worst case year.

15.3 Baseline Conditions

View from the Road

M1 Junction 13 (M1 J13) to Brogborough Hill

15.3.1 Vehicle travellers using the existing A421 from M1 J13 travelling east towards Bedford are presented with views to the south of the M1 and the large industrial warehouses of the Prologis Distribution Park which are also illuminated at night. To the north, the view is of open countryside towards Salford Road, interrupted periodically by planting including conifer hedgerows. The view travelling west in this location is of M1 J13, which is lit and includes a number of signalled junctions. Travelling east towards Brogborough, the view is generally contained within the road line, with glimpsed views of Prologis Park to the south and of paddocks and smallholdings to the north.

15.3.2 The settlement at Brogborough provides visual distraction. East of Brogborough, the road rises to traverse the southern side of Brogborough Hill. From the apex of the hill, the views to the east are very wide and include Lidlington, Stewartby brickworks, the town of Bedford and the historic airship hangers located at Cardington. Southwest from this location, the views are of the M1, Prologis Park and beyond to the Greensand Ridge, which runs broadly parallel to the M1 and includes Aspley Guise.

Brogborough Hill to Wood End

15.3.3 As the road descends to the east of Brogborough Hill into Marston Vale, vehicle travellers' views are restricted to the road corridor with glimpses through vegetation across Brogborough Lake to the south towards Lidlington and the Greensand ridge and to Brogborough Landfill Site to the north. The quality of the landscape in this area is poor and the views afforded are of a degraded landscape. Litter is particularly obvious to the road user.

15.3.4 As the road continues to make its way around Brogborough Lake, views are less interrupted and the quality of the view to the south of the Greensand Ridge improves. Conversely, the view to the north deteriorates as vehicle travellers are exposed to more open views of the landfill site, its associated traffic and infrastructure.

15.3.5 The road continues to sweep around Brogborough Lake towards Marston Moretaine. Beyond the landfill site to the northwest, the views open up to the countryside beyond, which is relatively featureless. In the distance the road user has views towards Marston Thrift Nature Reserve and the urban fringes of Cranfield.

15.3.6 A small cluster of houses and small businesses including Vale Farm and Escheat Farm prevents views to the north. On the approach to Wood End, the view is generally restricted to the road by road side vegetation.

Wood End to Lower Shelton

15.3.7 The view between Wood End and Marston Moretaine is generally limited to the road by the presence of mature vegetation with oblique views to the north-east towards Marston Moretaine, including Marston Moretaine church. As the traveller nears the Marston Junction at Marston Moretaine, he or she is presented with views to the northwest of a service station, motel and roadside restaurant which is illuminated at night along with the junction itself. Views to the south into Marston Moretaine along Beancroft Road are possible, but are limited due to the speed of travel.

15.3.8 To the east of Beancroft Road, the A421 is a dual carriageway, which is partly lit at night and includes a grassed central reservation allowing views across all four lanes of traffic. To the north, the vehicle traveller has views of the settlement of Lower Shelton and the arable countryside surrounding it. Views range from open in some locations to limited in others, where intermediate vegetation provides screening. To the south, views into Marston Moretaine are limited by roadside vegetation and a close boarded fence which runs along much of the dual-carriageway allowing views of top storey windows of houses.

Lower Shelton to Fields Road, Wootton

15.3.9 East of Lower Shelton, the view from the road is dominated to the north by large open agricultural fields and to the south by sparse residential properties and mature vegetation. East of Green Lane, the road becomes enclosed by roadside hedgerows and trees focusing the travellers' view to the road. To the south of the road, Stewartby Landfill Site dominates the skyline from the perspective of the vehicle traveller, as the traveller is close to the road and the landfill is several metres high. On the opposite side of the road, where gaps in hedgerows and vegetation allow, there are views into Berry Farm Wood, and beyond to the urban limits of the village of Wootton.

15.3.10 To the east of Broadmead Road, views to the south are across flat, open agricultural fields and include a railway line in the mid-distance. Beyond, the westbound traveller has clear views of the tall chimneys of Stewartby brickworks.

Fields Road, Wootton to Marsh Leys Junction

15.3.11 Beyond Fields Road the view is dominated to the north by the village of Wootton, which can be seen in the distance over agricultural fields. To the south, the views remain open across the surrounding landscape until Manor Road. Beyond Manor Road, the views to the south are dominated by the large industrial sheds of Marsh Leys Distribution Centre, which is surrounded by a large vegetated bund. East of Manor Road the landscape is open, affording views towards the urban fringes of Kempston on the edge of Bedford.

15.3.12 As the vehicle traveller approaches the Marsh Leys roundabout, the view is dominated by a large sculpture signifying the Forest of Marston Vale, which is constructed from brick and steel and symbolises the area. The sculpture includes representations of swans in flight, and brickworks. The Marsh Leys Distribution centre warehouses to the south of the road visually dominate this area and draw the traveller’s eye away from the road.

Marsh Leys Junction to the A6

15.3.13 East of the Marsh Leys roundabout, the view to the north of the road is of the Woburn Road Industrial Estate in the foreground and residential areas of Bedford beyond. To the south, as the road is on embankment, the views are generally open towards the Marston Vale and are dominated by the Marsh Leys Distribution Centre which is surrounded by lakes and ponds on its northern side. Long distance views include the chimneys of Stewartby brickworks.

15.3.14 As the traveller approaches the roundabout at the Interchange Retail Park, views of the roofs of buildings are seen to the north. To the east, the A421 passes under the A6 and the traveller’s view is dominated by a large junction with industrial buildings to the north and a service station and hotel to the south. The landfill site between the A6 and B530 is also visible from this location.

Driver Stress under Existing Conditions

15.3.15 Representative sections of the existing A421 have been assessed according to the driver stress criteria as detailed in Tables 15.1, 15.2 and 15.3, above, and the results shown in Table 15.4, below. For ease of comparison, the table has been spilt into the descriptive sections considered in the paragraphs above.

15.3.16 Table 15.4 indicates that both east- and westbound drivers are likely to experience high levels of stress.

Table15.4 Existing A421 - Driver Stress Levels (2005 Flows)

Location	Average peak hourly flow per lane, in flow Units/1 hour	Average Speed (km/h)	Driver Stress
Eastbound			
M1 J13 to Brogborough	1284	49	High
Brogborough to Marston Moretaine	1293	43	High
Marston Moretaine to Lower Shelton Road (Dual)	642	103	Moderate
Lower Shelton Road to Fields Road, Wootton	1635	35	High
Fields Road, Wootton to Marsh Leys Junction	1426	11	High
Marsh Leys Junction to A6	1559	43	High

Location	Average peak hourly flow per lane, in flow Units/1 hour	Average Speed (km/h)	Driver Stress
Westbound			
M1 J13 to Brogborough	1209	37	High
Brogborough to Marston Moretaine	1085	57	High
Marston Moretaine to Lower Shelton Road	605	81	Moderate
Lower Shelton Road to Fields Road, Wootton	1489	41	High
Fields Road, Wootton to Marsh Leys Interchange	1595	36	High
Marsh Leys Interchange to A6	1739	36	High

15.3.17 As highlighted in paragraph 15.2.9, above, three factors contribute to driver stress, namely: frustration, fear of accidents and uncertainty. Taking into account the existing conditions on the A421, it is considered that driver stress is being caused by the following:

- The existing A421 is generally a single carriageway which has lengths of substandard alignment where forward visibility, horizontal and vertical curvature are below current standards for a modern single carriageway road. The high volumes of opposing traffic and limited overtaking opportunities are also sources of driver stress, as are the high volumes of HGV traffic (frustration and fear of accidents).
- Traffic joining from side roads, driveways or waiting to make right turns off the trunk road are frequently subject to delays (frustration and fear of accidents)
- The A421 is a variable speed road and the driver is required to reduce speeds from national speed limits for a single carriageway to 50mph at Brogborough. (frustration, uncertainty and fear of accidents)
- The volume of traffic in the peak hours is already in excess of 800 vehicles/lane, except on the 1.6 km dual carriageway section, which leads to journey speeds that are below many drivers' expectations (frustration and fear of accidents)
- Pedestrians and agricultural vehicles crossing the A421 (fear of accidents)
- Cyclists can slow other vehicles down due to the single lane width and limited overtaking opportunities (frustration and fear of accidents)

15.3.18 Taking into account the points raised above, and the criteria included in Table 15.3, above, it is considered that the road's physical characteristics are likely to cause a high adverse effect on driver stress.

15.4 Mitigation and Detailed Development of the Scheme Design

15.4.1 The Scheme would be constructed as a dual two-lane all-purpose rural trunk road as detailed in Figures 4.1.1 - 4.1.10, with the exception of the easternmost 600m, which would be dual three-lane, with grade-separated junctions. Such a design would relieve problems due to driver stress from congestion, overtaking of slow vehicles, access from side roads and the associated frustration and uncertainty.

15.4.2 In order to mitigate driver stress during the construction phase, a Traffic Management System would be used which would have the aim of minimising traffic disruption (see Chapter 4: Description of the Scheme).

15.4.3 The road would be lit at all junctions. The mainline would not be lit. Proposals for lighting are shown on Figures 4.2.1 - 4.2.2. These illustrate where new lighting would be provided and where lighting on the existing A421 would be removed. The visual impacts of lighting are covered in Chapter 8: Landscape and Visual Assessment.

15.4.4 The signage strategy for the Scheme would comply with current standards. Distance signs would be provided at the appropriate intervals, whilst all roundabout and junctions would be signed on the approaches. Direction signs to local towns and villages would be provided off roundabouts and junctions. The landscape planting would be designed to ensure it would not obscure sign sightlines, thereby reducing driver stress from uncertainty.

15.4.5 The landscape strategy for the Scheme has been developed to replace areas lost to the Scheme, whilst conserving, restoring and increasing the diversity of the planting types in line with the objectives of the Highways Agency, local planning policy and the Forest of Marston Vale. The strategy aims to reduce the Scheme's adverse visual impact on the landscape, people and properties and integrate the Scheme into the local landscape. The strategy objectives have been achieved by:-

- Retention of existing vegetation where possible
- Integration and screening of junctions and structures with enveloping planting
- Design of balancing ponds as natural features where possible
- Screening of residential properties where appropriate with planting
- Use of local provenance plant material from Marston Vale
- Retention and integration of existing hedgerows within the Scheme where practicable
- Grading out of earthworks to integrate the Scheme into the local landscape

15.4.6 Further details are provided in Chapter 8: Landscape and Visual Assessment.

15.5 Environmental Effects

15.5.1 During Scheme construction there would be adverse impacts associated with the views of the construction works. However, these would be limited to the duration of construction. As working areas are completed and restored, the visual effect of the works would diminish until the day of Scheme opening when all restoration and mitigation measures would be in place (although planting would be immature). The presence of existing vegetation, retained as part of the Scheme would continue to interrupt views in some locations. During Scheme operation, the landscape planting and other mitigation measures would mature and the effect of these measures would reach an optimum level by year 15 of Scheme operation.

Effects of Construction

View from the existing A421

15.5.2 The variety and quality of views available to the traveller would alter as traffic is managed throughout the construction programme. As much of the works is off line, only limited lengths of the existing A421 would be directly affected by the construction process. A description of various changes and extent of views along the proposed alignment is provided below

15.5.3 Construction impacts which could affect vehicle travellers' views include the following:

- Signs indicating speed restrictions and carriageway switch-overs
- Road cones indicating contra-flow and works areas
- Temporary lighting during the winter to illuminate the works
- Adjacent haul routes with plant and equipment travelling parallel, and in the opposite direction, causing potential confusion
- Views of large pieces of construction equipment
- Tree and hedgerow felling opening up views
- Creation of cuttings and mounds to screen views
- Creation of embankments to open up views
- Construction compounds, offices, material and equipment stores.

M1 J13 to Brogborough Hill (Ch. 0 - 2000)

15.5.4 At M1 J13, much of the existing vegetation on either side of the existing A421 would be lost during construction to make way for the construction of the revised junction. This would open up views to the passing motorist to the south towards Aspley Guise and Church End.

15.5.5 The area surrounding M1 J13 during construction would be subject to disturbance. Part of the area to the east of the junction would be used for the location of a site compound. The compound would house offices, car parking, workshops and temporary storage for materials and plant. While traffic is still using the old A421, this compound would be relatively well screened.

15.5.6 Much of the work around the junction would be carried out under traffic management, increasing the amount of driver confusion and stress. As construction progresses earthworks material would be moved around the site for the creation of raised junctions and embankments. Some night work would be carried out to install bridge beams across the M1 carriageway, which would be visible to vehicle travellers on both the existing A421 and the M1.

15.5.7 While traffic is still using the existing A421 much of the work between Ch.400 and 1200 would be screened from the passing motorist due to intermittent vegetation, although works would be more visible during the winter months when deciduous trees and shrubs are not in leaf.

15.5.8 However, the creation of the cutting through Brogborough Hill between Ch.700 and 2050 would result in considerable earth movement which would be visible to the passing motorist using the existing A421 and Salford Road. This work would also necessitate the removal of existing vegetation including sections of hedgerow and some areas of young and mature woodland. It is anticipated that earth moving equipment would use a haul road constructed along the proposed alignment. The installation of the new bridleway bridge across the cutting at Ch.1750 would also be visible from the existing A421.

15.5.9 The overall effect on vehicle travellers' views in this area during construction is considered to be **high adverse**.

Brogborough Hill to Wood End (Ch.2000 - 5000)

15.5.10 From Ch.2000, the new road would be constructed on an embankment requiring the movement of large volumes of material which would be visible from the existing A421, as it is close to the proposed alignment. A considerable amount of existing vegetation would be removed in this area opening up views to the vehicle traveller particularly to the southeast across Brogborough Lake and beyond to the Greensand Ridge.

15.5.11 Between Ch.2200 and 3200 a new embankment would be constructed to the south of the existing A421 upon which the existing A421 would be realigned.

15.5.12 At Ch.3000, the Scheme would diverge from the existing A421 to the north. The construction of this section of the carriageway, which would be on a slight embankment, would be visible from the existing A421 to travellers. While traffic is still using the existing A421 between Thrupp End Road and Beancroft Road, the effects of construction of the new carriageway would be screened by buildings and intermittent vegetation. Local traffic accessing residential properties and businesses at Wood End would be visually affected by the construction of the road in this area.

15.5.13 The overall effect on vehicle travellers' views in this area at the time of construction is considered to be **moderate adverse** due to the intermittent nature of the views of the construction works.

Wood End to Lower Shelton (Ch.5000 - 7000)

15.5.14 Vehicle travellers using the existing Beancroft Road would be subject to disruption during construction as the road is realigned. Also the construction of the cutting to accommodate the new Marston Junction would involve a considerable amount of construction equipment. Activities would be visible to motorists using the existing A421 dual carriageway to the east of Marston Moretaine. During construction, the current eastbound carriageway would be closed and broken up, requiring traffic management and contraflow on the westbound carriageway. The construction of the new junction, main carriageway and realignment of local roads would require the removal of some existing vegetation including hedgerows. This would open up views, which are not currently visible from the existing road. The resulting effect is considered to be **high adverse**.

Lower Shelton to Fields Road, Wootton (Ch.7000 - 10000)

15.5.15 While traffic is restricted to the existing A421, vehicle travellers would be subject to views of the construction of the new mainline. As the new road moves away from the existing A421, views of construction activity for passing motorists would be intermittent due to intervening vegetation. Vehicles using the existing A421 would however experience views of the main construction compound which would be located between the proposed A421, the existing A421, Hoo Lane and Green Lane, but would be partly screened by the existing hedge. The compound would include offices, welfare facilities, car parking, workshops, temporary storage of materials, equipment, a recycling centre and staff accommodation. This would be a large and active site, which may cause distraction to the passing motorist.

15.5.16 Overall, it is considered that there would be a **moderate adverse** effect on travellers' views, due to the proximity of the works to the existing A421.

Fields Road, Wootton to Marsh Leys Junction (Ch.10000 - 11450)

15.5.17 The construction of the new over-bridge at Fields Road would be clearly visible to vehicle travellers using the existing A421. The bridge would span both the new and existing roads and would require traffic management and possibly night time working, causing visual distraction to the road user. The bridge embankments would also begin to alter views from the existing A421 towards Wootton and Kempston to the north. A new bridleway bridge at Manor Road would also cause visual distraction to the passing motorist during construction. The construction of the embankments adjacent to the existing A421 would screen existing views to the north and there would be considerable heavy goods traffic here during construction.

15.5.18 The construction of the Marsh Leys Junction would be highly visible to passing motorists. The construction of the flyover would involve the use, and storage, of large quantities of construction materials and heavy plant including large cranes. During construction, existing vegetation would be lost including hedgerows, opening up views to the north. The construction of the embankments and bridge deck, however, would block views for vehicle travellers to the east towards Kempston.

15.5.19 Overall, it is considered that there would be a **high adverse** effect on travellers' views, due to the proximity of the works to the existing A421.

Marsh Leys Junction to A6 (Ch.11450 - 13600)

15.5.20 The widening of the road in this location would require the movement of construction materials which would be visible to the passing motorist. A new railway bridge would be constructed at Ch.13000. The loss of the existing roundabout at the Interchange Retail Park junction early in the Scheme would be particularly apparent to the vehicle traveller. The effect is therefore considered to be **high adverse**.

Driver Stress

15.5.21 Construction impacts for the vehicle driver, which could result in driver stress, include:-

- Creation of uneven road surfaces
- Abundance of temporary signs indicating speed restrictions, carriageway switchovers, temporary closure of side roads, etc
- Closure of side roads
- Temporary lighting during winter
- Adjacent haul routes with plant and equipment travelling parallel in the opposite direction causing potential confusion with headlights
- Construction plant crossings
- Speed restrictions
- Traffic congestion
- Tie-ins into existing road.

15.5.22 The greatest sources of driver stress are likely to be the creation of the tie-ins at M1 J13; where the existing A421 passes Lower Shelton Road; Fields Road Overbridge; Marsh Leys Junction and the section to be widened on line east of Marsh Leys. The traffic layouts would change as various parts of the construction are completed.

15.5.23 The vehicle traveller is likely to continue to experience high levels of stress throughout the construction period and may well experience queuing, restricted traffic movements and speed limits within the roadworks for limited periods.

15.5.24 In order to mitigate driver stress during the construction phase, a Traffic Management System would be used which would have the aim of minimising traffic disruption (see Chapter 4: Description of the Scheme).

Effects during Operation

View from the Road during operation

M1 J13 to Brogborough Hill (Ch.0 - 2000)

15.5.25 The proposed improvement to M1 J13 comprises three separate roundabouts, all of which would be raised above the existing ground level by several metres. Considerable areas of woodland planting both on embankments and within the areas between the roads which link the roundabouts would result in restricted or intermittent views of the surrounding landscape during the summer months. This would reduce the scale of this large, complex junction to the vehicle traveller.

15.5.26 Continuing east from the M1 J13 (Ch.400–1200), views to the north would be restricted by tree and shrub planting adjacent to the carriageway and to the south by significant woodland planting. The planting in this area would create a wooded gateway to the Forest of Marston Vale, giving the road user an impression of relative enclosure. Views east from this location would be of the cutting through Brogborough Hill, which would be 15m deep at its deepest point. The curved alignment through the cutting means that complete views through the cutting to the landscape on the eastern side of the hill would not be possible. Despite being in cutting, vehicles travelling in a westerly direction between Ch.1600 and 800 would have wide open views towards Aspley Guise, due to the height of the land at this point.

15.5.27 Within the cutting, views either side of the carriageway would be restricted by the slopes which would be seeded and planted with trees and shrubs. Vehicles travelling east from Ch.1500 would be presented with an open, framed view of the Marston Vale between the sides of the cutting and the Manor Farm Bridleway 1 Overbridge, which would cross the cutting at Ch.1750. The view between here and Ch.2000 would be the most extensive possible from the Scheme. As vehicles pass under the bridge travelling east, features including Bedford and Stewartby Brickworks to the northeast and Lidlington and Millbrook Proving Ground to the southeast would come into view.

15.5.28 In comparison with the baseline views, the visual effect on vehicle travellers using the existing road is considered to be **moderate beneficial**.

Brogborough Hill to Wood End (Ch.2000 - 5000)

15.5.29 At Ch.2100, the road changes from being in cutting to being on an embankment. Between here and Ch.3100, intermittent views would be available to the northwest towards Brogborough Hill and the landfill site. By the year 2025/26, this area would be planted with woodland as part of the Forest of Marston Vale. To the southeast, the landscape proposals allow for intermittent views across Brogborough Lake towards the village of Lidlington and the wooded greensand ridge beyond providing a variation in view.

15.5.30 Between Ch.3100 and 4000, the road would be on a slight embankment and road users would have intermittent views through or over the hedgerows on either side of the road across the arable landscape beyond, and of Vale Farm Bridleway 31Overbridge at Ch.3630. Vehicles travelling towards Bedford would have open views towards Wood End where the Wood End Ooverbridge with associated woodland planting would be located. Vehicles travelling west towards the M1 would have views dominated by the wooded Brogborough Hill and the cutting, which passes through it.

15.5.31 Beyond Ch.4000 the road would remain on embankment. Views from the road would, however, be screened to some extent by the woodland planting which is proposed on the northbound side of the road between Ch.4300 and 4500, and then by the earth bunding between Ch.4900 and 5300. This bunding would also be planted with trees and shrubs further restricting views. Views to the south would be intermittent, interrupted beyond Ch.4350 by tree and shrub planting and the earthworks associated with the Wood End Overbridge.

15.5.32 The effect on the views of vehicle travellers is considered to be **moderate beneficial**, in comparison with the views from the existing A421.

Wood End to Lower Shelton (Ch.5000 - 7000)

15.5.33 Bunding with associated tree and shrub planting on either side of the road between Ch.5000 and 5400 restricts views to the line of the route. Between Ch.5400 and 5600, the road would be on a slight embankment and would be bounded on the northern side by a hedge. Views to the north are correspondingly wide and open towards the ridge some 1.25km away. Views from the road to the south however are contained by woodland which screens Marston Moretaine from the road. Prominent in the view travelling east from Ch.5400 would be the grade-separated Marston Junction (Ch.6000) at Marston Moretaine. The landscape mitigation proposals for this junction include extensive areas of tree and shrub planting, which screen much of the associated road infrastructure including parts of slip roads.

15.5.34 At Ch.6000 the road would be within cutting, restricting views within the road corridor. As it rises back to grade at approximately Ch.6400, views would be restricted by roadside screening vegetation which separates the mainline of the road from the local access roads. Between Ch.6500 and 6800, there would be intermittent views of the residential areas of Marston Moretaine to the south and Lower Shelton to the north. From Ch.6800, this would be screened out by noise fencing.

15.5.35 The effect on the views of vehicle travellers is considered to be **low beneficial**, in comparison with the views from the existing A421.

Lower Shelton to Fields Road, Wootton (Ch.7000 - 10000)

15.5.36 Between Ch.7000 and 7850 the road would be enclosed on both sides by woodland and tree screening (and close to Lower Shelton Road by noise fencing), focusing the driver's eye on the road. At Ch.7850 views to the north of the road open up to give views through and over the hedge to Berry Farm Wood beyond. This open character continues through to Ch.10000 allowing intermittent views of the urban edge of Wootton through the roadside vegetation and the northern limits of Berry Wood. Extensive roadside woodland planting between the new and existing A421 would restrict views to the south. The overbridges and double roundabout at Fields Road, Wootton would dominate the view in both directions between Ch.9300 and 10600. Tree and shrub planting on the embankments of the overbridge would screen much of the engineering from the road user.

15.5.37 In general, the improvements to the A421 would result in a **neutral** effect on travellers' views.

Fields Road, Wootton to Marsh Leys Junction (Ch.10000 - 11450)

15.5.38 Between Ch.10000 and 10600, views to the north would be restricted by noise fencing. Views to the south would be restricted by roadside woodland planting with some open areas of grassland increasing the sense of scale. Between Ch.10600 and 10900, the road would be again enclosed by woodland and tree screen planting, reducing the sense of scale and restricting views either side of the carriageway to the line of the road. Manor Road Bridleway 23 Overbridge, located at Ch.10600, would provide a visual distraction to the road user. The embankments would be left open allowing views from the road beyond to the adjacent woodland.

15.5.39 Marsh Leys Junction, located at Ch.11450, would visually dominate the surrounding area. The main carriageway would rise approximately 8 metres above the surrounding ground level. Travellers approaching the junction from either direction would be faced by the elevated carriageway, roundabout and associated lighting columns providing intermittent views beyond to the urban fringes of Kempston. Open views would be available to the south of the Scheme towards the large Marsh Leys Distribution Centre buildings. The landscape treatment on and around the junction would include both woodland and tree screen planting and semi-ornamental planting giving seasonal interest to the road user. The striking 'Swan Sculpture' representing the Forest of Marston Vale would be of particular visual interest. This would be particularly visible to traffic travelling towards the M1 both on the mainline and using the roundabout below.

15.5.40 Vehicles on the elevated carriageway would have open views in all directions. From this location, travellers would be able to see the southern areas of Kempston and

Bedford to the north, Wootton to the southwest and Cardington Hangars to the northeast.

15.5.41 The effects of the A421 improvements are considered to be **Low Adverse** due to the increase in scale of junctions at Fields Road and Marsh Leys.

Marsh Leys Junction to Interchange Retail Park (Ch.11450 - 12750)

15.5.42 The road would be on a high embankment at this point, located several metres above the surrounding ground level. Views from the Scheme to the south remain open, obstructed occasionally by intermittent vegetation. From this section of road, the distribution centres at Marsh Leys would dominate the view with long distance views beyond to the tall chimneys at Stewartby brickworks. In the foreground, the lakes, some of which are attractively planted would provide visual interest to the road user. North of the road, where the existing vegetation is more substantial, intermittent views of the urban areas of Bedford and Kempston are available in the distance with restricted views of Woburn Road Industrial Estate below the embankments.

15.5.43 Again, due to the scale of features including the Marsh Leys Junction and the widening of the main carriageway, the overall effect on vehicle travellers' views is considered to be **low adverse**.

Summary of Traveller Views

15.5.44 During Scheme construction there would be adverse impacts associated with the views of the construction works. However, these would be of limited duration and would not all occur at once. As working areas are completed and restored, the visual effect of the works would diminish until the day of Scheme opening when all restoration and mitigation measures would be in place (although planting would be immature and ineffective as a visual screen). During Scheme operation, travellers' views from the Scheme would be contained by existing and proposed roadside vegetation along the majority of its length. Variety would be provided by open views such as those across Brogborough Lake, and between Berry Wood and Wootton. Travellers' views from the road would generally be intermittent or restricted with occasional open views across a mix of water bodies, woodland, open countryside and urban areas. The tree and shrub structure planting and other mitigation would mature and the effect of these measures would reach a minimum required level by year 15 of Scheme operation. The established planting would be effective in integrating the road into its landscape setting. At this time the effects on travellers' views would range from **low adverse to moderate beneficial** in comparison with the baseline view.

Driver Stress

15.5.45 It is considered that the Scheme would reduce driver stress for the following reasons:

- The Scheme has been designed using the latest geometric design criteria providing a significant improvement in terms of reduced congestion and improved safety
- The Scheme would provide route certainty, due to clear signage
- Cyclists, equestrians and pedestrians would be diverted away from the road onto footpaths and bridleways that pass under or over the Scheme, thus removing conflicts
- Vehicles wishing to cross the A421 would be able to pass across the Scheme safely on dedicated overbridges or underpasses and not be subject to delays
- Laybys would be provided for temporary vehicle traveller use
- Slower traffic could be safely overtaken by other motorists

- The provision of grade-separated junctions would enable the free flow of traffic, eliminate right turns, and resulting queuing, thus reducing driver frustration and stress, and increasing safety.

15.5.46 Using data from the traffic model (refer to Chapter 4), and the qualitative criteria listed in Table 15.3, above, an assessment of driver stress has been made for the situation 15 years after Scheme opening (2025/26). This is shown in Table 15.5, below.

Table 15.5 Scheme Design Year - Driver Stress Levels (2025/26 Flows)

Location	Average peak hourly flow per lane, in flow Units/1 hour	Average Speed (km/h)	Driver Stress
Eastbound			
M1 J13 to Marston Junction (Dual)	1362	91	Low
Marston Junction to Marsh Leys Junction (Dual)	1706	74	Low
Marsh Leys Junction to A6 (Dual three lane)	1368	77	Low
Westbound			
M1 Junction 13 to Marston Junction (Dual)	1648	77	Low
Marston Junction to Marsh Leys Junction (Dual)	1717	74	Low
Marsh Leys Junction to A6 (Dual three lane)	1341	58	Low

15.5.47 Table 15.5, above, indicates that the Scheme would reduce driver stress levels from the high (moderate on the dual carriageway section) currently experienced, to low. This represents a **significant improvement**. This is primarily due to the greatly improved alignment and carriageway design, and the fact that the road would be grade-separated.

15.6 Summary

15.6.1 This Chapter has assessed the impacts and effects of the Scheme on vehicle travellers. Travellers' views from the existing A421 are generally wide ranging over the predominantly flat agricultural landscape, with a number of settlements, landfill sites and warehouses visible. The existing route is considered to result in high levels of driver stress due to its sub-standard nature.

15.6.2 During Scheme construction, along most of the length of the existing A421, travellers would experience views of the construction works, generally to the north-west of the road. During this time, travellers would generally experience a **high** level of **adverse** visual effect.

15.6.3 The level of driver stress during the Scheme construction phase is expected to remain high, although traffic management procedures would be implemented to reduce stress as far as possible.

15.6.4 During Scheme operation, the overall effect on travellers' views is expected to range from **low adverse to moderate beneficial** (as compared to the existing situation) for the majority of the Scheme, due to the landscape planting proposed, and the more rural views visible from some of the realigned sections. However the 2.75km closest to Bedford would experience a **low adverse** effect.

15.6.5 Scheme operation would have a **beneficial** effect on driver stress due to the increased carrying capacity of the carriageway, enhanced highway design, including grade-separated junctions, provision of lay-bys, safer driving conditions, and the separation of NMU facilities from motorists. Overall, driver stress on the new A421 would be **low** due to the reduction of frustration, fear of potential accidents and route uncertainty; a **significant beneficial** effect.

References

Highways Agency (1993), *Design Manual for Roads and Bridges: Volume 11, Section 3, Part 9. Vehicle Travellers*.

CONTENTS

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16 DISRUPTION DUE TO CONSTRUCTION

16.1 Introduction

16.1.1 This Chapter reports on the predicted effects of Scheme construction on people and the natural environment from the start of the pre-construction works to the end of the contract maintenance period, in accordance with Design Manual for Roads and Bridges (DMRB) Volume 11 Section 3 Part 3. Construction impacts such as noise, dust and loss of amenity, although temporary, may be significant. Construction works are currently planned to commence in 2008 and last approximately two years. It is, therefore, important that nuisance and disturbance to the local community and travellers on and around the A421 Scheme are kept to a minimum during this time. While most construction impacts would be confined to a short distance from the site boundary, other impacts could extend for a considerable distance either along access routes or downstream along potentially affected watercourses. Details of the proposed construction strategy are included in Chapter 4: Description of the Scheme. This includes details of construction operations, the construction programme and traffic management.

16.2 Construction Activities

Pre-Construction Activities

16.2.1 Prior to the onset of the construction works, a range of activities would be required in order to minimise the operational constraints, which are imposed mainly by the area's ecology and archaeology. Activities include the following:

- Pre-construction monitoring in order to confirm area ecological usage
- Badger sett closure and installation of badger fencing (if required)
- Bat roost closure (if required)
- Reptile exclusion/translocation
- Amphibian exclusion/translocation
- Fish exclusion/translocation
- Site clearance prior to the onset of the bird breeding season
- Installation of protective fencing around areas of vegetation to be retained
- Preparation of translocation sites for soils
- Preparation of translocation sites for hedges (if required)
- Treatment of Giant Hogweed and Japanese Knotweed (if required)
- Topographical survey/earthworks recording of identified sites
- Geophysical survey of proposed construction compounds
- Archaeological trial trenching of identified sites, including proposed construction compounds
- Establishment of site accesses and construction plant crossings
- Archaeological investigation of identified sites
- Archaeological watching brief during soil stripping, where necessary.

Main Construction Works

16.2.2 The main activities involved during Scheme construction would be as follows:

- Setting up of construction compounds
- Traffic management
- Diversion of statutory undertakers services
- Site clearance – mainly trees, hedges and other vegetation, but also some structural demolition
- Fencing
- Stripping and storage of topsoil
- Installation of pre-earthworks drainage
- Bulk excavation works
- Bridge construction
- Carriageway drainage
- Road pavement construction
- Finishes (safety fencing, signs and markings)
- Landscape planting and aftercare.

16.2.3 Each of these activities has the potential to cause adverse impacts, covering a number of environmental issues, the most important of which are shown in Table 16.1 below.

Table 16.1 Potential Impacts Associated with Construction Activities

Activity	Potential Impacts
Establishment and use of offices and site compounds	Cultural heritage Air quality Ecology Land use Noise Traffic noise and congestion Visual NMUs Agricultural soils
Site clearance	Cultural heritage Air quality Noise Ecology (both terrestrial and aquatic) Water quality Landscape character Agricultural soils
Pre-earthworks drainage Topsoil strip and storage Bulk earthworks	Cultural heritage Air quality Noise and vibration Ecology (both terrestrial and aquatic) Visual Water quality Agricultural soils

Activity	Potential Impacts
Drainage and pavement construction	Air quality Noise and vibration Cultural heritage Traffic noise and congestion Water quality
Bridge construction	Ecology (both terrestrial and aquatic) Noise and vibration Water quality Visual Cultural heritage
Finishes	Air quality Noise and vibration Traffic noise and congestion Water quality
Landscape (including planting)	Ecology (both terrestrial and aquatic) Visual Water quality Landscape character Cultural heritage Agricultural soils

16.2.4 The Construction Environmental Management Plan (CEMP) described in Section 16.5 outlines how the potential impacts would be avoided.

Construction Compounds

16.2.5 The main construction compound area would be situated between the proposed A421 to the north and the existing A421 to the south, with Hoo Lane to the west and the junction of the existing A421 and Broadgreen Road to the east. The location of the proposed compound is shown on Figure 4.1.7. This location, although not central to the Scheme, provides good access directly onto the site and its haul road. Consideration would be given as to whether the footpath FP1 that crosses the compound and Scheme could remain open during the construction phase dependant on the layout. Once the compound has been demobilised, on completion of the Contract, the site would revert to a landscaped area.

16.2.6 A second compound is planned for the western section of the project. It would be positioned between the proposed A421 to the south, the existing Salford Road to its west and the property known as Llanberis to the north. Landowners would be allowed through the compound area to access other fields severed by the temporary arrangements.

16.2.7 During the construction phase, a number of satellite compounds would also be established to accommodate welfare and storage facilities. The location of these would be identified at a time nearer to construction, but they would be located within the proposed site boundary.

Earthworks

16.2.8 The Scheme has been designed to try and achieve an earthworks balance, whereby the volume of excavated material equals the volume of fill material needed for embankment construction and landscape ground shaping. This method would maximise the use of materials available within the site. It would also minimise the import of materials from quarries and avoid sending inert waste to landfill. Where appropriate or required, material would be modified to maximise its suitability for inclusion in the Scheme. However, it is likely that some material would be required from off site sources to supplement on site materials. Refer to paragraphs 16.5.6 - 16.5.9 below for reference to the requirements concerning borrow pits.

16.2.9 Topsoil would be stripped using an excavator and transported by dump truck to identified stockpile locations. Topsoil would generally be stripped from areas within the construction footprint and may be subject to archaeological watching brief, depending upon the outcome of pre construction surveys. Where possible, topsoil would be stockpiled near the point of excavation or the point of deposition where it would be stored for between 6 and 18 months at a height of no more than 3m. Stockpiles would be sealed and seeded to prevent wind and rain erosion. Proposed soil storage areas are shown on Figures 4.1.1 - 4.1.10. If a surplus of topsoil exists, embankments greater than 2 metres in height may not be stripped. This would have the advantages of reducing programme time and the haulage being required.

16.2.10 The Scheme would require the movement of approximately 2.3m m^3 of material. The main earthworks quantities associated with the Scheme are shown in Table 16.2 below. Approximately 1,730,000 m^3 of this material would be used on-site as structural fill with the remainder used as landscape mitigation fill. Earthworks operations would entail moving earth around the site to achieve the elevation and profile of the new road. Operations would generally be carried out using excavators feeding dump trucks that would transport material to identified fill locations. Fill operations would involve using bulldozers and vibrating rollers. On completion of the areas of embankment construction and backfilling, the balance of the excavated material would be used to form the landscape mitigation fill areas to the designed shape. These areas would be covered with topsoil and planted according to the specified landscape design. The programme aims to minimise any double handling of material. This would reduce construction plant movements and limit the area of land required for temporary storage.

Table 16.2 Major Earthwork Quantities

Material Usage	Volume (m^3)
Bulk excavation	2,000,000
General fill requirements	1,730,000
Surplus excavated fill to be used in landscape areas	150,000
Topsoil excavated	270,000

16.2.11 Wherever possible, haul roads would be located within the proposed Scheme footprint, with two notable exceptions:

- Ch.2700 - 3100: A 10m wide haul road running outside the highway boundary within Brogborough Landfill Site and a possible temporary bailey bridge due to conflicting traffic movements.
- Ch.7000 - 7380: A 10m wide haul road running outside the proposed highway boundary including a possible temporary bailey bridge due to the existing and proposed roads being on the same alignment.

16.2.12 For the purposes of construction, the Scheme would be sub-divided into three main sections as described below:

- Section 1: Ch.0 - 400: M1 Junction 13 (M1 J13) to Salford Road
- Section 2: Ch.400 - 11400: Salford Road to Marsh Leys Junction
- Section 3: Ch.11400 - 13100: Marsh Leys Junction to the A6 Junction.

16.2.13 During the busiest periods of the construction process, the works have been estimated to require a total of approximately 350 heavy duty vehicles (HDVs) and 400 light duty vehicles (LDVs) or cars to access and exit the site each working day. This would increase the existing daily traffic flow of HDVs and LDVs on the A421by 1.3% and 0.3% respectively. The magnitude of the additional noise and air quality impacts of construction traffic on receptors close to the existing A421 and those receptors close to the offline sections is considered to be negligible (refer to Chapters 12 Noise and Vibration, and 13 Air Quality).

Bridges/Underpasses/Junctions

16.2.14 Bridges, underpasses and junctions that would be constructed as part of the Scheme are listed in Table 16.3 below. There are also a number of drainage culverts required throughout the Scheme.

Table 16.3 Bridges/Underpasses/Junctions to be built as Part of the Scheme

Structure Name	Chainage (Ch.)
M1 J13 Brogborough Interchange South	0
M1 J13 Brogborough Interchange North	100
Salford Road Underbridge	350
Manor Farm Bridleway 1 Overbridge	1750
North Common Farm Underpass	2400
Vale Farm Bridleway 31 Overbridge	3630
Wood End Overbridge	4750
Marston Overbridge	6025
Lower Shelton Subway	6960
Berry Farm Underpass	8520
Fields Road North Overbridge	9990
Fields Road South Overbridge	N/A
Manor Farm Bridleway 23 Overbridge	10640
Marsh Leys Junction West Underbridge	11400
Marsh Leys Junction East Underbridge	11480
Marsh Leys Railway Bridge South	12280

Structure Name	Chainage (Ch.)
Marsh Leys Railway Bridge North	12300

16.2.15 Preliminary designs for the structures have been prepared. During the detailed design process these structures would be reinvestigated and subject to "value engineering" exercises, resulting in the preparation of the detailed design. The construction process would be similar for all the structures as follows:

- Establish the working area at the site. This would involve the laying of crushed hardcore platform on top of the existing ground to provide a hard surface for the safe, stable operation of construction equipment (e.g. piling rigs, cranes)
- Provision of welfare facilities (toilets, washroom and mess room)
- Construct foundations and columns – comprising reinforced concrete, cast in situ
- Construct the bridge deck, generally comprising steel beams with reinforced concrete deck cast in situ

16.2.16 Structures operations would be confined to the immediate vicinity of their location, although deliveries of concrete, steel reinforcement and other materials would be required.

Concrete Batching

16.2.17 A concrete batching plant may be established within the main site compound. The plant would be designed and operated to industry best practice. Cement silos would be the primary visual feature of the plant. Several silos would be required for the plant, each being approximately 20m in height.

Temporary Lighting

16.2.18 Temporary lighting would be required for the following areas:

- Temporary traffic management e.g. cross-overs and replacement of permanent lighting
- The main and secondary compounds and other temporary working areas
- In addition, the short daylight hours in winter would require the lighting of working areas for structures to allow normal shift working.

Road Pavement Construction

16.2.19 The pavement design has been developed to provide for a low-noise running surface (Thin Surface Course). The following works would be undertaken:

- Modification of imported granular material and compaction to form a stabilised foundation and sub-base for the road
- Possibility of reinforced concrete base layer
- Bituminous material would be imported and placed in layers to form the base and wearing course of the road surface.

Landscape and Planting

16.2.20 Substantial earth shaping and planting works would be included to blend the Scheme into the surrounding landscape and to provide habitats and wildlife corridors. Subject to seasonal and construction constraints, planting would be undertaken as early as possible to ensure maximum growth and coverage by the time the project is complete. The planting would mainly consist of species of local provenance.

Post-Construction

16.2.21 Following completion of the construction works, there may be a small amount of completion work on landscape implementation. It is expected that the level of activity would decrease quickly following Scheme opening and be intermittent.

Subsequent Maintenance Works

16.2.22 The Contractor would be responsible for the maintenance of environmental and landscape features for a period of 5 years following completion of construction. Maintenance activities would include the following:

- Ecological monitoring
- Mowing of verges and other areas of grass
- Desilting of balancing ponds
- Replacement of failed trees and shrubs
- Periodic pruning, thinning or coppicing of shrubs and trees.

16.2.23 These activities would be carried out in accordance with good site practice and should cause only slight, temporary environmental impacts.

16.2.24 Small-scale repair work would inevitably be required over the lifespan of the Scheme, and larger scale maintenance such as resurfacing would be necessary at intervals. The potential environmental effects of these works may be greater than those associated with routine maintenance activities, although they would generally all be temporary. Any potential impacts would be considered as and when works were necessary and, where appropriate, measures would be put in place to mitigate any adverse effects. "Design for Maintenance" forums have been held in order to reduce the amount of required maintenance through thoughtful design thereby minimising any environmental impact.

16.3 Baseline Conditions

Properties Likely to be affected by Construction Noise and/or Dust

16.3.1 The construction process for the Scheme involves considerable earthworks, the range of potential dust transferral off-site and of subsequent potential adverse effects of increased Particulate Matter $(PM)_{10}$[1] levels (e.g. potential nuisance) may extend up to around 100m from the site boundary. Some 150 residential properties have been identified within 100m of the boundary of the works. Properties closest to the construction works are those most likely to be affected by dust. Adverse noise impacts during construction are also likely to affect properties located within approximately 100m of the works, with those closest to construction activities being most affected. The likely levels of vibration would give rise to negligible effects. Refer to Chapter 12: Noise and Vibration and Chapter 13: Air Quality.

Areas of Ecological Value

16.3.2 There are a number of ecologically important areas within 100m of the Scheme that might be affected by construction. These areas are described more fully in Chapter 9: Ecology and Nature Conservation.

[1] PM_{10} is particulate matter with a diameter of less than 10μg, which can pose potential health risks because they are small enough to penetrate into the lungs.

16.3.3 There are no nationally designated sites in close proximity to the Scheme. However, there are a number of County Wildlife Sites (CWSs), which are non-statutorily designated sites of county or district importance within the study area. There are 16 CWSs within 2km of the Scheme centre line (refer to Chapter 9: Ecology and Nature Conservation). However, only Brogborough Lake CWS would be directly affected.

16.3.4 Land use within the Scheme corridor is predominantly arable farmland, with a few grass leys and limited areas of permanent pasture. The remaining areas of grassland are agriculturally improved or semi-improved. There are limited areas of unimproved grassland that are mainly small, narrow and isolated areas, such as road verges. The hedgerow framework includes numerous mature hedges, some of which contain scattered trees.

16.3.5 There are 51 ponds within 500m of the Scheme corridor, distributed throughout the agricultural landscape. Whilst these ponds are not particularly valuable in themselves, they do provide an ideal habitat for the protected great crested newt. The majority of watercourse lengths within the study area have been modified for land drainage and are intermittently wet as a result of their frequent dredging. There is little remaining mature woodland within the Scheme area, and existing woodland consists mainly of recent planting under the Forest of Marston Vale Community Forest scheme. An area of mature semi-natural woodland exists at Brogborough Road Spinney, which would be directly affected by the Scheme.

Areas of Archaeological Value

16.3.6 There are extensive known or suspected archaeological remains along the route of the Scheme, including a possible prehistoric barrow cemetery, Iron Age–Romano-British settlements and medieval settlements. These areas are described in detail in Chapter 7: Cultural Heritage. Of particular note are:

- Possible prehistoric barrow cemetery south of Salford Road
- Iron Age–Romano-British farmstead and field system at Brogborough Hill
- Deserted medieval settlement at Lower End
- Possible Iron Age–Romano-British settlement in vicinity of Beancroft Road
- Medieval settlement at Lower Shelton
- Further possible Iron Age–Romano-British settlement in the vicinity of Hoo Lane, Fields Road, Manor Road and north of Marsh Leys.

Traffic and Public Rights of Way

16.3.7 The existing A421 carries between 20,000 and 30,000 vehicles per day. The higher flows occur between Marston Moretaine and Kempston.

16.3.8 The Scheme is crossed by many public footpaths and bridleways, many of which would be directly affected, to varying degrees, by the construction of the Scheme.

Geology

16.3.9 The underlying geology is of Jurassic Clay, usually referred of as Oxford Clay. These clays are variously covered with drift deposits of river terrace and glacio-fluvial origin. Over the eastern and central parts of the A421 there is an extensive plain at a general elevation of 30-40m Above Ordnance Datum (AOD) that is of Jurassic Clay overlain with river terrace, other drift deposits and locally alluvium. The central parts of the site are at a slightly higher elevation and are dominated by chalky boulder clay. At the western end of the site, adjacent to the M1, the parent materials are river terrace deposits and non-calcareous drift.

16.4 Detailed Development of the Scheme

16.4.1 Several aspects of the Scheme design would help to minimise adverse construction impacts, whether by design or as an indirect benefit of other decisions. The Scheme would be more than 100m away from most properties in the area, helping to minimise disruption due to construction for most of the community. The new A421 alignment has been selected to avoid sensitive ecological habitats and archaeological features. In addition, the new A421 has been designed to achieve a materials balance, which would reduce impacts associated with material haulage off-site.

16.4.2 The Scheme design has been carried out with input from the chosen Scheme Contractor (should the Scheme be constructed), Balfour Beatty. As such, throughout the preliminary design process, the "buildability" of the Scheme has been taken into account, as well as applicable methods whereby the impact of the construction process could be minimised.

16.5 Construction Environmental Management Plan

16.5.1 Scheme construction would be undertaken in a manner that aims to manage and control disruption and environmental impacts. The procedures for managing the environmental implications of Scheme construction are described in the outline CEMP produced as part of the Phase 1A works. This would be reviewed, revised and updated should the project progress to Phase 2 detailed design. The site would be operated in accordance with the Contractor's Environmental Management System (EMS) certified to the international standard ISO14001.

16.5.2 The outline CEMP consolidates all elements of environmental management with regard to the construction phase of the Scheme. It is the aim of the CEMP to clearly state the commitment and approach to environmental management during the Scheme construction phase. The outline CEMP aims to ensure that the commitments of the Site Environmental Policy Statement are translated into site practices and procedures, which can be audited and improved upon where necessary. The outline CEMP aims to:

- Ensure that all construction work is undertaken in strict compliance with all legislative and contractual obligations, and in accordance with good practice and the Site Environmental Policy Statement
- Ensure that all adverse impacts of the work are identified, minimised and controlled to acceptable levels
- Define roles and responsibilities with regard to environmental issues
- Enable all personnel and visitors to operate in an environmentally responsible manner
- Undertake the work in such a way as to maximise the long-term environmental benefits of the Scheme, in particular with regard to any environmental enhancement features
- Ensure that all incidents, emergencies or complaints are dealt with efficiently and effectively
- Develop site practices and procedures that can be audited and improved where necessary.

16.5.3 The Outline CEMP contains the following information:

- Introduction
- Aims and Objectives
- Register of Environmental Aspects, Potential Impacts and Significant Effects

- Register of legislative and other requirements
- Site Reference Notes
- Safety, Health and Environmental Policy
- Environmental Management System – Certificate of Registration
- Roles, Responsibilities and Reporting
- Contractors Management Plans
- Environmental Risk/Impact Assessment Form
- Training and awareness
- Site Based Safety, Health and Environment Risk Assessment forms.

16.5.4 In addition to the above, throughout the Scheme construction phase, there would be an Environmental Manager and team Management Environmental Representatives who would manage the environmental detailed design and site works, respectively.

16.5.5 The CEMP to be adopted on the Project would fall within the scope of the Contractor's externally certified environmental management system, and as such would be subject to regular independent audits by the Contractor's certification body.

Restrictions Governing Bulk Import and Export of Earthworks Material

16.5.6 The earthworks have been designed to balance as far as is practical, thus minimising the requirement for material import and export from the site. It is intended that any material generated by the Scheme would be re-used within the construction corridor. Should contaminated material be encountered, it would either be remediated and re-used on-site, or be disposed of at a licensed landfill site in accordance with applicable Waste Management Licensing Regulations. Any surplus topsoil would be put to effective re-use off-site.

16.5.7 There are various restrictions governing the bulk import and export of earthworks materials that are designed to minimise the environmental impact of these operations. The choice of "borrow pits" (temporary workings that supply construction material and that are typically backfilled and restored upon project completion) and disposal sites is ultimately a commercial decision, bearing in mind relevant legal and planning requirements. The environmental impacts of existing quarries and disposal sites would have been taken into account by the local planning authority at the time when they were granted permission. Any new disposal sites or borrow pits would require planning permission, and the local authority would be required to consider environmental factors before determining applications. The illicit dumping of surplus fill is prevented by legal controls.

16.5.8 During the Scheme detailed design and construction stages, opportunities for re-use and recycling would be investigated. These include proposals for transferral of concrete and redundant road pavements to crushing and recycling facilities for re-use on the project or in the local area.

16.5.9 The properties of the Lower Oxford Clay make it perfect for brick making. Historical maps show that small isolated brick pits are located across the Bedford area. Isolated pits for gravel abstraction are also indicated. The Scheme would run through approximately 1400m of land that has the potential to be mined for mineral extraction and one of the construction compounds is planned to be located within an area which has a mineral licence from Ch.8500 - 8700. The local geology is therefore such that construction material would potentially be available locally.

16.6 Construction Phase Mitigation

16.6.1 As detailed in Section 16.4 above, construction phase impacts would be controlled and minimised through the implementation of actions as defined in the CEMP. The CEMP would define appropriate measures for protecting the environment and limiting disturbance from construction activities as far as reasonably practicable. The CEMP describes controls that would ensure that good site practices are adhered to, and that risks of accidental damage to the environment are minimised. Compliance with the CEMP would be monitored by the Highways Agency's professional representatives on-site, by the local authority, and by the Environmental Manager/Management Environmental Representatives as part of the Balfour Beatty/Scott Wilson project team. Details of construction related management and mitigation measures for each specific topic have not been repeated within this chapter, as they are detailed in the various specialist chapters included in this Environmental Statement. However, the sections below consider the potential impacts/effects during the construction phase following the implementation of applicable mitigation measures.

16.6.2 For further details of proposed mitigation measures, reference should be made to the following chapters:

- Chapter 6: Land Use and Agriculture
- Chapter 7: Cultural Heritage
- Chapter 8: Landscape and Visual Assessment
- Chapter 9: Ecology and Nature Conservation
- Chapter 10: Geology and Soils
- Chapter 11: Road Drainage and the Water Environment
- Chapter 12: Noise and Vibration
- Chapter 13: Air Quality
- Chapter 14: Pedestrians, Cyclists, Equestrians and Community Effects.

16.7 Environmental Effects and Mitigation

16.7.1 In this section the main environmental effects associated with Scheme construction processes after implementation of applicable mitigation techniques are outlined.

Land Use and Agriculture

16.7.2 Construction of the works is anticipated to have minimal impact on adjacent land use for the following reasons:

- The surrounding area is predominantly agricultural
- Land required for the Scheme would be acquired in advance of construction
- The construction sites could be entered from public roads.

16.7.3 Some agricultural activities could be slightly affected depending on the timing of different sections of the works due to access routes being severed. Accommodation works would be carried out expeditiously to minimise disruption. Where this is not possible temporary access arrangements would be agreed between the Contractor and landowner. In some instances land would be temporarily acquired to provide a diversion route during construction; for example Manor Road bridleway. Permission from the appropriate authorities would be obtained and landowners would be kept fully informed of progress and access arrangements through the Contractor's Public Liaison Officer.

16.7.4 During the construction phase, it would be necessary to establish a number of satellite compounds. These would generally be located within the proposed site boundary. Welfare and office facilities would be provided in order to serve several structures construction sites, significant junction works and areas remote from the main compound. They would consist of a number of portable cabins, a canteen and washroom facilities.

16.7.5 As detailed in paragraph 16.2.5 above, the main construction compound would be located adjacent to Hoo Lane (Ch.8200). Following its use during the construction phase, it would be regraded and landscaped as part of the Scheme.

Cultural Heritage

16.7.6 The most likely cultural heritage/archaeological effects of the A421 Scheme would be direct damage to archaeological remains during proposed construction activities. Visual impacts to the historic landscape setting would also occur.

16.7.7 The archaeological Watching Brief on the geotechnical site investigation and the trial trenching completed at Brogborough Hill, and in the vicinity of Beancroft Farm (refer to Chapter 7 Cultural Heritage) has demonstrated that buried archaeological features survive immediately below the topsoil or at greater depth beneath relict cultivation layers. Under these circumstances, topsoil-stripping operations would generally be sufficient to cause irreversible damage to archaeological remains, unless construction plant movement is carefully controlled. Damage may be caused by wheel rutting in wet ground conditions even before the topsoil is removed. Where archaeological remains are anticipated to survive, vehicle movements on topsoil would be avoided or kept to a minimum. Where it is necessary for construction plant to move on topsoil (either before it is removed, or where it would not be removed – for instance on topsoil storage areas) archaeological remains would be protected by the careful control of plant operations and the use of geotextile membranes.

16.7.8 The creation of cuttings, service trenches, drainage channels, ponds and other excavations would normally result in the unavoidable removal of archaeological deposits, which would therefore require mitigation in the form of archaeological recording (preservation by record). There are options for preservation of significant remains under embankment or temporary earthworks (preservation in-situ), although an assessment of compression effects would be required for fragile remains under these circumstances.

16.7.9 Given the limited nature of the intrusive archaeological investigation to date, a programme of archaeological trial trenching would be required to establish the nature and extent of archaeological remains at the identified sites. The results of the trial trenching would form the basis for pre-construction archaeological recording as part of the enabling works, guided by an archaeological research strategy. Within such areas, archaeological recording would preclude any requirement for further evaluation or Watching Brief, thereby eliminating the risk of unanticipated discoveries in the highest risk sections of the new A421 during the main earthworks programme. Other sections of the route corridor would be subject to the Watching Brief, unless there is clear evidence for modern disturbance/truncation of archaeological horizons.

Landscape and Visual Effects

16.7.10 Temporary landscape and visual impacts associated with the Scheme construction phase would be inevitable, and could not be readily mitigated. The most significant potential temporary impacts include the following:

- The presence of a central construction compound and satellite compounds
- The presence of temporary haul roads

- The activity of construction, and in particular, the passage of construction plant and delivery vehicles on the local road network
- Site clearance operations, including the removal of lengths of hedge, trees, grassland and natural landforms
- Earthmoving operations ands stockpiling of excavated soils
- Service diversions
- Ditch creation
- Traffic management signs and equipment
- Temporary fencing
- Construction of structures – temporary works and construction plant in areas of sensitivity would result in a significant visual impact in some areas, for example Salford Road, Brogborough, Wood End, Lower Shelton, Marston Moretaine, Wootton and Kempston.

16.7.11 Landscape bunds, proposed as part of the permanent works would be constructed early whenever possible in order to minimise the visual impact of the construction activity.

Ecology and Nature Conservation

16.7.12 The construction process has a range of potential impacts on the nature conservation resource of the area, including:

- Landtake and habitat clearance
- Severance
- Disruption of hydrology affecting wetlands
- Culverting of watercourses
- Pollution of watercourses, water bodies and wetlands
- Dust deposition
- Site lighting
- Noise, physical and visual disturbance.

16.7.13 In addition to land take, construction would have the potential to cause adverse impacts to badgers, amphibians, birds, bats, and aquatic macro-invertebrates. The construction programme would be carefully controlled in order to accommodate applicable ecological mitigation works and to facilitate site clearance. As described in Chapter 7 construction activities would also be controlled to prevent ecological damage associated with substances in suspension or solution (for example site run-off, dust, spillages). Control of the construction process would minimise the effects upon the area's sensitive ecological receptors.

Geology and Soils

16.7.14 The construction process would have no significant effect on the geology and soils of the area. Topsoil would be stored in such a way as to minimise structural damage and unnecessary pollution to it. Any contaminated material encountered would be handled and transported in a manner that does not lead to further contamination. If asbestos was encountered during demolition of buildings, it would be removed and disposed of in accordance with the Asbestos Licensing Regulations, the Control of Asbestos at Work Regulations and the Special Waste Regulations, as appropriate.

16.7.15 The storage and maintenance of construction plant on proposed construction sites, together with storage of construction materials, fuels and oils, would be controlled in order to avoid localised ground contamination due to spillage or leakage.

16.7.16 Earthworks estimations indicate that approximately 2.0 million m^3 of material (excluding topsoil) would be excavated along the route alignment. The majority of this excavated material would be re-used for general fill in embankments and for landscape regrading purposes. Of the excavated material, it is estimated that approximately 1.73 million m^3 would be re-used as general fill. In addition, approximately 270,000m^3 of topsoil is anticipated to be generated. It is the intention that the majority of this material be re-used on-site in landscape areas and areas to be re-soiled.

16.7.17 The Scheme would require the removal of predominantly moderate-grade agricultural soils, though some higher-grade soils would also be affected. There would be permanent landtake associated with the main carriageway, structures and balancing ponds, and temporary landtake for the construction compounds and general construction access. The Scheme would result in the landtake of approximately 16ha of Grade 3a agricultural land, which is considered to be a **moderate adverse** effect in terms of agricultural soil.

16.7.18 The stripped topsoil would either be re-used elsewhere along the route for such purposes as agricultural improvement and soft landscape areas, or re-used beneficially outside the Scheme. In particular, topsoil stripped from areas of sub-Grade 3a would be stored separately and re-used in those Grade 3a areas that would be regraded and returned to agriculture upon completion of the works, as described in Chapter 10 Geology and Soils. As detailed in Chapter 9 Ecology and Nature Conservation, it is proposed that grassland soils would be translocated from the Brogborough Lake area, to an area on the embankment of the new road. Soils for translocation would be clearly marked to avoid cross-contamination.

Road Drainage and the Water Environment

Effects on Surface Water

16.7.19 Where works are undertaken in close proximity to surface watercourses, there is the risk of adverse impacts on surface waters due to the spillage or deposition of soil, sediment, concrete, oil, fuel or other construction chemicals. Such materials could be deposited or spilled directly into a watercourse, or may enter the watercourse via uncontrolled surface run-off. Any watercourses (including drainage ditches and culverted streams) crossed by the Scheme would potentially be at risk, as would any ditches, streams or ponds in close proximity to construction compounds. Given the fairly good quality of water in the relevant catchments together with the ecological sensitivity of the areas (for example Elstow Brook), the sensitivity of watercourses in the area is regarded as moderate. This potential risk would be mitigated through the adoption of appropriate mitigation measures, which would minimise the potential for any adverse impacts to occur. Appropriate mitigation measures are defined in Chapter 11 Water Quality and Drainage, and in the CEMP. This includes details of construction phase watercourse monitoring.

Effects on Groundwater

16.7.20 The analysis of the available groundwater level data indicates that the majority of the A421 vertical alignment would lie above the regional water table. The majority of the route is underlain by strata classified as non-aquifer. Minor aquifers of low leaching potential are located in the alluvial soils underlying the Scheme. These minor aquifers also provide rivers with their baseflow. There are several licences for surface water abstractions for agricultural uses in operation along the Scheme. Licences are also held by landowners for discharge consents (refer to Chapter 11 Water Quality and Drainage).

16.7.21 Wherever construction works are undertaken, there is potential for spillage or leakage of oil, fuel or other liquid chemicals to contaminate the ground and subsequently leach into underlying groundwater. The risk is greatest in areas of soils of high permeability, areas of relatively high water table, areas where excavation works are undertaken and site compounds in material and plant storage areas. While most of the road alignment lies above the water table, it also lies fairly close to the groundwater level along many parts of the route. Furthermore, much of the route is underlain by soils of intermediate permeability. The groundwater along the route is considered to be of medium sensitivity, given the presence of a minor aquifer beneath the route and of a number of licensed groundwater abstractions. With the mitigation measures in place as described in Chapter 11 Water Quality and Drainage, any effects on groundwater would be minimised and are likely to be minor. Further reference should also be made to the CEMP.

Disruption to Road Users

16.7.22 Construction of the Scheme would directly affect the existing A421, as well as some of the associated side roads. Disruption to road users would be minimised through the provision of a Traffic Management Scheme implemented according to Chapter 8 of the Traffic Signs Manual, published by the Department for Transport 2006, which would include appropriate signing and traffic controls (e.g. traffic lights). The Traffic Management Scheme would be implemented by the Traffic Safety Officer and installed under his/her supervision together with that of fully trained operatives. Details of traffic management requirements are given in Chapter 4: Scheme Description. Specific activities that would be undertaken in order to minimise disruption to road users are as follows:

- A421 traffic would remain on the existing alignment whilst construction work is carried out off-line and would therefore be generally unaffected
- Construction of the centre pier to the bridge over the M1 would require traffic to run on the existing motorway hard shoulders and at a reduced speed in order to safe access to the central reserve
- Beams for the bridge over the motorway would be placed during full carriageway closures. A diversion route would be implemented utilising the A421 between M1 J13 and Milton Keynes M1 J14. This work would be carried out during night time closures
- M1 J13 works that interface with traffic would be carried out at night
- A number of night time closures on the A421 would be required in order to enable on-line bridge beams to be lifted into place near Fields Road over the existing carriageway and in order to install ducted road crossings for service diversions. Alternative routes would be signed
- Plant crossing signals would give the road user priority. Most crossings would operate using a vehicle activation system that only prevents the road user crossing when a site vehicle can be detected approaching the signals. On busy crossing points (e.g. A421 between M1 J13 and Milton Keynes) signals would be operated manually to give the road user maximum benefit
- A421 traffic between Marsh Leys and the A6 Junction would be diverted onto the new westbound carriageway once constructed
- Traffic on the existing section of dual carriageway at the A6 Junction would either be put in contraflow (on a single carriageway) or would use one lane each direction in order to complete the works
- Alterations to the existing A421 would be carried out after the main A421 traffic has been transferred onto the new alignment.

- The public would be kept fully informed through the use of newsletters, local newspapers articles and the pro-active involvement of the Public Liaison Officer.

16.7.23 Whilst the sections above highlight that temporary access arrangements would facilitate traffic flow in most locations, there would be a need for some temporary traffic control at some of the tie-ins. The duration of such temporary traffic controls would be periodic and relatively short at any one location.

16.7.24 Outline agreement to the traffic management proposals has been reached with the relevant Highway Authority, Bedfordshire Police and Bedford/Luton Safety Camera Partnership. Permits to operate the temporary traffic signals and any temporary speed limits on the public highway would be sought from Bedfordshire County Council and the Highways Agency. Regular meetings would be held with the Highway Authorities and Police to agree traffic management schemes, to review the safe operation of the network and minimise any disruption.

16.7.25 There would be indirect effects due to access by construction plant and delivery vehicles to the A421 throughout the construction period. It is anticipated that there would be approximately 750 additional vehicle movements each day during the construction phase. Such traffic flows are not anticipated to result in any noticeable noise or air quality effects (refer to Chapter 12: Noise and Vibration, and Chapter 13; Air Quality).

16.7.26 A Memorandum of Understanding has been agreed with the owners of Brogborough Landfill Site to minimise disruption to the public, the operator and contractor through a continuous communication approach.

16.7.27 During the construction phase, actions to prevent the spread of mud from the site onto the existing road network would be taken. This would be achieved by:

- The provision of wheel wash facilities at high density site access locations
- Construction of temporary access roads that allow mud to be removed before entering onto the public highway.

16.7.28 In addition, road sweepers would be employed as and when required. The works Site Supervisors and the Traffic Safety Officer would monitor mud on the road.

Noise and Vibration

16.7.29 Construction activities have the potential to increase local noise levels and be a source of ground-borne vibration. The severity of the impact varies with the activities in progress, the noisiest typically being site clearance, piling and bulk earthworks. Construction noise can be a nuisance to local people, although it is temporary and of limited duration.

16.7.30 The majority of predicted construction noise levels do not exceed the adopted criterion of 70 dB $L_{Aeq,\ 1hr}$ at the chosen assessment receptors. Where this level is exceeded, it is predicted that levels would not remain above 70 dB $L_{Aeq,1hr}$ for more than the adopted duration of six weeks in a year, except at a small number of properties, namely Llanberis and Omega on Salford Road, Elms Farm, Brogborough Manor Cottages, the Travelodge Motel, and several properties at the junction of Lower Shelton Road and the existing A421. At these locations, the employment of temporary barriers and best practicable means would bring noise levels down to below the criterion level. Overall, the significance of construction noise is rated as **moderate adverse**. The contribution of construction-phase haul road traffic to ambient noise levels would be minimal.

16.7.31 Any vibration associated with Scheme construction is unlikely to give rise to the onset of cosmetic building damage or justifiable vibration complaints at local residential property. Vibration monitoring would be carried out where required.

Air Quality

16.7.32 Construction dust could potentially cause the following impacts:

- The soiling of surfaces such as window ledges and cars causing a nuisance
- Physical or chemical contamination – e.g. affecting laboratory and medical facilities
- Coating of vegetation and soil – affecting the growth of vegetation
- Contamination of water sources.

16.7.33 During construction, topsoil stripping and excavation and embankment creation are considered to have the greatest potential to generate dust. The potential for stockpiles of materials to generate dust largely depends on the nature of the material. Earth is soft and friable compared to stone or rock material. However soil generally has higher moisture content. Earth and soil can both be a potential source of dust.

16.7.34 Construction dust would only have a significant temporary impact on sensitive receptors if a receptor were located in fairly close proximity to the activity. Construction of the A421 involves considerable earthworks. The range of potential dust transferral off-site and subsequent potential nuisance is likely to be limited to around 100m from the site boundary. Reduction in dust would be achieved by:

- The use of dust suppression equipment e.g. water bowsers with spray bars
- Maintenance of site speed limits that do not generate significant amounts of dust.

16.7.35 Overall, the incorporation of effective site management procedures and mitigation measures to control dust as part of good site practice would ensure that the impact of the construction works on nearby sensitive receptors would be **moderate adverse**.

16.7.36 Traffic emissions from construction vehicles are not anticipated to cause notable impacts upon air quality given that an increase in traffic flow of at least 10% is generally required in order to generate a significant contribution to traffic pollution concentrations (refer to paragraph 16.2.13 above).

Pedestrians, Cyclists, Equestrians and Community Effects

16.7.37 During construction, those PRoW's that traverse the Scheme would be kept open where possible with designated crossing points. In some cases, temporary closures may be necessary on safety grounds. The duration of closure or diversion would be kept to the minimum possible. Closures would be discussed and agreed with Bedfordshire County Council and local Parish Councils in advance.

16.7.38 Construction is not anticipated to have impacts upon pedestrians or community facilities at settlements along the Scheme. Following completion of the construction works, the new A421 overbridges and underpasses would ensure the re-establishment of the area's footpath, bridleway and cycleway network, especially in respect to north-south movement.

16.8 Summary

16.8.1 Construction of the Scheme would inevitably cause a degree of disruption to local people and users of the A421 trunk road, and associated side roads, between M1 J13 and Bedford, despite measures that would be taken to minimise adverse effects.

16.8.2 Receptors near the Scheme would be subject to the most serious disruption.

16.8.3 The most significant effects are likely to be temporary PRoW severance, visual intrusion, increased noise and reduced air quality associated with works on the site (particularly site clearance, earthworks, bridge construction, and traffic) and disruption to road users.

16.8.4 Construction activities also have the potential to have impacts upon the area's ecological, archaeological and water resources. Good site practice measures would minimise the risk of adverse impact.

16.8.5 Construction phase environmental effects would be minimised through the implementation of measures as detailed in the CEMP.

16.8.6 Communication via the Public Liaison Officer would enable the public to be kept fully informed of progress and planned traffic management changes.

References

Highways Agency (2006), *A421 Improvements M1 Junction 13 to Bedford, Construction Environmental Management Plan,* Report No D109831-P1A-ENV-R007