

Identifying and clarifying the interfaces between urban underground space and its environment

Presented by:
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Image source: London Transport Museum, undated.



Populations are urbanizing and cities are densifying, globally.



Sau Paulo, Brazil



New York, US

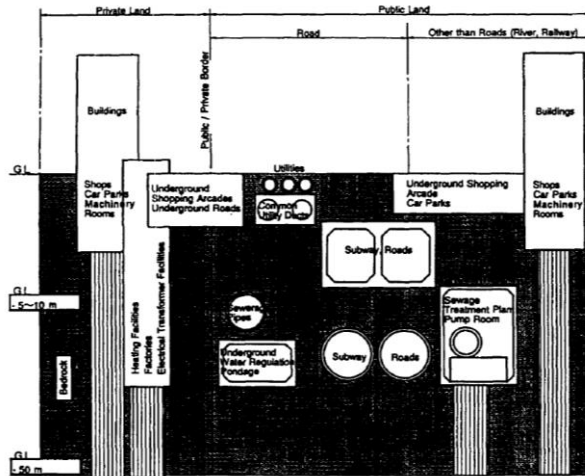


Paris, France



London, UK

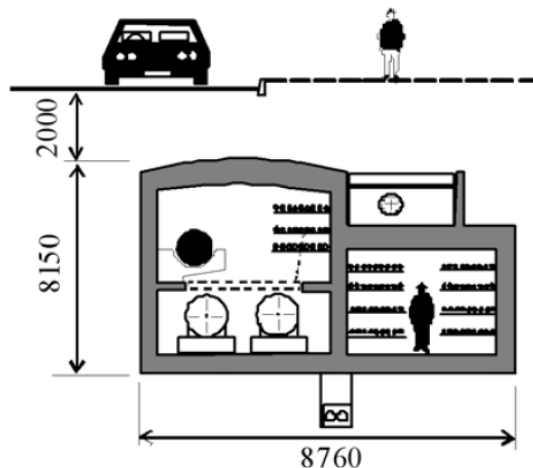
Urban stakeholders are building underground to increase urban space.



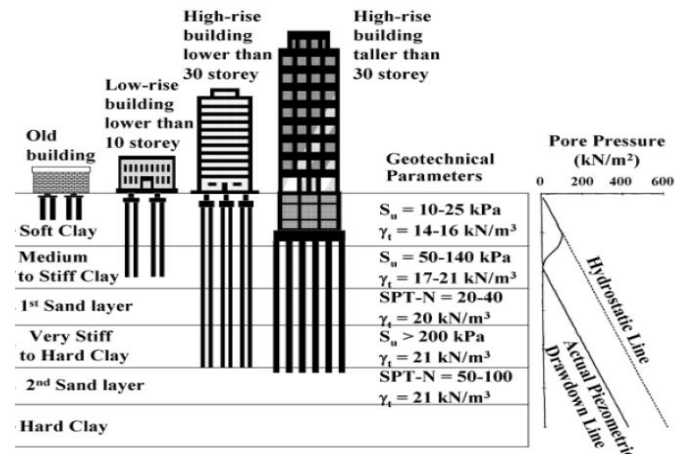
Potential uses for Urban Underground Space in Japan.
Source: International Tunnelling Association, 2000



Central China's mega-city Wuhan has started the construction of the country's largest "underground city," as more cities look to underground space as land resources become scarce.
Source: Hubei, 2015



Multi utility tunnels.
Source: Hunt, Jefferson, and Rogers, 2011.



Typical design of superstructure using Piled Foundation concept in Bangkok subsoil.
Source: Cheang, Phien-weij, Almorfa, 2013.

Metro systems are a major user of urban underground space.

“Metros are of critical importance for mobility, as societies are becoming ever more urbanised. At the end of 2017, there were metros in 182 cities in 56 countries, carrying on average a total of 168 million passengers per day. 75 new metros have opened since the year 2000 (+70%). This massive growth is to be credited largely to developments in a few countries in Asia.”

“In 2017, the 182 metro systems accounted for a total annual ridership of 53,768 million passengers. In the last six years, annual metro ridership grew globally by 8,716 million passengers (+19.5%)”.

Source: UITP, 2014.



Rush hour at Oxford Circus station entrance.

Source: Alamy, undated.



Rush hour at Vauxhall LU station, London.

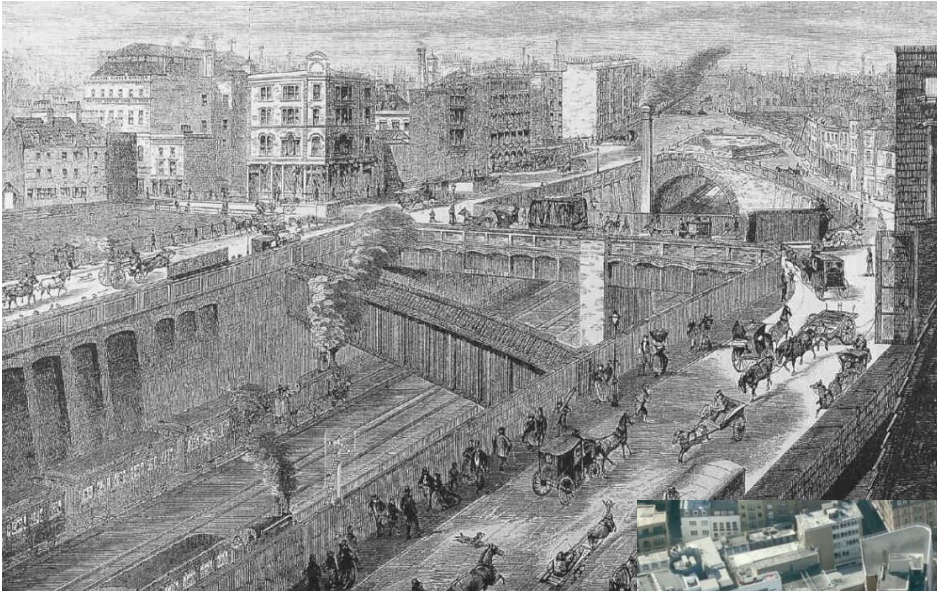
Source: Author, undated.



Rush hour at 51st Street Station, New York.

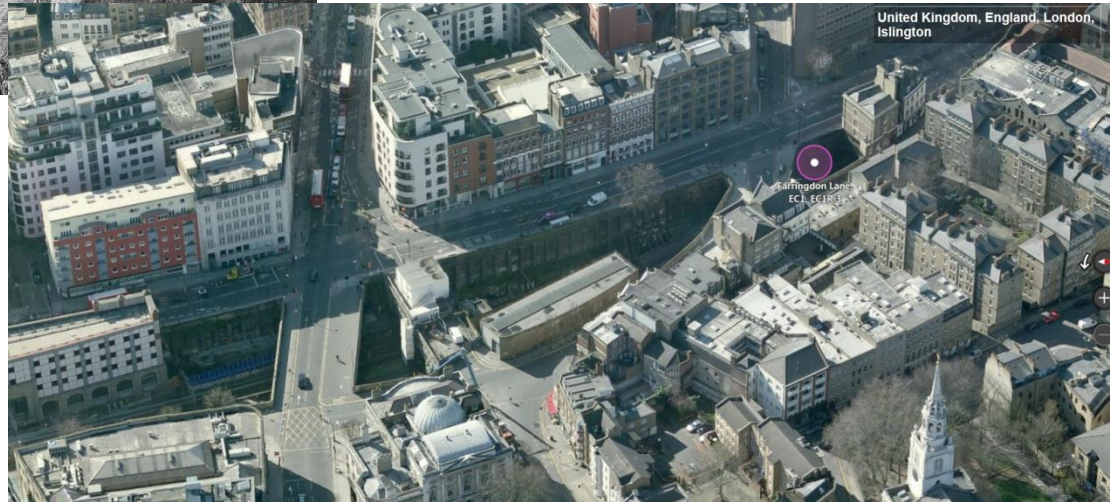
Source: Author, undated.

Metro systems are also some of the oldest *modern* users of urban underground space.



1868

2017

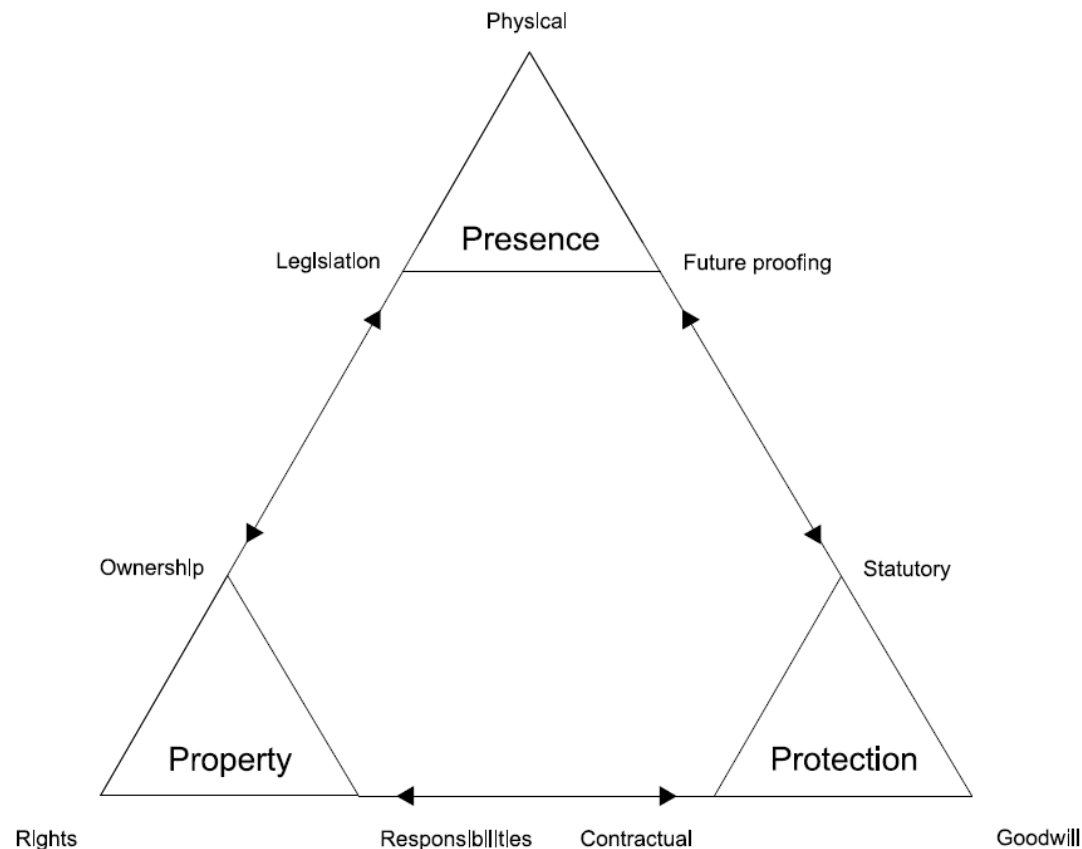


Sources:

Drawing: British History Online, 2017.

Satellite image source: Bing Maps, 2017.

What can metro systems tell us about asset management within urban environments?



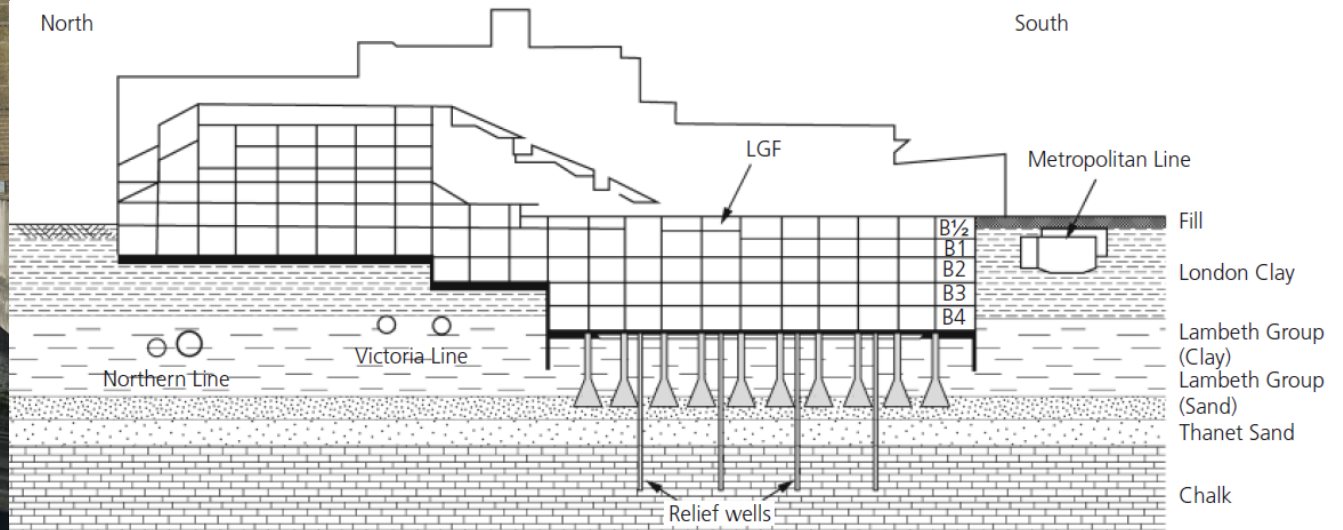
A conceptual framework to assist identification and clarification of asset presence, property, and protection interfaces.

Source: Darroch, Beecroft, and Nelson, 2016.

Metros have and will continue to have direct and indirect effects on and interfaces within their environment.

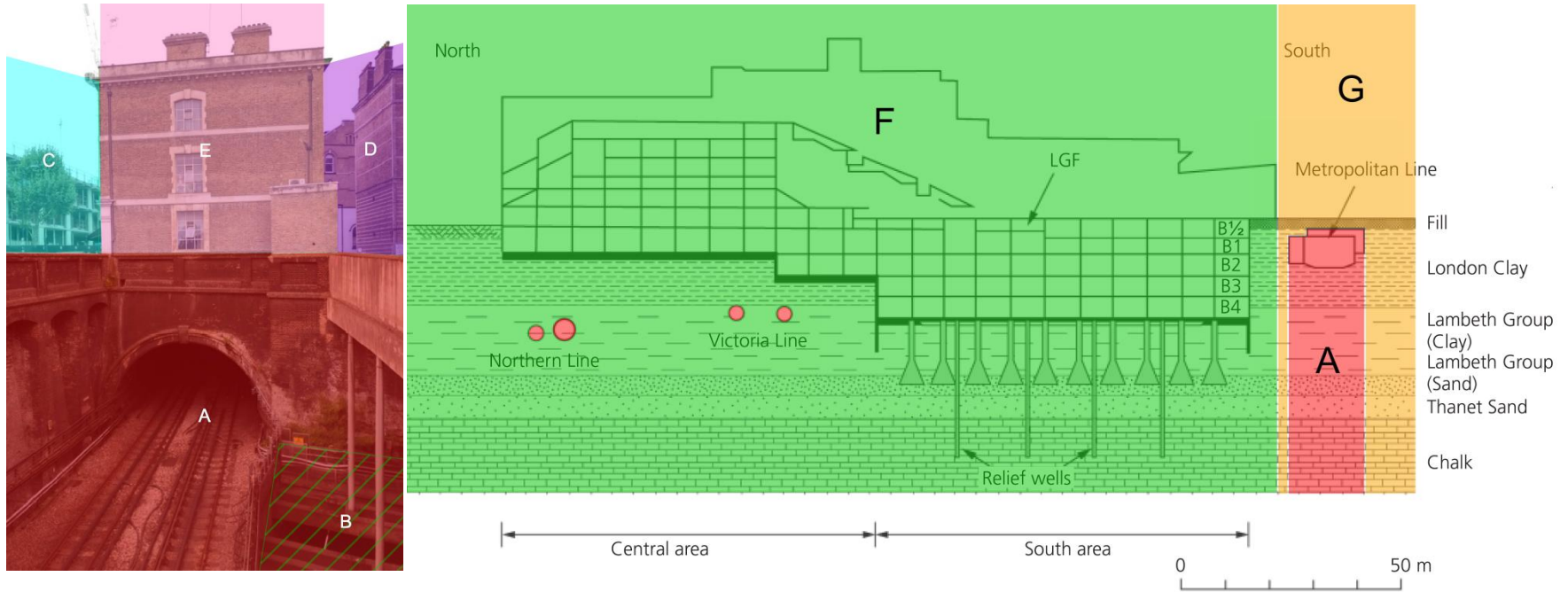


Building located over sub-surface railway tunnel.
Source: Author, undated.



North-south section through the British Library.
Source: Simpson and Vardanega, 2014.

These interfaces are not only physical but also relate to property - asset ownership, rights, and responsibilities.



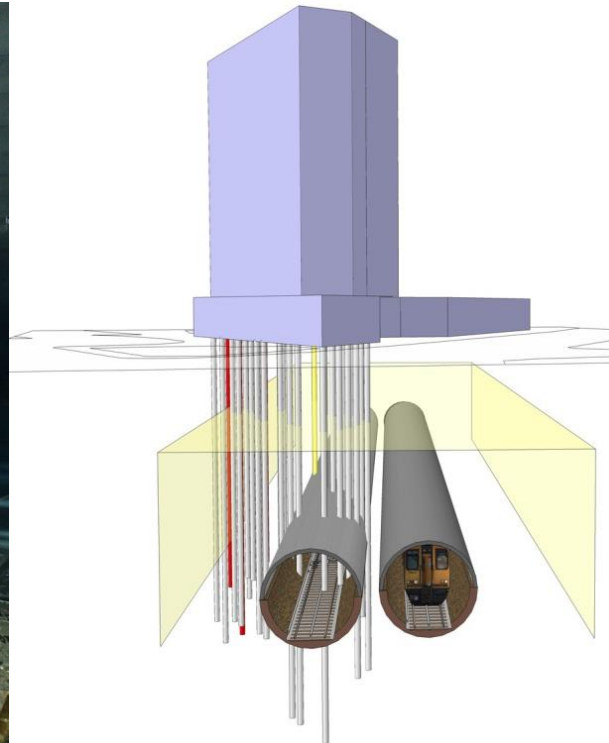
Ownerships:

- A = London Underground land and airspace
- B = Network Rail land and airspace (below)
- C = TfL Streets highway
- D = Local authority highway
- E = Building owner
- F = British Library
- G = Local Highway Authority

Asset presence and property interfaces must be clearly understood to enable effective protection within changing urban environments.



Penetration of tunnel lining and debris on track.
Source: RAIB, 2014.



Scale diagram showing proposed foundation layout and extent of interaction with railway tunnel.
Source: RAIB, 2014.



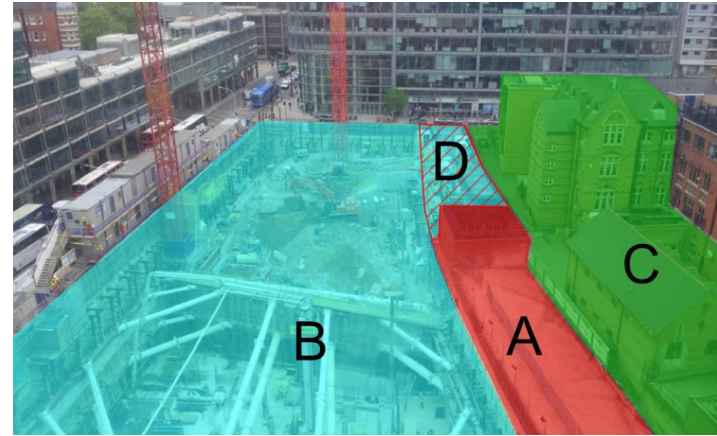
Auger sections and debris on the track.
Source: RAIB, 2014.

An example of a development on Victoria Street, London, designed, and constructed to accommodate the presence of metro infrastructure.



Birds Eye view of construction site on Victoria Street, London.

Source: London Underground, undated.



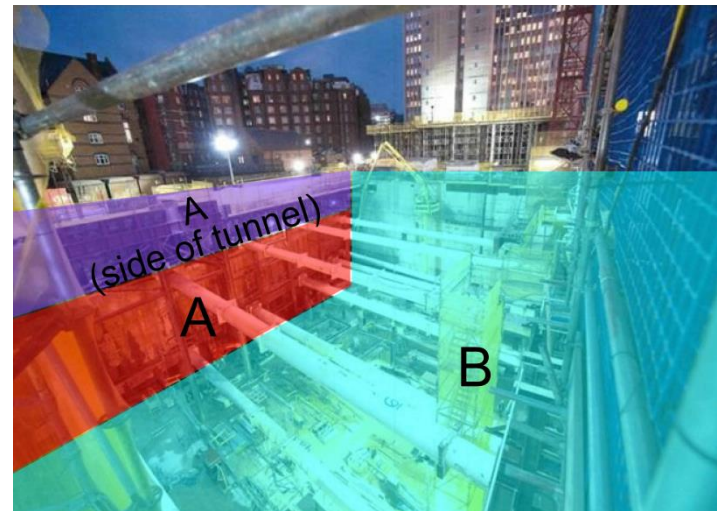
Birds Eye view of construction site on Victoria Street, London, with simplified property overlaid.

Source: London Underground, undated.



View along construction site on Victoria Street, London.

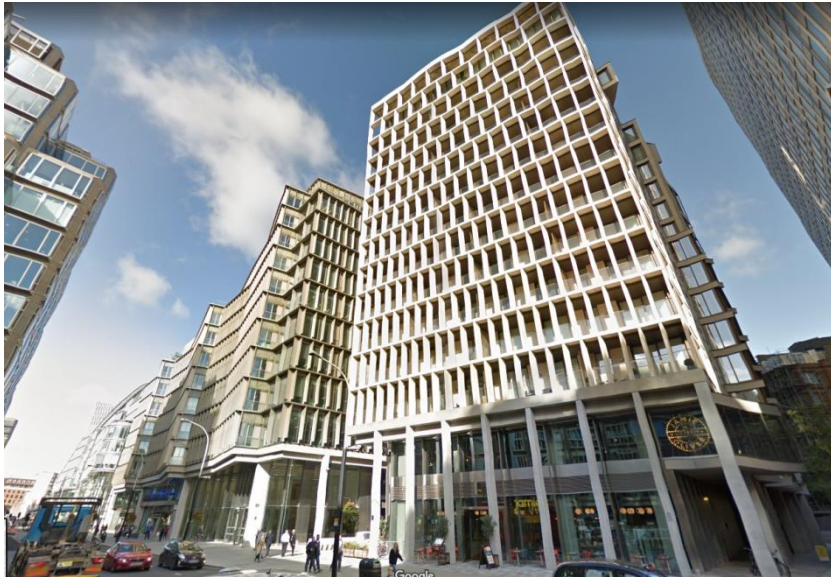
Source: London Underground, undated.



View along construction site on Victoria Street, London, with simplified property overlaid.

Source: London Underground, undated.

Having a clear understanding of the interfaces enabled the demolition of the original buildings, and construction of new buildings.



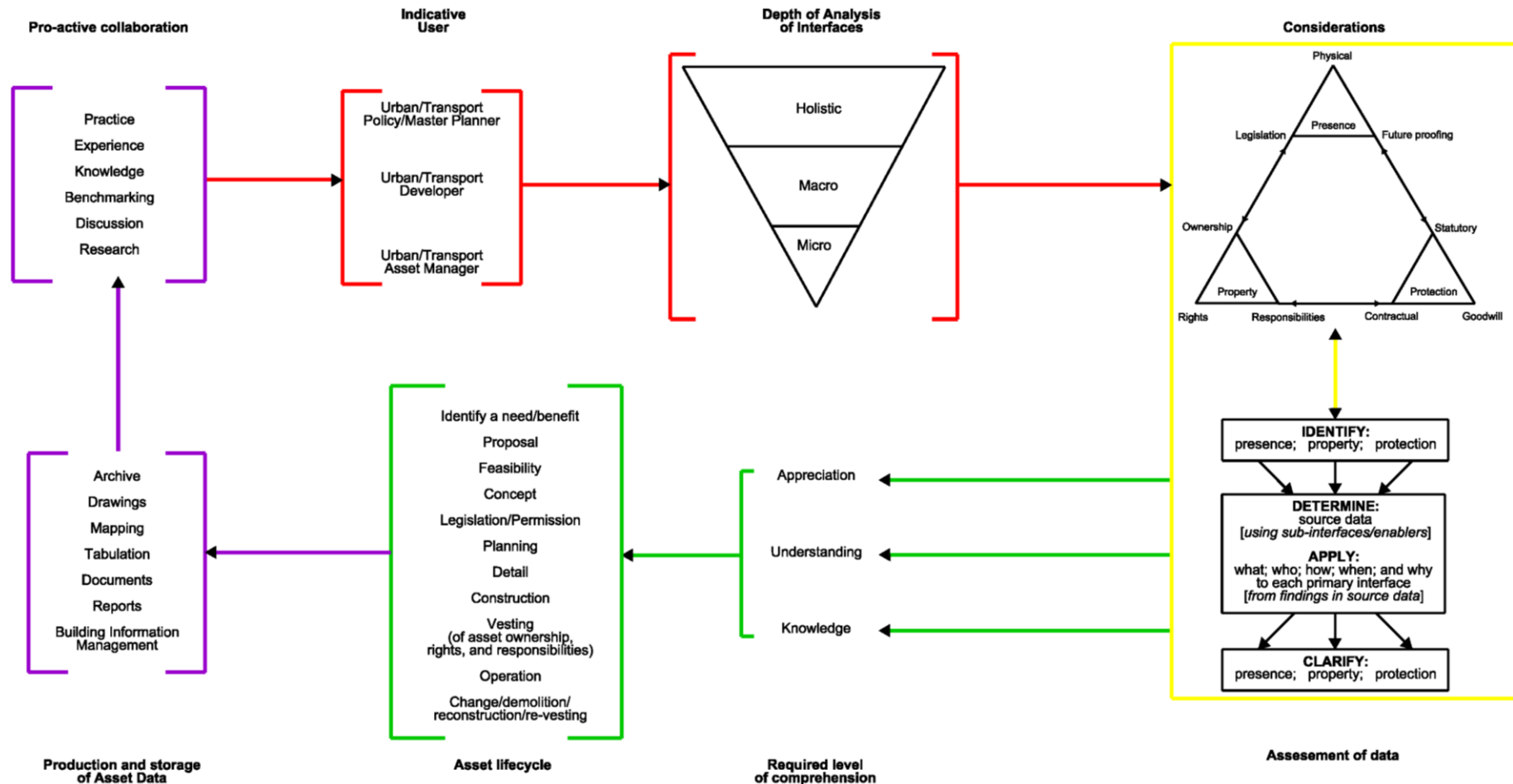
View along new construction on Victoria Street, London.

Source: Author, undated.

The new development is:

- 8 storeys below ground level, at its lowest point;
- up to 14 storeys above ground level;
- 22 storeys in total;
- directly adjacent to an underground railway.

Identifying and clarifying the interfaces is not just relevant to urban change, or metros, but to whole life cycle asset management.



Workflow showing potential benefits from application of the conceptual framework.
Source: Darroch, Beecroft, & Nelson, 2018.

The principles of identification and clarification of asset interfaces also apply to other urban environments and infrastructure.



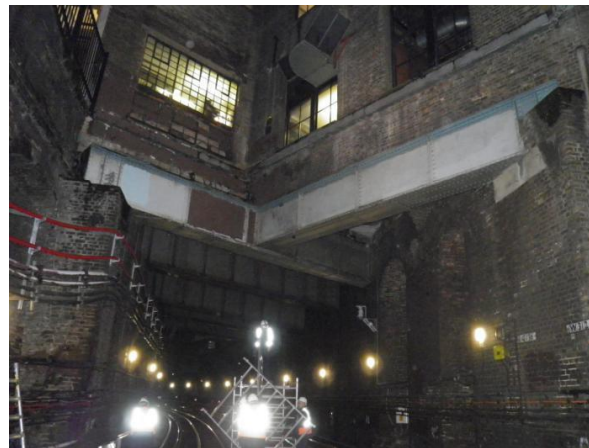
Urban surface tramway passing under apartment building in Den Haag, Netherlands. **Source:** Author, undated.



Elevated monorail within an urban environment, Wuppertal, Germany. **Source:** Author, undated.



Urban environment, with public highway passing through a building, Osaka, Japan. **Source:** Morrison, G., undated.



Buildings supported on girders above metro infrastructure, London, UK. **Source:** Author, undated.



Urban environment consisting of buildings and highway, New York, USA. **Source:** Author, undated.

What the research considered and what was the outcome?

- *The research consisted of a literature review including national and international standards, legislation, professional and academic literature;*
- *it was found that identification of asset **presence** is undertaken in practice, and in principle - but differently by different people within the same **and** other organisations;*
- *there appears to be no co-ordinated clearly documented process for identifying **and** clarifying asset **presence**, **property**, and **protection** interfaces within urban environments, locally, nationally (UK), or internationally;*
- *a conceptual framework was developed to assist identification **and** clarification of asset interfaces; it was tested on London Underground infrastructure and other sample urban metro systems;*
- *the principles of historical geography were used throughout the research.*

Outcome of the research and its relevance to asset management.

- *Urban environments should be treated as 'organisations', as defined within ISO55,000 'Asset Management'. After all it is the people and groups within the urban environment that enable that city to achieve its objectives;*
- *infrastructure owners and asset managers must look beyond their primary assets (those they are responsible for) and consider how these interface with, affect, and are affected by their specific and larger environments, locally, nationally, and internationally;*
- *there must be clearly documented and standardised processes, which also enable variability to achieve common understanding and best practice. The conceptual framework and workflow is arguably one potential method of doing this;*
- *due to the varying natures, and ages of urban infrastructure, the principals of historical geography should be added to the existing disciplines managing urban environments (engineering; urban and transport planning; law).*

Principally, asset managers must identify *and* clarify the '3P's':

Presence

- *What assets/infrastructure are present?*
- *How do they interface with their environment?*
- *How and why do specific assets interface?*

Property

- *Who owns what and why?*
- *What are your rights, what are the rights of others?*
- *What are your responsibilities and those of others, and why?*

Protection

- *What effect do your and other parties assets have on their environment?*
- *How is ongoing safe presence and operation assured?*
- *How is change effectively managed?*
- *How is risk mitigated?*

Are these principals clearly understood and documented by all relevant parties?

Any questions?

- Thank you for listening.

“If historical geography is about understanding how the past shapes the ‘geographies of the present and the future’ [Heffernan, M., 2008], it must be used to advise and guide those managing and planning the urban environment, and its transport infrastructure, now and in the future”.

Darroch, N., 2018.

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Sources and References:

- Alamy, undated. *Rush hour at Oxford Circus station entrance*. [photograph] Available at: <<http://www.theguardian.com/uk-news/davehillblog/2013/nov/15/tomorrow-tube-london-underground-stations-commercial-development>> [accessed: 2 February 2016];
- British History Online, 2017. *Farringdon Road*. [online] Available at: <<http://www.britishhistory.ac.uk/survey-london/vol46/pp358-384>> [Accessed 20 October 2017];
- Cheang, W., Phien-weij, N., Almornfa, K., 2013. Optimisation of a Piled-Raft foundation system via 3D FEM. *Geotechnics for Sustainable Development*, Hanoi, Vietnam, 2013. [online] Available from: <https://www.researchgate.net/publication/259079320_Optimisation_of_a_Piled-Raft_foundation_system_via_3D_FEM> [accessed Sep 24 2018];
- Darroch, N., 2012. *London's deep tube railways: visibly invisible*. MA. University of York. [online] Available at: <<http://etheses.whiterose.ac.uk/id/eprint/3905>> [Accessed 20 October 2017];
- Darroch, N., 2014. *A brief introduction to London's underground railways and land use*. [online] Journal of Transport and Land Use. Available at: <<http://dx.doi.org/10.5198/jtlu.v7i1.411>> [Accessed 20 October 2017];
- Darroch, N., Beecroft, M., & Nelson, J., 2016. *A conceptual framework for land use and metro infrastructure*. [online] Journal of Infrastructure Asset Management. Available at: <<https://doi.org/10.1680/jinam.16.00008>> [Accessed 20 October 2017];
- Darroch, N., Beecroft, M., & Nelson, J.D., 2018. Going underground: an exploration of the interfaces between underground urban transport infrastructure and its environment. *Tunnelling and Underground Space Technology*. [e-journal] 81 (November), pp.450-462. Available through: ScienceDirect <<https://doi.org/10.1016/j.tust.2018.08.027>> [Accessed 23 August 2018];
- Hubei, 2015. Wuhan builds China's largest "underground city". [online] Available at: <http://en.hubei.gov.cn/news/newslst/201512/t20151223_767134.shtml> [Accessed 24 September 2018];
- Hunt, D. V. L., Jefferson, I., Rogers, C.D.F., 2011. Assessing the sustainability of underground space usage — A toolkit for testing possible urban futures. *Journal of Mountain Science*, [e-journal] 8 (2011) pp.211-222. Available through: SpringerLink <<https://doi.org/10.1007/s11629-011-2093-8>> [Accessed 26 June 2018];
- International Tunnelling Association, 2000. Planning and mapping of underground space — an overview. *Tunnelling and Underground Space Technology*, [e-journal] 15 (3), pp.271-286. Available through: ScienceDirect <[https://doi.org/10.1016/S0886-7798\(00\)00056-0](https://doi.org/10.1016/S0886-7798(00)00056-0)> [Accessed 13 April 2016];
- London Transport Museum, undated. *Piccadilly Circus - Gavin Dunn* (1989). [online] London Transport Museum. Available at: <http://www.ltmuseumshop.co.uk/posters/london-transport-poster-archive/gallery/gallery-product/poster/piccadilly-circus-gavin-dunn-1989/posterid/32/1062-32.html> [Accessed: 28 January 2016];
- Morrison, G., undated. *In Osaka, Japan There's A Highway That Goes Through A Building*. [online] Available at: <<https://www.forbes.com/sites/geoffreymorrison/2016/10/31/in-osaka-japan-theres-a-highway-that-goes-through-a-building/#1c1885ed541f>> [Accessed 4 January 2018];
- Quora, undated. <https://www.quora.com/Which-airports-in-the-world-dont-have-flights-departing-at-after-midnight-there>
- Simpson, B., and Vardanega, P., 2014. *Results of monitoring at the British Library excavation*. [online] Proceedings of the Institution of Civil Engineers - Geotechnical Engineering. Available at: <<https://doi.org/10.1680/geng.13.00037>> [Accessed 20 October 2017];
- RAIB, 2014. Penetration of a tunnel at Old Street. [pdf] Railway Accident Investigation Branch. Available at: <https://assets.publishing.service.gov.uk/media/547c8fb940f0b60241000157/R032014_140213_Old_Street.pdf> [Accessed 11 April 2018].
- UITP, 2014. UITP unveils world metro figures in new Statistics Brief. [online] Available at: <<http://www.uitp.org/news/uitp-unveils-world-metro-figures-new-statistics-brief>> [Accessed 24 September 2018];