3rd Brazilian Congress of TT Trenchless Technology

1st No•Dig Latin American Edition

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February 13 - 15, 2008
São Paulo - SP - Brazil

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- Trenchless Technology
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Central Theme:
A Trenchless City
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Environmental Benefits of Using Trenchless Technologies

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Problem Statement

Develop a methodology to determine greenhouse gas emissions resulting from open cut and trenchless pipeline construction activities.

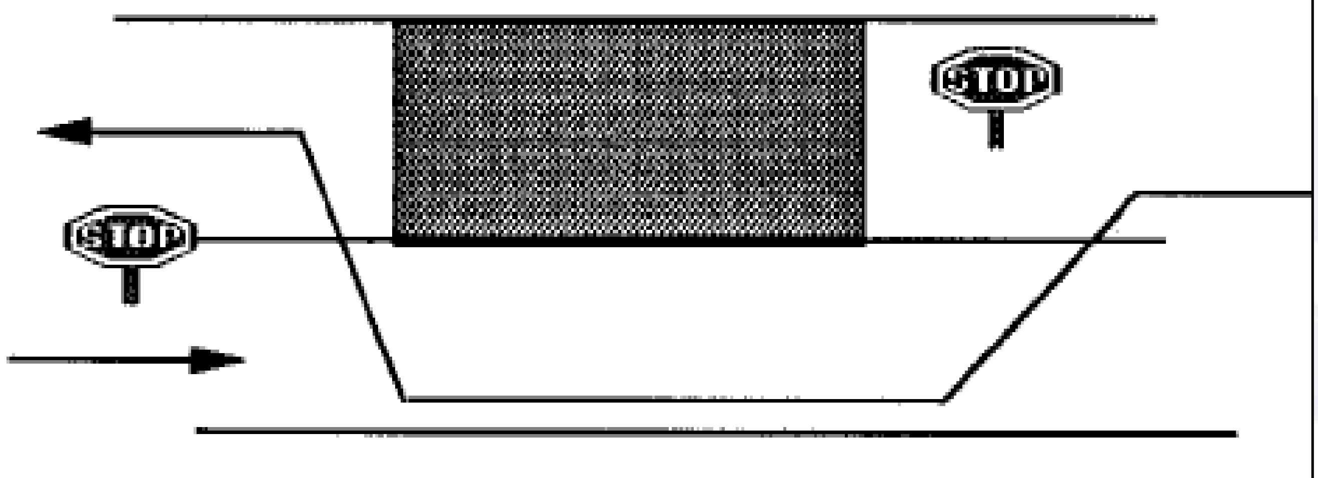
Major Sources of CO_2

- **vehicles during construction induced traffic delays and detours;**
- **heavy construction equipment required to install the pipeline;**
- trucks used to dispose off excavated materials from the site;
- trucks used to haul construction materials to the site;
- equipment used to manufacture construction materials i.e. asphaltic concrete, backfill materials, etc.

Methodology

Determine the additive greenhouse gas emissions resulting from traffic user delays and construction equipment.

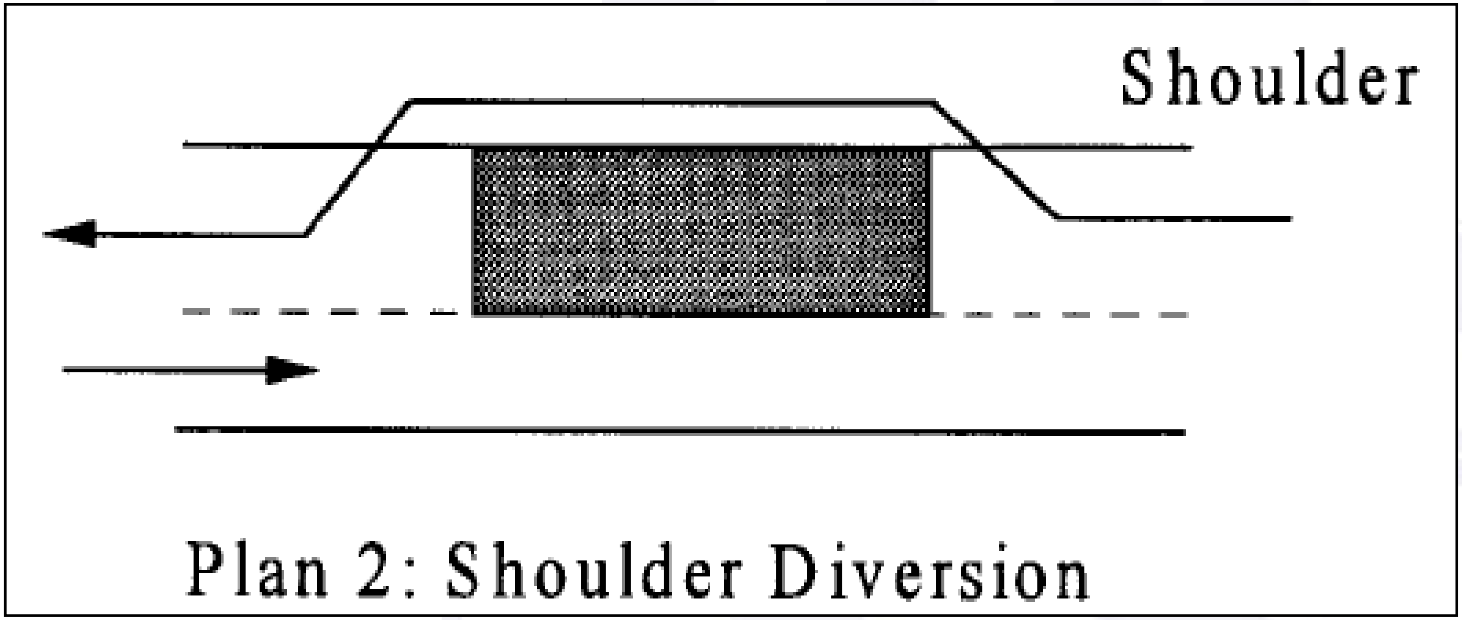
CO_2 EMISSIONS DUE TO TRAFFIC DELAYS



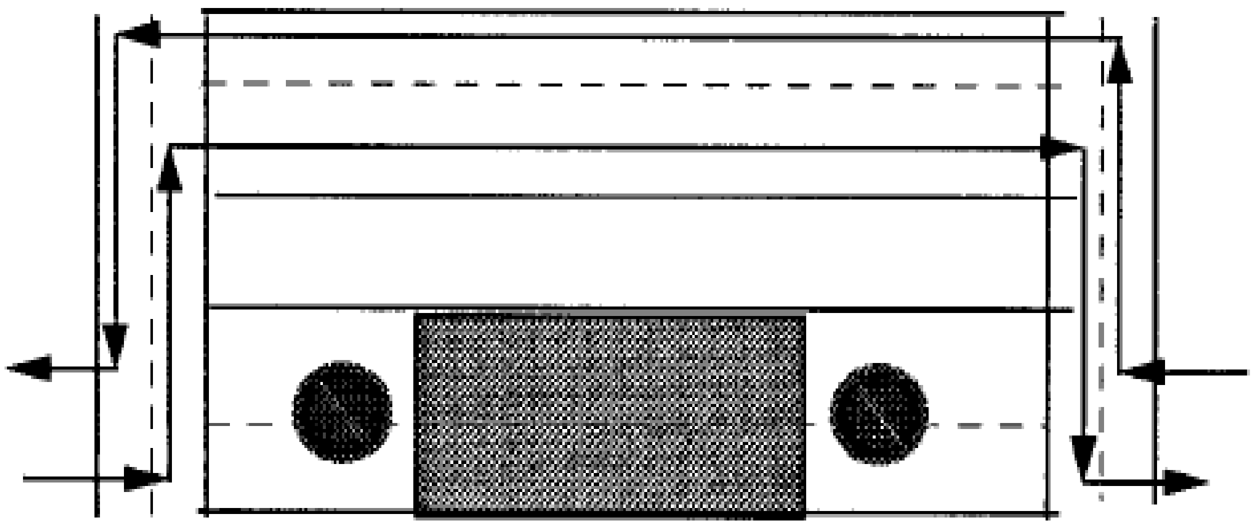
Plan 1: Flagperson

Tighe, S., Lee, T., McKim, R., & Haas, R. 1999

CO_2 EMISSIONS DUE TO TRAFFIC DELAYS



CO_2 EMISSIONS DUE TO TRAFFIC DELAYS



Plan 3: Detour

Traffic Delay Calculation

Use methodology proposed by Tighe, S., Lee, T., McKim, R., & Haas, R. 1999

Traffic delay cost savings associated with trenchless technology.

Journal of Infrastructure Systems, American Society of Civil Engineers, 1999, Volume 5, No. 2, pp. 45-51

Traffic Delay Calculation

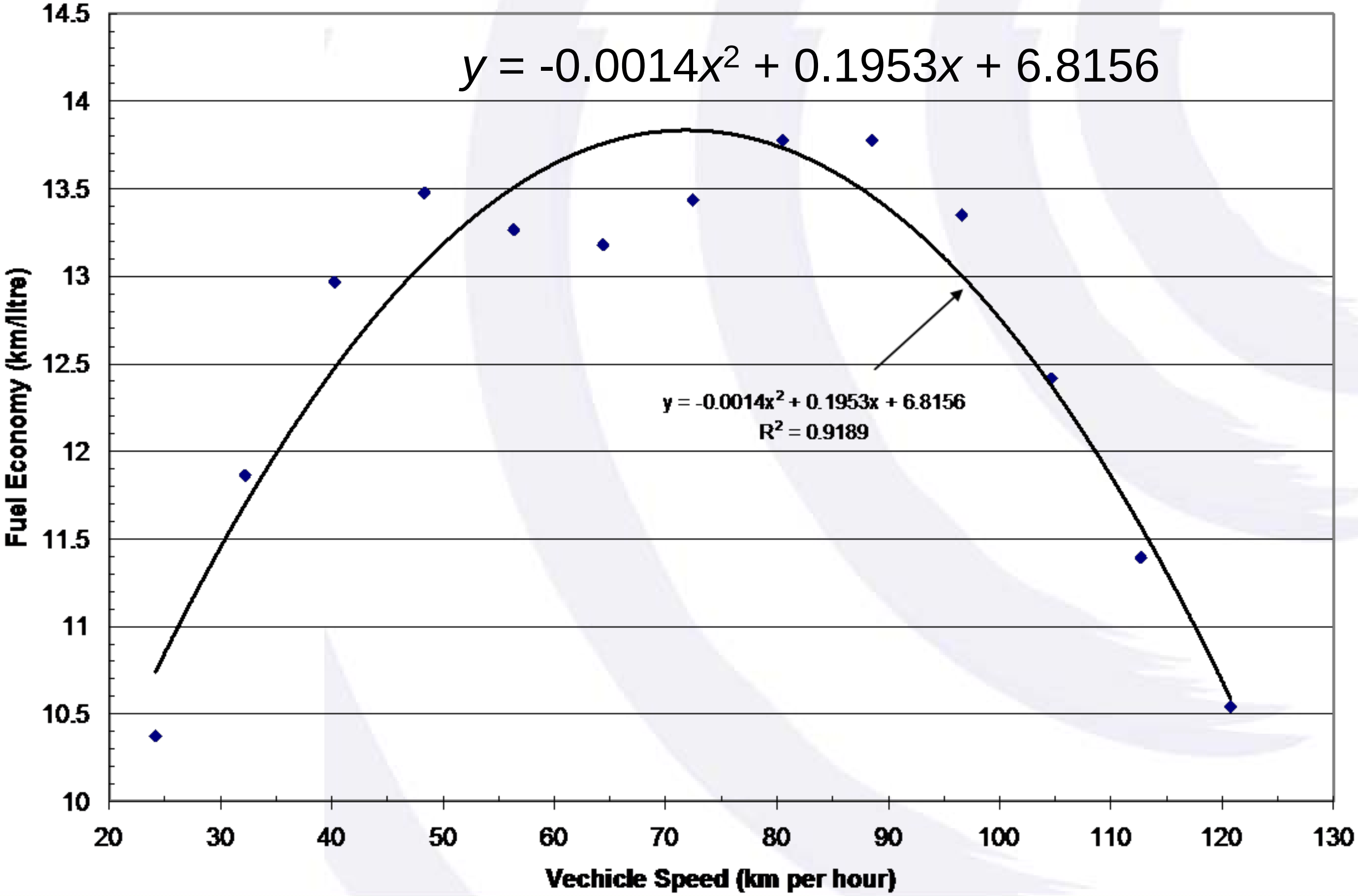
Calculate:

1. Normal capacity of single lane
2. Determine hourly traffic volume
3. Determine normal and reduced traffic speeds
4. Determine traffic idling time

Fuel Economy vs Vechicle Speed

Davis, S. C., & Diegel, S. W. Transportation Energy Data Book, 26th ed

$$y = -0.0014x^2 + 0.1953x + 6.8156$$



$C0_2$ CALCULATION METHODOLOGY

Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K. B., Tignor, M., & Miller, H. L. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, United States, 2007

$C0_2$ (gasoline)= 2,421 gms x 0.99 x (44/12) = 8,788 gms = 8.8 kg/gal = 2.3 kg/litre

$C0_2$ (diesel) = 2,778 gms x 0.99 x (44/12) = 10,084 gms = 10.1 kg/gal = 2.6 kg/litre

CO_2 EMISSIONS DUE TO OPERATION OF CONSTRUCTION MACHINERY

OPEN CUT

- diesel consuming heavy construction equipment (i.e., excavators, backhoes, compaction rollers, etc)
- hauling vehicles to excavate and restore excavations
- RS Means was used to determine that approximately 16.5 m/day of pipe can be installed

CO_2 EMISSIONS DUE TO OPERATION OF CONSTRUCTION MACHINERY

Trenchless Construction

- very limited usage of heavy equipment to excavate and restore small access pits, and to install the pipeline.

CO_2 EMISSIONS DUE TO OPERATION OF CONSTRUCTION MACHINERY

- Estimate time for each piece of diesel burning construction equipment
- multiplying it by a fuel consumption rate of 40 litres per hour
- $C0_2$ (diesel) = 2,778 gms x 0.99 x (44/12) = 10,084 gms = 10.1 kg/gal

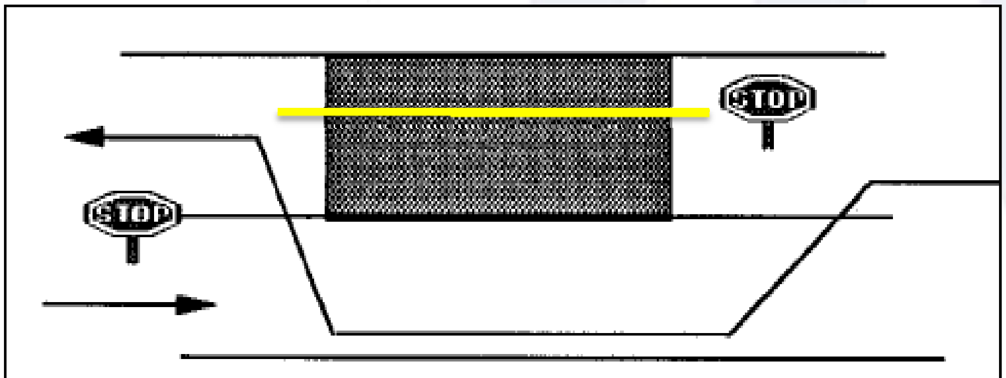
CASE STUDIES

- Installation of a new 250 metres long, 300mm diameter sewer pipe using open-cut and trenchless construction methods
- Open cut pipeline construction will require the excavation of a continuous trench along the entire pipeline length

CASE STUDIES

- Trenchless pipeline construction will require the excavation of only entrance and exits access pits.
- Thus, this analysis will only be considered applicable for
  - pipe bursting
  - auger boring
  - pipe ramming
  - microtunneling

CASE STUDY I



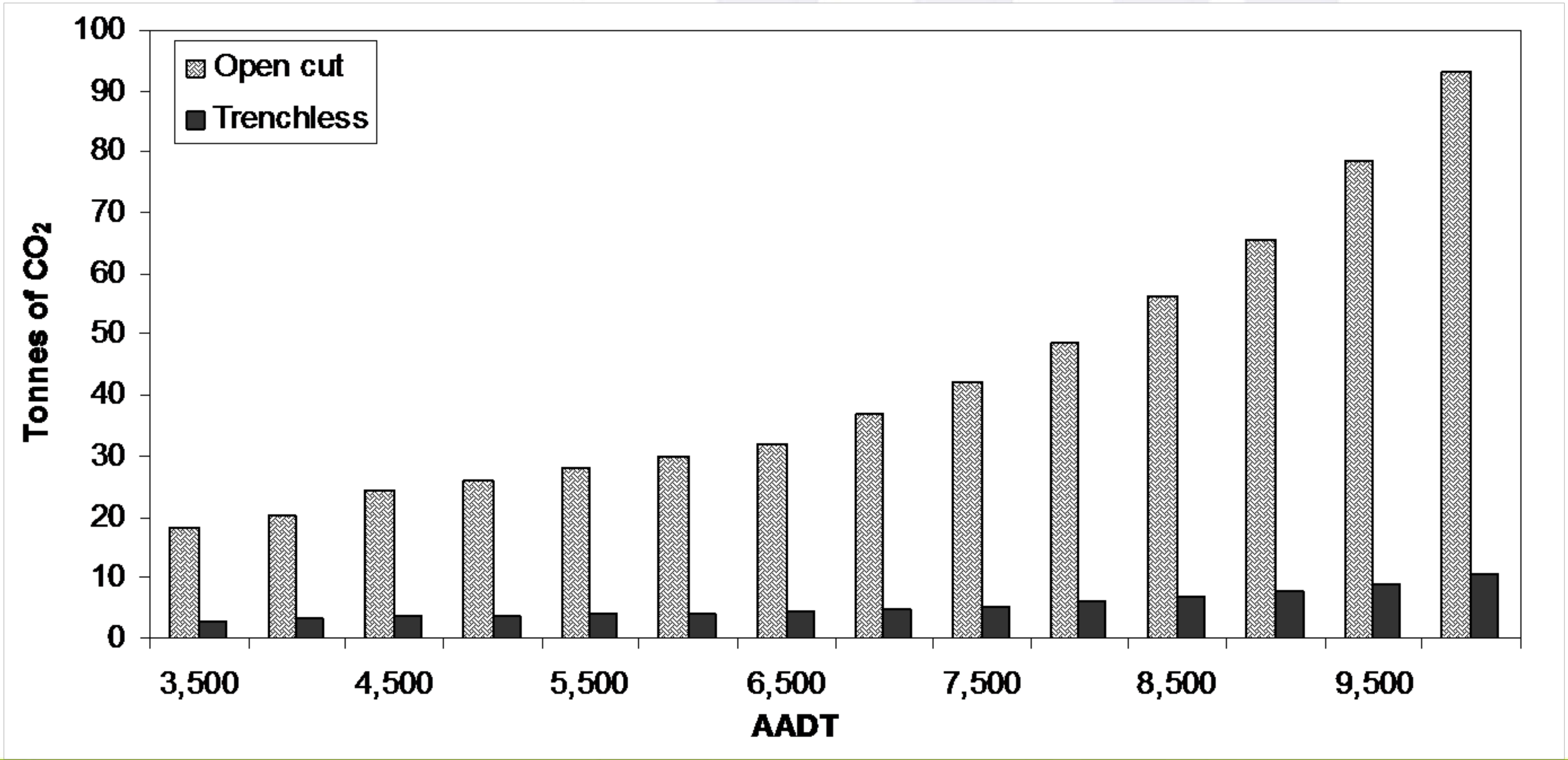
Plan 1: Flagperson

250 metres long section of the highway will be closed

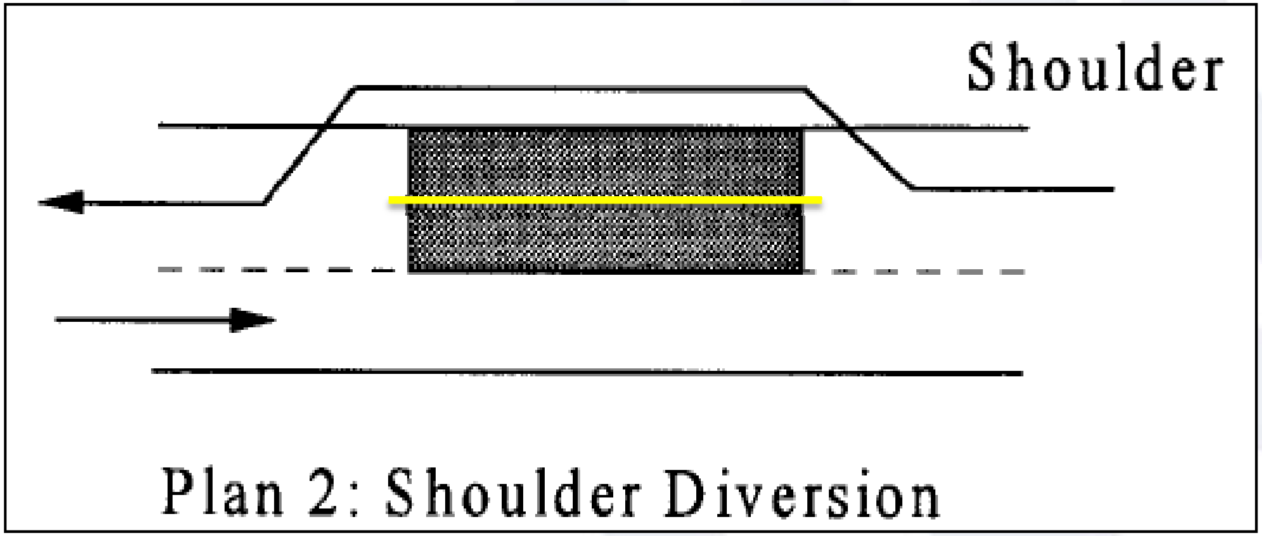
CASE STUDY I

- Open-cut method is estimated at 120 working hours and the trenchless construction job duration is estimated at 10 hours
- Simulations were run for annual average daily traffic (AADT) values ranging from 3,500 to 10,000

CASE STUDY I

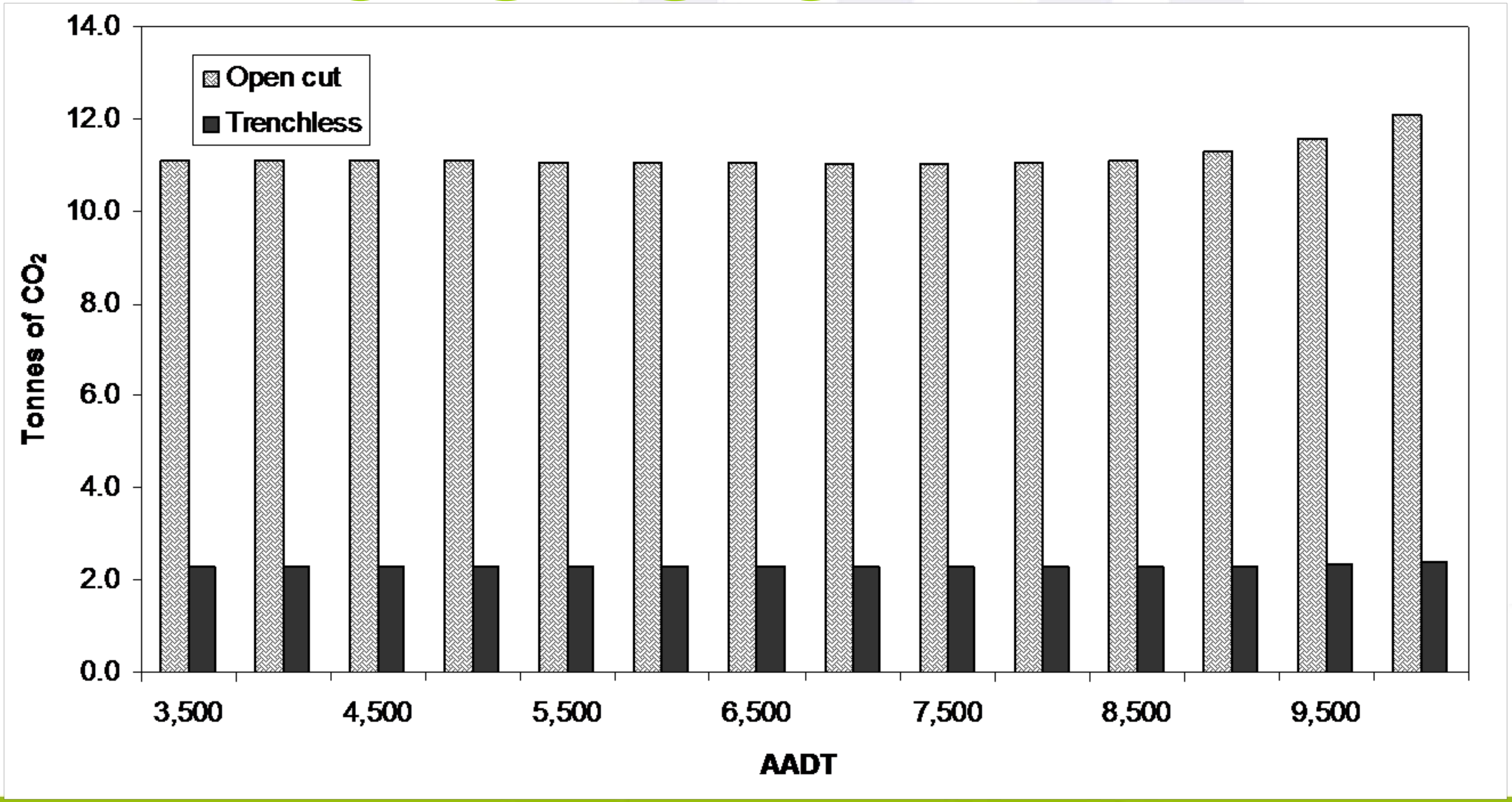

Open cut
Trenchless
Tonnes of CO_2
100
90
80
70
60
50
40
30
20
10
0
3,500
4,500
5,500
6,500
7,500
8,500
9,500
AADT

CASE STUDY II

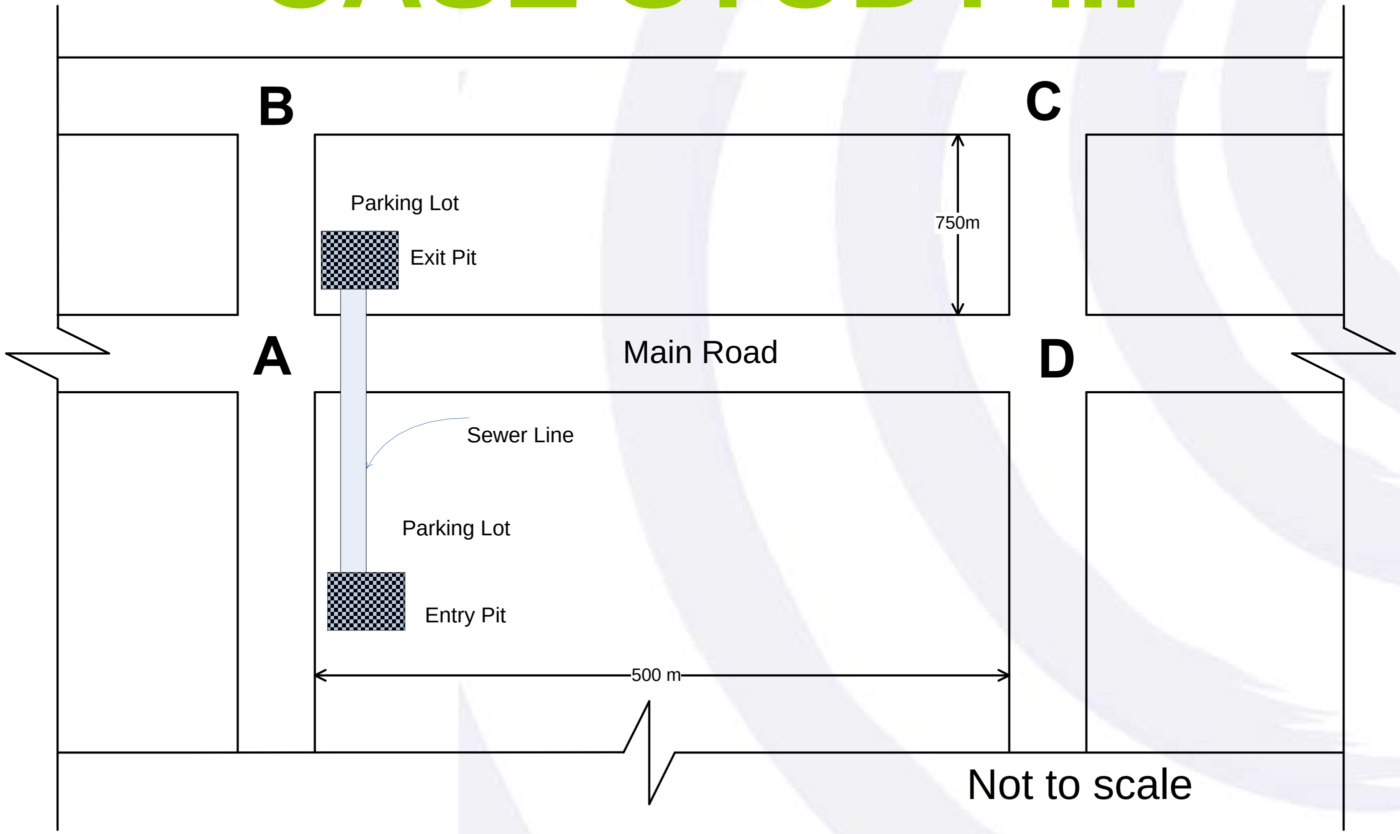


- One lane traffic diverted to shoulder
- Slow down of traffic

CASE STUDY II

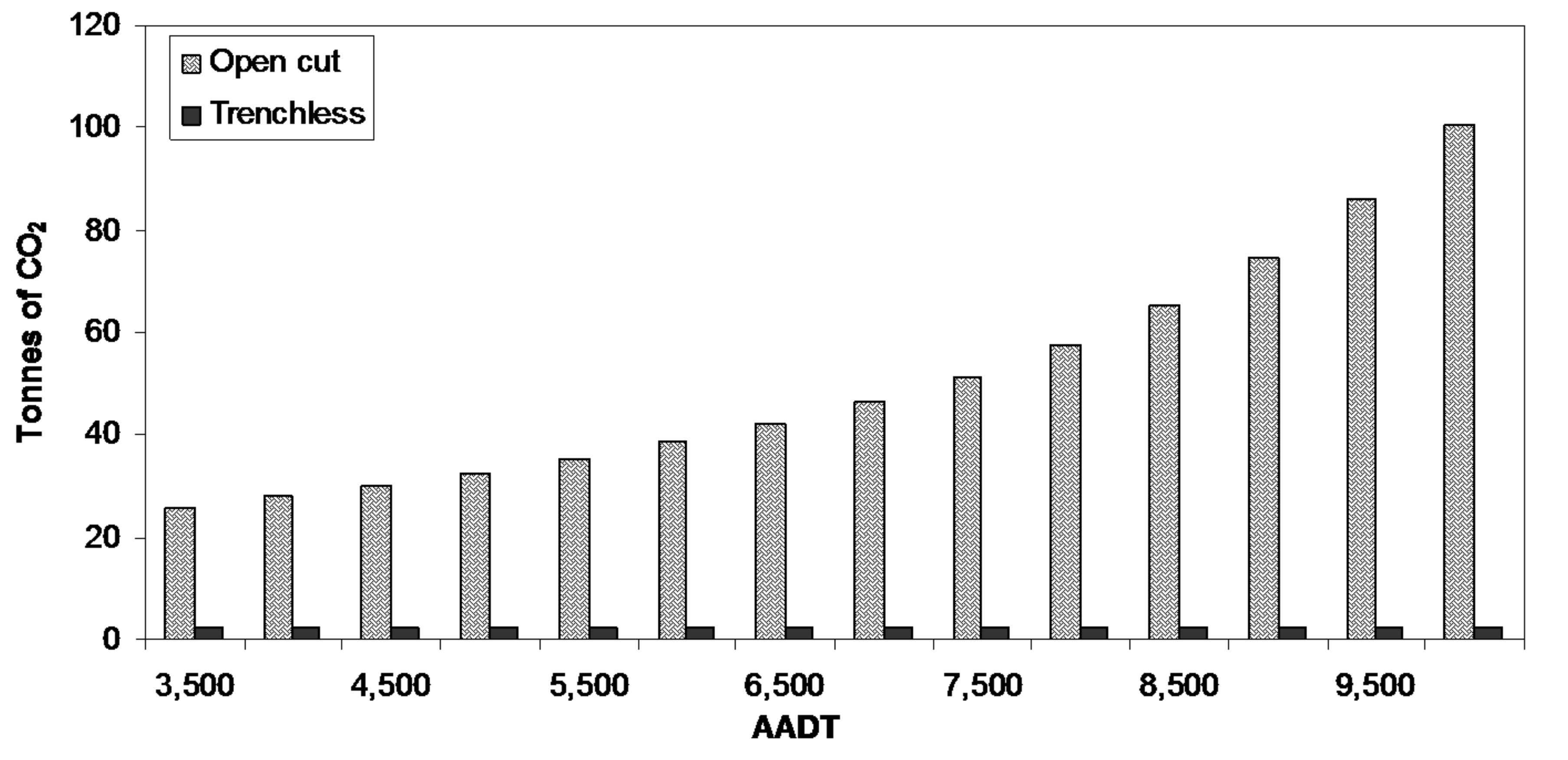


CASE STUDY III



Trenchless no traffic delays

CASE STUDY III



Conclusions

- Proposed a method to determine the amount of green house gas generated during the installation of a pipeline using open cut and trenchless construction methods.
- Trenchless construction can result in 80 to 98 percent less green house gas than open cut

Conclusions

- Trenchless green house gas savings are generated mainly by:
  - a reduction in user traffic delays
  - shorter project duration, and
  - less use of heavy construction equipment.
- User traffic delays are a major source of green house gas emissions especially on high traffic volume roads

Conclusions

- The amounts of $C0_2$ emissions determined in this study are considered to be conservative.
- Need to add greenhouse gas emission due to:
  - The production and transportation of trench restoration materials.
  - Life cycle traffic delays resulting from pavement rehabilitation and maintenance.

Acknowledgement

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