

Mole Solutions Evidence to the National Infrastructure Commission.

Executive Summary

This paper submits evidence to the NIC that the Mole Solutions Limited freight pipeline concept can bring innovation and benefits to future UK and global transport systems in general and that of connecting northern cities in particular. The evidence focusses on Q2: *‘What cost-effective infrastructure investments in city-to-city connectivity could address these weaknesses? We are interested in all modes of transport’*.

DEFRA, Innovate UK, Future Railway and the Nuclear Decommissioning Agency have already invested in Mole Solutions Limited R and D projects that have proved both the viability of the concept and demonstrated the technology. Studies have taken place over 50km long bulk products supply chains and in Northampton for unitised goods. These studies establish that the business case for the use of the concept’s use in both environments can be economically, socially and environmentally viable at comparatively low volumes.

Examples are given as to how the concept could be used in a number of current scenarios within future Transport for the North’s transport schemes.

The next step is to embrace the concept as a significant input to future transport planning and integrate it as a complimentary feature with existing transportation infrastructure.

Introduction.

Mole Solutions Limited (MSL) evidence to the NIC is based on the potential impact that freight pipeline technology can have on the freight strategy needs of the UK and for connecting northern cities specifically.

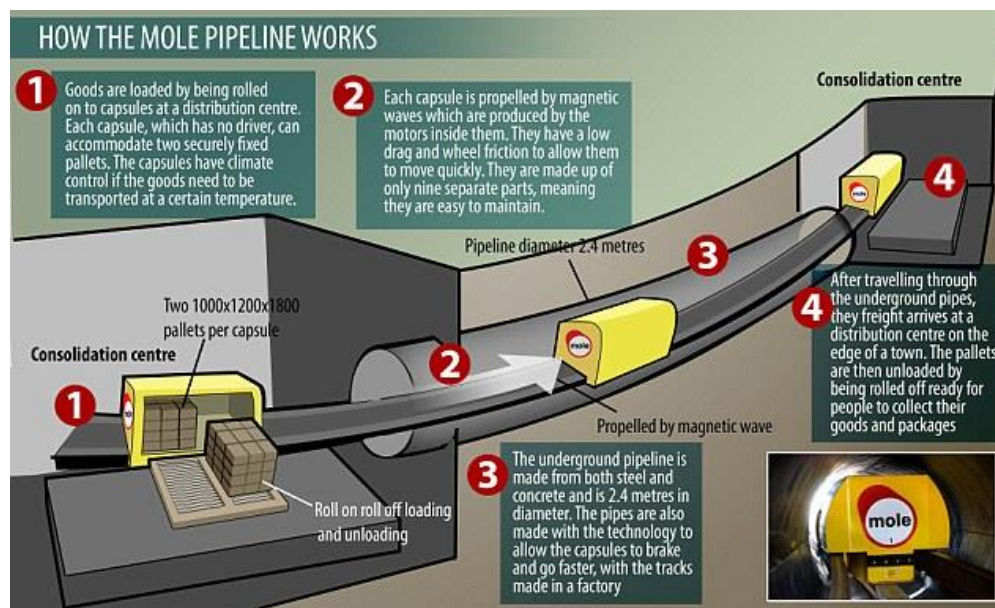
Underground passenger transport has been commonplace in London, and many other global cities, since the 19th century but underground freight transport of solid goods within cities does not exist anywhere in the world. Freight pipelines are currently limited to the transport of liquids and gases and also play an important role in the delivery of clean water to, and dirty water from, most properties in the civilised world.

MSL was established in 2002 with the business objective of developing and commercialising the concept of freight pipelines designed to carry unitised and non-unitised goods: tote bins, pallets, roll cages, shipping containers; bulk products: minerals, building spoil, aggregates, biomass, etc. See www.molesolutions.co.uk

MSL’s research has shown that the major applications of freight pipelines in connecting northern cities can be:

1. Incorporation of a Mole freight pipeline system into Transport for the North’s investment strategy for both road and rail as a cost effective means of increasing overall capacity and contributing to a reduction in accidents,

2. In major regeneration projects, for example Manchester Piccadilly Station with the arrival of HS2 where a freight pipeline could be used for the removal of spoil and the delivery of a large percentage of building products to the regeneration site
3. On completion of the building project the freight pipeline can be readily converted to provide a goods delivery system to the site's new function
4. In the use of consolidation centres where freight is delivered to an out of area consolidation point avoiding HGV's in the congested city centre. Freight is then transported in a freight pipeline to its point of use or to a substation for 'final furlong' delivery by appropriate eco friendly transport. See illustration



Principles of the Mole Freight Pipeline concept are:

- SIMPLE and MATURE technology to provide high reliability, availability and maintainability
- ELECTRICALLY POWERED to be sustainable and have low environmental impact
- ENCLOSED to be safe and secure
- HIGHLY AUTOMATED to allow 24x7 unmanned operation
- MODULAR CONSTRUCTION to minimise time and cost of installation
- LAID BESIDE/UNDER EXISTING TRANSPORT INFRASTRUCTURE to simplify installation and integrate with existing supply chains

Benefits of the Mole system are:

- VERY LOW DIRECT OPERATING COSTS: automated, energy efficient, simple maintenance and repair offers direct operating costs of approximately 15% of road costs

- **COST EFFECTIVE INCREASE IN INFRASTRUCTURE CAPACITY:** modular construction using the total 3D footprint of existing and disused transport infrastructure shortens the construction time and provides attractive investment returns at low capacity utilisation
- **INDIRECT COSTS:** resilient transport infrastructure enables reliable Just-In-Time services allowing the full JIT benefits to be realised
- **SOCIAL:** freight only, separate system offers intrinsically the lowest accident rates of any mode; transferring freight from the roads releases capacity and contributes to a reduction in congestion
- **ENVIRONMENTAL:** lowest environmental impact of all the transport modes - power is as green as the electricity supply; low carbon, air pollutants and noise, significant reduction in road damage.

Freight Pipeline projects since 2010

The Freight Pipeline concept has been recognised as an emerging and viable transportation system by DEFRA/DfT, the Technology Strategy Board, Innovate UK and Future Railway all of whom have grant funded research and development projects by MSL over the last five years. Additional support in these projects has come from a number of partners including DHL, Laing O'Rourke, Morgan-Sindall, PA Consulting Group, Arup, Force Engineering, WGH Engineering, Lafarge-Tarmac and Urban and Civic. MSL have shown in the following projects that the concept is applicable to a wide range of freight transport:

1. 2015 completed on time and budget four projects:
 - a. An Innovate UK 'Proof of Concept' project to establish the viability of the Mole Urban Freight System in Northampton. The conclusion is that the concept is viable and it is planned to begin in 2016 the development of a comprehensive Business Plan for Northampton. The project has also developed the methodology that can be used to evaluate the concept in any conurbation anywhere in the world.
 - b. A Pre-Feasibility Project of the Mole Urban Freight System for Transport for Greater Manchester. The proposed system could be used: to extract spoil from the major regeneration of the Manchester Piccadilly Station area; the delivery of most of the building products to the site; a legacy goods delivery system from Port Salford into Manchester. An outline Feasibility Study proposal was produced and is being considered by TfGM as part of their total transport strategic plan.
 - c. In conjunction with ARUP, an evaluation for Radioactive Waste Management of the use of the Mole system in the development of Deep Storage Facilities. The conclusion reached was that the concept offered significant benefits for much of the freight transportation required in the development and operation of the proposed facility. Outline designs for the components of the system were produced which would provide the basis for a detailed Feasibility Study when required.
 - d. MSL were successful in a Future Railway competition to study the use of Linear Induction Motors (LIMS) to provide independent braking to trains when the conventional wheel on rail braking fails due to circumstances such as leaves on the track. The study showed, using computer simulation and physical trials on a modification to our development track, that the Mole concept met the competition brief. The next stage

is to submit a proposal for second stage funding to scale up the components and evaluate a full size pilot system. If MSL are successful with their proposal, work will begin in the middle of 2016.

2. In addition, in July 2015 MSL were selected by the University of Texas (UoT) to be a member of the Stakeholder Group for the Feasibility Project into the potential use of freight pipelines in Texas. This 3M\$ study is financed by the State of Texas and is focussed on evaluating the use of LIM powered freight pipelines to transport thousands of shipping containers over distances in excess of 250 miles. We have reached an agreement with UoT that MSL will provide technical input on the design of the hardware and software in the development of the concept.
3. 2013/14 designed, commissioned and demonstrated to more than 70 organisations a bulk system capable of carrying 10m tonnes per annum in a pipeline of 1.3m internal diameter. The project was part funded by a TSB 'Development of Prototype' grant.
4. 2012 completed a 'Proof of Concept' project, partly funded by the TSB 'Smart Grant Scheme', the objective of which was to: produce outline designs for the components of a bulk freight pipeline system; compare the financial viability of a Mole system with long haul conveyors; produce an animated video explaining the concept. The project outputs are: the outline designs; a financial analysis that showed for volumes greater than 750ktpa and distances greater than 750m, a Mole system offered a better investment than conveyors and would be much safer and cleaner; the video can be viewed at our website: www.molesolutions.co.uk
5. 2010 Completed a DEFRA funded/DfT managed Feasibility Study: '*Assess the feasibility of using freight pipelines to transport aggregates in England*'. The conclusions reached are that: the individual technologies are well proven - the innovation is in the manner in which they are combined; at relatively low levels of capacity utilisation (~ 10%) the return on investment was calculated as 10% and this increased with utilisation; major social and environmental benefits would be generated; simple routes could be developed in less than three years

Technology Readiness Level (TRL).

The recent projects have shown the individual components of the Mole Concept are all well proven technologies; the innovation that Mole Solutions has developed is combining these individual technologies into a world leading Freight Pipeline system with extensive global applications.

Global potential.

MSL have attended and presented papers at the last three International Society Underground Freight Transport Conferences: University of the Ruhr, Shanghai and University of Texas. Attendance at these events came from the UK, USA, China, Japan, Germany, The Netherlands, Italy, Canada, Belgium and Turkey.

In April 2015, MSL were interviewed by the FT and the subsequent article produced a tsunami of publicity both in the UK and from around the world. The level of interest in this innovative approach to the global issue of road congestion is considerable. Further press releases are planned for the first quarter of 2016.

Specific evidence for Connecting Northern Cities infrastructure.

Mole Solutions evidence is focussed on the Commission's question 2, *'What cost-effective infrastructure investments in city-to-city connectivity could address these weaknesses? We are interested in all modes of transport.'*

Our submission is based on the development of underground freight pipelines to take a significant volume of road freight off of the trunk roads connecting northern cities and to transfer the goods to capsules travelling on rails in pipelines of approximately 2.4m internal diameter. The same technology can be used within the cities for major regeneration projects and in this application provides a legacy urban goods delivery system.

"I've seen the Mole Solutions demonstrator and therefore seen how much of freight can be transported in the 21st century; anyone involved in designing transport infrastructure should understand what role the Mole concept can, and can not, perform within their plans". Darryl Stephenson, Head of Value Engineering, HS2, July 2014.

Examples of how a freight pipeline system could fit with the planned and existing transport infrastructure projects for Transport for the North are given below. The examples are suggestions only, there are many other applications where the freight pipeline concept would be part of, if not all of, the solution.

Example A – new road and rail investments.

The specification for HS2 includes a 'sterile strips' of land on both sides of the 'fence to fence' area. Likewise the construction of trunk roads incorporates 'sterile strips' beside the road. These strips are ideal for incorporating an underground freight pipeline. Including the construction of pipelines, within the plan for new road or rail infrastructure, offers a low cost of construction and improves the cost effectiveness of the total infrastructure investment.

The Mole system is driverless and therefore not constrained by drivers' hour's regulations nor, external conditions such as road works, accidents or weather conditions. This enables resilient 24 hour, seven days per week operation that offers capacities in excess of 5000 truck movements per day per pipeline. By transferring thousands of freight movements from the roads provides a significant increase in road capacity, reduces pollution, reduces damage to the roads and, most importantly, saves lives.

Incorporating freight pipelines into new wide bore tunnels for road or rail is also cost effective as they can be laid under the road bed or in smaller bores alongside the main tunnels.

Example B – regeneration of Manchester Piccadilly Station

As mentioned in the above section on projects completed in 2015 by MSL, we completed a short 'Pre-Feasibility Study' for TfGM on the application of the freight pipeline concept in the regeneration

of the Manchester Piccadilly Station area. The same concept can be applied for most, if not all, of the Northern Cities. 'Connecting Northern Cities' we suggest is about connecting city centre to city centre and not between city boundaries. Over 80% of congestion occurs within urban areas (Eddington Study 2006) and therefore it is important to reduce urban congestion as part of the total connectivity offering of transport infrastructure.

The objective of the concept is to transfer freight from road to capsules operating in pipelines of 2.4m internal diameter laid beside or under existing or new transport infrastructure. The following extracts from our report to TfGM describe: the key elements of the concept; the use of the concept and the nature of the benefits and outline costs.

1 Key elements of the generic concept are:

- A Consolidation Centre, at an edge of the city location, to which goods for all businesses, of all types, in the city are delivered. As the Consolidation Centre is out of town, the large goods vehicles no longer need to make the journey to the centre of town. Not only does this reduce congestion, it also means that the vehicle can be more productive as a result of not having to travel the last few kilometres at a relatively slow speed
- The pipeline through which the goods are transported to the city centre in capsules designed to suit the various types of goods to be transported. The pipeline, due to it being buried underground, does not cause congestion or impact adversely on the environment in terms of emissions and noise pollution
- 'Molehills' which are located at centres of high demand within the city centre: shopping centres, hospitals and other Public Sector buildings for example. The 'Molehill' also operates as a collection point and a base for low impact 'last mile' delivery modes including couriers, electric vans and tricycles. The existence of the 'Molehills' enable goods to be delivered in a Just-in-Time (JIT) manner as the distances required to make the deliveries are short and the roads are less congested. Being able to deliver in a consistent manner several times a day, should it be required, enables businesses of all types to convert their city centre storage space to more productive activities such as selling or service activities

2 The concept could be used in a) the regeneration of the Manchester Piccadilly area with the arrival of HS2 and b) post regeneration as a cost effective, safe and low environmental impact supply chain system for the area.

Preliminary consideration has been given to a number of pipeline routes into the centre of the city. While a Feasibility Study will consider those routes in detail, this Pre-Feasibility Study has identified Port Salford, some 10kms from Piccadilly Station as a potential Consolidation Centre location. The top-level primary investigation established that the Manchester Ship Canal and the Bridgewater Canal can jointly provide a wayleave to within 100m of Piccadilly Station.

The arrival of HS2 in Manchester is being seen as a catalyst for the regeneration of the Piccadilly area and provides Manchester with a unique opportunity to lead the world in low environmental impact, safe and cost effective regeneration of a major inner-city area. A freight pipeline designed to transport 'spoil' out of the city centre could be constructed from Port Salford under the canals to a point close to Piccadilly. Spoil from the pipeline construction would be transported back along the advancing pipeline to Port Salford and therefore, minimal disruption during the construction of the

system. Once operational the pipeline could transport almost all of the 'spoil' out of the area and deliver into the site, a large volume of the building products. On completion of the site, the freight pipeline capsules would be replaced with capsules designed for general distribution products and provide for the area a low cost, safe and low environmental impact supply chain system for many years to come.

3 The nature of the potential generation and post regeneration benefits together with an indication of the size of the benefits and an initial estimate of the capital costs.

The concept provides a significant, increase in the capacity of the transport infrastructure of Manchester. It offers a freight only system with inherent safety and resilience features. Potential benefits from adoption of the concept include:

- Less congestion in the city centre creating more predictable journey times for both private and public transport
- Lower supply chain costs as a result of the improved utilisation of long haul vehicles and the use of an automated, energy efficient freight transport system for the stem mileage into the city centre
- A safer distribution operation by the removal of a significant percentage of the heavy goods vehicles from the city centre
- An improved quality of life for people living and working in the city due to removal of much of the HGV traffic, lower emissions, improved air quality and less noise pollution
- Significant reduction in the road maintenance costs.

The benefits of Consolidation Centres for both retail products and for supplying building products to construction sites are well documented, see:

- http://ukerc.rl.ac.uk/pdf/RR3_Urban_Freight_Consolidation_Centre_Report.pdf
- <https://tfl.gov.uk/cdn/static/cms/documents/building-on-the-benefits-of-consolidation-centres.pdf>
- <http://www.ttr-ltd.com/downloads/pdf/DfTFreightConsolidationCentreStudy-04112010.pdf>

'Last mile logistics' (LaMiLo) are receiving a great deal of attention, particularly within Europe where fleets of electric powered, low impact delivery vehicles are being trialled. (See www.lamiloproject.eu). The Mole freight pipeline concept provides a safe, environmentally acceptable, sustainable and cost effective link between these two facilities to provide the ultimate urban distribution system.

An initial top-level calculation for Manchester city centre, relating only to the cost of congestion in the legacy use of the system produced the following results:

- Congestion costs per head of the population: £500 pa (Transport Systems Catapult)
- Population in the centre of Manchester: 505,000
- Congestion cost for the centre of Manchester: £252.5m pa
- Large goods vehicles assuming 20% of total congestion cost = £50m pa
- Percentage uptake of freight pipeline by current large goods vehicle users: 50%
- Congestion cost saving: £25m pa

It should be noted that the uptake of the concept to a level of 50% may take some time to achieve. Any calculations in the Feasibility Study should utilise a range of uptake percentages over a period of years in the total life of the pipeline. In addition to the benefits associated with a reduction in congestion, there are other socio-economic benefits including reduced levels of accidents involving large goods vehicles, improved air quality and lower vibration damage to historic buildings. During the regeneration phase, the use of the Mole concept will provide major social and environmental benefits as well as providing major operational savings from the use of a Building Products Consolidation Centre.

It has been estimated that a twin 10km pipeline from the outskirts of Manchester, for example Port Salford, into the city centre would cost £54m in terms of capital expenditure. A sum that could be depreciated over the 25 year life of the pipeline.

Example C – regeneration of other Northern Cities.

The same principles can be applied to not only the major Northern Cities of Liverpool, Leeds, Sheffield, Newcastle and Hull but also, as the Northampton Project showed, smaller cities such as York and Bradford.

Understanding the potential benefits and costs of the concept in an urban environment can produce freight transport solutions designed for the 21st century. For example, the Northampton study has concluded that the development of a freight pipeline from edge of town consolidation centres into the centre of the town is economically viable using the wayleave of a disused railway. This route offers benefits for a number of ‘users’:

1. Goods destined for the centre of town are delivered to consolidation centres, transferred to capsules that travel **under** the disused railway line to centre of town ‘Molehills’ located at centres of high demand. These Molehills also act as ‘Click and Collect’ points and as a base for low impact last mile delivery means: courier, tricycle, quad cycle, electric van, etc
2. The pipeline is also planned to transport the finished goods from the brewery in the centre of Northampton to their National Distribution Centre, located on the same Logistics Park as the Consolidation Centre, and to deliver from this store, packaging materials into the brewery. This transport link will remove more than three hundred 44t HGVs journeys per week from the streets of Northampton
3. **Above** the freight pipeline is planned a ‘Smart Corridor’ for walkers and cyclists as traffic free routes into the town
4. **In the pipeline space** are smaller pipes carrying district heating and electric power from two gasification plants located alongside the pipeline route. The Mole system may well be used to deliver biomass to these plants and will be powered by the electricity generated by them.

Possible route of freight pipeline from Port Salford, under the Manchester Ship Canal and the Bridgewater Canal to Piccadilly Station.



Summary and Conclusions

This paper submits evidence to the NIC that the MSL freight pipeline concept can bring innovation and benefits to future UK and global transport systems in general and that the connectivity of Northern Cities in particular.

DEFRA, Innovate UK, Future Railway and the Nuclear Decommissioning Agency have already invested in R and D projects that have proved both the concept and demonstrated the technology. Studies have taken place in Northampton that show the business case for its use can be sound. Examples are given as to how the concept could be used in a number of current scenarios within future Transport for the North schemes.

The next step is to embrace the concept as a significant input to future transport planning and integrate it as a complementary feature with existing transportation infrastructure.