# Sustainability Appraisal and Carbon Management Report

## Forth Replacement Crossing: Fife ITS

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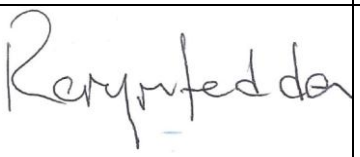
| ***Approved by*** | **Rory McFadden** |  | **28.02.2013** |

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# 1.0 Introduction

## 1.1 Background to the Forth Replacement Crossing Fife ITS Project

### 1.1.1 Introduction

The Forth Replacement Crossing (FRC) Fife Intelligent Transport System (ITS) project forms part of a major infrastructure project being undertaken by Transport Scotland, an agency of the Scottish Government. As stated in the scheme-wide FRC Sustainability Appraisal and Carbon Management Report (Jacobs Arup, 2009a), the FRC comprises a new cable-stayed bridge across the Firth of Forth and associated new and improved roads infrastructure to both the north and south of the bridge. The project is driven by uncertainty over the future viability of the existing Forth Road Bridge, and is designed to safeguard this vital connection in Scotland's transport network. The proposed scheme will retain the existing Forth Road Bridge as a public transport corridor for use by buses, taxis and other specified users and for continued use by pedestrians and cyclists. The new bridge (referred to as the Main Crossing) will be used by all other traffic including private cars and heavy goods vehicles.

The Fife ITS project comprises the supply and installation of 18 overhead gantries and associated civil works, including the installation of facilities such as lane control/speed control signals, speed compliance cameras, emergency roadside telephones, CCTV cameras, below ground detection and associated infrastructure including testing and commissioning. In addition, the project includes a dedicated bus lane running on the M90 southbound carriageway. Other works including mine workings consolidation, resurfacing works and landscaping, also form part of the Fife ITS contract.

Project specific sustainability objectives have been developed by GRAHAM Construction (GRAHAM) in conjunction with Transport Scotland for the Fife ITS project as outlined in this report

### 1.1.2 Overall Scheme Objectives

Eight specific transport planning objectives have been identified for the overall FRC scheme:

- Maintain cross-Forth transport links for all modes to at least the level of service offered in 2006;
- Connect to the strategic transport network to aid optimisation of the network as a whole;
- Improve the reliability of journey times for all modes;
- Increase travel choices and improve integration across modes to encourage modal shift of people and goods;
- Improve accessibility and social inclusion;
- Minimise the impacts of maintenance on the effective operation of the transport network;
- Support sustainable development and economic growth; and
- Minimise the impact on people, and the natural and cultural heritage of the Forth area.

## 1.2 Purpose and Content of the Sustainability Appraisal and Carbon Management Report

The purpose of this Sustainability Appraisal and Carbon Management Report is to summarise the sustainability appraisal process as developed and applied to the Fife ITS project.

The Sustainability Appraisal and Carbon Management Report is structured as follows:

- Section 1: Introduction;
- Section 2: Policy context for undertaking sustainability appraisal;
- Section 3: Sustainability appraisal: targets, findings and future opportunities;
- Section 4: CEEQUAL; and
- Section 5: Conclusions.

## 1.3 Benefits of the Sustainability Appraisal and Carbon Management

The benefits of undertaking this sustainability appraisal and carbon management process are that it:

- draws together all the information on sustainability and carbon management relevant to the scheme;
- makes sure that the ethos of sustainable design and development is embedded within the project throughout its life-cycle:
    - encourages a more efficiently designed and effectively delivered scheme; and
    - demonstrates how the scheme contributes towards the delivery of Scottish Government policies on sustainable development and climate change.

### 1.3.1 The Sustainability Benefits of the Fife ITS project

The benefits of the Fife ITS project are:

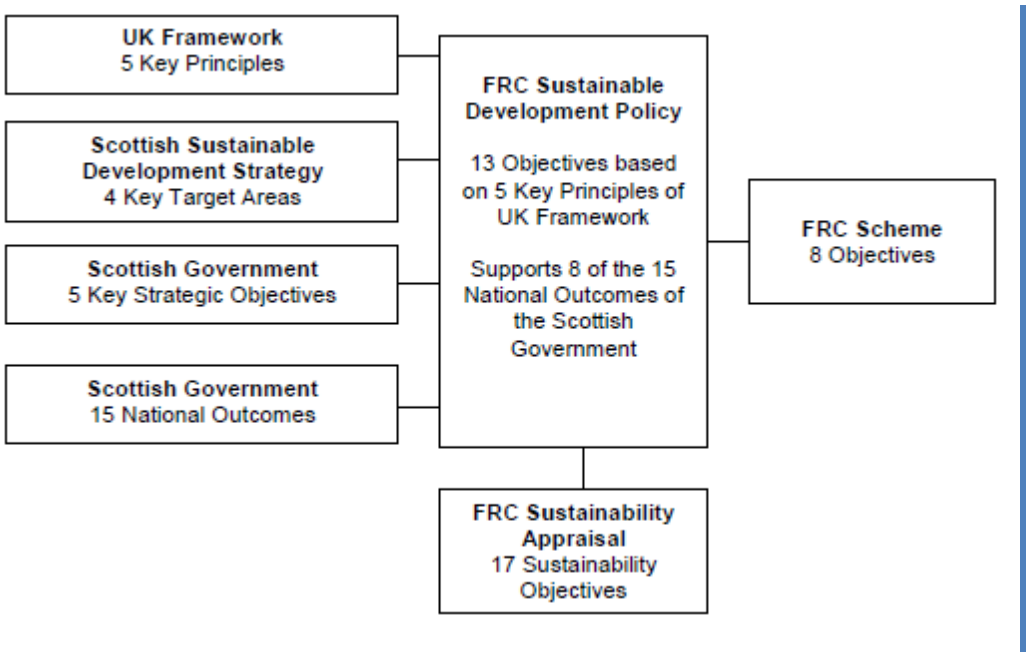
- It is a fundamental element of the overall FRC scheme.
- It will support and enhance the Forth crossing infrastructure.
- Information provided by the ITS will alert road users to potentially dangerous or inconvenient situations.
- It will help to minimise time and energy by optimising journeys and reducing road congestion, therefore improving driving performance resulting in lower energy use, pollution levels and environmental impact (UNECE, 2012).
- Faster emergency response and increased efficiency of road operators by providing a means of communication.
- Intelligent Transport Systems increase road operational efficiency, capacity and safety. It is suggested that systems which reduce vehicle queues can also reduce accidents (Transport Scotland, 2012).

# 2.0 Policy Context for Undertaking a Sustainability Appraisal

## 2.1 Introduction

This section outlines the policy context for the appraisal of sustainability sourced from the FRC Sustainability Appraisal and Carbon Management Report (Jacobs Arup, 2009a). The relationship between the FRC sustainability policy objectives and UK and National Objectives are shown in Figure 1:

**Figure 1*:* Relationship between UK/National Objectives and FRC Objectives for Sustainability**




## 2.2 UK Framework for Sustainable Development

In 2005, Scotland signed up to the UK-shared framework for sustainable development (DEFRA, 2005). This framework sets out a common goal for sustainable development across the UK, that is:

*"To enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations".*

The framework commits the Scottish Government to promoting a clear understanding of, and commitment to, sustainable development in all that it does so that everyone can contribute to the overall goal.

The UK Framework sets out five key principles for delivering sustainable development:

- living within environmental limits;
- ensuring a strong, healthy and just society;

- achieving a sustainable economy;
- promoting good governance; and
- using sound science responsibly.

## 2.3 Scottish Sustainable Development Strategy and Objectives

Following the UK Framework, the Scottish Executive (now Scottish Government) published "*Choosing Our Future*" (Scottish Executive, 2005), which sets out Scotland's sustainable development strategy based on the five principles of the UK Framework and outlining at a high level what the government, with others, would try to achieve in Scotland. The strategy encompasses four key target areas:

- the well-being of Scotland's people;
- supporting thriving communities;
- Scotland's global contribution; and
- protecting Scotland's natural heritage and resources.

These target areas have helped to shape the more recent Scottish Government Strategic Objectives and associated national outcomes (Scottish Government, 2008), providing the policy framework within which the FRC project should operate. The five key Strategic Objectives set by the Scottish Government are that Scotland will become:

- *wealthier and fairer* - enable businesses and people to increase their wealth and more people to share fairly in that wealth;
- *safer and stronger* - help local communities to flourish, becoming stronger, safer places to live, offering improved opportunities and a better quality of life;
- *smarter* - expand opportunities for Scots to succeed from nurture through to lifelong learning ensuring higher and more widely shared achievements;
- *greener* - improve Scotland's natural and built environment and the sustainable use and enjoyment of it; and
- *healthier* - help people to sustain and improve their health, especially in disadvantaged communities, ensuring better, local and faster access to health care.

## 2.4 Transport Scotland's Aspirations for Sustainable Development

### 2.4.1 Sustainable Development

Transport Scotland is committed to promoting sustainability within its future projects. This will contribute to the achievement of the Scottish Government's overall purpose of achieving sustainable economic growth and the delivery of the five key Strategic Objectives.

GRAHAM is also committed to promoting sustainability with the Fife ITS project and the Sustainability Construction Policy is presented in Annex 1.

### 2.4.2 Climate Change

The Climate Change (Scotland) Act 2009 (Scottish Government, 2009) sets targets for the reduction of greenhouse gas emissions and places a climate change related duty on public bodies. The Act also includes provisions for mitigation of and adaptation to climate change.

The new climate change duty requires that public bodies must, in exercising their functions, act:

- in a way best calculated to contribute to the delivery of the targets;
- in a way best calculated to deliver any statutory adaptation programme; and
- in a way that it considers most sustainable.

One of the key aims of the Climate Change (Scotland) Act (Scottish Government, 2009) is to improve carbon management and help the transition towards a low carbon economy in the UK.

GRAHAM, in accordance with the requirements of Transport Scotland, will exercise its duties in relation to the FRC scheme in a way that it considers is most sustainable, including the requirements of the Climate Change Act.

To ensure sustainability was a key element in the construction of the Fife ITS project, GRAHAM's proposals comprised:

- Adopt a sustainable resource management.
- Ensure community engagement takes place at all key stages in the Fife ITS Project.
- Minimise the scheme footprint and severance of land.
- Reduce, reuse and recycle materials and products where practical.
- Seek to minimise embodied energy and carbon associated with key materials and their transport to site.
- Reduce noise and air emissions.

The above noted proposals were presented to Transport Scotland as part of a Sustainability Core Management Group hosted by the Employer. These proposals were then taken forward as GRAHAM's six key objectives, which are discussed in Section 3 of this report.

# 3.0 Sustainability Appraisal: Targets, Findings and Future Opportunities

## 3.1 Introduction

Drawing on the FRC Sustainability Appraisal and Carbon Management Report (Jacobs Arup, 2009a), GRAHAM set out clear sustainability objectives that reflect the nature of the Fife ITS project and that are specific to GRAHAM's activities. This section provides an overview of the sustainability objectives for the Fife ITS project as outlined below and as detailed in the Sustainability Appraisal Framework Table in Annex 2.

**Objective 1:** To adopt sustainable resource management in the construction of the Fife ITS Project.
The purpose of this objective was to ensure resources were managed carefully and resourced responsibly to meet ethical, social and environmental standards

**Objective 2:** To ensure community engagement takes place at all key stages in the Fife ITS Project.
The purpose of this objective was to ensure that the approach to engagement was fully inclusive and to ensure the use of appropriate consultation methods to reach target audiences.

**Objective 3:** To minimise the scheme footprint and severance of land.
The purpose of this objective was to recognise the economic importance of current land uses and the importance of avoiding and reducing the amount of land-take by the scheme, whether temporary or permanent.

**Objective 4*:*** To reduce, reuse and recycle materials and products where practical.
The purpose of this objective was to capture resource use issues relating to scheme earthworks and to maximise; local sourcing of earthwork materials, the reuse and recycling of materials and the improvement of brownfield and/or contaminated areas of land within the scheme.

**Objective 5:** Seek to minimise embodied energy and carbon associated with key materials and their transport to site.
The purpose of this objective is to promote the minimisation of energy use and carbon emissions during construction.

**Objective 6:** To reduce noise and air emissions.
The purpose of this objective was to promote the reduction and mitigation of impacts associated with construction and operational noise where practicable and to minimise the opportunities for air quality limits to be exceeded as a result of the proposed scheme and to minimise dust deposition at sensitive receptors.

## **3.2 Sustainability Objective 1**: To Adopt Sustainable Resource Management in the Construction of the Fife ITS Project

**3.2.1 Objective 1 - Target 1**: Develop a Sustainable Resource Management Framework.
The purpose of the Framework was to apply best practice in sustainability in the design, construction and implementation of the project where practicable; and encourage sustainable best practice. For example, as part of the Fife ITS project a commitment was made to responsible sourcing of materials including local sourcing. Cement was sourced from the Skene Group; a local supplier located within a distance of 2 miles of the project; see Materials Sourcing Report (Register), Annex 3.

#### 3.2.1.1 Target Selection

This target was selected to reflect the importance of managing resources carefully, specific materials planning and responsible sourcing to meet ethical, social and environmental standards.

#### 3.2.1.2 Methodology

The methodology employed comprised the development and implementation of a Sustainable Resource Management Framework (SRMF) within the construction of the Fife ITS project.

#### 3.2.1.3 Indicators

As described in the FRC Sustainability Appraisal and Carbon Management Report (Jacobs Arup, 2009a), the Framework was based on the following key stages for dealing with resources and materials that were likely to be used during the project:

- materials specification;
- materials and resource sourcing;
- transportation of materials;
- workforce travel;
- storage and handling of materials;
- use of resources and materials; and
- disposal of materials.

#### 3.2.1.4 Objectives and Targets

The following key objectives were set to address materials specification within the SRMF which in the case of GRAHAM would be typically:

- to minimise the amount of materials used, maximise the re-use of materials and prevent the unnecessary production of waste;
- to minimise the contribution made to the depletion of finite resources from the materials used throughout the life cycle of the project;
- to minimise the use of hazardous materials and the impacts of any used; and

- to maximise the use of materials and components that can be readily disassembled and re-used.

To deliver the above objectives, the following aspirational targets were created prior to construction:

- 100% of all earthworks materials used should be sourced from either re-used or recycled stocks;
- 20% of all other materials used should come from either re-used or recycled stocks.
- Minimise the volume of materials that were derived from fossil fuels;
- 90% of material coatings and treatments should have a low-VOC content;
- 100% of coatings and treatments for wood-based and other relevant materials should be non-persistent and biodegradable; and
- 100% of all coatings and treatments for permanent work materials should be factory applied (except for cut ends).

#### 3.2.1.5 Appraisal Findings

A SRMF (Annex 4) was developed for the Fife ITS project and implemented throughout the construction phase.

In order to measure the success of the framework a Materials Register was maintained throughout the construction phase. The materials register, presented in Annex 3 was developed in order to record the sustainability of the materials used within the Fife ITS project.

The material types recorded in the material register are as shown below. These material types were the core materials used within the project:

- reinforcement steel;
- concrete;
- aggregates;
- drainage pipe;
- grouting materials;
- surfacing materials; and
- structural steel.

A summary of the information collated and recorded within the Materials Register is summarised in Table 1.

| Table 1 - Materials Register – Summary<br><br>Outline of Information Recorded and Assessed | |
|---|---|
| **Information Recorded** | **Description and Reason for Assessment** |
| **Material description** | Description and Secondary description of material. |
| **Source of the material and distance from source to site** | Address of source and distance in mileage from the Fife ITS site office. Information required in order to assess transport impacts and to aid identification of local suppliers. |
| **Use of Sustainable Materials** | To identify whether material contents were from a sustainable source. |
| **Consideration of Supply Chain** | To ensure that members of the supply chain operated in a sustainable manner. |
| **Durability of material*** | To ensure the material is robust and to identify materials with the greatest lifetime without deteriorating. |
| **Recyclability of material** | To ensure that material could be recycled whether incorporated within the project or if surplus to requirement. |
| **Life Expectancy** | To identify materials with the greatest life expectancy. |
| **Ease of Disassembly** | To ensure that materials could be disassembled at the end of their design life and to allow the materials to be recycled. |
| **Hazardous Properties** | To identify whether any material or their composition had the potential to impact on the environment either during construction, during operation, or on disassembly. |
| **Maintenance Requirements** | Materials with limited maintenance requirements offer the most sustainable solution. |

*A material's durability will be considered greater where the life expectancy is based on the material not requiring maintenance.

The information derived from the materials register, which identified the gross statistic for each of the particular items measured on the Fife ITS project, are summarised as follows:

- 83% of construction material suppliers to the Fife ITS project were located within 20 miles of the site.
- More than 60% of the suppliers used sustainable materials.
- 100% of suppliers had an Environmental Policy / System in place.
- 58% of construction materials had a life expectancy of 100 years, 33% of construction materials had a life expectancy of 50 years and 8% of construction materials had a life expectancy of less than 20 years.
- 91% of construction materials can be recycled.
- 83% of construction materials can be disassembled with the remaining percentage comprising grout and concrete.

- 25% of construction materials had hazardous properties. For these materials appropriate COSHH assessments and risk assessments were undertaken.

**3.2.2 Objective 1 - Target 2**: Minimise material use (Topsoil, Cut and Fill materials) through adoption of material reduction measures.

**3.2.2.1 Target Selection**

This target was selected to reflect the importance of minimising the impact of soil and materials storage and handling on the environment.

**3.2.2.2 Methodology**

A Materials Handling and Management Plan, Annex 5, was developed and implemented on the Fife ITS project.

The key policy objective of Fife ITS project's Materials Handling and Management Plan was to minimise the impact of soil and materials storage and handling on the environment, and to preserve the soils for reuse within the Fife ITS project. The MHMP was based on DEFRA's 2009 publication on the Sustainable Use of Soils on Construction Sites (DEFRA, 2009).

In line with these objectives, the following information formed the basis of the Materials Handling and Management Plan:

- Clear identification of soil resources, grades of earthworks, fill and aggregate materials – assessment of soil resources was undertaken to identify their potential for reuse within the works.
- Appropriate storage areas were utilised for each category of soil, fill and aggregate material - Designated storage areas were assigned for each category. These areas were located as near as possible to the point of excavation and final placement to ensure that the material movement was limited.
- Storage areas were selected in order to reduce transport movements.
- Storage areas were assessed to ensure that the possibility of erosion, flooding, cross contamination and material decay was minimised.
- Stockpiles were afforded suitably designed protection - Where required, stockpiled materials were seeded to limit the potential for erosion and proliferation of weeds.
- A sustainable use for any surplus soils on the site (both topsoil and subsoil) was identified where possible - Surplus soils were placed in designated areas to eliminate the need for off-site disposal.

**3.2.2.3 Indicators**

To measure the success of the Fife ITS project in view of Objective 1 Target 2 the estimated quantities of materials (Topsoil, Cut and Fill Materials) were compared with actual quantities used.

#### 3.2.2.4 Measurable Targets

GRAHAM aimed to achieve a 5% reduction in material use compared with the predicted usage over the course of the contract.

#### 3.2.2.5 Appraisal Findings

Appraisal Findings have been split into two sections – Topsoil & Cut and Fill Materials.

##### 3.2.2.5.1 Topsoil

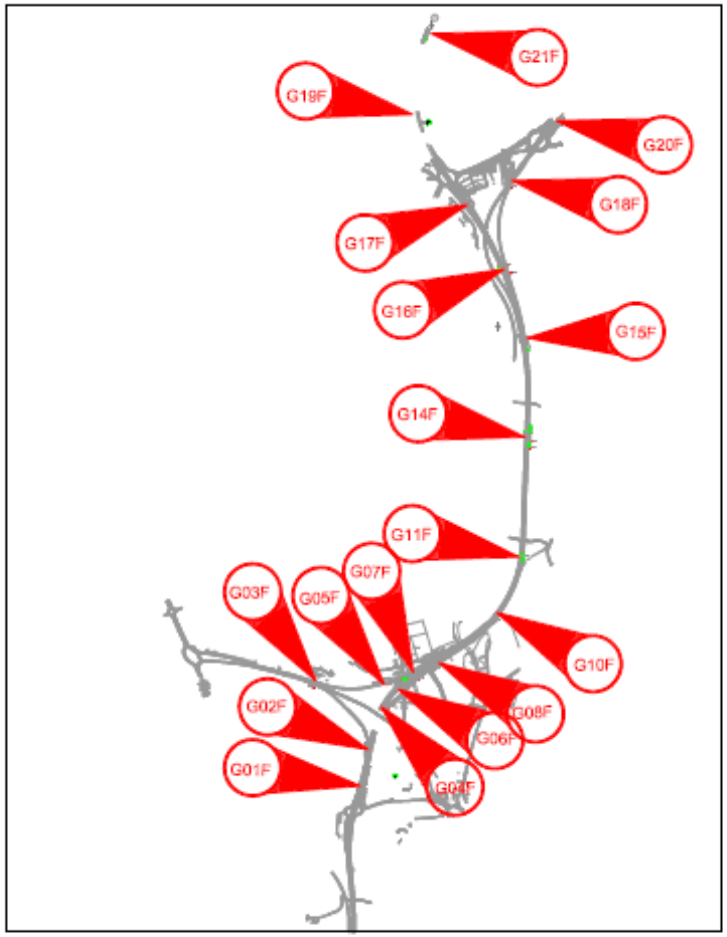
As detailed in the Landscape Management Plan (Annex 6), careful consideration was given to the location of soil storage mounds at the design and construction stage. Soil storage mounds were located in areas where they did not require handling or disturbance until required for restoration. A plan showing the location of soil storage mounds and quantities stored in each is presented in Figure 2. Different soil types were stored in separate, non-overlapping mounds and topsoil was stripped from any areas used for subsoil storage.

As detailed in the Landscape Management Plan (Annex 6), soil stripping was programmed to be carried out during dry weather, where possible. Topsoil and subsoil were stripped and stored separately in a manner that minimised vehicle trafficking across un-stripped areas or storage mounds.

Soils were not stored in any areas which were poorly drained or prone to water-logging. The minimum amount of compaction was applied when forming soil storage mounds, and measures were taken to ensure that the mounds were not driven across. Topsoil mounds were no greater than 2m in height and subsoil mounds were no higher than 3m. Stockpiles were covered where necessary to provide further protection (Figure 3).

Several methods were employed in order to prevent contamination of soils from chemicals or other materials including appropriate chemical storage in the site compound, the use of plant nappies under all static plant, appropriate training in materials handling and storage, secure material storage areas located across the site and the implementation of dampening down methods where dust generation was identified. In addition, spill kits were deployed where any spills or leaks occurred by the on-site, trained, spill response team. The control measures employed by GRAHAM proved effective with no contamination of soils occurring as a result of the construction phase.

There was no surplus of ‘suitable’ soils on the project. Where possible, site-won material was reused to reduce the volume of imported fill required.




OVERALL SITE LOCATION PLAN
FRC - FIFE ITS

| GANTRY | NORTH BOUND | SOUTH BOUND |
|---|---|---|
| 06 | 26m³ | |
| 11 | 15m³ | 39m³ |
| 14 | 24m³ | 515m³ |
| 15 | | 272m³ |
| 16 | 42m³ | |
| 19 | | 1003m³ |
| 21 | | 104m³ |
| Site Compound | 811m³ | |
| Total | 2877m³ | |

TOPSOIL STORAGE QUANTITIES
AND LOCATIONS

REV | DATE | BY | DESCRIPTION

GRAHAM

PROJECT
FORTH REPLACEMENT
CROSSING - FIFE ITS

TITLE
TOPSOIL
STORAGE
LOCATION
PLANS

DRAWG NO FRC-ITS-GC-SK-09 REV 0
SCALE NTS | BY RMcF | DATE 21/03/12

**Figure 2: Plan showing location and volumes of soil storage mounds**

**Figure 3: Stockpiles covered to prevent deterioration of soils**

#### 3.2.2.5.2 Cut and Fill

The detailed design proposal was to reuse all of the excavated material on-site (Design 'Cut' 8,482m$^3$) to help reduce the overall amount of fill material required (Design fill 15,256m$^3$). However, due to the unsuitable nature of existing material and subsequent additional excavation, the total cut volume required was 18,544m$^3$. The total cut volume was reduced by using 6,800m$^3$ of excavated material, which resulted in a recovery of 36.67% of bulk materials for reuse on-site. Calculation of Bulk Earthworks is presented in Annex 7.

### 3.2.3 Outcomes and Problems identified with Objective 1

Although a SRMF and Materials Handling and Management Plan were developed for the Fife ITS project: Appendix 4 and Appendix 5; Objective 1 proved difficult to achieve. A significant volume of soils present on-site were found to be unsuitable for use within the project from a geotechnical perspective. For this reason unsuitable soils had to be excavated and removed from site. In addition, over-excavation was required to ensure the ground conditions were structurally robust to support the new works.

**3.3 Sustainability Objective 2:** To ensure community engagement takes place at all key stages in the Fife ITS project process

**3.3.1 Objective 2 - Target 1**: To make sure that all groups whose interests are affected by the proposed scheme are identified and have access to information and opportunity to engage.

**3.3.1.1 Target Selection**

This target was selected to ensure that the approach to engagement was fully inclusive and to capture performance against Transport Scotland's FRC commitment to encouraging public interest and involvement as set out in TS's 'Engaging with Communities' document (Transport Scotland, 2011a).

**3.3.1.1.1 Community Liaison & Communications Procedures Plan**

On project commencement, GRAHAM developed a Community Liaison and Communications Procedures Plan (CLCP), Annex 8. This document set-out the framework upon which GRAHAM engaged with communities and outlined the communication protocols to be adopted through delivery of the Fife ITS project.

The principal objectives of the CLCP ensured:

- Effective community engagement was maintained throughout the construction period and active relationships were developed with the communities alongside the scheme.
- Affected communities were consulted and informed in advance of the relevant construction works about how the effects of construction activities would be mitigated.
- Affected communities were consulted and kept informed in advance about the timetable of any relevant construction works.

The liaison protocols and communications procedures outlined in the CLCP ensured compliance with the particular requirements detailed in the following key project documents:

- Forth Crossing Act 2011 (Scottish Government, 2011);
- FRC Environmental Statement (Jacobs Arup, 2009b);
- FRC Code of Construction Practice (Revision 5) (Jacobs Arup, 2010); and
- Employers Requirements (Transport Scotland, 2011b).

**3.3.1.1.2 Employers Communication Team**

Transport Scotland put in place a dedicated Communications Team for the FRC scheme to ensure that the Community Engagement and Communication Procedures being applied by the project delivery teams were in accordance with the Code of Construction Practice. Regular communication meetings were convened to allow early identification of potential issues and on-going development of action plans.

Transport Scotland's 'Engaging with Communities' (Transport Scotland, 2011a) document was later updated and Version 1.0 was published August 2011.

Key communities and stakeholders targeted on the Fife ITS project are illustrated in Figure 4.

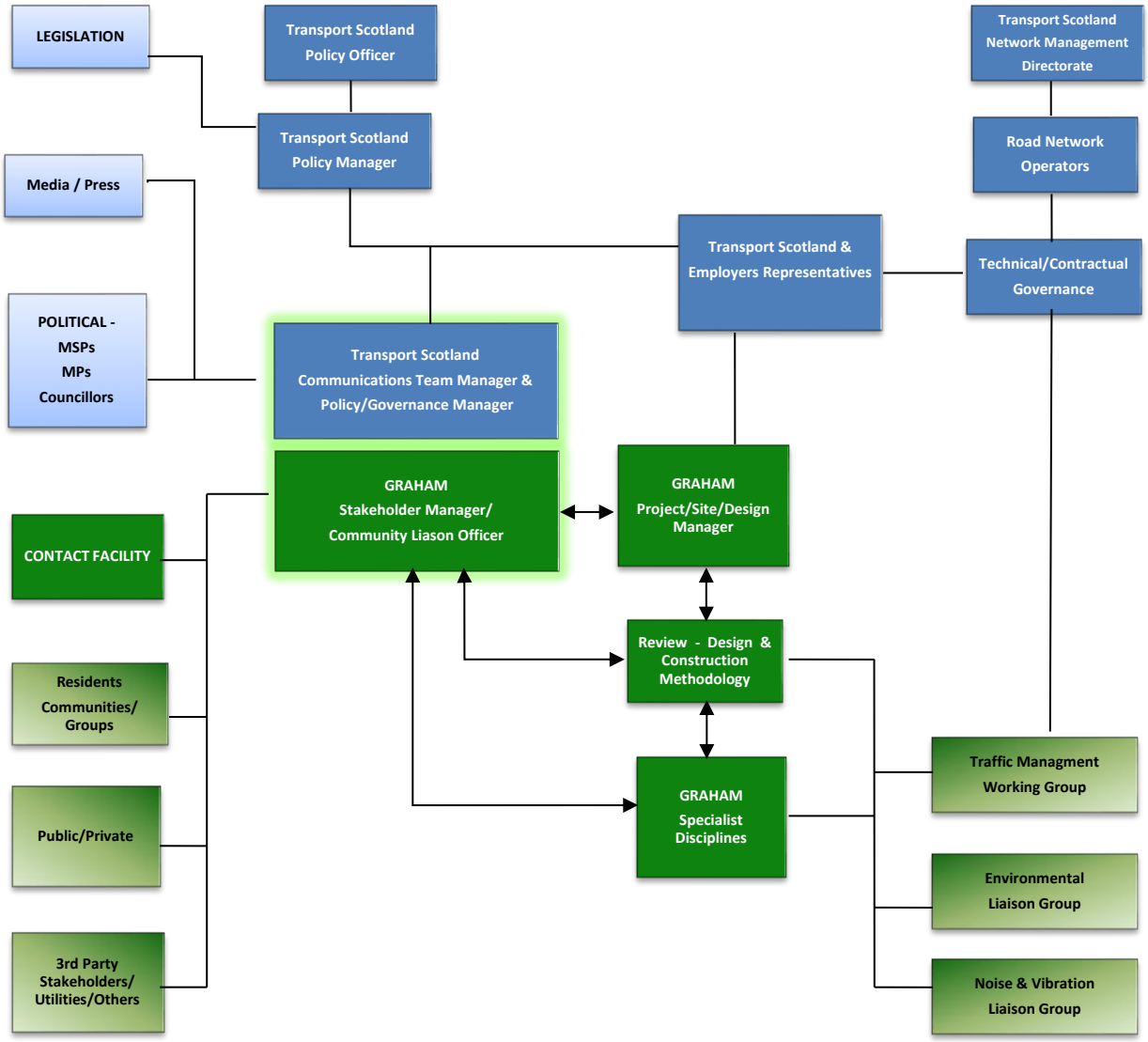



**Figure 4: Communication Groups**

### 3.3.1.2 Methodology

A purpose built Contact and Education Centre (CEC) was constructed for the FRC Project. This facility formed the main on-site communication hub for the project - located within the grounds of the existing FETA offices in South Queensferry.

The CEC was staffed during normal site working hours by a member of the Employers Communications Team. In addition, the Community Liaison Officer (CLO) for the Fife ITS Project was in daily attendance during normal weekday office hours to provide support and address any specific project queries. A 24hr Freephone contact number was established for the FRC Project (0800 078 6910).

#### 3.3.1.2.1 Key Personnel

The Contract specified the requirement for a Community Liaison Officer (CLO) to be appointed on a part-time basis. Due to the scale and high profile nature of project, GRAHAM considered the Fife ITS project warranted a more dedicated resource and duly assigned an experienced Stakeholder Manager with a proven track record in community engagement – on a full-time basis. The Stakeholder Manager fulfilled the role of the CLO whilst ensuring a close construction interface was maintained with the Employer's internal communications team, the construction teams on-site, all external third parties, project stakeholders and communities as illustrated in Figure 4 above.

CLOs were appointed for each of the two other contracts associated with the FRC scheme. Close liaison was maintained between the three CLOs to identify project commonalities. This ensured integration across the three CLO functions towards a single project focus, and in turn, provided a united communication platform. This process facilitated at the Employers discretion:

- Promotion of the project in the public arena.
- Informed decision-making through communications freeze/review.
- Development of communications strategies and action plans through feedback.

#### 3.3.1.2.2 Communications through the Project Lifecycle

It is important to recognise the importance of establishing a firm communication platform on the initial start-up of the FRC Project. In this regard, the Fife ITS Project set a benchmark that, subject to the employer's discretion, could be adapted as the Principal Contract took precedence in the public arena.

Prior to works commencing, through ongoing development of the CLCP, a specific action plan was prepared ready for the project going 'live'. This, under the direction and control of the employers FRC Communications Team, included prior advertising through a number of media/communication channels conveying the Key Project Message. It is worth noting that the key project message changed slightly through the delivery phases, for example, specific good-news emphasis on early completion of gantry sites or lane openings proved beneficial. Communication mediums (Table 3) and the key project messages were specifically pitched towards the following project lifecycle phases:

- Preliminary Phase – Design Development and Finalising of the Solution.
- Mobilisation Phase – Initial Project Impacts and Perceptions.
- Construction/Delivery Phase – Disruption & Damage limitation.
- Commissioning Phase – Reinstatements, Clean & Tidy.

### 3.3.1.3 Indicators

In order to demonstrate the success or otherwise of the Fife ITS CLCP, a documented register of all complaints and enquiries were recorded by the Fife ITS Community Liaison Officer.

### 3.3.1.4 Measurable Targets

GRAHAM aimed to achieve 0% complaints over the course of the Fife ITS contract.

### 3.3.1.5 Appraisal Findings

Community consultations were undertaken at tender stage, and continued immediately on contract award and through the project duration. Ongoing consultations were carried out with all key stakeholders including community residents, public groups, and statutory and non-statutory bodies. The consultation protocols and procedures adopted by GRAHAM on the Fife ITS project fully met, and in many cases exceeded, the robust and flexible community engagement requirements stipulated in the FRC Code of Construction Practice (Jacobs Arup, 2010) in accordance with the Forth Crossing Act (Scottish Government, 2011).

Consultations were recorded in the 'Enquiries and Complaints Log' and reviewed at the monthly liaison/communication group meetings. The final enquiries and complaints log is presented in Annex 9.

The results of the Enquiries and Complaints Log are summarised in Table 2.

**Table 2: Enquiries and Complaints Log - Summary**

| Nature of Entry | Total (No.) | Total (%) |
|---|---|---|
| **Total Entries** | 96 | 100 |
| **Total Enquiries** | 82 | 85 |
| **Total complaints*** | 12 | 12.5 |
| **Total Feedback** | 2 | 2 |

*Entries relate to public complaints

The Enquiries and Complaints Log demonstrates that of the 96 total entries logged, 12.5% comprised complaints. Therefore, the target to achieve 0% complaints over the Fife ITS contract was not achieved.

The most common complaints received during the construction of the Fife ITS project related to noise disturbance and road closures. These complaints were responded to swiftly by the site team and resolved at the time through heightening of control measures and undertaking additional noise monitoring.

Based on the nature of the complaints and the nature of the project itself, as well as the close interaction with members of the public, it is not unreasonable to suggest that the nature and number of complaints received was minimal. The Fife ITS project employed a robust noise monitoring and mitigation programme throughout the construction period, which included numerous earthworks, installation of CFA bored piles up to a depth of 32m, grouting of mineshafts and mine workings, motorway re-surfacing, installation of an ITS, extensive landscaping and the fabrication, testing and installation of 18 overhead gantries.

**3.3.2 Objective 2 - Target 2**: To select appropriate methods of engagement for target audiences and to make sure information is made available at appropriate stages in the project.

### 3.3.2.1 Target Selection

This target was selected to ensure the use of appropriate consultation methods to reach target audiences and the provision of information to stakeholders at appropriate stages in the project.

### 3.3.2.2 Methodology

The Fife ITS dedicated CLO was responsible for ensuring a close construction interface with the third parties was maintained and that appropriate methods of engagement for target audiences were employed. The channels through which GRAHAM's engaged stakeholders and communities are illustrated in Table 3.

**Table 3: Communication Medium**

| Communication Medium | Purpose & aims |
|---|---|
| Stakeholder meetings & briefings | Two-way dialogue.<br><br>Meeting and building relationships with key stakeholders.<br>Facilitating and recording information sharing and feedback.<br>Promote the project and dispel negative preconceptions.<br>Uphold reputations – Project and Employer.<br><br>Monthly meeting with key stakeholders were held to keep them up to date on the project as a whole. These meetings would follow on from the monthly project meetings and allowed the key stakeholders to raise any issues that have materialised during the preceding month, and for GRAHAM's to update them on progress, and what work would be undertaken in the coming month. |
| Letter | Specific information dissemination – to individuals and collective groups.<br>Informal courtesy introductions and approaches.<br>Informal notifications of intention.<br>Formal complaints and responses.<br>Confirmation of agreements, actions and resolutions.<br>Formal notifications and statutory obligations. |
| Project Newsletters and Updates<br>(Employer led with GRAHAM support) | Information dissemination.<br><br>An official source of project news not subject to media interpretation.<br>Provide notice of forthcoming works / activities.<br>Bring the project to life for local communities.<br>Issue a newsletter on a quarterly basis to Key stakeholders. |
| Project Specific Website<br>(Employer led with GRAHAM support) | Information dissemination and two way dialogue.<br><br>Act as up-to-date hub of all project information.<br>Provided feedback facility via email with project team.<br><br>This was proved a good medium for providing information rapidly, particularly on aspects where there were numerous traffic management installations. |
| Reports, leaflets & Guides<br>(Employer led with | Information dissemination.<br><br>Communicating technical findings, decisions and project policy.<br>Communicating aims and benefits of the project. |

| Communication Medium | Purpose & aims |
|---|---|
| GRAHAM support) | Illustrating works that will take place on the ground. |
| Exhibitions/Public Open Day<br>(Employer led with GRAHAM support) | Two-way dialogue.<br><br>Present large volumes of information.<br>Meet affected stakeholders.<br>Facilitate discussion and feedback.<br>Allow communities to study plans and pick up literature.<br>Open evening - Contact and Education Centre.<br>Meet The Contractor Events. |
| Media Relations<br>(Employer led with GRAHAM support) | Information dissemination.<br><br>Supporting FRC Project media relations – construction milestones, news releases, features and profiles.<br>Reactive statements.<br>Media briefings.<br>Widely communicate information about the project.<br>Ensure flow of positive messages.<br>Provide rebuttals and clarifying statements.<br>Supporting employers press office function if required. |
| Advertising<br>(Employer led with GRAHAM support) | Information dissemination.<br><br>Ensure wide coverage and fair notice of forthcoming activities. |
| Ambient media (posters, postcards) | Information dissemination.<br><br>Ensure wide coverage and fair notice of forthcoming activities. |
| 24-hr Freephone Contact | Information assimilation.<br><br>Contact and Education Centre.<br>Enquiries and Contact information.<br>Complaints and Resolutions. |

**3.3.2.3 Indicators**

The Fife ITS Community Liaison Officer ensured that the following were maintained, actioned, and up to date:

- Enquiries and Complaints Log (Annex 9) including requests for information.

It was also the role of the CLO to retain information on:

- attendance of meetings to ensure that the appropriate target audiences were in attendance and that the appropriate information was provided to the necessary individuals; and
- letter drop locations in the surrounding community, where required for specific activities (Annex 10).

**3.3.2.4 Measurable Targets**

GRAHAM aimed to achieve 0% complaints over the course of the Fife ITS contract.

#### 3.3.2.5 Appraisal Findings

The enquiries and complaints log demonstrates that of the 96 total entries logged, 12.5% comprised complaints (Table 2). Therefore, the target to achieve 0% complaints over the Fife ITS contract was not achieved.

### 3.3.3 Outcomes and Problems identified with Objective 2

The main targets outlined for Objective 2 were:

- To make sure that all groups whose interests are affected by the proposed scheme are identified and have access to information and opportunity to engage.
- To select appropriate methods of engagement for target audiences and to make sure information is made available at appropriate stages in the project.

Consultations were recorded in the enquiries and complaints log and reviewed at the regular liaison/communication group meetings. Responses were fully taken on board by GRAHAM throughout the Fife ITS project.

In response to the outcome of the consultation programme a number of changes were made to construction methods and design. Examples include:

- Use of quieter CFA piling method as opposed to potentially noisy percussive driven piling.
- Additional fencing provided at Park Lea following concerns from the residents over the removal of vegetation which aided in partially screening the road.
- Additional noise and vibration monitoring undertaken at key sensitive areas – despite no exceedances previously recorded and out with the requirements of the NVMPs.
- Additional goodwill tree planting as visual screen on request of resident.

Based on the foregoing, it is considered that the target of achieving 0% complaints over the course of the Fife ITS project was a very ambitious target, unlikely to be attainable given the complexity of the scheme and the location of nearby sensitive receptors. However, any complaints were responded to effectively due to the measures put in place for community engagement.

## 3.4 Sustainability Objective 3: To Minimise the Scheme Footprint and Severance of Land

### 3.4.1 Objective 3 - Target 1: Minimise Temporary Land Take for the Scheme.

#### 3.4.1.1 Target Selection

This target recognised the economic importance of existing land uses and the importance of avoiding and reducing the amount of land-take by the project, whether temporary or permanent.

#### 3.4.1.2 Methodology

In order to mitigate the area of land take it was necessary to identify existing hard standing areas such as hard shoulders that could be utilised for the set-up of welfare facilities and parking. In addition, areas where hard standing could be created within the proposed location of permanent works were identified to avoid the requirement for temporary land take.

#### 3.4.1.3 Indicators

The adopted indicator for this target was the comparison of the original proposed land take plans with the actual temporary land take utilised for the project.

#### 3.4.1.4 Measurable Targets

GRAHAM aimed to reduce the area of temporary land take associated with the construction of the project and to return 100% of the agricultural land taken for temporary use back to agricultural use.

#### 3.4.1.5 Appraisal Findings

At four gantry locations, namely, G01 S/B, G05 E/B, G08 S/B and G19 S/B the actual temporary land take area was reduced compared to the proposed temporary land take areas. The area by which temporary land take was reduced at each of the four locations is indicated in Table 4.

**Table 4 – Land Take Areas – Summary**

| Gantry | Proposed Land Take Area | Actual Land Take Area | Reduction in Land Take Requirement * |
|---|---|---|---|
| **G01 S/B** | 546 $m^2$ | 196 $m^2$ | 350 $m^2$ |
| **G05 E/B** | 500 $m^2$ | 112 $m^2$ | 388 $m^2$ |
| **G08 S/B** | 2000 $m^2$ | 750 $m^2$ | 1250 $m^2$ |
| **G19 S/B** | 2500 $m^2$ | 0 $m^2$ | 2500 $m^2$ |

*Relates to temporary land take

In order to reduce the area of temporary land taken at each of the above noted gantry locations, the hard shoulder, or land available adjacent to the hard shoulder, was utilised to

set up welfare facilities and plant and materials storage areas. Specific measures implemented at each of the gantry locations were as follows:

G01 S/B: Existing surfaced areas in the Belleknowes Industrial Estate were used instead of taking more undeveloped land as originally planned, see Figure 5.
*Proposed Temporary Land take was reduced by 350m$^2$.*

G05 E/B: Additional temporary traffic management; namely, reduced speeds and reduced lane widths were established to provide a safe working zone to undertake the works which resulted in reduced temporary land take, see Figure 6. *Proposed Temporary Land take was reduced by 388m$^2$.*

G08 S/B: The hard shoulder was used for the setup of short-term welfare facilities and parking. Hardstanding was created adjacent to the hard shoulder in the location of the permanent works to reduce the area of temporary land required, see Figure 7.
*Proposed Temporary Land take was reduced by 1,250m$^2$.*

G19 S/B: Existing farmers hardstanding was utilised for the storage of site won material, which would eventually be incorporated into the Gantry G19 embankment. There was no disturbance or land take of additional land at G19 – this area was returned to its original condition, see Figure 8.
*Proposed Temporary Land take was reduced by 2,500m$^2$.*

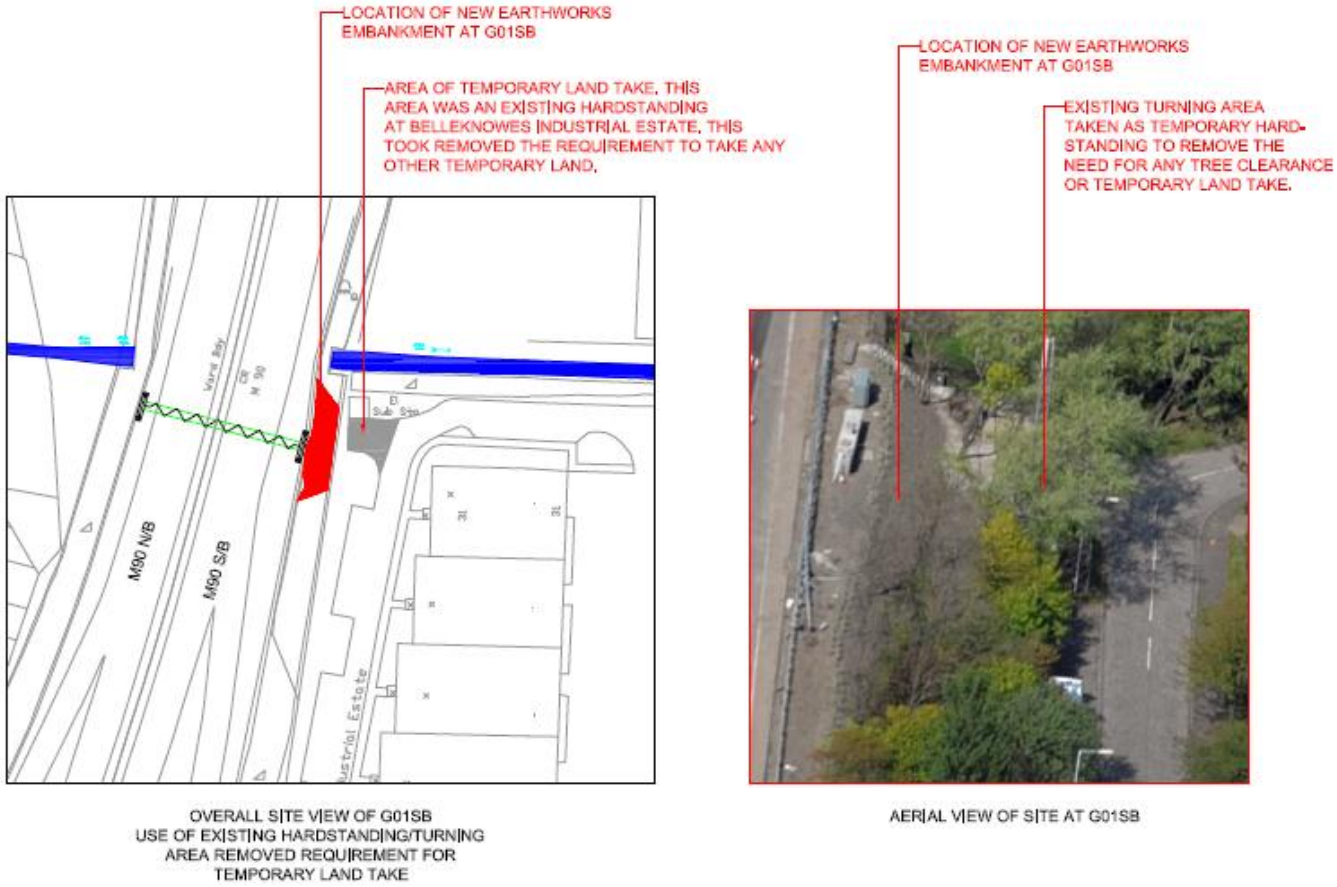



**Figure 5: G01 S/B**

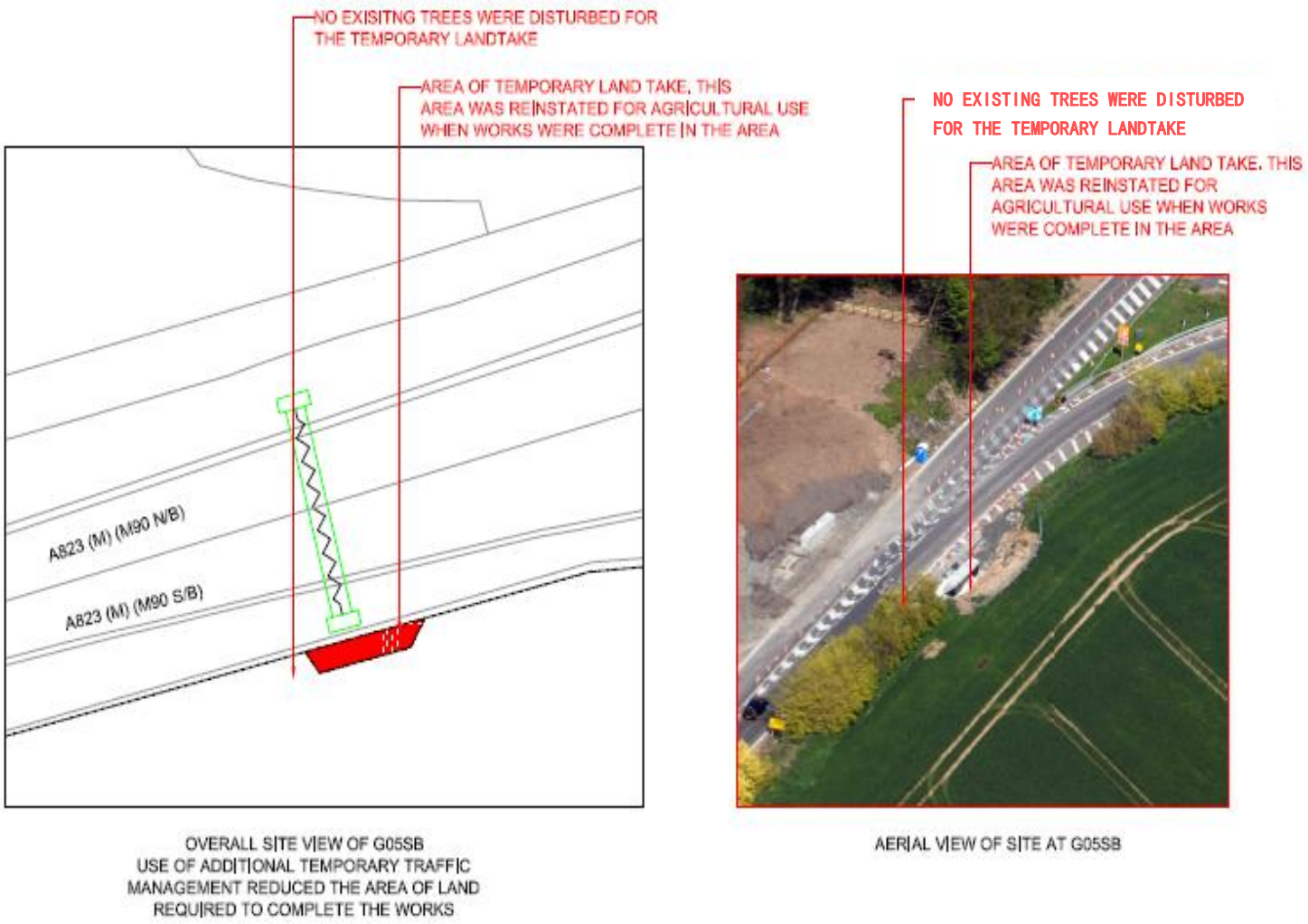



**Figure 6: G05 E/B**

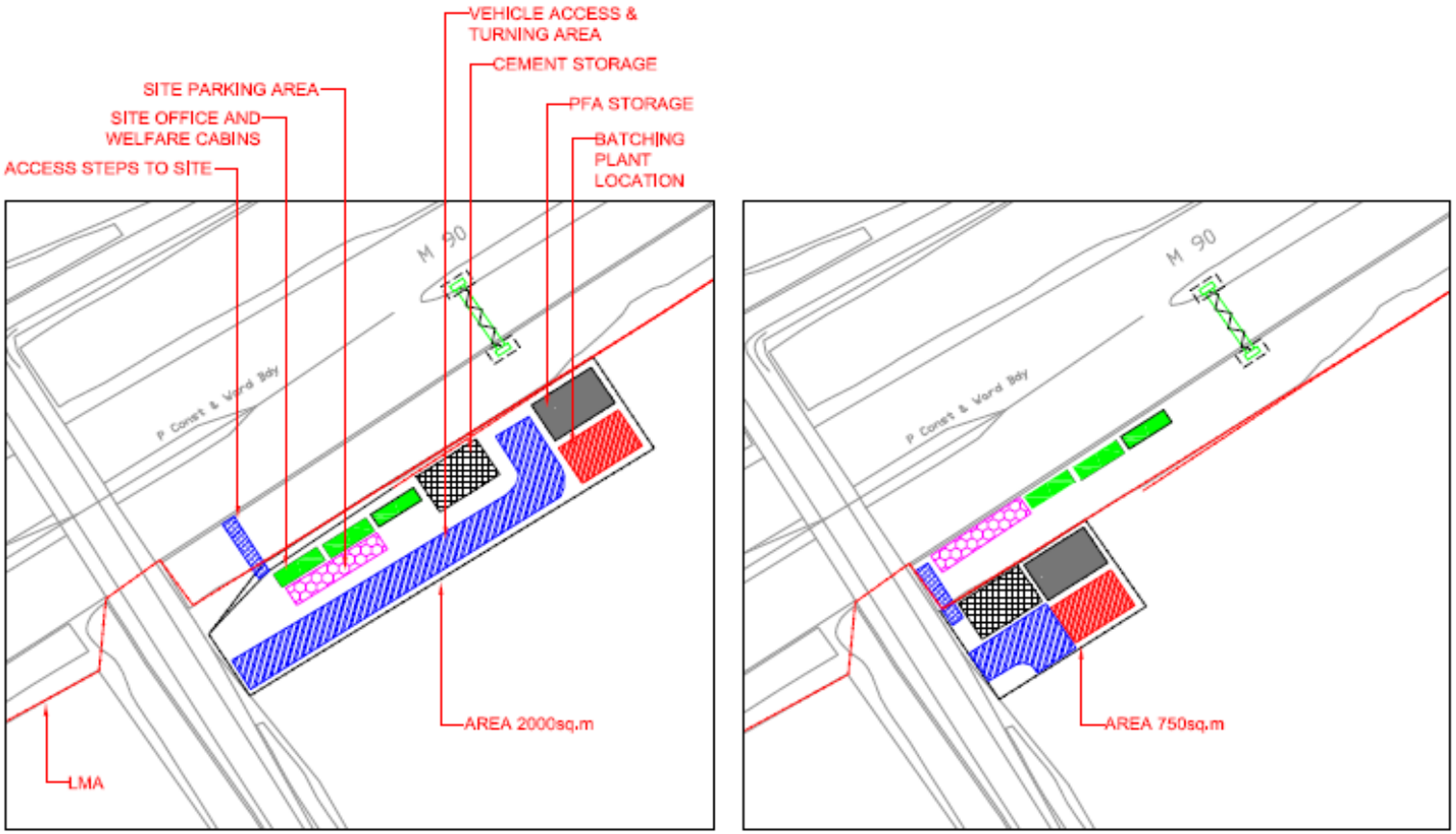



**Figure 7: G08 S/B**

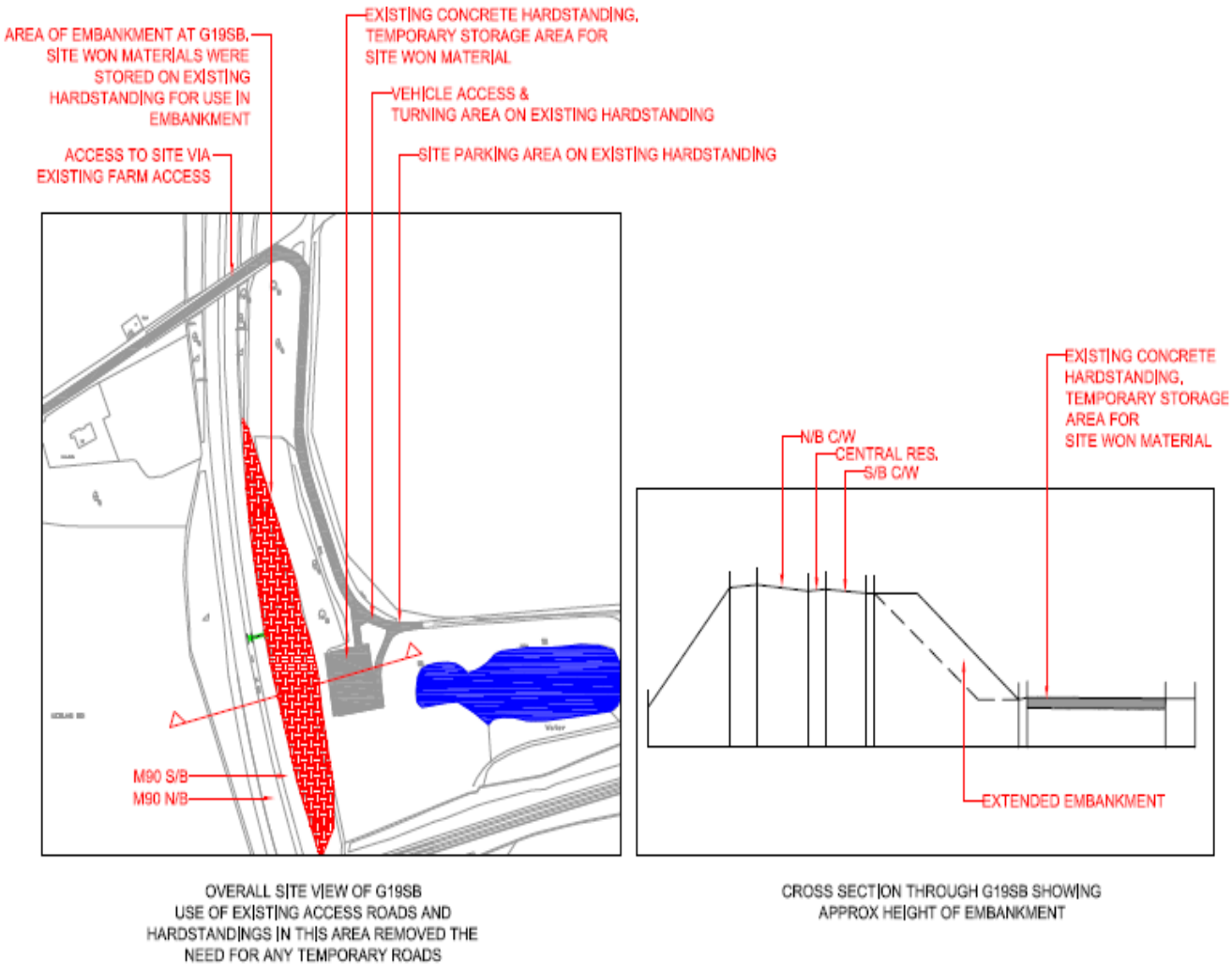



**Figure 8: G19 S/B**

### 3.4.2 Outcomes and Problems identified with Objective 3

Objective 3 aimed to minimise temporary land-take and land severance associated with the Fife ITS project. It was evident that there was generally no opportunity to minimise permanent land-take within the project. On this basis it was considered more relevant to look at opportunities to reduce temporary land-take. It was considered that by reducing temporary land-take, and in particular a reduction in "undeveloped" land take, this would also result in a direct reduction on land severance.

To achieve the foregoing, existing hard-standing areas were identified at gantry locations which could be used for site set-up and welfare facilities as opposed to taking nearby undeveloped agricultural land. In addition, early involvement with subcontractors was key to ensuring that methods and construction plant were tailored to the works at an early stage.

The measurable targets selected for this objective were reduction in temporary land take and the return of 100% of agricultural land to agricultural use. Through the methods employed this objective was achieved as demonstrated by the information contained in Table 4 and supporting Figures 5 to 8.

## **3.5 Sustainability Objective 4**: To reduce, reuse and recycle materials and products where practicable

**3.5.1 Objective 4 - Target 1**: Minimise the difference between cut and fill earthworks quantities.

This objective was established in order to minimise the carbon footprint of the scheme by reducing the need for transport of earthwork materials by balancing cut and fill quantities as much as possible.

#### 3.5.1.1 Target Selection

This target was selected to capture resource use issues relating to scheme earthworks.

#### 3.5.1.2 Methodology

To identify areas where the volume of imported fill could be reduced, the original design proposal was to reuse all of the excavated material on-site (Design 'Cut' 8,482m$^3$) to help reduce the overall amount of fill material required (Design fill 15,256m$^3$) (Annex 7).

#### 3.5.1.3 Indicators

The adopted indicator for this target was the comparison of the 'proposed' and 'actual' proportions by volume of cut material that was used on site as part of the works.

#### 3.5.1.4 Measurable Targets

GRAHAM aimed to use 100% by volume of suitable cut material as part of the works.

#### 3.5.1.5 Appraisal Findings

The detailed design plan was to reuse all of the excavated material on-site (Design 'Cut' 8,482m$^3$) to help reduce the overall amount of fill material required (Design fill 15,256m$^3$). However, due to unsuitable material from the design 'Cut' and additional excavation required due to unsuitable formation, the total cut volume was 18,544m$^3$. The actual excavation volume was therefore 10,062m$^3$ more than envisaged by the detailed design. This volume was reduced by using 6,800m$^3$ of excavated material (including rock from G07). This resulted in a recovery of 36.67% of bulk materials on-site. The Bulk Earthworks Calculation for the Fife ITS Project is presented in Annex 7.

**3.5.2 Objective 4 - Target 2**: Maximise percentage of materials sourced locally.

#### 3.5.2.1 Target Selection

This target was selected to ensure earthworks materials are sourced locally where appropriate.

#### 3.5.2.2 Methodology

To investigate local suppliers and organisations that may be used to identify materials for re-use. As part of the Fife ITS project a Materials Register (Annex 3) was developed to record the source of materials used within the project.

#### 3.5.2.3 Indicators

The adopted indicator for this target was to compare the 'predicted' and 'actual' percentage (%) of materials by type sourced locally within 10km.

#### 3.5.2.4 Measurable Targets

GRAHAM aimed to source at least 75% of materials from suppliers located within 10km of the site.

The indicators for this target were selected in order to ensure consistency with the FRC Sustainability Appraisal and Carbon Management Report (Jacobs Arup, 2009a).

#### 3.5.2.5 Appraisal Findings

As highlighted in Section 3.2.1.5, information collated by the Materials Register for the Fife ITS project relates to the following material types which were sourced from nine different suppliers:

- reinforcement steel;
- concrete;
- aggregates;
- drainage pipe;
- grouting materials;

- surfacing materials; and
- structural steel.

In terms of identifying the distance from source to site, the results of the Materials Register are summarised in Table 5. It was identified that 25% of construction material suppliers to the Fife ITS project were located within 10km with a further 58% located within 32km.

| Table 5: Distance from Source to Site | | | |
|---|---|---|---|
| **Item** | **Distance in km from Source to Site** | **Number of Suppliers / Materials** | **% of Suppliers within this Distance** |
| **Source of the material and distance from source to site** | <10 | 3 | 25 |
| | <16 | 0 | 0 |
| | <32 | 7 | 58 |
| | >161 | 2 | 18 |

The materials that were successfully sourced within the targeted 10km radius of the site were:

- concrete mixes supplied by the Skene Group;
- pipe bedding supplied by Grant Construction; and
- crushed concrete supplied by Muir Construction.

It should be noted that the distance from site that certain materials were sourced was due to the complexity of the project, and the high standards required to be achieved from the particular materials, such as gantry components.

**3.5.3 Objective 4 - Target 3**: Maximise the volume of material taken off-site for reuse and recycling as opposed to sending to landfill.

**3.5.3.1 Target Selection**

To maximise where reasonable, reuse and recycling of materials, in order to reduce adverse environmental effects associated with disposal off-site to landfill and reduction in the carbon footprint of the scheme.

**3.5.3.2 Methodology**

In line with best practice for the recycling of waste, a designated area was established and signed to facilitate the separation of materials for potential reuse, salvage, return and recycling. In order to minimise the carbon footprint of the project, the reduction and reuse of waste was a priority over any other form of diversion.

The segregation of wastes was carried out for the following waste streams:

- timber;
- metal;

- hazardous/special; and
- mixed waste (for all other wastes).

Prior to use, it was ensured that all skips utilised on site would:

- prevent spillages or leakages;
- be corrosive resistant (to the weather elements);
- be covered to prevent rainwater accumulation and to prevent dust and litter being blown;
- be clearly labelled at all times whilst on site;
- be suitable to prevent scavenging from animals; and
- be regularly inspected by a designated member of staff and replaced when full.

Any waste streams which could not be reused on site were segregated into separate skips/stockpiles. All opportunity for the reuse and recycling of materials off-site was then explored and before subsequently removing the materials to the approved recycling facility or reuse destination.

#### 3.5.3.3 Indicators

The indicator adopted for this target comprised comparing the volume of waste diverted from landfill against the actual volume sent to landfill.

#### 3.5.3.4 Measurable Targets

GRAHAM aimed to maximise the volume of material taken off-site for reuse and recycling as opposed to landfill, in order to achieve their "halving waste to landfill" commitment (Annex 14).

#### 3.5.3.5 Appraisal Findings

Materials are a valuable commodity and maximising their recovery and reuse within the Fife ITS project was a priority in terms of sustainability and reducing the carbon footprint of the project.

At organisation level, materials management forms part of a key area governed within GRAHAM's Environmental Management System (EMS). The EMS is certified by National Quality Assurance (NQA) against the requirements of BS EN ISO 14001:2004 (Annex 11). The EMS was utilised to assist in the employment of waste reduction techniques on the Fife ITS project in conjunction with the Site Waste Management Plan (Annex 12) which was prepared in accordance with the GRAHAM Environmental policy, Waste Management policy and Waste Management procedures, all of which are presented in Annex 13, and was maintained throughout the Fife ITS project.

The GRAHAM commitment to waste reduction and recycling was underlined by sign up and commitment to the joint government/industry sustainable construction strategy to half waste to landfill by 2012 (Annex 14).

In order to monitor the nature and quantity of material removed from site and associated diversion routes, the Site Waste Management Plan was maintained throughout the scheme with quarterly reports detailing waste arising and destinations. The quarterly waste reports for the Fife ITS project are presented in Annex 15 with a summary of waste arisings and percentage diversion rates presented in Table 6.

| Table 6 : Waste Generation (tonnes) | | | | |
|---|---|---|---|---|
| **Reporting Period** | **Quantity Sent in tonnes** | **Quantity Recovered in Tonnes** | **Quantity sent to Landfill** | **% Diverted from Landfill** |
| **Oct - Dec 2011** | 9496.88 | 9492.14 | 4.7 | 99.95 |
| **Jan - Mar 2012** | 23.99 | 18.6 | 5.39 | 77.53 |
| **Apr - June 2012** | 29.34 | 21.4 | 7.94 | 72.94 |
| **July - Sept 2012** | 24.59 | 16.4 | 8.19 | 66.69 |
| **Oct - Dec 2012** | 99.17 | 81.32 | 17.85 | 82 |
| **Jan - Mar 2013** | 0.4 | 0.2 | 0.2 | 50 |
| **Totals** | **9674.37** | **9630.06** | **44.27** | **99.54** |

The information presented in Table 6 demonstrates that 99.54% of the waste generated as part of the Fife ITS project was diverted from landfill.

Based on the foregoing it is considered that this target namely, *to maximise the volume of material taken off-site for reuse and recycling as opposed to landfill,* has been achieved.

**3.5.4 Objective 4 - Target 4**: Promote the restoration of brownfield sites within areas affected by the scheme.

**3.5.4.1 Target Selection**

This target addresses the issue of brownfield land in the scheme and aims to promote the improvement of sites where this would be appropriate.

**3.5.4.2 Methodology**

Identify an area of brownfield land that would be suitable for the siting of the site compound.

**3.5.4.3 Indicators**

The indicator adopted for this target was the area of brownfield land brought back into beneficial use as a result of siting the site compound.

**3.5.4.4 Measurable Targets**

GRAHAM aimed to promote the restoration of brownfield sites within areas affected by the scheme.

### 3.5.4.5 Appraisal Findings

Due to the nature of the Fife ITS project, it was considered that the only area of land that could fulfil the criteria for Objective 4 - Target 4 was the area of land on which the site compound would be sited. Prior to the siting of the Fife ITS compound, the area comprised a brownfield site containing a large derelict warehouse (Figure 9).

This area of land was brought back into use as part of the Fife ITS project with portions of the site resurfaced for the purposes of car-parking and siting of temporary offices. In addition, the large warehouse was utilised throughout the project as a secure storage area for construction materials (Figure 10).


**Figure 9: Photograph 1 – Area of land prior to the Fife ITS project**


**Figure 10: Photograph 2 – Fife ITS Site compound Established and Area Improved**

### 3.5.5 Outcomes and Problems identified with Objective 4

The main targets for Objective 4 were to:

- Minimise the difference between cut and fill earthworks quantities.
- Maximise percentage of materials sourced locally.
- Maximise the volume of material taken off-site for reuse and recycling as opposed to landfill.
- Promote the restoration of brownfield sites within areas affected by the scheme.

The aims were therefore to use 100% (by volume) of suitable cut material as part of the works.

The actual excavation was 10,062m$^3$ more than the excavation envisaged by the design. The reason for the over excavation was due to the unsuitability of the soils encountered. The aim however was to reuse all of the “suitable” material which was undertaken, therefore this aim was achieved.

The only soils removed from site were unsuitable soils which were subsequently reused for the ecological improvement of a local quarry.

In terms of benefits to sustainability and the carbon footprint of the scheme, the excavation and transport of this unsuitable material off-site would have contributed significantly to the overall carbon footprint compared with the original proposal to retain all material on-site. The

reuse of the material however, as opposed to landfilling, is beneficial from a sustainability perspective.

- Aim to source at least 75% of materials from suppliers located within 10km of the site.

In terms of sourcing materials locally, the Materials Register maintained throughout the Fife ITS project identified that that 25% of construction material suppliers to the Fife ITS project were located within 10 km of the site. In this instance the aim to source at least 75% of materials from suppliers located within 10km of the site was not achieved. The reason for this is due to the complex nature of some of the materials required for the project, and the availability of local suppliers.

- Maximise the volume of material taken off-site for reuse and recycling as opposed to landfill.

Over 99.5% of the material removed from site was diverted from landfill, which contributed significantly to the sustainable aspirations of the scheme. Diverting the materials from landfill also resulted in a lower carbon footprint when compared with carbon arising from the landfilling of such materials.

It should be noted however that although the material was diverted from landfill, the actual processes involved in removing materials from site, as well as transporting them to their point of reuse or a recycling facility, also contributed substantially to the carbon footprint of the scheme through transport impacts and any processes employed in modifying the material for end use.

- Promote the restoration of brownfield sites within areas affected by the scheme.

Due to the nature of the works involved in the Fife ITS project, there was limited scope to promote the restoration of brownfield sites. In line with this target however, the area of land on which the site compound was sited was restored. This area, which comprised a brownfield site containing a large derelict warehouse, was therefore brought back into use as part of the Fife ITS project with portions of the site resurfaced for the purposes of car-parking and siting of temporary offices. In addition, the large warehouse was also utilised throughout the project as a secure storage area for construction materials and for testing of the ITS gantries.

The selection and subsequent restoration of this site for use as the site compound made a significant contribution to the sustainability of the scheme as well as the carbon footprint. The location of the site, which was effectively adjacent to the scheme, significantly reduced transport impacts associated with employees and contractors traveling between the site offices and the scheme itself. The size of the site also allowed considerable storage potential for plant, equipment and materials, including the actual gantries themselves. This again reduced transport impacts between the scheme, material storage areas (for materials that were not stored locally) and plant and equipment.

**3.6 Sustainability Objective 5**: Seek to minimise embodied energy and carbon associated with key materials and their transport to site

**3.6.1 Objective 5 - Target 1**: Minimise energy use and all carbon emissions during construction

**3.6.1.1 Target Selection**

This target was selected to promote the minimisation of energy use and carbon emissions during construction.

**3.6.1.2 Methodology**

GRAHAM is committed to responsible energy management and to practising energy efficiency throughout operations. GRAHAM recognises that climate change is emerging as one of the most serious environmental challenges currently threatening the global community. GRAHAM understands that there is a need to minimise greenhouse gas emissions produced as a result of fossil fuel consumption and acknowledge that we have a role to play in tackling these issues.

The implementation of an Energy and Carbon Management Plan (ECMP) (Annex 16) within the Fife ITS project, defined the steps that GRAHAM would take to achieve these outcomes, by specifying and timetabling key actions that were credible and adequately resourced and had clear responsibilities allocated for implementation.

In order to achieve the objectives, there were a number of key priorities that required investment, as well as the need for behavioural and structural change throughout the scheme. These included:

- Ensuring that information regarding the ECMP, its aims and successes, was regularly communicated to all personnel involved in the project.
- Instilling the idea that carbon and energy management was the responsibility of every individual and not just that of an interested few.
- Educating personnel to ensure that they were fully aware of how to facilitate the success of the programme and drive awareness campaigns such as poster campaigns and toolbox talks and implementing the following:

  - Site Waste Management Policy, Annex 13;
  - Sustainable Resource Management Framework, Annex 4;
  - Materials Register, Annex 3;
  - Responsible Sourcing Code of Practice, Annex 17;
  - Materials Transportation Strategy, Annex 18;
  - Materials Handling and Management Plan, Annex 5;
  - Creating a Green Travel Plan, Annex 19;
  - Clear allocation of responsibilities for energy management, monitoring and control; and
  - Use energy efficient plant and equipment.

#### 3.6.1.3 Indicators

The adopted indicators for this target are outlined below.

- Utility (plant) Energy Emissions – energy data was recorded and monitored.
- Waste Emissions – waste quantities were managed, monitored and recorded via the Fife ITS SWMP.
- Business Travel Emissions – mileage was logged at the site entrance and collated on a monthly basis.

#### 3.6.1.4 Measurable Targets

GRAHAM initially aimed for a 5% reduction in energy consumption and carbon emissions during the course of the Fife ITS project. At the outset of the project it was intended to use the first quarter data as a baseline. However, for utility energy and business travel emissions, it became apparent that this approach would not provide a robust means to determine whether any reduction had taken place (see findings below).

#### 3.6.1.5 Appraisal Findings

##### 3.6.1.5.1 Utility Energy Impacts

In order to monitor and reduce utility energy emissions, the fuel consumption was monitored, which identified a peak in consumption during January and February 2012 (Figure 11).

In order to assess energy consumption the volume of consumption was normalised against hours worked (Figure 12). This data is also presented in Table 7.

In order to assess whether the target for this objective was achieved it was initially intended to calculate the energy impacts for the first three months of the scheme to use as a baseline. However it became apparent that this was not a valid baseline, as fuel consumption was dependent upon the different phases of work being undertaken, which varied over the course of this relatively short timescale project. More fuel was inevitably used during busy periods of the contract, which would have been greater than the initial three months when works were mobilising. The results are presented here for information.

The second quarter showed the highest fuel consumption and $CO_2$ emissions per hour worked. This is attributed to an increase in energy and carbon-intensive works during the second quarter of the construction programme. After the second quarter, the energy consumption during the remaining period of the construction phase reduced.

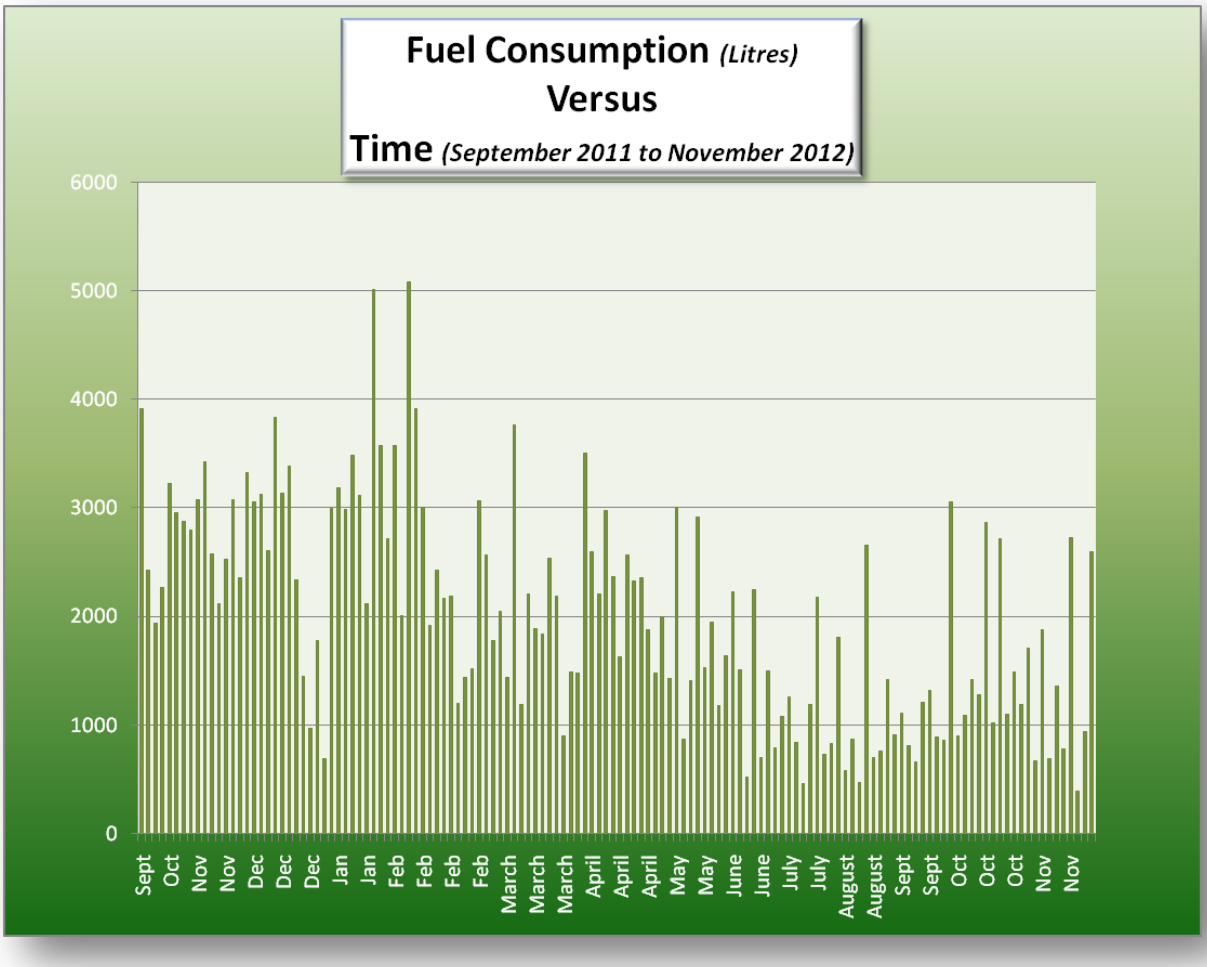



**Figure 11: Fuel Consumption V's Time On-site**

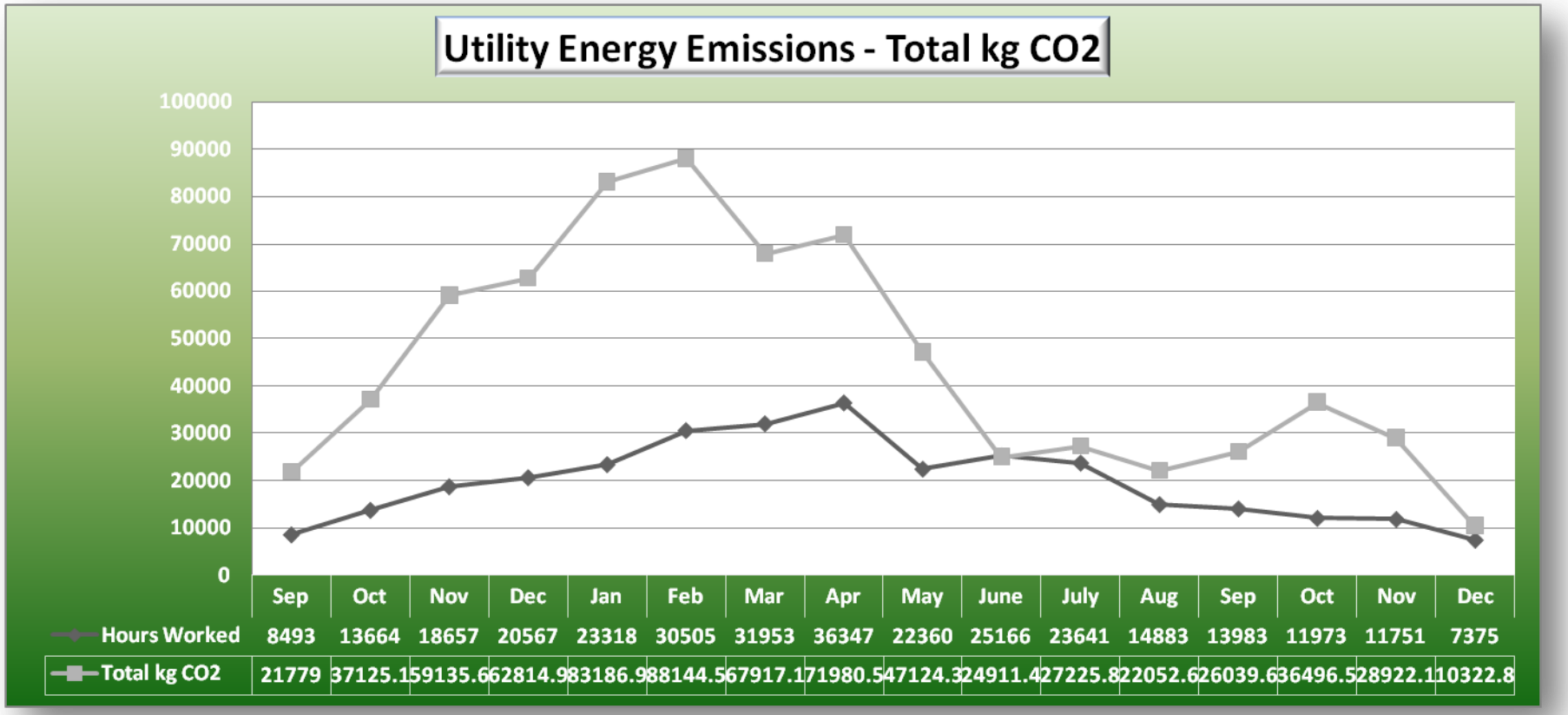



**Figure 12: Utility Energy Emissions**

| Table 7: Energy Impacts | | | | |
|---|---|---|---|---|
| Month | Hours Worked | Total kg $CO_2$ | Fuel Consumption (litres) | Total kg $CO_2$ per hour worked |
| Sept | 8493 | 21779 | 8281 | |
| Oct | 13664 | 37125 | 14116 | |
| Nov | 18657 | 59136 | 22485 | |
| Quarter (1) Total | 40814 | 118040 | 44882 | 2.89 |
| Dec | 20567 | 62815 | 23884 | |
| Jan | 23318 | 83187 | 31630 | |
| Feb | 30505 | 88144 | 33515 | |
| Quarter (2) Total | 74390 | 234146 | 89029 | 3.15 |
| Mar | 31953 | 67917 | 25824 | |
| Apr | 36347 | 71980 | 27369 | |
| May | 22360 | 47124 | 17918 | |
| Quarter (3) Total | 90660 | 187021 | 71111 | 2.06 |
| June | 25166 | 24911 | 9472 | |
| July | 23641 | 27226 | 10352 | |
| Aug | 14883 | 22053 | 8385 | |
| Quarter (4) Total | 63690 | 74190 | 28209 | 1.16 |
| Sep | 13983 | 26040 | 9901 | |
| Oct | 11973 | 36497 | 13877 | |
| Nov | 11751 | 28922 | 10997 | |
| Quarter (5) Total | 37707 | 91459 | 34775 | 2.42 |
| Dec | 7375 | 10323 | 3925 | 1.40 |

**3.6.1.5.2 Waste Impacts**

In accordance with the Site Waste Management Plan (Annex 12), GRAHAM's aim for the Fife ITS project was to maximise, where reasonable, the reuse of site-won materials within the construction of the Project, and recycling of surplus materials in order to reduce adverse environmental effects associated with disposal off-site.

The site team measured and monitored actual waste data whenever waste was removed from the site and submitted quarterly waste reports to the Environmental Advisor for the scheme to review against project targets.

Actual waste quantities/data were recorded within an excel spreadsheet (SWMP data sheet), Figure 13.

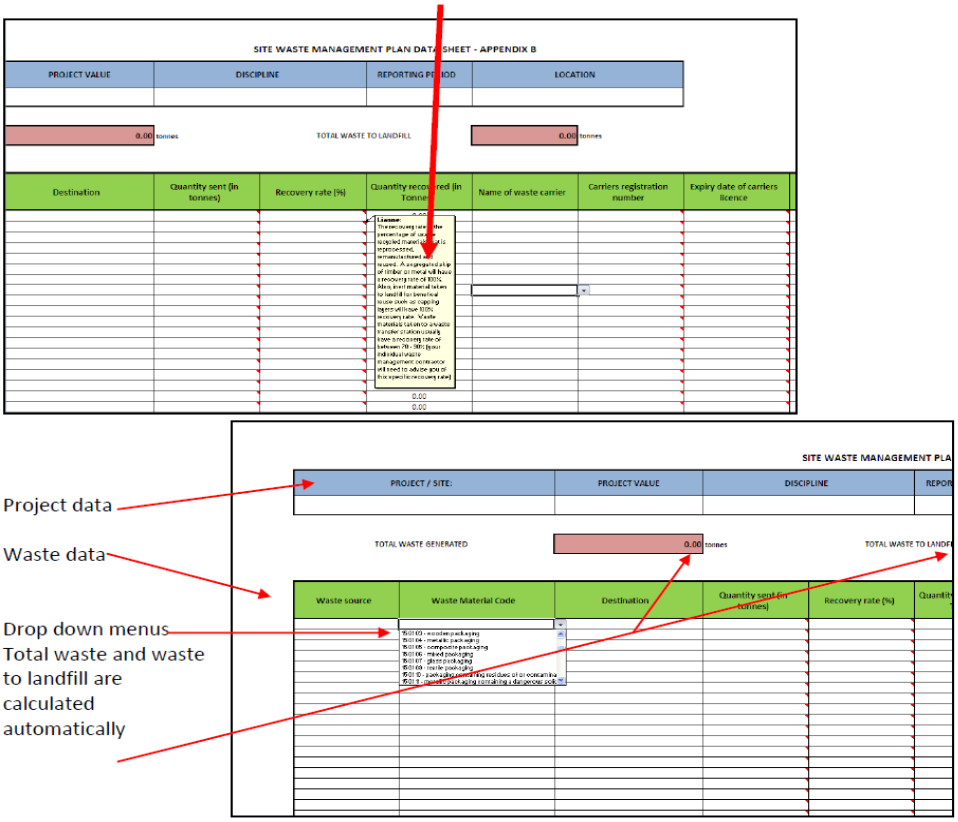



**Figure 13 – SWMP Data Sheet**

The quarterly waste reports for the Fife ITS project, detailing the types, quantities and diversions routes of the waste are presented in Annex 15. A summary of the total waste arisings and percentage diversion rates from landfill are shown in Table 8 (replicated from Table 6).

In order to calculate the waste impacts in terms of $CO_2$ emissions, the conversion factors utilised were based on the 2012 Guidelines to DEFRA and the Department of Energy and Climate Change (DECC) Greenhouse Gas (GHG) Conversion Factors for Company Reporting (DEFRA and DECC, 2012).

| Table 8: Waste Generation (Tonnes) | | | | |
|---|---|---|---|---|
| Reporting Period | Quantity Sent in tonnes | Quantity Recovered in Tonnes | Quantity sent to Landfill | % Diverted from Landfill |
| Oct - Dec 2011 | 9496.88 | 9492.14 | 4.7 | 99.95 |
| Jan - Mar 2012 | 23.99 | 18.6 | 5.39 | 77.53 |
| Apr - June 2012 | 29.34 | 21.4 | 7.94 | 72.94 |
| July - Sept 2012 | 24.59 | 16.4 | 8.19 | 66.69 |
| Oct - Dec 2012 | 99.17 | 81.32 | 17.85 | 82 |
| Jan - Mar 2013 | 0.4 | 0.2 | 0.2 | 50 |
| Totals | 9674.37 | 9630.06 | 44.27 | 99.54 |

Figure 14 to Figure 19 present the quarterly carbon emissions associated with each waste arising on the Fife ITS project.

In terms of meeting the target for this objective, it is clearly demonstrated that the total waste arising on the Fife ITS project significantly decreased after the first quarter, which saw more than 98% of the waste production. The majority of the waste arising in the first quarter consisted of bulk excavation and removal of 'unsuitable soils' off-site.

The total carbon emissions associated with waste arising on the project was 1635.2 kg $CO_2$ which represents 24.6% of the total carbon emissions for the project (Annex 20, Carbon Calculator).

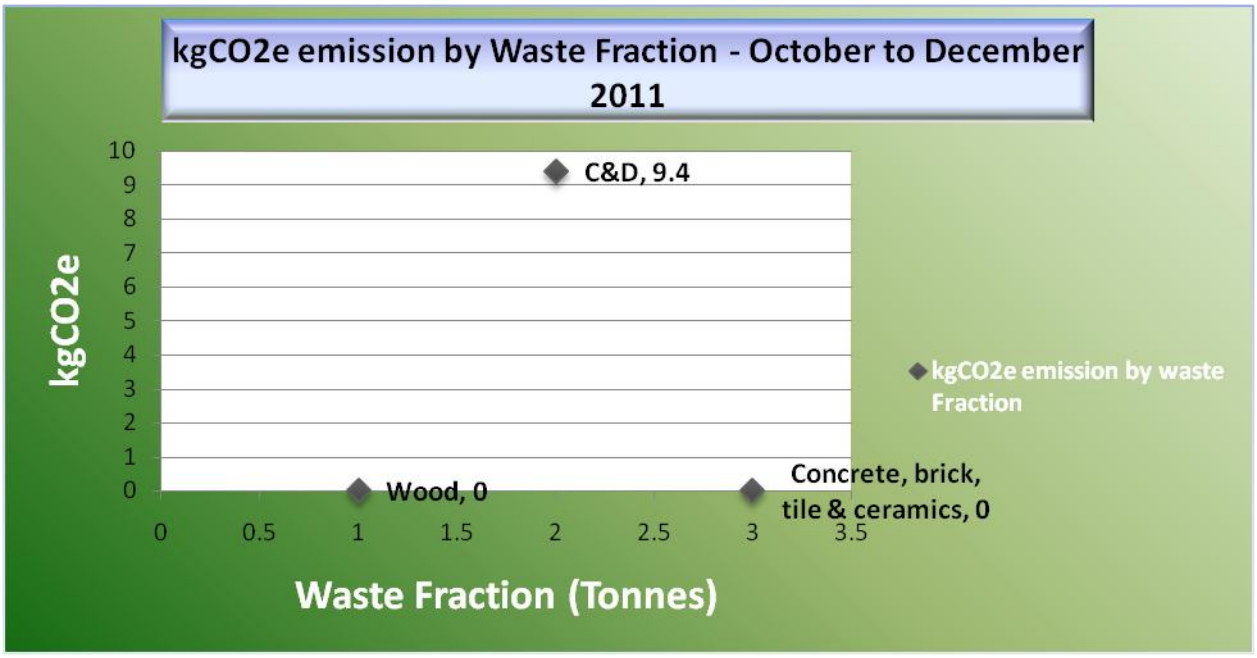



**Figure 14: Kg $CO_2e$ Emission by Waste Fraction – October to December 2011 (C&D = mixed construction and demolition wastes)**

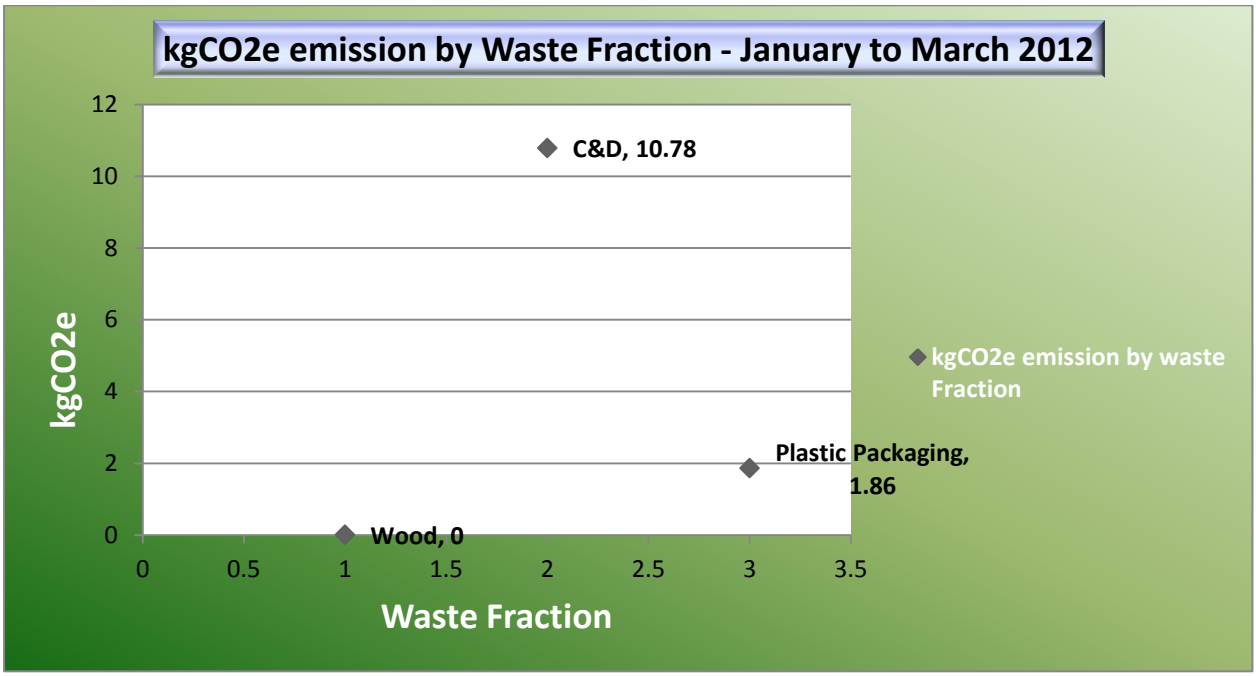



**Figure 15: Kg$CO_2e$ Emission by Waste Fraction – January to March 2012 (C&D = mixed construction and demolition wastes)**

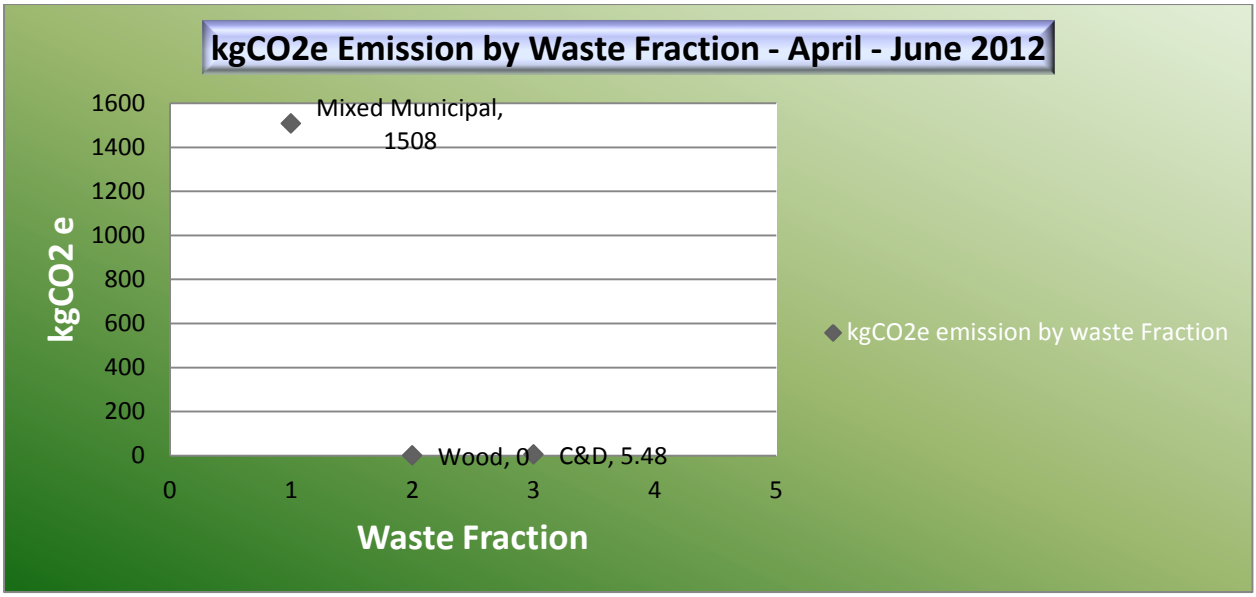



**Figure 16: $KgCO_2e$ Emission by Waste Fraction – April to June 2012 (C&D = mixed construction and demolition wastes)**

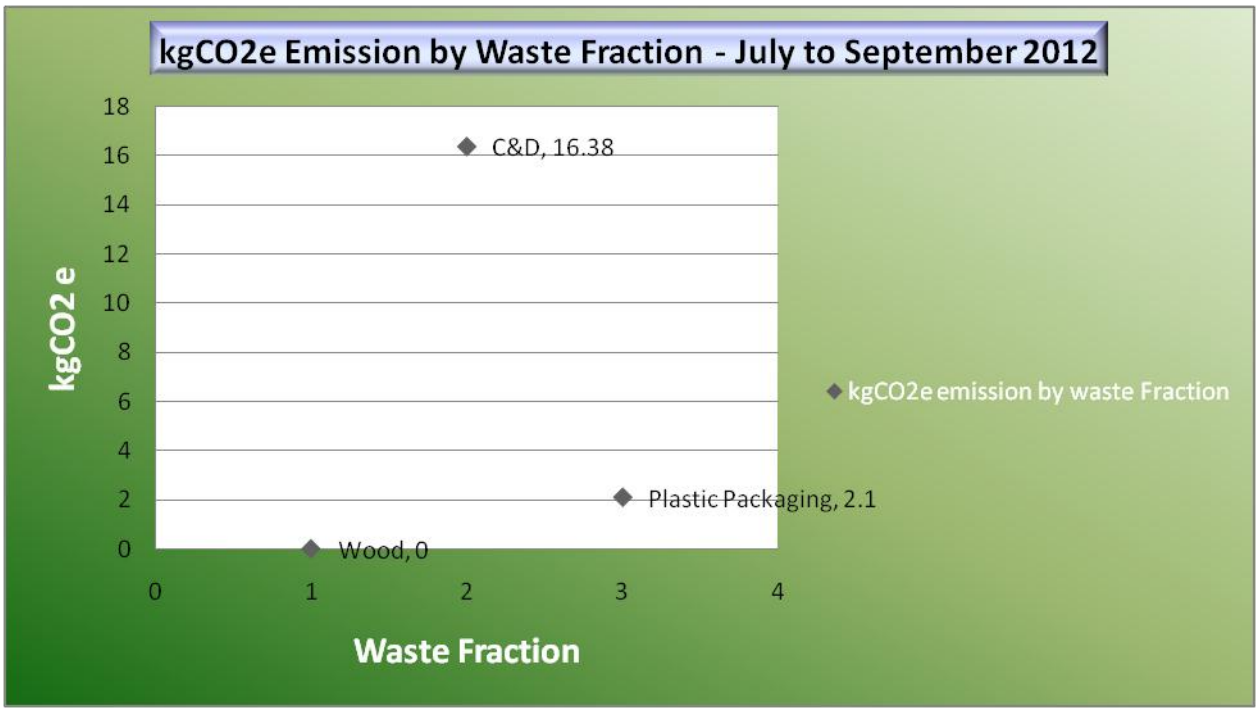



**Figure 17: $KgCO_2e$ Emission by Waste Fraction – July to September 2012 (C&D = mixed construction and demolition wastes)**

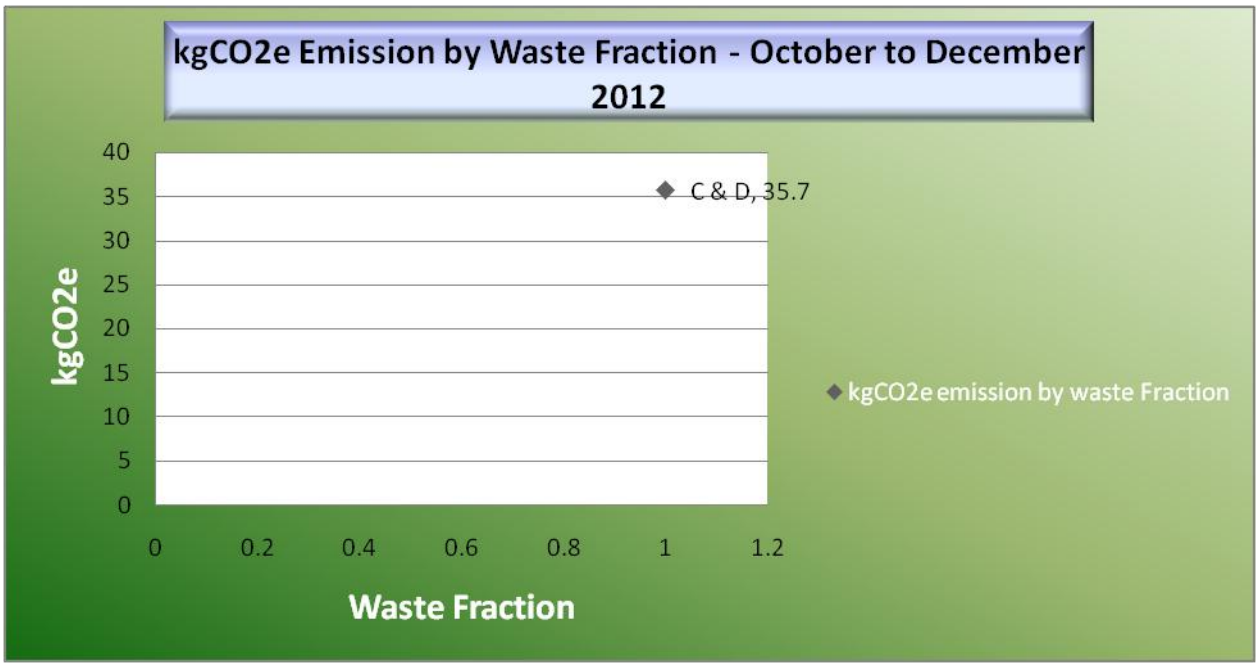



**Figure 18: $KgCO_2e$ Emission by Waste Fraction – October to December 2012 (C&D = mixed construction and demolition wastes)**

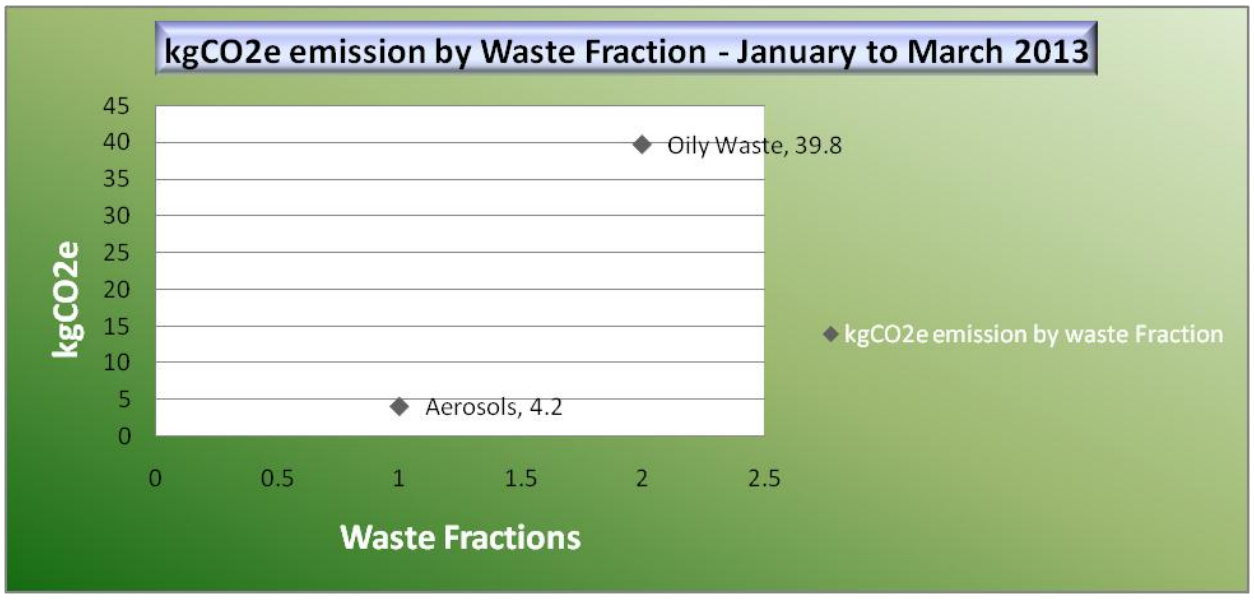



**Figure 19: $KgCO_2e$ Emission by Waste Fraction – January to March 2013**

#### 3.6.1.5.3 Business Travel Impacts

As part of the Fife ITS project, a Green Travel Plan (GTP) (Annex 19), was implemented during the Works activities. The GTP comprised a package of measures designed specifically in view of the individual site and aimed to promote more sustainable travel choices. A GTP functions by helping to reduce the impact of an organisation's travel on the environment, in particular, the impact on those factors affecting climate change.

Travel management aims to reduce the demand and volume of travel undertaken by single occupancy vehicles (SOV) and improve conditions and choice for cyclists, pedestrians and those using public transport. By supporting alternatives to car-based travel, it was hoped that the GTP initiatives would contribute to relieving congestion and pollution by decreasing travel-related impacts during the construction phase.

The implementation and management of the GTP was co-ordinated by the Site Manager, who was supported by the GRAHAM-appointed Sustainability Manager and Environmental Advisor.

The success of the GTP was dependent on employee participation. It was therefore essential to involve employees from an early stage and GRAHAM made every effort to ensure this. It was anticipated that employee involvement would encourage ownership and it was consequently expected to result in employees reviewing their travel behaviours and considering/adopting new or alternative travel modes.

In order to assess the success of the GTP, and the resultant business travel impacts, green travel surveys included in the GTP were undertaken during the Fife ITS contract and site staff mileage was recorded daily in the form of a sign in/sign out sheet.

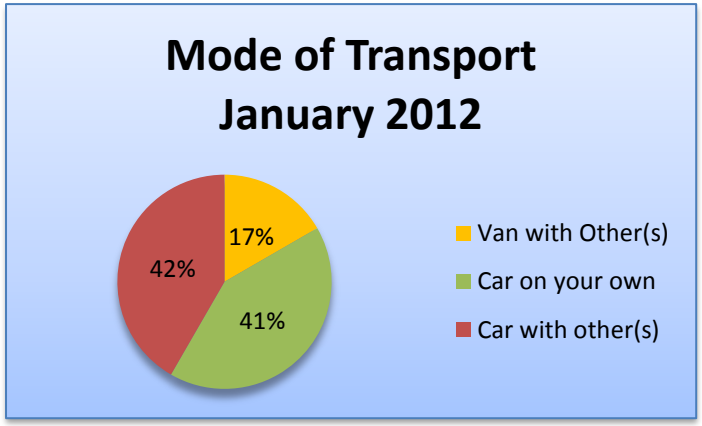
**3.6.1.5.4 Green Travel Survey**

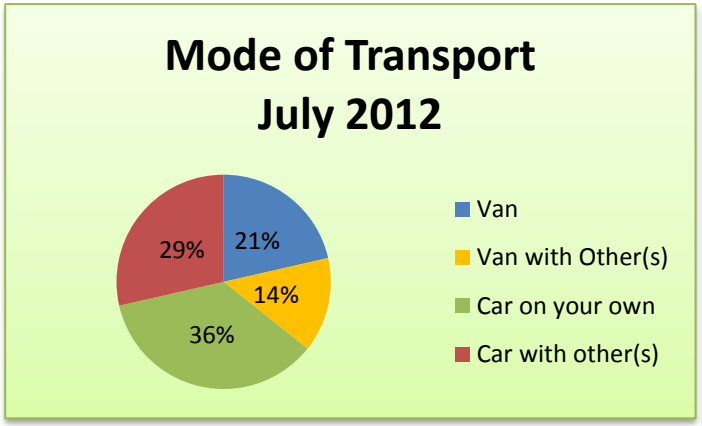
The main objective of the GTP implemented on the Fife ITS project was to achieve a reduction in Single Occupancy Vehicle (SOV) use. In addition, GRAHAM aimed to increase the use of public transport.

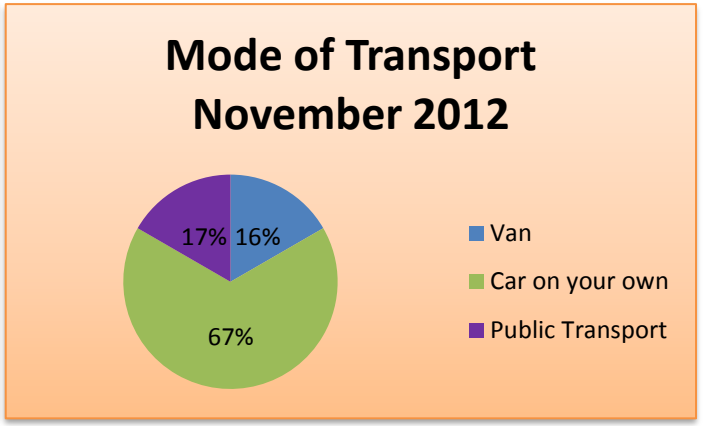
In order to assess the success of the Green Travel Plan, three surveys of the workforce travel arrangements were carried out. These surveys were undertaken in January 2012, April 2012 and November 2012.

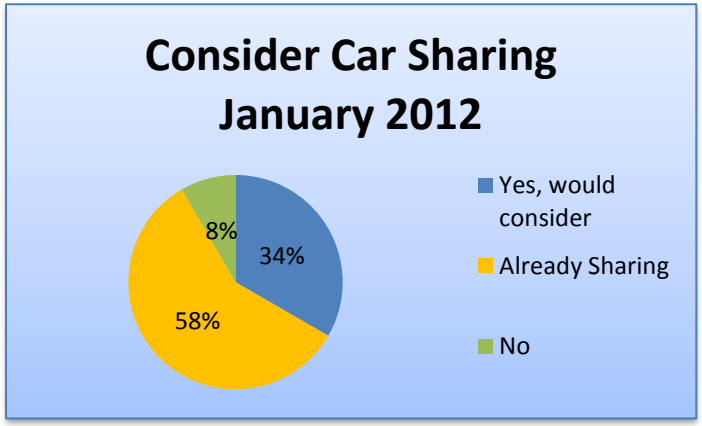
The results of the surveys were reviewed and summarised with graphical presentation (Figure 20), showing that over the period of the Fife ITS project the outcomes detailed in Table 9 were achieved.

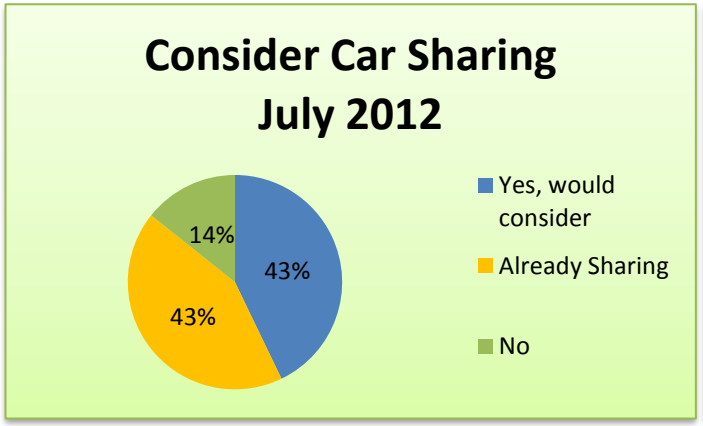
**Figure 20: Results of Green Travel Survey – Fife ITS**

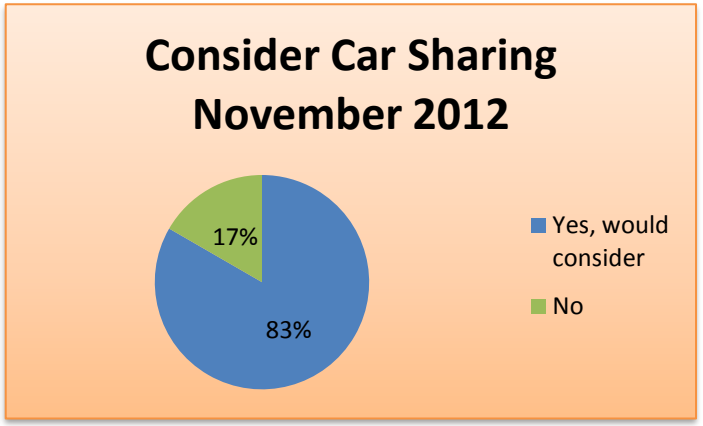


| Table 9 - Green Travel Surveys – Summary of Results | | |
|---|---|---|
| **Surveyed Area** | **Period January – July 2012** | **Period July – November 2012** |
| **Mode of Transport** | Single Vehicle Occupancy (SOV's) (car and van) *increased* | Use of Public transport *increased*<br>Car and van with others *decreased* |
| **Consider Car Sharing** | Consideration of Car Sharing (including those already sharing) *decreased* | Consideration of Car Sharing (including those already sharing) *decreased* |

The results of the surveys showed that SOV use rose from 41% in January 2012 to 67% in November 2012, and during the same period, the number of people who would consider car sharing, or who were already part of a car share, reduced slightly from 92% to 83%.

It is considered that the reason single occupancy vehicle use rose, even though there was a general consensus that car sharing was considered, is due to the following reasons:

- Work programme

At the time of the last green travel survey, in November 2012, the construction phase of the Fife ITS project was close to finishing. During the last few months of the project there were a number of staff changes due to the nature of the on-going works. It is likely therefore that car sharing partnerships were hampered by these changes in personnel.

- Car Sharing opportunities

The percentage of those who considered car sharing, and those who were already part of a car share, was shown to reduce slightly throughout the course of the project. It is considered that the reason for this was lack of opportunity. This may have been improved by running car sharing awareness schemes more regularly during the project, particularly during periods where there were significant changes in personnel such as the last few months of the construction phase.

- Public Transport opportunities

Public transport opportunities were not exploited until the end of the contract. It is possible that due to staff changes, personnel who were previously car sharing had to identify other routes to work, therefore public transport may have become a more feasible option. Another possibility is that it took a significant length of the project time for personnel to identify suitable public transport links. To increase the use of public transport, as with car sharing, a greater focus may have aided in the shift from SOV to public transport, also the option of coupling the use of public transport with car sharing opportunities for those who had longer journeys to work.

It is evident from the surveys carried out that personnel were willing to consider other transport options however this did not become a reality. To improve the uptake of alternative transport methods and reduce the use of SOVs in the future, a dedicated programme would need to be implemented throughout the contract with dedicated personnel identifying car

sharing opportunities. A rewards scheme could be set-up to reward employees who reduce their carbon footprint for travel to work.

#### 3.6.1.5.5 Daily Business Mileage

Business miles were recorded within the site office on a daily basis (monthly mileage logs are presented in Annex 21), and the total miles per month (Dec 2011-Dec 2012) and associated $CO_2$ emissions are presented in Table 10.

**Table 10: Summary of Business Miles**

| Month | Miles Travelled to site | Assumed Round Trip | CO2 Emissions (kg CO2e per unit)[1,2] |
|---|---|---|---|
| December | 2924 | 5848 | 1911.13 |
| January | 6494 | 12988 | 4244.48 |
| February | 6648 | 13296 | 4345.13 |
| March | 7373 | 14746 | 4818.99 |
| April | 10244 | 20488 | 6695.48 |
| May | 7100 | 14200 | 4640.56 |
| June | 14779 | 29558 | 9659.55 |
| July | 13422 | 26844 | 8772.62 |
| August | 13747 | 27494 | 8985.04 |
| September | 9885 | 19770 | 6460.84 |
| October | 10014 | 20028 | 6545.15 |
| November | 5712 | 11424 | 3733.36 |
| December | 2448 | 4896 | 1600.01 |

1. Average petrol car - 0.3344 kg $CO_2$e per mile. Average diesel car 0.3192 kg $CO_2$e per mile. Average car emission - 0.3268 kg$CO_2$e per mile.

2. Based on average car emission figure and assumed round trip mileage.

SOURCE: Carbon Trust (Energy and Carbon Conversions 2009 update).

At the outset of the project it was intended to use the first quarter data as a baseline and aim for a subsequent 5% reduction in carbon emissions throughout the remainder of the project. However, as per the utility energy emissions, it became apparent that this approach would not provide a robust means to determine whether any reduction had taken place for business travel emissions. Greater business travel, and corresponding higher carbon emissions, would have occurred during busy periods of the contract when there were more staff travelling to site. This may have been greater than the initial three months when works were mobilising. The results are presented in Table 11 for information.

| Table 11 - Business Miles – Quarterly Results | | | |
|---|---|---|---|
| Month | Miles Travelled to site | Assumed Round Trip | $CO_2$ Emissions (kg $CO_2$e per unit)[1,2] |
| December | 2924 | 5848 | 1911.13 |
| January | 6494 | 12988 | 4244.48 |
| February | 6648 | 13296 | 4345.13 |
| Quarter 1 | | | 10501 |
| March | 7373 | 14746 | 4818.99 |
| April | 10244 | 20488 | 6695.48 |
| May | 7100 | 14200 | 4640.56 |
| Quarter 2 | | | 16155 |
| June | 14779 | 29558 | 9659.55 |
| July | 13422 | 26844 | 8772.62 |
| August | 13747 | 27494 | 8985.04 |
| Quarter 3 | | | 27417 |
| September | 9885 | 19770 | 6460.84 |
| October | 10014 | 20028 | 6545.15 |
| November | 5712 | 11424 | 3733.36 |
| Quarter 4 | | | 16739 |
| December | 2448 | 4896 | 1600.01 |
| Quarter 5 | | | 1600 |

### 3.6.2 Outcomes and Problems identified with Objective 5

The main target for Objective 5 was to minimise energy use and all carbon emissions during construction of the Fife ITS project.

The initial aim for this target was a 5% reduction from the initial three month consumption and emissions rates for utility energy, waste and business travel.

#### 3.6.2.1 Utility Energy Emissions

Energy use during the project was initially compared against the baseline (energy used in first three months of construction). However it became apparent that this was not a valid baseline, as fuel consumption was dependent upon the different phases of work being undertaken, which varied over the course of this relatively short timescale project. .

Energy consumption and total $CO_2$ produced was found to increase during the second quarter of the construction phase. This is attributed to an increase in energy and carbon-intensive works during the second quarter of the construction programme. After the second quarter the energy consumption during the remaining period of the construction phase reduced.

Although the reduction in energy used cannot be quantified for this project, energy reducing measures were in place which it is hoped would have contributed to a reduction in fuel use. The data recorded may be useful for future projects.

#### 3.6.2.2 Waste Impacts

In accordance with the SWMP, the aim was to maximise, where reasonable, reuse of site-won materials within the construction of the Project and recycling of surplus materials in order to reduce adverse environmental effects associated with disposal off-site.

It was demonstrated that the total waste arising on the Project significantly decreased after the first quarter, in which more than 98% of the waste was produced. The majority of the waste arising in the first quarter consisted of bulk excavation and removal of unsuitable soils off-site.

#### 3.6.2.2 Business Travel Impacts

A GTP was implemented within the Fife ITS project. The success of the GTP was dependent on employee participation and GRAHAM made every effort to involve employees.

GRAHAM initially aimed to reduce carbon emissions associated with business travel by 5% against the first quarterly baseline. However, as per the utility energy emissions, it became apparent that this approach would not provide a robust means to determine whether any reduction had taken place for business travel emissions. Greater business travel, and corresponding higher carbon emissions, would have occurred during busy periods of the contract when there were more staff travelling to site. This may have been greater than the initial three months when works were mobilising.

Green Travel surveys undertaken throughout the course of the contract showed that SOV use rose between the start and end of the contract, and during the same period, the number of people who would consider car sharing, or who were already part of a car share, reduced slightly. It is considered that SOV use increased due to the following reasons:

- Work programme;
- Lack of Car Sharing opportunities; and
- Lack of Public Transport opportunities.

It is evident from the surveys carried out, that personnel were willing to consider other transport options however this did not become a reality. To improve the uptake of alternative transport methods and reduce the use of SOVs in the future, a programme could be implemented throughout the contract with dedicated personnel identifying car sharing opportunities. A rewards scheme could be set-up to reward employees who reduce their carbon footprint for travel to work.

## 3.7 Sustainability Objective 6: To reduce noise and air emissions

**3.7.1 Objective 6 - Target 1**: Manage effectively, construction noise impacts and reduce and mitigate significant operational noise impacts where practicable.

#### 3.7.1.1 Target Selection

This target was selected in order to promote the reduction and mitigation of impacts associated with construction and operational noise where practicable.

#### 3.7.1.2 Methodology

GRAHAM is committed to avoiding unnecessary noise and vibration, and mitigating noise and vibration levels during construction of the Fife ITS project through the adoption of Best Practicable Means as defined in Section 72 of the Control of Pollution Act 1974 and the FRC Code of Construction Practice (Jacobs Arup, 2010). GRAHAM complied with the recommendations set out in BS5228 (BSI, 2009) to ensure construction noise levels did not impact on nearby neighbours or ecological receptors.

#### 3.7.1.3 Indicators

A combination of unattended continuous noise monitoring and attended noise monitoring will be carried out at each phase of the works:

- Monitoring will be carried out during working hours and data downloaded weekly;
- Number of specific complaints received will be recorded; and
- Weekly inspection of construction vehicles, plant and machinery.

#### 3.7.1.4 Measurable Targets

GRAHAM will aim for 0% exceedances of noise level threshold values, specified within Tables 5.4.1a and 5.4.1b of the FRC CoCP ((Jacobs Arup, 2010), on the Fife ITS project.

#### 3.7.1.5 Appraisal Findings

A Noise and Vibration Management Plan (NVMP), Annex 22, was developed for the Fife ITS project by GRAHAM. This Plan was developed to provide information on the measures to be implemented to control and mitigate noise and vibration during construction. It also provided details of the monitoring systems that were used during the construction phase.

A PCNV (Plan for Control of Noise & Vibration) was completed for each of the construction activities to be undertaken on the project. In order to minimise the number of PCNVs to be submitted, GRAHAM agreed with the Employer and other third parties to employ a Risk Assessment Approach in assessing the noise and vibration potential of each activity, grouping similar activities together into one PCNV where possible.

It was a requirement of the contract that any works programmed to take place outside the normal working hours set out in the CoCP, should have separate specific PCNV's completed for them. All equipment on site was kept well maintained to reduce excessive noise and the site team operated during agreed working hours.

The summary table of the PCNV Risk Assessment Approach completed for the programmed works is presented in Figure 22. When completing the PCNV Risk Assessment, each construction activity was assessed in terms of its proximity to noise and vibration sensitive receptors, the hours of work and the information in the NVMP. The activity was then given a risk potential rating of either low, medium or high. Using these ratings and grouping similar activities together the schedule of PCNV's was formed.

Noise and vibration monitoring, as discussed below, was undertaken to ensure compliance with the PCNVs. Noise limits were set in terms of $L_{Aeq,T}$ and $L_{Amax,F}$ and thresholds set in accordance with the CoCP.

A combination of attended and unattended continuous noise monitoring was carried out (Figure 23). The results of the monitoring throughout the construction phase are presented in Annex 23.

The risk assessment approach identified that resurfacing works during May 2012 could result in elevated levels of noise and vibration. Based on the foregoing, a programme of noise and vibration monitoring was undertaken throughout this period. This was the only period where exceedances in noise and vibration were recorded both during and outwith periods associated with the resurfacing works. Following site visits and analysis of data, it was determined that these exceedances were as a result of general traffic HGV movements along the adjacent M90 and not as a result of the Fife ITS construction activities.

| | | | Title | Revision | Date Submitted/ To be submitted to Employer | Submission Notice | Document Transmittal Ref |
|---|---|---|---|---|---|---|---|
| | | | NVMP | 0 | 17/06/2011 | N/A | N/A |
| | | | | 1 | 13/07/2011 | N/A | N/A |
| | | | | 2 | 12/08/2011 | SN013 | FRC-FITS-JG-DT00024 |
| | | | | 3 | 22/08/2011 | SN025 | FRC-FITS-JG-DT00030 |
| **PCNV No.** | **Risk Rating** | **Approx. Const Date** | **PCNV Title** | **Revision** | **Date submitted to Employer** | **Submission Notice** | **Document Transmittal Ref** |
| 1 | LOW | 15/08/2011 | Contractor's Compound Setup | 0 | 20/07/2011 | N/A | FRC-FITS-JG-DT00003 |
| | | | | 1 | 04/08/2011 | N/A | FRC-FITS-JG-DT00017 |
| | | | | 2 | 09/08/2011 | SN008 | FRC-FITS-JG-DT00020 |
| | | | | 3 | 10/08/2011 | SN009 | FRC-FITS-JG-DT00021 |
| 2 | HIGH | 02/09/2011 | M90 Southbound Carriageway Pavement Testing | 1 | 04/08/2011 | N/A | FRC-FITS-JG-DT00017 |
| | | | | 2 | 12/08/2011 | SN012 | FRC-FITS-JG-DT00024 |
| | | | | 3 | 25/08/2011 | SN034 | FRC-FITS-JG-DT00035 |
| | | | | 4 | 02/09/2011 | SN039a | |
| 3 | LOW | 07/11/2011 | Low Risk Gantry Sites | 0 | 04/08/2011 | N/A | FRC-FITS-JG-DT00017 |
| | | | | 1 | 17/08/2011 | SN019 | FRC-FITS-JG-DT00027 |
| | | | | 2 | 16/09/2011 | SN003a | FRC-FITS-JG-DT00055 |
| 4 | MEDIUM | 07/11/2011 | Med Risk Gantry Sites (Rock Breaking) | 0 | 23/08/2011 | SN026 | FRC-FITS-JG-DT00031 |
| | | | | 1 | 14/09/2011 | SN026b | FRC-FITS-JG-DT00054 |
| 5 | MEDIUM | Jan 2012 | Med Risk Gantry Sites (Park Lea (02&03)) | 0 | 09/09/2011 | SN060 | FRC-FITS-JG-DT00047 |
| | | | | 1 | 10/10/2011 | SN060a | FRC-FITS-JG-DT00085 |
| 6 | HIGH | 12/12/2011 | Gantry Site 01 | 0 | 17/10/2011 | SN0108 | FRC-FITS-JG-DT00098 |
| | | | | 1 | 22/11/2011 | SN108a | FRC-FITS-JG-DT00153 |
| 7 | HIGH | 28/11/2011 | Mineworking Gantry Sites | 0 | 11/10/2011 | SN097 | FRC-FITS-JG-DT00090 |
| | | | | 1 | 14/11/2011 | SN097b | FRC-FITS-JG-DT00140 |
| 8 | LOW | 26/09/2011 | Ducting and Drainage Installation | 0 | 25/08/2011 | SN033 | FRC-FITS-JG-DT00035 |
| | | | | 1 | 29/09/2011 | SN0066b | FRC-FITS-JG-DT00070 |
| 9 | HIGH | April 2012 | Overhead Gantry Installation | 0 | 26/01/2012 | SN0249 | FRC-FITS-JG-DT00275 |
| 10 | HIGH | March 2012 | S/B Carriageway Resurfacing | 0 | 23/12/2011 | SN0229 | FRC-FITS-JG-DT00237 |
| 12 | HIGH | 12/12/2011 | Northbound H/S Planing and Surfacing | 0 | 27/09/2011 | SN0079 | FRC-FITS-JG-DT00066 |
| | | | | 1 | 14/11/2011 | SN0123 | FRC-FITS-JG-DT00105 |
| 13 | HIGH | March 2012 | Widening of Hardshoulder @ Admiralty | 0 | 01/02/2012 | SN0254 | FRC-FITS-JG-DT00280 |
| 14 | HIGH | March 2012 | Existing Gantry Removal | 0 | 22/12/2011 | SN0221 | FRC-FITS-JG-DT00231 |
| | | | | 1 | 12/01/2012 | SN0221a | FRC-FITS-JG-DT00256 |
| | | | | 2 | 26/01/2012 | SN0221b | FRC-FITS-JG-DT00275 |
| 15 | LOW | 08/12/2011 | Cross Carriageway Ducting | 0 | 17/10/2011 | SN0109 | FRC-FITS-JG-DT00098 |
| | | | | 1 | 09/12/2011 | SN109a | FRC-FITS-JG-DT00203 |
| | | | | 2 | 20/12/2011 | SN109b | FRC-FITS-JG-DT00226 |
| 16 | HIGH | Feb 2012 | Piling at Gantry 10F | 0 | 15/10/2011 | SN0107 | FRC-FITS-JG-DT00094 |
| | | | | 1 | 07/12/2011 | SN107a | FRC-FITS-JG-DT00197 |
| | | | | 2 | 04/01/2012 | SN107b | FRC-FITS-JG-DT00231 |

| KEY |
|---|
| APPROVED |
| SUPERSEDED |
| PCNV SUBMITTED TO EMPLOYER FOR REVIEW |
| TARGET DATE FOR PCNV SUBMISSION TO EMPLOYER |

**Figure 22: PCNV Risk Assessment**

**Figure 23: Attended noise monitoring during the Fife ITS project**

**3.7.2 Objective 6 - Target 2**: Minimise the impact on air quality and dust deposition associated with the Fife ITS project.

#### 3.7.2.1 Target Selection

This target aims to minimise the opportunities for air quality limits to be exceeded as a result of the proposed scheme, and to minimise dust deposition at sensitive receptors.

#### 3.7.2.2 Methodology

The overall objectives of the FRC scheme included minimising impacts on people, and the natural and cultural heritage of the Forth area. Additionally, Transport Scotland is committed to promoting sustainability within its future projects. This will contribute to the achievement of the Scottish Government's overall purpose of achieving sustainable economic growth and the delivery of the five key Strategic Objectives, one of which is to improve Scotland's natural and built environment and the sustainable use and enjoyment of it. In line with these commitments, the GRAHAM Site Management Team utilised best practicable means to prevent nuisance as a result of dust including limiting the potential for dust and air pollution impacts during the construction phase.

The site was laid out such that machinery and dust-causing activities were located away from sensitive receptors, where reasonably practicable.

Hoardings and other barriers erected along the site boundary helped to mitigate the spread of dust to any sensitive buildings or other environmental receptors, such as local residential areas, surface water features and undeveloped agricultural land. However, the use of these was limited due to the nature of the project.

One area identified as posing a potential risk to air quality from heightened dust levels was the earthworks programme. A number of measures were therefore implemented during the earthworks programme to mitigate this risk, including:

- Topsoil was stripped as close as reasonably practicable to the period of excavation or other earthworks activities to avoid risks associated with run-off or dust generation.
- Drop heights from excavators to vehicles involved in the transport of excavated material was kept to the minimum practicable to control dust generation associated with the fall of materials.
- Water misting or sprays were used as required if potentially dusty works activities were necessary during dry or windy periods.
- Deposited materials were compacted as soon as possible after deposition, with the exception of topsoil.
- Soiling, seeding, planting or sealing of completed earthworks was undertaken as soon as reasonably practicable following completion of the earthworks (Figures 24 and 25).

**Figure 24: Planting at Gantry 10 following completion of earthworks.**

**Figure 25: Gantry 8 – Location of Batching Plant.** Land was reinstated following removal of batching plant with seeding evident.

**Monitoring**

The inspection and monitoring procedures were implemented to monitor the effectiveness of measures to prevent dust and air pollutant emissions and to avoid detrimental effects on the health of workers due to exposure to dust and air pollution. These were as follows:

- Implementation of the Area Management Plan with regard to site inspections covering the establishment of operation of the construction site.
- Weekly inspection of areas adjacent to the construction site to monitor any dust and air pollution which may be generated despite the use of best practicable means to prevent dust and air quality emissions.
- Weekly inspection of construction vehicles, plant and machinery. These inspections were logged within inspection and maintenance schedules.
- Weekly inspection of the level of trafficking.

Works were to be stopped where inspections identified a nuisance arising, until prevention and remediation measures could be implemented.

#### 3.7.2.3 Indicators

- Regular inspection of areas adjacent to the construction site to monitor any dust and air pollution
- Regular inspection of construction vehicles, plant and machinery

#### 3.7.2.4 Targets

Minimise the impact on air quality and dust deposition associated with the Fife ITS project.

#### 3.7.2.5 Appraisal Findings

The results of the Air Quality Monitoring inspections undertaken between July 2011 and May 2012 as part of the Fife ITS project are presented in Annex 24. Air quality was assessed against a traffic light system as follows:

- GREEN: No Action Required.
- AMBER: Dust Present but No Action Required (Continue to Monitor).
- RED: Action Required Immediately.

The results of the air quality monitoring throughout the Fife ITS construction phase are summarised in Table 12 and are presented in Figure 26. Table 12 shows the percentage of Visual Air Monitoring Inspections requiring differing levels of action:

- No Action – no dusting levels identified by visual inspection.
- Dust present but no action required – very low levels of dust were encountered; however, these were not considered to pose a potential environmental risk.
- Action required immediately – dust levels were considered to pose a potential environmental risk.

| Table 12: Visual Air Quality Assessment | | | |
|---|---|---|---|
| Month | No Action (%) | Dust Present - No Action Required (%) | Action Required Immediately (%) |
| July | 100 | 0 | 0 |
| Sep | 50 | 50 | 0 |
| Oct | 79 | 21 | 0 |
| Nov | 64 | 36 | 0 |
| Dec | 81 | 19 | 0 |
| Jan | 100 | 0 | 0 |
| Feb | 93 | 7 | 0 |
| Mar | 75 | 15 | 10 |
| Apr | 47 | 38 | 15 |
| May | 90 | 0 | 10 |
| Total % | 77.9 | 18.6 | 3.5 |

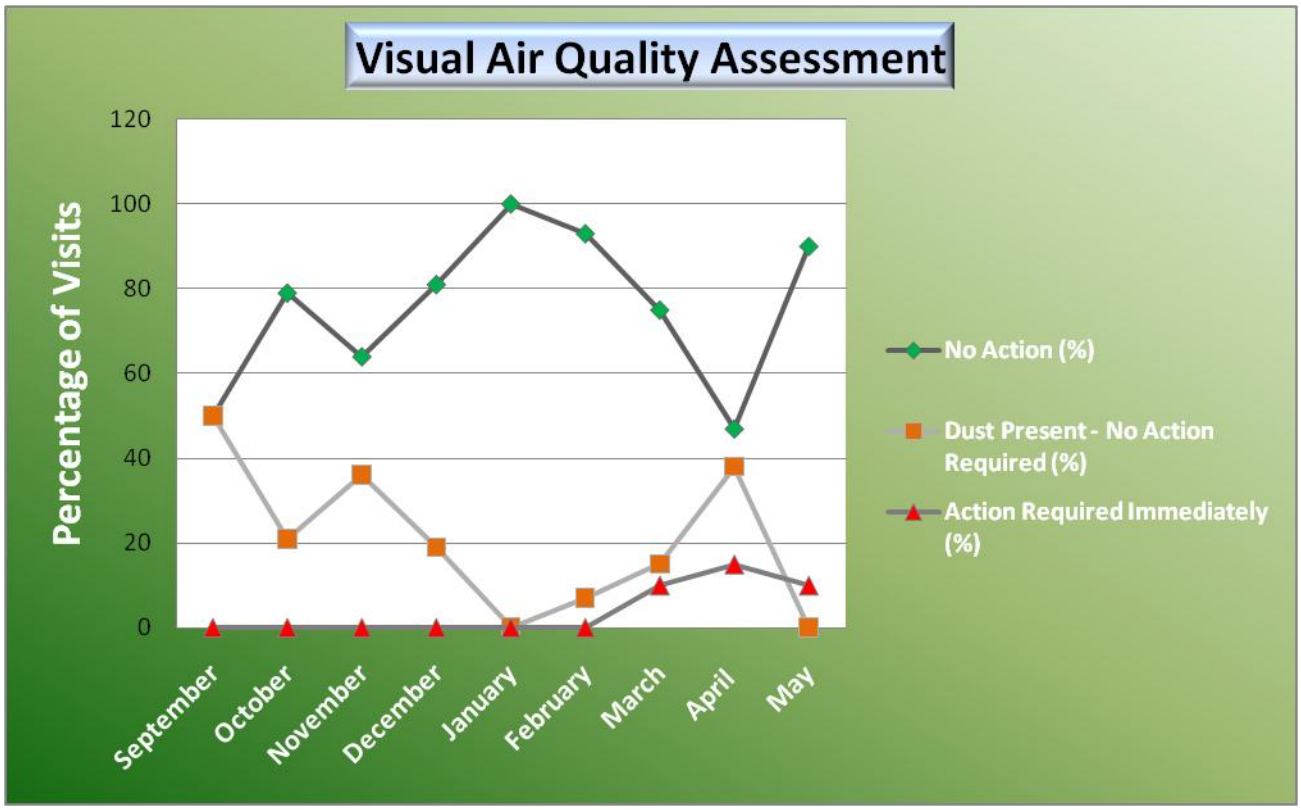



**Figure 26: Visual Air Quality Assessment**

In total, almost 78% of the Visual Air Monitoring Inspections carried out identified no significant dust levels with almost 19% of the remaining visits identifying low dusting levels that did not require further action other than continuing to monitor. Only 3.5% of the total inspections identified significant dust levels, relating to an actual total of only six occasions where dust levels required remedial action.

On two occasions in March 2012, the operations resulting in remedial action was dust arising from the PFA storage area. On the four remaining occasions in April and May 2012, high dust levels were generated from the removal of gullies.

Remedial measures were implemented by dampening down and the use of covers.

Given the very low levels of dust generated and the low percentage of occasions that required dust mitigation measures to be implemented, it is considered that the target for this objective to *'minimise the impact on air quality and dust deposition'* was achieved.

### 3.7.3 Outcomes and Problems identified with Objective 6

The main targets for this objective were to:

- Manage effectively, construction noise impacts and reduce and mitigate significant operational noise impacts where practicable.
- Minimise the impact on air quality and dust deposition associated with the Fife ITS project.

The aim was therefore to attain 0% exceedances of noise level threshold values on the Fife ITS project.

A NVMP was developed for the Fife ITS project to provide information on the measures to be implemented to control and mitigate noise and vibration during construction.

Noise and vibration monitoring was undertaken throughout the project but, more specifically throughout May 2012 during resurfacing works. This was the only period where exceedances in noise and vibration were recorded. Following further analysis of data it was determined that these exceedances were as a result of HGV movements along the M90 and not as a result of the Fife ITS construction activities.

Based on the foregoing, it is considered that this target has been met, as any exceedances in noise threshold levels were identified as not being associated with the project construction activities.

- Minimise the impact on air quality and dust deposition associated with the Fife ITS project.

In total, almost 78% of the Visual Air Monitoring Inspections carried out identified no significant dust levels with almost 19% of the remaining visits identifying low dust levels that did not require further action other than continuing to monitor. Only 3.5% of the total inspections identified significant dust levels, relating to an actual total of only six occasions where dust levels required remedial action.

Given the very low levels of dust generated, and the low percentage of occasions that required dust mitigation measures to be implemented, it is considered that this target was achieved.

# 4.0 Carbon Management Tool

Transport Scotland's Road Infrastructure Projects Tool was used to measure the Carbon Footprint for the scheme. The tool was updated throughout the construction phase and produced a report detailing the schemes GHG Emissions Summary which is presented in Annex 20. The highest emission levels comprised 'Materials Embodied Carbon' at 4,879.3 $tCO_2$ and 'Plant Fuel / Electric' at 1,166.9 $tCO_2$ which equates to 73.6% and 17.6%, respectively, of the total $tCO_2$ produced throughout the project.

The asphalt binder course comprised 45.3% of the embodied carbon within materials and was therefore the largest contributor of $tCO_2$ emissions for this aspect, with steel the second largest contributor at 31.6%. Given the nature of the scheme, which mainly comprised the erection of 18 ITS gantries and highway resurfacing works, it is not surprising that the two materials contributing the most to the $tCO_2$ would consist of asphalt and steel. The nature and scope of the project did not allow the Fife ITS construction team much scope to make any significant changes to this outcome.

Areas that demonstrated the highest proportion of $tCO_2$ savings were also identified by the tool. Re-use of earthworks and recycling within the structural concrete; namely, the use of Pulverised Fuel Ash (PFA) and Ground Granulated Blast-Furnace Slag (GGBS), resulted in $tCO_2$ savings of 46.5 tonnes in total. The earthworks savings could have been considerably higher if the soil on-site had been fit for purpose and was able to remain within the scheme. In order to assess the potential $tCO_2$ savings that could have been realised, had unsuitable soils remained on-site, the earthwork inputs were altered. The tool showed that the $tCO_2$ saving that could have been realised, increased significantly from 3.5 $tCO_2$ to 649.8 $tCO_2$ (Annex 20).

# 5.0 Quality Assessment and Awards Scheme (CEEQUAL)

CEEQUAL is an assessment and award scheme that measures and seeks to improve the environmental performance of civil engineering projects through a series of questions and evidence gathering. It can apply across the life-cycle of the project to cover design, as well as construction and delivery.

Transport Scotland has decided that the CEEQUAL assessment scheme would provide a useful tool for assessing the environmental and sustainability performance of the FRC scheme. The Employer, Transport Scotland, achieved an 'Excellent' Interim Client and Outline Design Award score for the FRC scheme with a score of 92.7% (Transport Scotland, 2011b). It was therefore a contractual requirement that GRAHAM worked with the Employer to achieve this level of award for the Fife ITS project. The Fife ITS project achieved a Whole Project Award score of 91.6% (Excellent), therefore achieving a similar excellent score to the previous Interim Award for the FRC scheme. This reflected the considerable and collaborative team effort amongst all parties involved (Figure 27).


**Figure 27: GRAHAM team presented with CEEQUAL certificate (Presented by Professor Tim Broyd, Director of CEEQUAL Ltd, pictured L-R Rory McFadden, Professor Tim Broyd, Kirsty Strannigan, Des Millar).**

A summary of the Fife ITS CEEQUAL Assessment methodology is detailed below.

## 5.1 Project Management

A Sustainability and Carbon Management appraisal was carried out for the scheme and six sustainability objectives were developed by GRAHAM in conjunction with Transport Scotland for the Fife ITS project. These included:

- sustainable resource management;
- community engagement;
- minimising the scheme footprint;
- reducing, reusing and recycling material;
- minimising embodied energy; and
- reducing noise and emissions.

The benefits of undertaking this sustainability-driven process were that it brought together, in a clear and concise manner, the planning, delivery and monitoring of the sustainability targets/objectives of the scheme. Sustainable management principles formed an integral part of this project, which is demonstrated in the following key examples below.

## 5.2 Challenges Faced

### 5.2.1 Water Resources and Water Environment

The Fife ITS project involved grouting abandoned mineshafts and mine workings. The grout mix selected comprised Pulverised Fuel Ash (PFA), a cement replacement that reduces the overall $CO_2$ footprint of the concrete. A programme of groundwater monitoring was also undertaken to identify baseline conditions including water levels, gradient/flow direction and water quality in the surrounding water environment at each of the three gantry locations where grouting works were to be carried out. The monitoring programme demonstrated that the water environment was not adversely impacted as a result of the grouting procedure with monitoring wells left *in-situ* to allow continued monitoring.

The drilling process employed for mineshaft consolidation also ensured conservation of valuable water resources and reduced the water consumption on the project by continuously re-circulating and reusing water throughout the drilling process.

### 5.2.2 Material Use and Waste Management

In maximising the use of site-won materials within the construction of the project, all suitable excavated material was beneficially reused on site. For example, all topsoil was reused in combination with geo-mat to produce a structurally stable and proficiently designed slope.
Opportunities for reuse and recycling of materials were considered wherever possible during the design and construction phases of the project.

Site waste data was collated throughout construction to ensure that the site was meeting its challenging waste minimisation and resource efficiency targets. In total, more than 80% of non-hazardous waste (by volume) and 95% of inert waste generated throughout the project

was diverted from landfill. More than 90% of components and pre-fabricated units (by volume) incorporated within the project were separated into material types suitable for recycling.

### 5.2.3 Effects on Neighbours and Relations with the Local Community

Community consultations were undertaken by the contract Community Liaison Officer. On-going engagement was carried out with all stakeholders including community residents, public groups, and statutory and non-statutory bodies. Information on the construction of the project, including works which may affect the public, was provided in a timely manner and helped to facilitate constructive engagement with local communities during the lifecycle of the project.

As part of the community liaison programme, all comments and responses from the local community were taken into consideration within the design.

A programme of noise and vibration monitoring was planned and undertaken for each of the construction activities, Figure 28. The continuous noise monitoring data demonstrated that noise and vibration levels did not exceed the acceptable thresholds as a result of the construction works, during any of the monitoring period.


**Figure 28: Noise and Vibration Management Plan Site 01F and 02F.** (Desk top studies were carried out for all gantry locations to determine the nearest sensitive receptors in relation to noise and vibration).

Where there was a potential for noise and vibration threshold levels to be exceeded, additional mitigation measures were implemented adjacent to nearby sensitive receptors. For example, temporary acoustic screens were erected at various locations throughout the site as work progressed. CFA Piling was also selected for the project over driven piles as this method offers the advantage of producing less noise and vibration compared to conventional methods.

Operational noise impacts were also minimised by the use of surface course TS2010 comprising a range of Stone Mastic Asphalt (SMA) mixtures. The SMA mixtures contain a gap-graded aggregate mix, polymer modified bitumen, and additives, including fibres and has been indicated as producing lower noise levels.

Following the initial site clearance, a 3m high environmental barrier, in combination with a hedge and area of mixed woodland planting and extra heavy standard trees, were installed to replace the existing tree screen of the M90 for local residents, Figure 29.

**Figure 29: Visual screen and planting to replace existing screening of motorway.**

## 5.3 How the use of CEEQUAL influenced the project

Transport Scotland chose to use CEEQUAL on a trial basis for the FRC scheme as a tool for the comparison and evaluation of the sustainable appraisal process of the project. It was used in the Preparation Stage of the project and achieved an excellent (92.7%) for Whole Interim Client and Outline Design Award. After considering the values and advantages that CEEQUAL could bring during the design and construction stages, Transport Scotland gave the approval

for CEEQUAL to be incorporated into the contract documents for all the major contracts of the project with a requirement on the Contractors to maintain this “Excellent” achievement.

CEEQUAL was used to provide a systematic and comprehensive approach to the detailed design and construction of the Fife ITS project, tracking the site management activities and associated sustainability initiatives, within the overall sustainability objectives of the FRC project.

# 6.0 Conclusions

A summary of outcomes for the Sustainability Appraisal of the Fife ITS project are presented in Table 13.

| Table 13: Summary of Sustainability Appraisal | |
|---|---|
| **Objective 1: To adopt sustainable resource management in the construction of the Fife ITS Project.** | |
| **Target 1: Develop a Sustainable Resource Management Framework** | Sustainable Resource Management Framework implemented. |
| **Target 2: Minimise material use (Topsoil, Cut and Fill) through adoption of material reduction measures** | Target not achieved due to geotechnical nature of soils. |
| **Objective 2: To ensure community engagement takes place at all key stages in the Fife ITS Project.** | |
| **Target 1: To make sure that all groups whose interests are affected by the proposed scheme are identified and have access to information and opportunity to engage** | Appropriate engagement with consultees was achieved. However, the measurable target of 0% complaints was not achieved. |
| **Target 2: To select appropriate methods of engagement for target audiences and to make sure information is made available at appropriate stages in the project** | Appropriate methods of engagement with consultees were achieved. However, the measurable target of 0% complaints was not achieved. |
| **Objective 3: To minimise the scheme footprint and severance of land.** | |
| **Target 1: Minimise Temporary Land Take for the Scheme** | Target achieved. |
| **Objective 4: To reduce, reuse and recycle materials and products where practical.** | |
| **Target 1: Minimise the difference between cut and fill earthworks quantities** | Target not achieved due to geotechnical nature of soils. |
| **Target 2: Maximise percentage of materials sourced locally** | Target achieved. |
| **Target 3: Maximise the volume of material taken off-site for reuse and recycling as opposed to sending to landfill** | Target achieved. |
| **Target 4: Promote the restoration of brownfield sites within areas affected by the scheme** | Target achieved. |
| **Objective 5: Seek to minimise embodied energy and carbon associated with key materials and their transport to site.** | |
| **Target 1: Minimise energy use and all carbon emissions during construction** | Energy use and carbon emissions were representative of the works programme and level of activity on site.<br>SOV use increased during the course of the project. |
| **Objective 6: To reduce noise and air emissions.** | |
| **Target 1: Manage effectively construction noise impacts and reduce and mitigate significant operational noise impacts where practicable** | Target achieved. |

| | |
|---|---|
| **Target 2: Minimise the impact on air quality and dust deposition associated with the Fife ITS project** | Target achieved. |

The sustainability targets for the Fife ITS project were established early in the construction phase, which allowed the implementation of appropriate measures to achieve these targets. The sustainability targets were embedded within the Environmental Management Plan for the scheme which ensured that they formed part of any decision-making processes. This status, as well as the on-going CEEQUAL assessment of the project, ensured sustainability was not only embedded but that its success was also monitored and measured throughout the construction phase. The outcome for each of the sustainability targets has been clearly demonstrated in the preceding sections of this report, which demonstrate that, in general, there were some notable successes, as well as some lessons to be learned.

Due to the nature of the Fife ITS project there was limited scope in some key areas for real improvements to be identified and achieved. For example, one target was to promote the restoration of brownfield land. Given that the gantry locations were predetermined and the area that they encapsulated was limited, there was limited opportunity for the Fife ITS team to make any significant difference in this respect.

However, a number of successes were identified and these included:

- Maximising the volume of material sourced locally.
- Maximising the volume of material reused or recycled (off-site).
- Managing construction noise and vibration impacts.
- Minimising impacts on air quality.

The sustainability targets were achieved in areas that were within GRAHAM's control and demonstrated GRAHAM's ability to excel and successfully manage such aspects within a highway scheme environment. Maximising the volume of materials sourced locally was demonstrative of the ability of GRAHAM's well trained, highly focussed procurement team, whilst maximising the volume of material reused and recycled off-site was an example of the GRAHAM environmental team working hand in hand with the site team. The management and minimisation of construction noise and air quality impacts was attributed to the leadership of the site management team as well as the dedicated CLO resource who worked tirelessly to ensure a clear and open communication channel with the local community.

In general, the main areas that did not achieve success comprised targets where the construction team had less control, for example minimising the difference between the cut and fill earthworks. The geotechnical nature of the soils meant that the material was not suitable for use within the project. In addition, the fact that this was only identified once the construction phase had commenced did not provide suitable opportunity to treat and improve the soil conditions. This was due to the negative impact on the work programme as well as additional costs and risk that any remedial measures would prove unsuccessful.

Another target that did not prove successful was in the area of community engagement where the number of complaints was measured to identify the success of this target. The Fife ITS project employed a full time CLO resource, who ensured a community engagement programme with clear and open communication channels throughout the construction phase. Nevertheless, the project did receive some complaints, albeit very few, with each closed out within an agreed timescale.

Energy use and carbon emissions during the project were initially compared against the baseline (energy used in first three months of construction). However, it became apparent that this was not a valid baseline, as fuel consumption and business travel were dependent upon the different phases of work being undertaken, which varied over the course of the project. More fuel and business travel was undertaken, and corresponding carbon emissions produced, during busy periods of the contract, which would have been greater than the initial three months when works were mobilising.

There are a number of lessons that can be taken forward from this sustainability process and these have been highlighted. An adaptable site team with clear leadership and early setting of targets that are intrinsic to the decision-making processes, from procurement of plant and materials to work plans and processes, was essential.

Careful consideration needed to be given to identify the process targets. For example, although the Fife ITS project employed a robust and flexible Community Liaison and Communications Framework, the targets for this objective were still not met. It was considered that the choice of a measurable target did not represent the work carried out by the site team and that another measurable target should have been considered. This target should have been designed to fully take into account the dedicated work being carried out, the successes of the construction works and a more representative conclusion from the local community of the construction works.

The carbon footprint of the scheme did not show any significant savings due to the sustainability measures employed as part of this appraisal process. However, the appraisal highlighted that the scope of the Fife ITS project, although limited, was able to implement sustainable, measurable targets and produce successful outcomes as well as identify lessons for future projects of a similar nature which could be taken forward and used to identify larger potential $tCO_2$ savings in the future.

The Sustainability and Carbon Management Appraisal of the Fife ITS construction phase was an iterative process that required time and resources throughout. For an appraisal such as this, it was fundamental that clear objectives and goals were set early and that targets were measurable and representative of the work and actions that were carried out. The process demanded time and investment from the whole site team and it was essential that this was taken into consideration prior to the construction phase commencing, to ensure suitable resource was made available. It was this commitment that ensured, for the most part, that the six Fife ITS sustainability objectives were achieved.

# 7.0 References

BSI (2009) Code of practice for noise and vibration control on construction and open sites. Vibration, 2009. BS5228-1 2:2009. British Standards Institution.

Carbon Trust (2009) Conversion Factors. Available online: http://www.carbontrust.com/resources/guides/carbon-footprinting-and-reporting/conversion-factors

DEFRA (2005) One future – different paths: The UK's shared framework for sustainable development. Department for Environment, Food and Rural Affairs. Available online: http://www.sd-commission.org.uk/data/files/publications/050307One%20Future%20-%20Different%20Paths.pdf

DEFRA (2009) Construction Code of Practice for the Sustainable Use of Soils on Construction Sites. Department for Environment, Food and Rural Affairs. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69308/pb13298-code-of-practice-090910.pdf

DEFRA and DECC (2012) Guidelines to DEFRA/DECC's GHG Conversion Factors for Company Reporting. Department of Energy and Climate Change. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69554/pb13773-ghg-conversion-factors-2012.pdf

Jacobs Arup (2009a) Forth Replacement Crossing Sustainability Appraisal and Carbon Management Report. Available online: http://www.transportscotland.gov.uk/report/j11364-00.htm

Jacobs Arup (2009b) Forth Replacement Crossing: DMRB Stage 3 Environmental Statement, November 2009.

Jacobs Arup (2010) Code of Construction Practice, Revision 5, December 2010.

Scottish Executive (2005) Choosing our future: Scotland's Sustainable Development Strategy. Available online: http://www.scotland.gov.uk/resource/doc/47121/0020703.pdf

Scottish Government (2008) Strategic Objectives. Available online: www.scotland.gov.uk/About/scotPerforms/objectives

Scottish Government (2009) Climate Change (Scotland) Act 2009. Available online: http://www.legislation.gov.uk/asp/2009/12/contents

Scottish Government (2011) Forth Crossing Act 2011. Available online: http://www.legislation.gov.uk/asp/2011/2/contents

Transport Scotland (2011a) Engaging with Communities: Construction. Version 1.0, August 2011.

Transport Scotland (2011b) Forth Replacement Crossing: Principal Contract for the Design, Construction and Completion of the Forth Replacement Crossing – Employer's Requirements Part 1: General and scheme-specific requirements, 18 April 2011. TS/MTRIPS/WKS/2009/02.

Transport Scotland (2012) http://www.transportscotland.gov.uk/news/new-transport-system-goes-live-m90-next-week Published on 29 November 2012.

UNECE (2012) Intelligent Transport Systems (ITS) for sustainable mobility, February 2012. United Nations Economic Commission for Europe. Available online: http://www.unece.org/trans/publications/its_sustainable_mobility.html