Sustainable and economic futures - Multi-Utility Tunnels?

Dr Dexter Hunt

Streetworks for the 21st Century
1st February 2017
Warwickshire County Cricket Club, Edgbaston, Birmingham
...In urban areas ‘more of the same’ is becoming increasingly untenable and in the 21st Century traffic congestion due to repeated street works is becoming politically, as well as socially and environmentally, unacceptable.
Trenching - a sustainable solution?
Trenching - a sustainable solution?
Open-cut remains the most widely adopted solution for utility placement by practitioners and yet various alternative solutions exist.

...such as trenchless technologies

...and Multi-Utility Tunnels (MUTs)
Multi-Utility Tunnel (MUT)

“any system of underground structure containing one or more utility service which permits the placement, renewal, maintenance, repair or revision of the service without the necessity of making excavations; this implies that the structure is traversable by people and, in some cases, traversable by some sort of vehicle as well”

(APWA, 1997).
MUT - a sustainable solution?

(a) Flush fitting
(b) Shallow
(c) Deep
How should utilities be costed?

\[ C_{\text{SUSTAINABILITY}} = C_{\text{ECONOMIC (DIRECT and INDIRECT)}} + C_{\text{SOCIAL}} + C_{\text{ENVIRONMENTAL}} \]
Sustainability cost timeline

PRE-CONSTRUCTION
- Field survey work
- Ground investigation
- Asset location
- Legal issues/litigation
- Engineering and design
- Open-Cut vs Trenchless vs MUT?
- Bid preparation
- Working area requirements
- Mobilisation
- Equipment
- Labour
- Materials
- Road closures and Detour roads
- Shoring and sloping
- Dewatering
- Demobilisation
- Spoil removal
- Backfill and compaction
- Surface reinstatement
- Operation
- Emergency repairs
- Routine Maintenance
- Decommissioning and Renewal

CONSTRUCTION

POST-CONSTRUCTION

REFERENCES:
2 Jung and Sinha (2008)
3 Rogers and Hunt (2006)
4 Rao et al., (2001)
5 Kolator (1998)
6 Isley and Tanwani (1990)
7 Isley et al., (1999)
8 Ormsby (2009)
9 Mc Kim (1997)
10 Jung and Sinha (2007)
12 Ling et al., (1989)

KEY:
- ECONOMIC (DIRECT)

N.B. Positions are approximate and may vary considerably from project
Sustainability cost timeline

PRE-CONSTRUCTION
- Field survey work
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- Open-Cut vs Trenchless vs MUT?
- Bid preparation

CONSTRUCTION
- Head office
- Insurance
- Site office
- Field supervisory / Job site
- Lane occupancy
- Traffic control / diversion measures
- Temporary utilities
- Shoring and sloping
- Dewatering
- Equipment
- Labour
- Materials
- Mobilisation
- Legal survey work
- Asset location
- Working area requirements
- Working area

POST-CONSTRUCTION
- Demobilisation
- Operation
- Emergency repairs
- Routine Maintenance
- Decommissioning and Renewal
- Loss of revenue
- Road closures and Detour roads
- Working area requirements
- Utility damage
- Structural damage
- Lane occupancy
- Site office
- Field supervisory / Job site
- Lane occupancy
- Traffic control / diversion measures
- Temporary utilities
- Shoring and sloping
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CONSTRUCTION

- Head office
- Site office
- Field supervisory / Job site
- Working area requirements
- Equipment
- Labour
- Materials
- Mobilisation
- Loss of public space/amenities
- Traffic control/diversion measures
- Road closures and Detour roads
- Temporary utilities
- Shoring and sloping
- Dewatering
- Road damage
- Service disruption
- Noise
- Structural damage
- Utility damage

POST-CONSTRUCTION

- Lane occupancy
- Vehicular
- Visual impact
- spoilt removal
- Backfill and compaction
- Surface reinstatement / improvement
- Routine Maintenance
- Decommissioning and Renewal
- Emergency repairs
- Loss of revenue
- Loss of business
- Health
- Operational

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- Engineering and design
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- Bid preparation

CONSTRUCTION

- Head office
- Site office
- Field supervisory / Job site
- Equipment
- Labour
- Materials
- Mobilisation
- Loss of public space/amenities
- Traffic control / diversion measures
- Road closures and Detour roads
- Temporary utilities
- Shoring and sloping
- Dewatering
- Lane occupancy

POST-CONSTRUCTION

- Health and safety
- Vehicular
- Visual impact
- Road damage
- Utility damage
- Structural damage
- Dust and dirt pollution
- Air pollution and Greenhouse gases
- Environmental damage and Contamination
- Loss of business
- Health
- Service disruption
- Noise
- Spoil removal
- Backfill and compaction
- Surface reinstatement / improvement
- Demobilisation
- Emergency repairs
- Loss of revenue
- Routine Maintenance
- Decommissioning and Renewal

KEY:
- C_ECONOMIC (DIRECT)
- C_ECONOMIC (INDIRECT)
- C_SOCIAL
- C_ENVIRONMENTAL

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This research to show where the economic tipping point between the two methods occurs and hence this presentation shows it might be influenced by:

- utility type,
- pipe number (i.e. density),
- pipe diameter,
- number of excavation and reinstatement (E&R) procedures
- location (i.e. undeveloped, suburban and urban areas), and the
- choice of MUT being adopted (i.e. flush-fitting, shallow and deep).
Utility placement - cost by location

This study (900mm depth)
CSMG (2010)
Henderson (2011)

<table>
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<th>Undeveloped</th>
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<th>Urban</th>
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<td>Highest</td>
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</table>

AVERAGE 68
AVERAGE 118
AVERAGE 155
MUT placement - cost by type

- Open cut
- Flush-fitting MUT
- Shallow MUT
- Deep MUT

Legend:
- This study (200mm pipe)
- Riera and pasquel (1992)
- Wohlwend et al., (1998)
- Chasco et al., (2010)
- Hokkannen (1994)
MUT cost (undeveloped areas)
Economic tipping point in favour of flush fitting when we take into account excavation and reinstatement (E & R) procedures per m length over the lifetime of the utility.
MUT cost (undeveloped areas)

Multiple economic tipping points for each MUT type
MUT cost (Sub-urban)

...and in other locations
MUT cost (Urban)

...and in other locations
Tipping points (Flush-fitting MUT)

![Graph showing tipping points for undeveloped, suburban, and urban areas with different pipe sizes.](image-url)
Likelihood of E&Rs by location
Conclusions

• A better understanding of potential ‘tipping points’ for the economics of MUTs in three locations (undeveloped, suburban and urban) has been gained;

• An MUT, during its lifetime, could provide a more economically sustainable method of utility placement;

...as long as they are used in the right conditions (i.e. the right number and type of utilities and E&R procedures).
Conclusions

- Robust economic costing model will provide the evidence base that can inform the feasibility of alternative utility placement solutions such as MUTS.

  ...however to truly reflect all three pillars of sustainability alternative cost models are required.
Conclusions

...Overcoming barriers towards adopting alternative utility placement options is vital toward achieving a more sustainable and ‘Liveable City’;

...One significant barrier is an ‘Evidence base’ showing ‘Best practice’ for MUT options (within and outside the UK) – Great potential for collaboration with NJUG to provide this guidance.
References


