Pipe Jacking v Open-Cut CO_2 Calculator

Developing a CO_2 Calculator

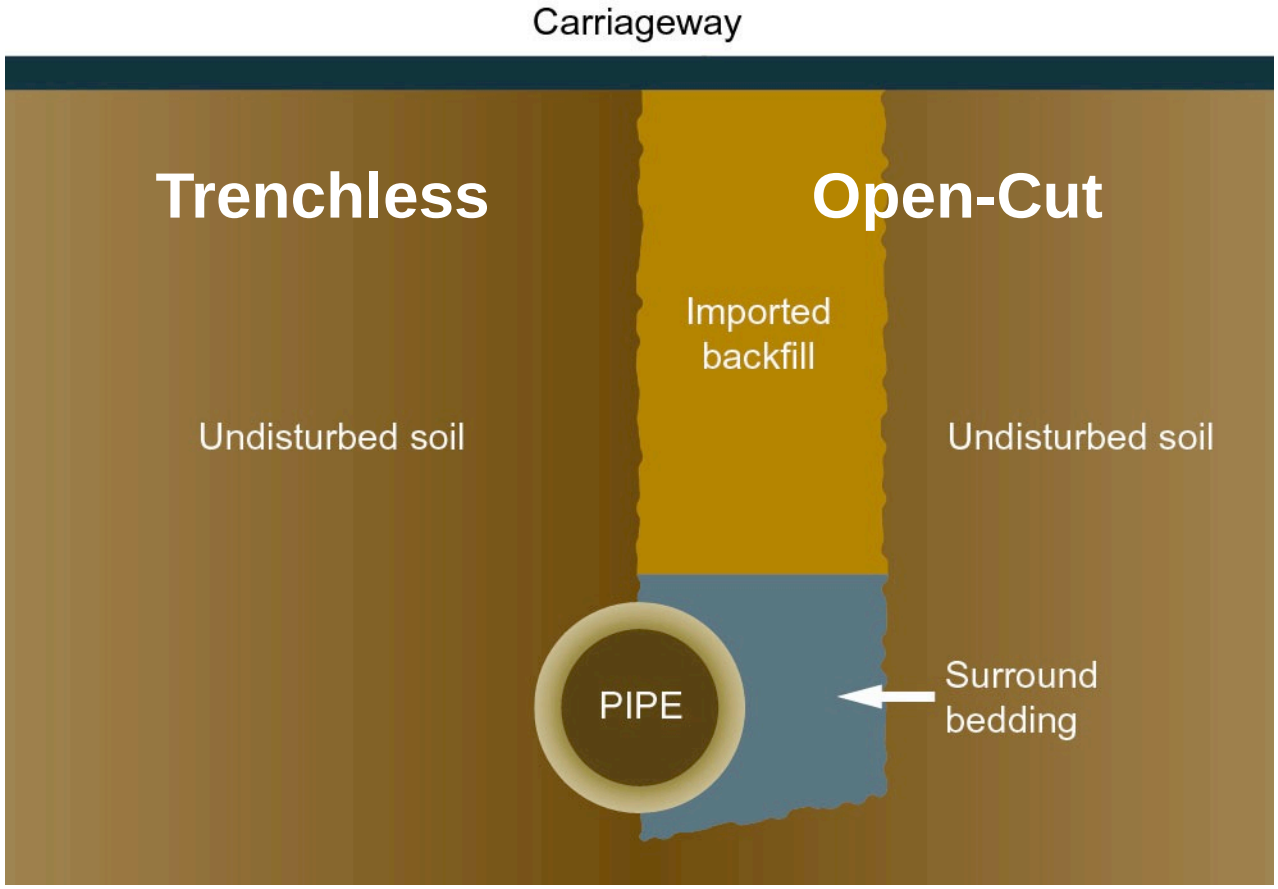
The Pipe Jacking Association has developed a **free and easy to use** web-based tool to compare greenhouse gas emissions for pipe jacking and microtunnelling with open-cut for sewer and utility pipeline installation

Why develop a carbon calculator for utility installation?

- The UK Government through the Department of Energy and Climate Change (DECC) is committed to reducing carbon emissions by 80% on 1990 levels by 2050. This ambition is enshrined in UK law with binding targets spanning successive Parliaments
- Utilities have an obligation to cut emissions and improve energy efficiency under the DECC CRC Energy Efficiency Scheme
- DEFRA's Key Performance Indicators (KPIs) oblige utilities to demonstrate corporate sustainability
- Carbon emissions apart, it is accepted that digging up roads for utility installation when there are practical and economic alternatives is socially unacceptable

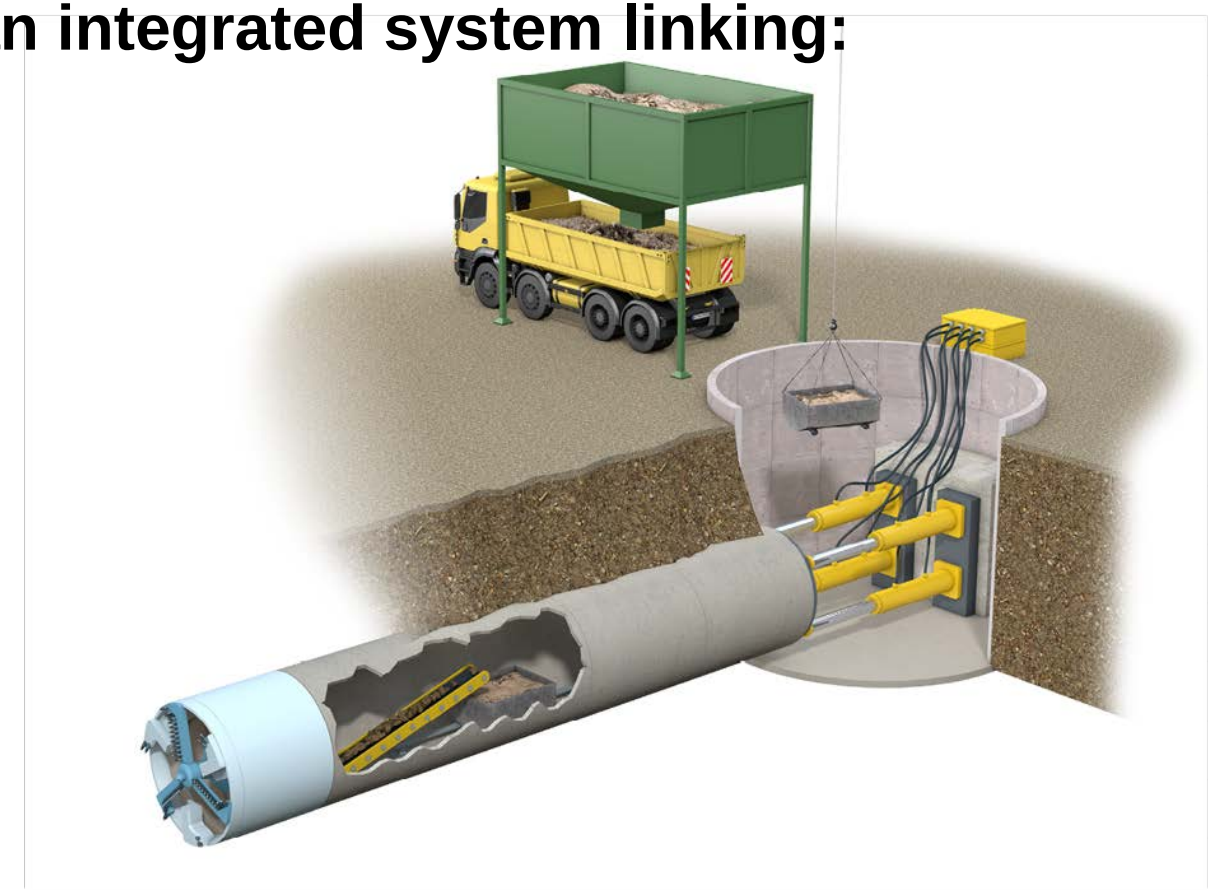
Background

- A carbon calculator developed to highlight the reduction potential of trenchless technology had been developed by the British Colombia Chapter of the North American Society of Trenchless Technology in association with the Action on Climate Change Team (ACT) of Simon Fraser University in British Columbia
- The project was transferred to NYSEARCH, a New York based research group, that works on behalf of North American gas and water utilities and the project put on hold
- As a result the UK Pipe Jacking Association decided to sponsor the development of a free and easy to use calculator and appointed TRL to carry out the project


Carriageway
Trenchless
Open-Cut
Imported backfill
Undisturbed soil
Undisturbed soil
PIPE
Surround bedding

Pipe Jacking is an integrated system linking:

- soils
- jacking shaft
- pipes
- shields
- jacking loads
- engineering



Objective

To develop a calculator to compare carbon emissions for pipe jacking and microtunnelling with open-cut construction for sewer and utility pipeline installation that was:

- **Easy to use**
- **Transparent**
- **Comprehensive** – to include all parameters
- **Authoritative**
- **Verified**

Input Datasets

The PJA prepared a range of datasets covering all pipe jacking and microtunelling and open-cut operations:

- **Comprehensive materials schedule** for all pipe diameters from 200 – 2400mm to include manholes, shafts, base slabs and all other components that impact on carbon emissions
- **Plant schedules** for both scenarios together with energy usage
- **Machinery selection** for all diameters in differing ground conditions, both wet and dry
- **Project duration** – realistic outputs and daily hours worked
- **Average haulage distances** for plant and materials

Consultant Appointed

- The PJA appointed TRL to carry out the project. TRL is an internationally recognised centre of excellence providing world-class research, consultancy, testing and certification for all aspects of transport
- The Association had worked with TRL previously in the production of a report “Mitigating the disruption caused by utility roadworks” which it is believed had a significant influence in revisions to the New Roads and Streetworks Act and the introduction of Lane Rental

TRL Data Sources and Protocols

- University of Bath Inventory of Carbon and Energy for construction materials
- Concrete Pipeline Systems Association – Carbon Footprint of pipes, slabs and manholes
- TRL's QUADRO program (Queues and Delays at Roadworks)
- PAS 2050: Assessing the Life Cycle Greenhouse Gas Emissions of Goods and Services

A life cycle approach

- Advocated by PAS 2050
- Assesses part of a pipeline's life cycle
  - Raw material extraction to installation
- Designed to be a comparative tool
  - open cut vs. pipe jacking on a level playing-field
- Consequential impacts not included
  - Re-instatement following open cut installation can result in significant highway degradation though not assessed at this stage

Materials

Product carbon footprints:

Manufactured pipeline components: pipes, manholes, bases & covers

Virgin aggregate fill

Asphalt

Transport

Transport emissions:

Pipeline components to site

Fill and asphalt to site

Spoil to disposal

Trench support to and from site

Installation

Machinery fuel consumption:

Detailed equipment inventories

Duration of operation algorithms

Load factors based on soil type

Presence of groundwater

Traffic

Emissions from queuing traffic:

Lane closures - shuttle working for open cut

Dependent on road types and traffic levels

QUADRO

FEASIBILITY

- Enter the pipeline depth, length and diameter
- All other parameters auto-filled
- Gives a “ballpark” CO_2e estimate

AS DESIGNED

- More parameters are certain
- Enter additional info regarding the site location, type of machinery, outputs and working durations
- Makes the “best available prediction”

AS BUILT

- Enter retrospective information on all parameters
- Effectively “audits” the as designed CO_2e figures

PREDICTION → INCREASING LEVEL OF DATA INPUT → INCREASING ACCURACY → **EVALUATION**

Data Verification

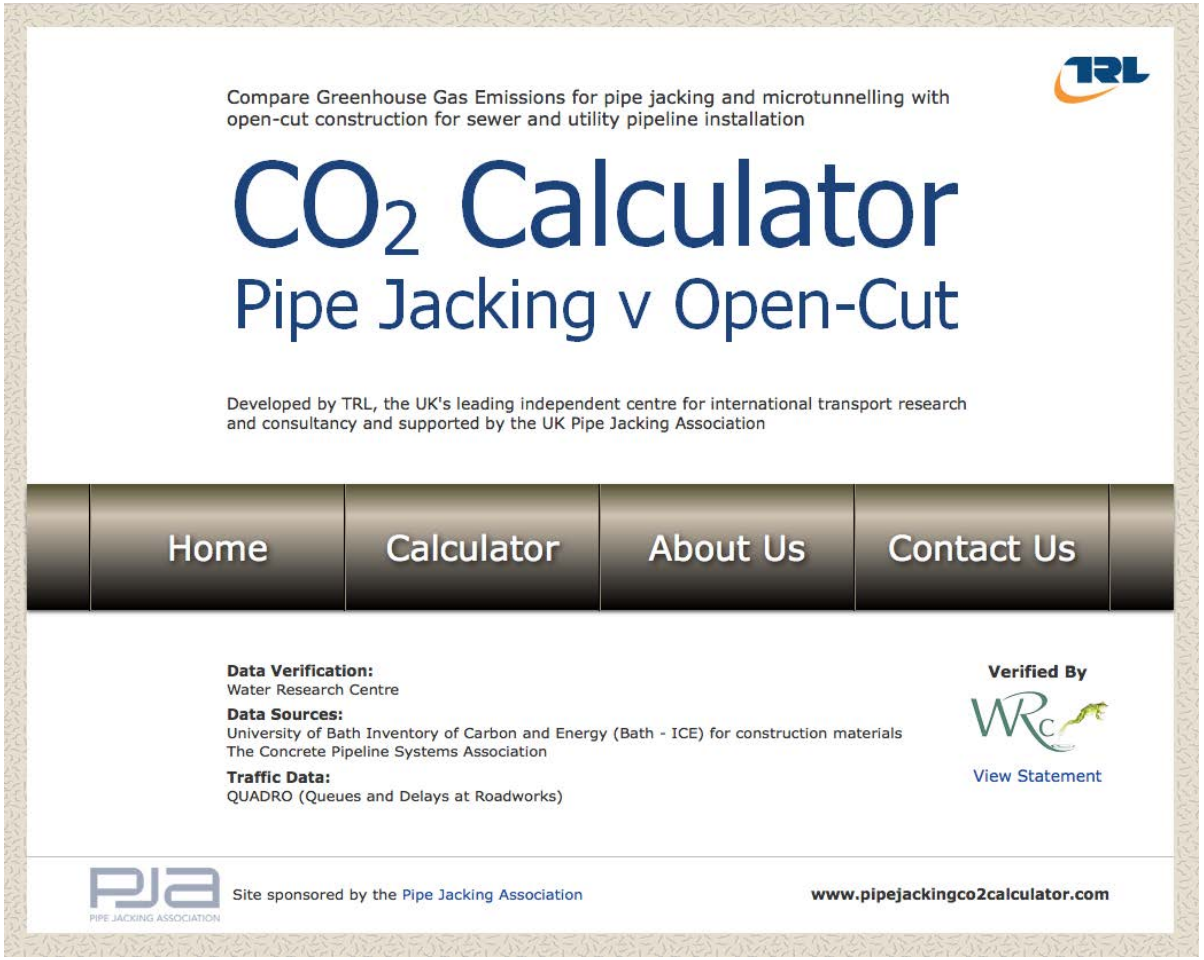
- An independent external source was used to verify the methodology and outputs produced by TRL
- Verification was carried out by WRc, a research-based consultancy, that utilises scientific and engineering skills to develop robust and sustainable solutions for clients in the water and waste industry.

The Calculator has been verified by WRc

WRc Peer Review

- WRc's audit examined the numerous equations developed by TRL to compare outputs between pipejacking and conventional open-cut trenching
- These calculations traced the input/output of CO_2 for materials, transport, traffic and machinery and equipment
- WRc also reviewed the data sources and assumptions used in the calculator although it did not review the sources for emission factors used by TRL as these are generally accepted industry standards

Home Page


Compare Greenhouse Gas Emissions for pipe jacking and microtunnelling with open-cut construction for sewer and utility pipeline installation
CO2 Calculator
Pipe Jacking v Open-Cut
Developed by TRL, the UK's leading independent centre for international transport research and consultancy and supported by the UK Pipe Jacking Association
Home
Calculator
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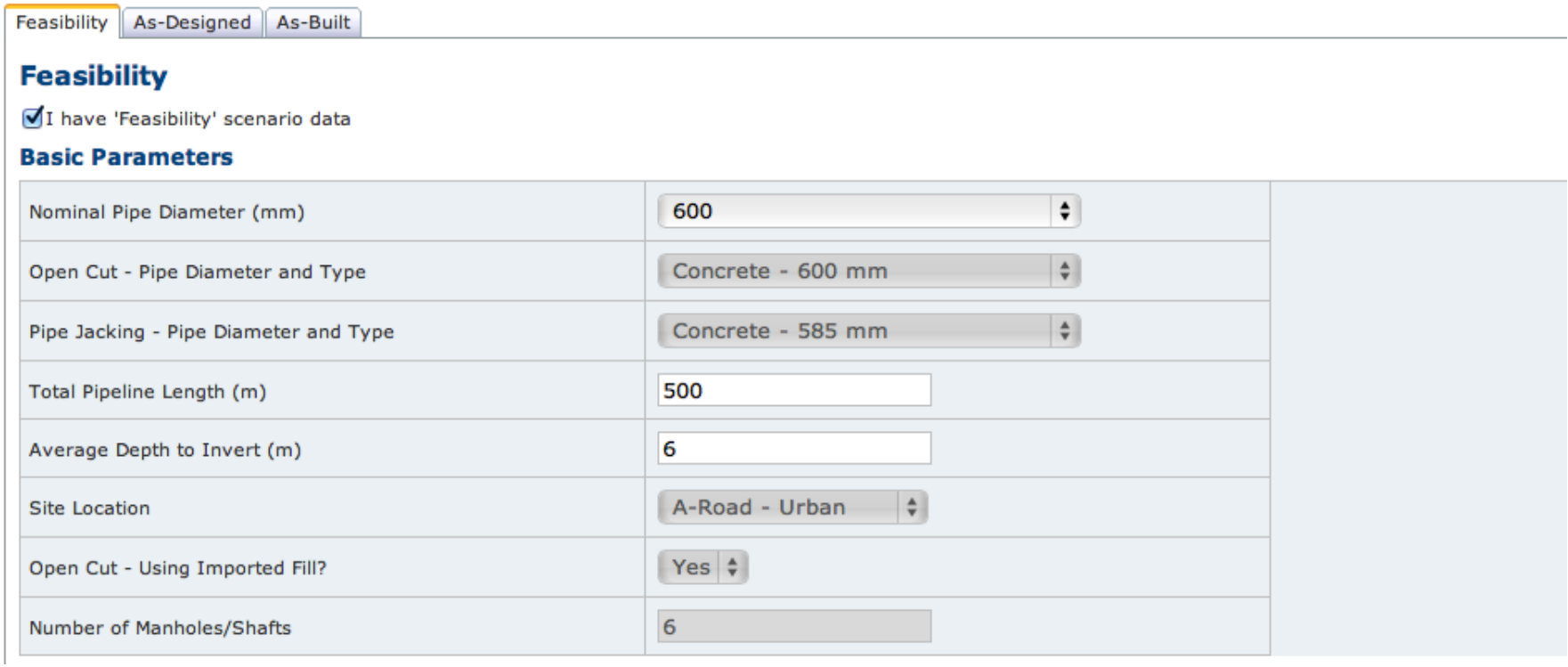
Data Verification:
Water Research Centre
Data Sources:
University of Bath Inventory of Carbon and Energy (Bath - ICE) for construction materials
The Concrete Pipeline Systems Association
Traffic Data:
QUADRO (Queues and Delays at Roadworks)
Verified By
View Statement
Site sponsored by the Pipe Jacking Association
www.pipejackingco2calculator.com

User Input Screen: Basic parameters

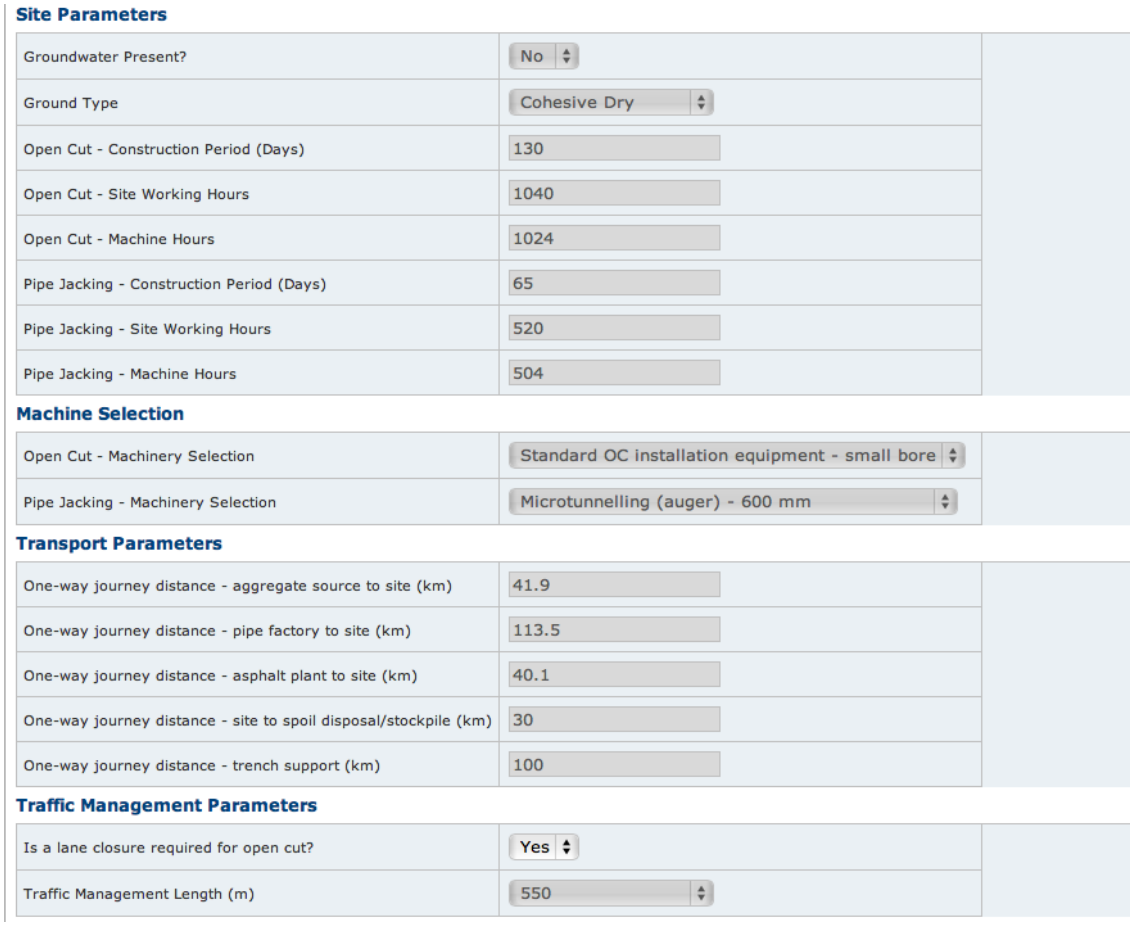
At feasibility stage the only inputs required are diameter, length and depth



User Input Screen:

Site parameters, machinery, transport and traffic

At feasibility these are default values detailed in data sources and assumptions



Site Parameters

Groundwater Present?	No
Ground Type	Cohesive Dry
Open Cut - Construction Period (Days)	130
Open Cut - Site Working Hours	1040
Open Cut - Machine Hours	1024
Pipe Jacking - Construction Period (Days)	65
Pipe Jacking - Site Working Hours	520
Pipe Jacking - Machine Hours	504

Machine Selection

Open Cut - Machinery Selection	Standard OC installation equipment - small bore
Pipe Jacking - Machinery Selection	Microtunnelling (auger) - 600 mm

Transport Parameters

One-way journey distance - aggregate source to site (km)	41.9
One-way journey distance - pipe factory to site (km)	113.5
One-way journey distance - asphalt plant to site (km)	40.1
One-way journey distance - site to spoil disposal/stockpile (km)	30
One-way journey distance - trench support (km)	100

Traffic Management Parameters

Is a lane closure required for open cut?	Yes
Traffic Management Length (m)	550

Report Output

Following data input, reports are produced literally in seconds and can either be saved or printed. Reports include:

- **Basic parameters** – diameter, length, depth, manholes/shafts and road type
- **Site parameters** – groundwater, construction period and working hours
- **Machinery selection**
- **Transport and traffic** management options
- **Tonnes of CO_2e generated** for each of the above and also for traffic delays at the site for open cut scenario
- **Data Sources and Assumptions**

Report Output Screen

CO_2e Estimates (tonnes)

Feasibility | As-Designed | As-Built

Feasibility

	Open Cut	Pipe Jacking
Material - Pipes/Shafts/Manholes	44.4	77.8
Material - Aggregates	49.0	0.0
Material - Spoil	136.7	14.9
Material - Asphalt	36.7	0.0
Total - Material CO_2e	**266.8**	**92.8**
Total Machinery CO_2e	**34.3**	**24.0**
Transport - Pipes/Shafts/Manholes	2.9	4.1
Tranport - Aggregates	45.4	0.0
Tranport - Spoil	33.7	3.7
Tranport - Asphalt	2.4	0.0
Tranport - Trench Support	2.3	0.0
Total - Transport CO_2e	**86.6**	**7.8**
Total Traffic CO_2e	**104.6**	**0.0**
Total CO_2e	**492.4**	**124.6**

Examples of CO_2 Savings using pipejacking

- 600mm dia x 500m length x 6m deep – **75%** saving
  (Open cut 492.4 tonnes: Pipejacking 124.6 tonnes)
- 1200mm dia x 500m length x 6m deep – **57%** saving
  (Open cut 756.5 tonnes: Pipejacking 328.3 tonnes)
- 600mm dia x 500m length x 4m deep – **67%** saving
  (Open cut 351.4 tonnes: Pipejacking 113.3 tonnes)
- 1200mm dia x 500m length x 4m deep – **47%** saving
  (Open cut 570.6 tonnes: Pipejacking 301.8 tonnes)

Overview

- Carbon savings only represents one of the benefits offered through the use of trenchless technology with emission savings of up to 75%
- Pavement life is reduced by up to 30% by open cut construction
- Lane rental costs for open-cut of up to £2,500 per day are a real cost to the community
- Roadworks related congestion costs the economy £4bn a year (DfT press release Jan 2012)

PIPE JACKING ASSOCIATION

Your guarantee of quality and experience

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