

# GPS Marine Tugs and Barges - River Transport for the Thames and Medway Estuaries

Case Studies of Three Major London Infrastructure Projects

January 2020



## Index

Executive Summary	3
1. Introduction	4
2. Elizabeth Line (Crossrail 1)	5
3. Northern Line Extension	8
4. Thames Tideway	11
5. Summary	15
6. References	18
Appendix A	19
Appendix B	20
Appendix C	21
Appendix D. Calculation of Carbon Saving	22
Appendix E. Reported Road Casualties Greater London	24

# Executive Summary

GPS Marine Contractors Limited (GPS Marine) have been at the forefront of maritime logistics for over 30 years. Whilst operating throughout Europe the use of river transport within the Thames and Medway estuaries has offered proven significant environmental, safety and financial benefits to Clients and Stakeholders.

In heavily urbanised environments where access to a river is available, the use of tugs and barges to deliver construction materials and remove wastes not only brings the gains outlines above but helps to close the Infrastructure sector's productivity gap by enhancing the ability for schemes to deliver their projects on time and to budget.

This report presents an overview of the benefits listed above through three case studies where GPS Marine were, or still are, integral to the scheme's successful delivery. They are:

1. Elizabeth line (London Crossrail) - Contract C305 Eastern Running Tunnels
2. Northern Line Extension - Kennington to Battersea
3. Thames Tideway Tunnel - Central Section

The scheme's listed above have required GPS Marine to manage the safe movement of millions of tonnes of excavated material and the delivery of hundreds of thousands of tonnes of construction materials. This approach has helped to reduce the amount of emissions from the more traditional approach of using heavy good vehicles. In fact, water transport is recognised as one of the most sustainable modes and The Mayor's London Plan goal is ensure London's waterways contribute to a sustainable future.

<https://www.london.gov.uk/what-we-do/planning/london-plan/current-london-plan/london-plan-chapter-seven-londons-living-space-5>

## Summary of key benefits:

1. A carbon reduction of 7179 tonnes compared to conventional lorry movements.
2. 3915 accident free barge movements.
3. Removal of approximately 358,000 lorry movements from UK roads.
4. Approximately 7,500,000 miles on public roads mitigated.
5. Helping infrastructure to deliver projects on time and to budget in a safer and environmentally beneficial way.
6. Reduced road wear and traffic congestion
7. Improved kerbside air quality due to reduction in vehicle journeys

GPS Marine are also innovators, with initiatives such as:

- Trialling Selective Catalytic Reduction (SCR) reducing Nitrogen Dioxide emissions by >90%
- Implementation and continuous improvement of a Safety Management System
- Development of a more efficient fleet, reducing engine emissions
- The largest tug and barge fleet on the Thames and Medway estuaries
- Continuous training with highly experienced and knowledgeable staff resource

The environmental benefits and GPS Marine's drive for excellence has already been recognised by several industry awards including;

- Freight Transport Association Sea Freight Operator of the Year 2018

Plus, two awards which are related to the work completed on the Thames Tideway project.

- The Edie: Mission Possible - Mobility award 2019
- The British Construction Industry Award, for the 'More by River' initiative

# 1. Introduction

GPS Marine Contractors Limited (GPS Marine) are proven leaders in their field of marine transportation, this report presents some of GPS's skills and capabilities along with the innovations they have implemented in order to improve the logistics associated with construction.

GPS Marine have been at the forefront of maritime logistics for over 30 years. Whilst operating throughout Europe the use of river transport within the Thames and Medway estuaries has offered proven significant environmental, safety and financial benefits to Clients and Stakeholders.

The report presents three case studies in the South East of England where significant positive impact on large infrastructure schemes has been created. In addition, information within the Appendices cover:

- The Port of London air quality strategy (see Appendix A)
- European regulation on emissions from internal combustion engines (see Appendix B)
- Changes to London's Non-Road Mobile Machinery Low Emission Zone (NNRM LEZ) (see Appendix C)
- Carbon Savings (See Appendix D).
- Potential reduction in road casualties due to the savings in millions of miles by the removal of hundreds of thousands of road movements by HGVs (See Appendix E) for the accident statistics in one year on London's roads

<https://tfl.gov.uk/corporate/publications-and-reports/road-safety>

It is worthy of note that HGV tipper lorries are rated to carry 20 tonnes, fully loaded. However, they are often underloaded due to the nature of the material carried and they cannot transport wet material. Excavated tunnel material is often wet. An assumption of 18 tonnes per loaded lorry journey therefore has been made in this report after discussions with major London hauliers.

Further details of the benefits GPS Marine have brought to major infrastructure and the environment are presented within this report.

## 2. Elizabeth Line (Crossrail 1)

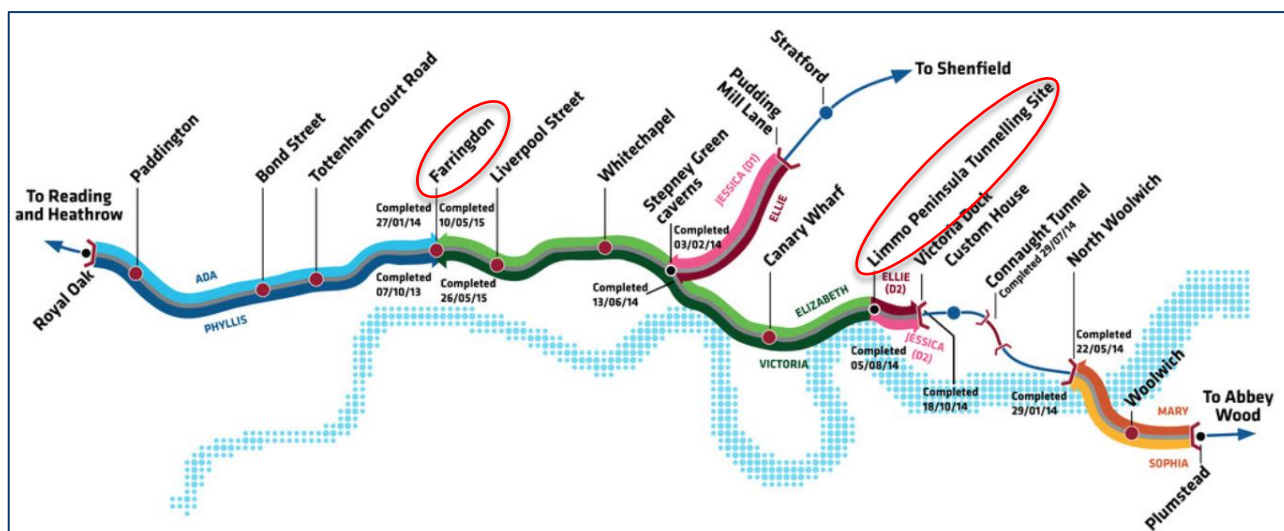
Crossrail Contract C305 was the largest tunnelling contract awarded on the scheme. Commencing at Limmo Peninsula and terminating at Farringdon the tunnel is approximately 8.3 km in length. Whilst originally designated for Wallasea Island, due to the physical properties of the excavated waste, generated through the tunnelling process, an alternative disposal solution had to be found. This resulted in approximately one million tonnes transported via hopper barge to a beneficial use site (Goshem's Farm) at East Tilbury.

### Key benefits:

1. A carbon reduction of 1147 tonnes compared to conventional lorry movements
2. 1,093 accident free return barge movements.
3. Removal of 111,110 lorry movements (the return trip is an empty lorry from the tip at Rainham, each return trip is 20 miles) related to waste removal.
4. Removal of 27,000 lorry movements (return trip is an empty lorry from site to segment factory at Chatham Docks, each return trip is 66 miles) for delivery of concrete tunnel segments\*.
5. Approximately 3,004,200 miles on public roads mitigated\*.
6. Reduced road wear and traffic congestion
7. Improved kerbside air quality due to reduction in vehicle journeys

\* Please note that no allowance has been made for the transportation of additional concrete tunnel lining segments required due to damage in transit by lorry or at site.

Figure 2-1: Elizabeth Line Contract C305  
(Limmo Peninsular to Farringdon)



GPS Marine were awarded the river transport contract for one million tonnes. The use of their hopper barges allowed them to overcome the complications associated with material handling (physical properties). Tugs pulling barges of varying capacities from 1,000 to 1,500 tonnes were used and a total of 833 barge movements were completed between Instone Wharf to the receiving facility at East Tilbury. Key to the management of the material and placement within the barges were the conveyor and tripper systems. Figure 2-2 overleaf shows the site arrangement at Instone Wharf (Limmo Peninsular).



**Figure 2-2: Conveyer and hopper barge at Instone Wharf (Limmo Peninsular)**



The benefits and efficiencies generated from the removal of materials were also captured for the import of concrete tunnel lining (segments). Manufactured in Chatham, these were transported to Limmo Peninsular, removing approximately 27,000 return lorry movements from the scheme. Figures 2-3 and 2-4 show the storage of tunnel segments at Chatham and loaded on a GPS barge respectively. There were 260 return barge movements from Chatham to site.

**Figure 2-3: Tunnel segments at Chatham Dockyard**



**Figure 2-4: GPS barge containing tunnel segments**





### 3. Northern Line Extension

The construction of the Kennington to Battersea Northern Line Extension (NLE) involved the excavation and transport of nearly 900,000 tonnes of waste soils. With little opportunity to re-use this material within the scheme decisions had to be made on how the considerable volume could be transported from the site. The NLE chose to use the services of GPS Marine. Utilising the existing jetty at the Battersea construction site, material was stockpiled for inspection and testing before being loaded on to barges via a conveyor system. The filling of the barges was completed with the tidal cycle, allowing works to progress both day and night, helping to drive efficiencies and assurance on construction programme.

#### Key benefits:

1. A carbon reduction of 2,600 tonnes compared to conventional lorry movements. **Information provided by NLE Contractor**
2. 701 return accident free barge movements.
3. Removal of 90,000 lorry movements related to waste removal.
4. Approximately 2,347,856 miles on public roads mitigated.
5. Reduced road wear and traffic congestion
6. Improved kerbside air quality due to reduction in vehicle journeys

Figure 3-1: Northern Line Extension  
(Kennington to Battersea)



The environmental and societal benefits from using river transport are significant and range from:

- Reduction in kerbside air emissions from heavy good vehicles
- Reduction in noise from vehicle's reversing and when travelling
- Reduced road wear and traffic congestion
- Preserving the safety of other road users, cyclists and pedestrians

The contractor of the NLE calculated that the use of barges, rather than heavy goods vehicles, avoided a total of 1,596,542 left turns, which are considered the highest risk in terms of collisions or deaths.

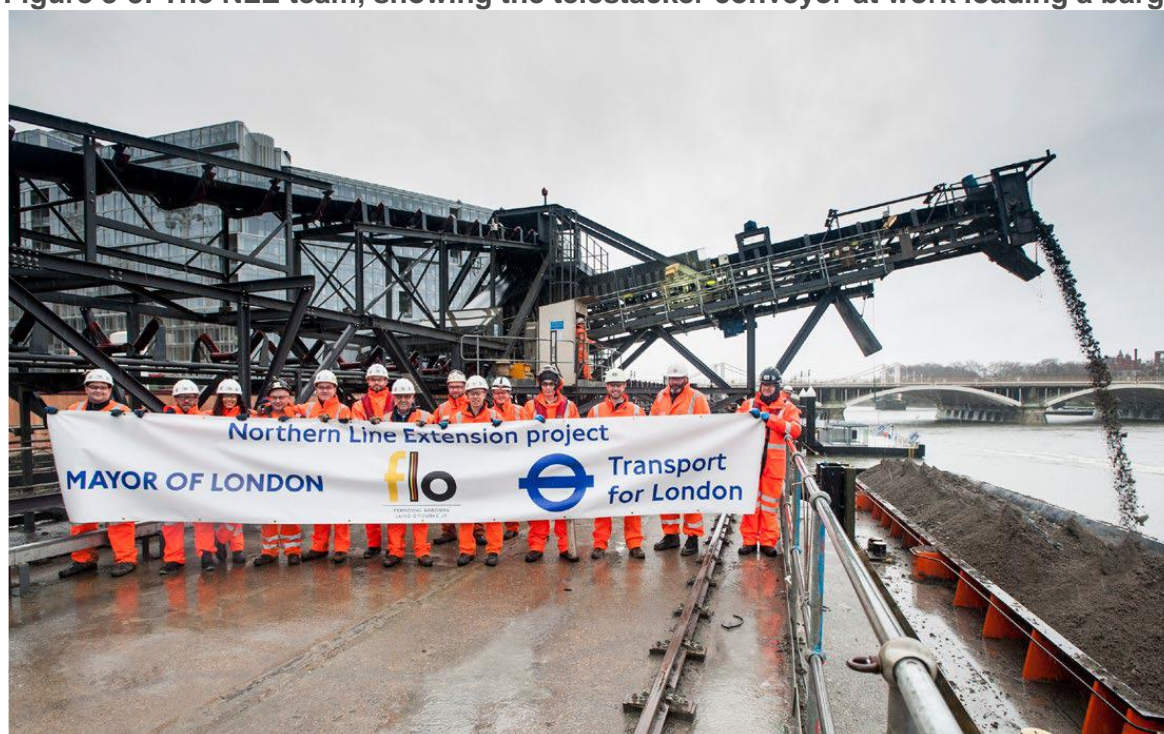


**Figure 3-2: GPS barge removing excavated spoil from the NLE scheme**



Through careful logistics management all barge movements were coordinated with tidal flows to reduce fuel use, reducing the need to push or pull the barges against the tide. Implementing this method of free energy reduced fuel used and emissions from the tugs.

**Figure 3-3: The NLE team, showing the telestacker conveyor at work loading a barge**



**Figure 3-4: The NLE team and GPS at the Green Apple Awards 2018**



The work completed by GPS along with the NLE contractor resulted in recognition through the Green Apple Environment Award in 2018 for their work on river transport.

<https://thegreenorganisation.info/2018-green-apple-environmental-awards-for-environmental-best-practice/>

## 4. Thames Tideway

The Thames Tideway Tunnel is the largest infrastructure project ever undertaken by the UK water industry. The Central Section Contract (valued at £746m) is being developed, designed and constructed by Ferrovial Agroman Laing O'Rourke JV. GPS Marine were chosen to supply river transport services for all seven sites within the central contract. GPS Marine's services includes both the delivery of construction plant and materials and the removal of tunnel spoil.

The sites all required different solutions, GPS adopted a flexible approach such as using small (300 tonne) to large (1,600 tonne) barges to different mooring requirements, such as mooring on newly installed cofferdams, jetty walls or temporary jack-up platforms.

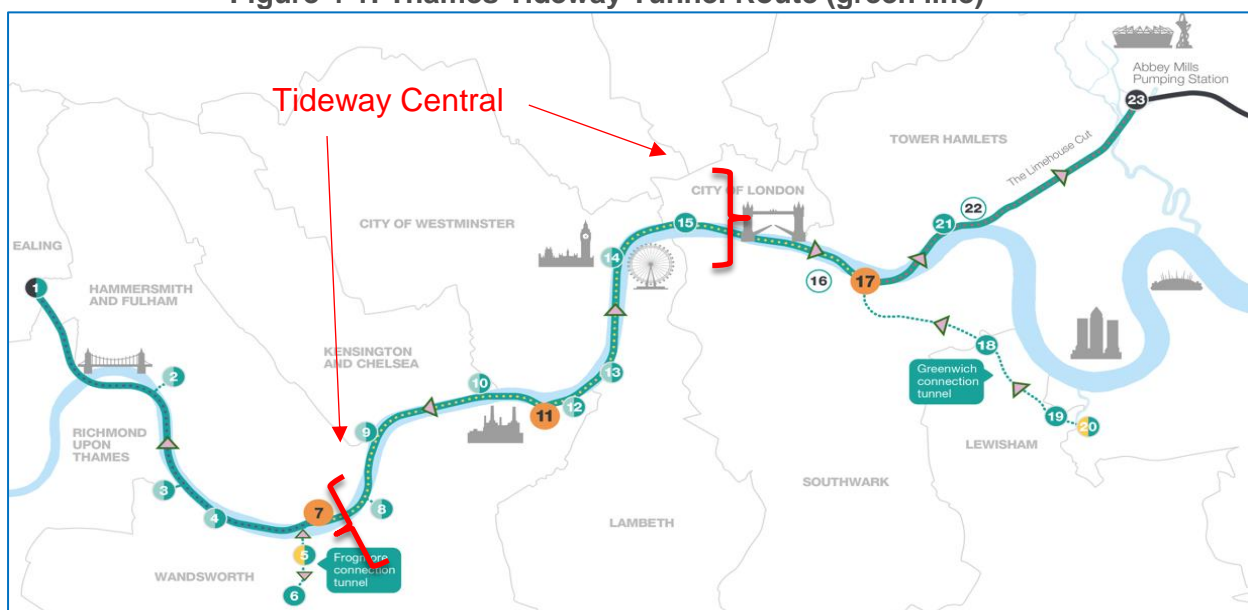
### Key benefits:

1. An approximate carbon reduction of 3344 tonnes compared to conventional lorry movements (to date).
2. 707 accident free return barge movements (to date).
3. Removal of over 1,000,000 tonnes of excavated material via tug and barge (to date).
4. Removal of 125,512 lorry movements prevented related to waste removal (to date) \*.
5. Approximately 3,000,000 miles on public roads mitigated (to date).
6. Delivery of 3600 tunnel lining rings, each weighing 43 tonnes, which has saved 14,400 lorry journeys \* \*.
7. Servicing of seven sites in London, delivering rebar cages, construction equipment, plant and steel piles.
8. Reduced road wear and traffic congestion
9. Improved kerbside air quality due to reduction in vehicle journeys

\* Assumed waste tip location is at Beaconsfield which is a 60-mile return trip

\* \* The segment factory is at Thamesport which is an 80-mile return trip

Figure 4-1: Thames Tideway Tunnel Route (green line)





Construction started in 2016 and tunnelling is due to be completed in 2022. In November 2019 the tunnelling reached a landmark 10km and with that GPS had transported 1,000,000 tonnes of excavated material.

Along with this achievement was a quote from Darren White, Head of Sustainability for Tideway, which states:

*“A total of 710 barges have removed the material from Kirtling Street to date, and each barge can hold up to 1,600 tonnes of spoil, with up to five barges attending site per day. Utilising the river to transport the spoil has removed the need for over 50,000 (return) lorry movements on the roads in the local area”.*

Further details from Tideway can be found via the following link:

<https://www.tideway.london/news/site-news/2019/october/1-million-tonnes-of-excavated-tunnel-material-removed-by-barge/>

**Figure 4-2: Delivery of steel reinforcement at Victoria Embankment**



As space is at a premium at the TTT riverside sites large components of the contract such as reinforcement cages, tunnel lining segments and heavy plant has been delivered by barge. This methodology allows the storage of materials on barges (and pontoons) at various anchorages which in turn prevents on site congestion and allows flexibility of programming.



**Figure 4-3: Telestacker conveyor and loading barge at Kirtling Street (Battersea)**



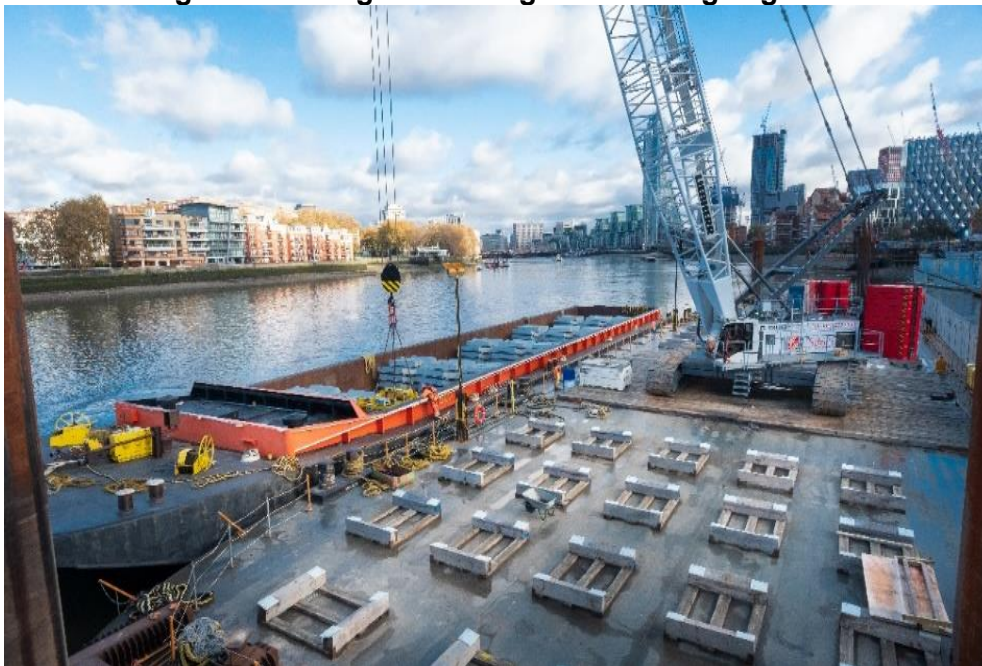
The loading of barges using conveyors plus telestackers enables the barges to be loaded at a far faster rate than lorries with speeds of 300-400 tonnes an hour being recorded on the listed contracts. This factor plus the ability of the barges to be loaded over a 24-hour period utilises less labour than that required to load lorries. Provided the riverbed at the loading jetty is well maintained (using dredging or the installation of a camp shed, if required) the barge loading process is straight forward.

The unloading process at riverside reuse facilities (such as Goshems Farm) can be carried out on a 24-hour daily basis (with an allowance for the tidal conditions).

**Figure 4-4: Removal of tunnel spoil from Kirtling Street (Battersea)**



**Figure 4-5: Barge delivering tunnel lining segment**



GPS Marine are proud to be the largest marine transport contractor employed on the Thames Tideway Tunnel Contract which has recently been awarded the edie “Mission Possible: Mobility award 2019”. Further details can be found via the following link: <https://www.edie.net/library/Meet-the-Sustainability-Leader--Tideway--Mobility/6921>

In addition, they have been awarded The British Construction Industry Award, for their ‘More by River’ initiative. Further details can be found via the following link: <https://bcia.newcivilengineer.com/bcia-winners-2019>

## 5. Summary

GPS Marine operate throughout the UK and Europe, having 30 years extensive experience in marine transport. For the UK they have supported and enhanced the ability for major infrastructure projects to meet or even exceed their ambitions to complete projects on time and to budget.

This report has presented three case studies demonstrating the benefits that utilising marine transport can bring.

### Benefits

Traditionally the removal of large volumes of excavated material from London's infrastructure projects has been carried out using lorries with a maximum 20 tonne capacity (which carry 18 tonnes on average). For some projects, such as tunneling schemes, there are challenges in maximising the capacity of these lorries due to the excavated material's physical properties, mainly being too wet.

By using GPS Marine, for both tunneling and more traditional projects, the learning experiences and benefits have been:

- Wet tunneled excavated material can be successfully transported by river using hopper barges. These barges are designed to transport slurries and do not require the 'Transportable Moisture Content' of the material to be measured
- Ability to reduce fuel consumption when transporting by using tidal flows, helping to reduce emissions
- The ability to secure significant environmental betterment by removing hundreds of thousands of vehicle movements from the UK road network
- Completely removing risk to road users (pedestrians, cyclists etc.) due to material transport being on the river

#### Figure 5-1: Key Benefits due to the use of tugs and barges instead of lorries

##### Key benefits:

1. A carbon reduction of 7179 tonnes compared to conventional lorry movements.
2. 3915 accident free barge movements.
3. Removal of approximately 158,000 lorry movements from UK roads.
4. Approximately 7,500,626 miles on public roads mitigated.
5. Helping infrastructure to deliver projects on time and to budget in a safer and environmentally beneficial way.
6. Reduced road wear and traffic congestion
7. Improved kerbside air quality due to reduction in vehicle journeys
8. Helped reduce accidents on the roads

The Key benefits listed above could be enhanced by taking in to account the following:

- A comparison of the actual volumes transported by lorries, which is typically less than their full capacity
- Inclusion of vehicle emissions during traffic jams, road works or highway congestion
- An estimate of the repair cost and subsequent delay that would have been caused by excess road repairs due to the significant mileage of the contractor's heavy good vehicles on the road network.
- A more detailed study into the risk to other road users compared to use of river transport

## Innovation

GPS Marine have not stood still, they continue to drive efficiency and innovation into everything they do. Current initiatives are:

- Implementation and continuous improvement of a Safety Management System (SMS) audited by the Maritime and Coastguard Agency which complies with the International Safety Management Code  
<http://www.imo.org/en/OurWork/HumanElement/SafetyManagement/Pages/ISMCode.aspx>
- Continuous improvement and development of a more efficient fleet, helping to reduce engine emissions below their current levels
- Their expansion to provide the largest tug and barge fleet on the Thames and Medway estuaries, giving them the ability to offer the benefits of river transport to the infrastructure market and therefore helping to close the productivity gap in the sector
- Continuous training and expansion of their staff with highly experienced and knowledgeable staff resource

Of note is the work GPS Marine are now undertaking with industry experts in order to further reduce emissions from their tugs. This involves trialing:

1. Selective Catalytic Reduction (SCR) which can further reduce Nitrogen Dioxide emissions by more than 90%. The SCR technology will be combined with both Active Diesel Particulate Filters (DPF) and Diesel Oxidation Catalysts (DOC) to reduce Carbon Monoxide (CO), Hydrocarbons (HC) and Particle Emissions. If successful, this will be implemented within the GPS business.
2. A Diesel Particulate Filter (DPF) to record the particulate emission reduction that can be achieved.
3. Selective Catalytic Reduction without using urea injection and DPF in order to understand the investment required to obtain the emission reductions that could be achieved in vessels where there is insufficient space to retrofit a urea injection system and DPF
4. The use of non-fossil fuels to monitor the emission reductions that can be achieved without additional emission reduction equipment being installed.

The above trials 1-4 will be analysed to provide the optimum cost/emission solution for each of the GPS Marine tug fleet.

The use of river transport is further enhanced as the emissions generated by the tugs are discharged on the river and away from direct contact with people. The effect of the tug emissions is therefore not affecting the kerbside air quality as recorded by lorries.



## Awards

The environmental benefits of the use of tugs and barges has been recognised by several industry awards, two of which are related to GPS Marine's work on the Thames Tideway project. These awards were:

- The Edie "Mission Possible: Mobility award 2019"  
(<https://www.edie.net/library/Meet-the-Sustainability-Leader--Tideway--Mobility/6921>)
- The British Construction Industry Award, for the 'More by River' initiative.  
(<https://bcia.newcivilengineer.com/bcia-winners-2019>)

On receiving these awards Darren White, Head of Sustainability for Tideway, said:

*"Compared to modern standard Euro VI HGVs, carrying the equivalent cargo, a 75 per cent engine load a 1,000-tonne barge will produce:*

- *90 per cent less CO<sub>2</sub> (carbon dioxide)*
- *95 per cent less CO (carbon monoxide)*
- *86 per cent less NO (nitric oxide)*
- *54 per cent less NO<sub>x</sub> (nitrogen oxides)"*

The air quality benefits of using tugs and barges (instead of lorries) increases when larger barges are used (GPS Marine use up to 1600 tonne barges on the TTT contract). The emission reductions occasioned by the use river transport are at present being achieved without the advantage of SCR, DPF or non-fossil fuels. Once these innovations are incorporated into the GPS Marine fleet the tug emissions will be truly negligible compared with Euro VI HGVs.

Further details on the comments made by Thames Tideway can be found via the following link:

(<https://www.tideway.london/news/site-news/2019/november/using-river-much-better-for-air-quality-study-finds/#sub-nav>).

## 6. References

Page 3. Freight Transport Association Sea Freight Operator of the Year 2018

<https://gpsmarine.co.uk/gps-marine-fta-sea-freight-operator-of-the-year-2018/>

Page 3. The Mayor's London Plan

<https://www.london.gov.uk/what-we-do/planning/london-plan/current-london-plan/london-plan-chapter-seven-londons-living-space-5>

Page 4. TfL Road Safety Report

<https://tfl.gov.uk/corporate/publications-and-reports/road-safety>

Page 10. The Green Apple Environment Award in 2018

<https://thegreenorganisation.info/2018-green-apple-environmental-awards-for-environmental-best-practice/>

Page 12. 1,000,000 tons of material removed from the Thames Tideway Contract by river

<https://www.tideway.london/news/site-news/2019/october/1-million-tonnes-of-excavated-tunnel-material-removed-by-barge/>

Page 14. The edie ‘Mission Possible: Mobility award 2019’

<https://www.edie.net/library/Meet-the-Sustainability-Leader--Tideway--Mobility/6921>

Page 14. The British Construction Industry Award, for the ‘More by River’ initiative.

<https://bcia.newcivilengineer.com/bcia-winners-2019>

Page 16. The International Safety Management Code

<http://www.imo.org/en/OurWork/HumanElement/SafetyManagement/Pages/ISMCode.aspx>

Page 18. Appendix A: The Port of London Air Quality Strategy for 2018

<https://www.pla.co.uk/assets/airquality2018.pdf>

Page 19. Appendix B: IMS Silencers

<http://www.silencers.co.uk/exhaust-silencers/ims-unveil-scr-system/>

Page 19 Appendix B: REGULATION (EU) 2016/1628 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 14 September 2016 on requirements relating to gaseous and particulate pollutant emission limits and type-approval

<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R1628&from=EN>

Page 21. Appendix C: Non Road Mobile Machinery (NRMM) Low Emission Zone Exemption Policy

<https://nrmm.london/sites/default/files/upload-docs/NRMM%20LEZ%20exemption%20and%20retrofit%20policy.pdf>

# Appendix A

## The Port of London Air Quality Strategy

<https://www.pla.co.uk/assets/airquality2018.pdf>

*The Thames in London is the UK's busiest inland waterway for freight and passengers.*

*In order to address public concern in relation to air quality on the tidal Thames, the Port of London Authority (PLA) has developed its first Air Quality Strategy. The Strategy aims to reduce river-based air pollution on the tidal Thames between Teddington and Southend, whilst facilitating future growth of waterborne freight and passenger transport in line with the aims of Thames Vision.*

*It is estimated that emissions from vessels on the River Thames contribute around 1% of the total emissions in London, NO<sub>x</sub> and PM being of most concern.*

One of the most cost-effective means of reducing NO<sub>x</sub> (NO<sub>2</sub>) is to retrofit vessels with Selective Catalytic Reduction (SCR) Technology which can reduce NO<sub>x</sub> in excess of 90%.

The SCR Technology when coupled with Diesel Oxidation Catalysts (DOCs) and Diesel Particulate Filters (DPFs) can reduce CO, HC and Particulate by similar levels helping to also reduce carbon emissions.

The PLA will work with Thames operators to promote the benefits of re-powering vessels with more modern, cleaner engines or retrofitting existing engines with Abatement Technologies such as SCRT to reduce NO<sub>x</sub>/PM emissions in line with EU Inland Waterways Stage V regulations and monitor the uptake.

# Appendix B

With thanks to IMS: <http://www.silencers.co.uk/exhaust-silencers/ims-unveil-scr-system/>

The “Stage V” European regulation 2016/1628 which was adopted by The European Parliament in September 2016 will tighten the emissions requirement for internal combustion engines installed in non-road mobile machinery (NRMM) such as Mobile Power Generation Equipment and Engines within Inland Waterway Vessels.

<https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R1628&from=EN>

All emissions including carbon monoxide (CO), hydrocarbons (HC), nitrogen oxides (NO<sub>x</sub>) particulate matter (PM) and particulate numbers (PN) will need to be dramatically reduced.

Emissions of nitrogen oxides (NO<sub>x</sub>) will need to be reduced by a factor of between 70-84 percent, while particulate matter (PM) and particulate numbers (PN) will need to be reduced by a factor of around 92.5 percent.

The EU Stage V emission standards for main and auxiliary engines on Inland Waterway Vessels below 300kW came into effect from 1<sup>st</sup> January 2019 whereas emissions limits for engines larger than 300kW will come into force from 1<sup>st</sup> January 2020 for category IWP, IWA and NRE engines.

The European regulation 2016/1628 not only applies to “new-build” inland waterway vessel engines but to vessels that are undergoing conversions.

## Relationship between Euro VI Truck legislation and Stage V EU Inland Waterways Legislation

	CO (g/kWh)	NO <sub>x</sub> (g/kWh)	PM (g/kWh)	Regulatory source	Year
Euro VI Truck	4	0.46	0.01	EU Diesel Road	201 3
Stage III	5	11.2 (HC inclusive)	0.5	EU Inland Waterways	200 9
Stage V	5 – 3.5	4.7 – 1.8	0.015	EU Inland Waterways	201 9
Tier II	4	7.7 – 14.4		IMO Annex VI	201 1
Tier III		2-3.4		IMO Annex VI	202 1



# Appendix C

## LONDON'S 'LOW EMISSION ZONE' FOR NON-ROAD MOBILE MACHINERY

<https://nrmm.london/sites/default/files/upload-docs/NRMM%20LEZ%20exemption%20and%20retrofit%20policy.pdf>

Air pollution is one of the most significant challenges facing London. We are in breach of European legal limits for Nitrogen Dioxide (NO<sub>2</sub>) and many areas exceed safe limits for Particulate Matter (PM) as set by the World Health Organisation. Bold new measures have been proposed by the Mayor to tackle emissions from road transport, particularly diesel vehicles, including an expansion of the Ultra-Low Emission Zone. However, this is only half the problem – current estimates of emissions from NRMM used on construction sites are shown to be responsible for 7% of NO<sub>x</sub> emissions, 14% for PM<sub>2.5</sub> and 8% of PM<sub>10</sub> emissions across the Capital and this is why the Mayor is determined to act.

### **Important changes to the NRMM LEZ in 2020 (engines 37kW-560kW) on sites in London:**

- 1<sup>st</sup> January 2020: All constant-speed engines, such as those typically found in generators, are required to be at Emissions Stage V throughout London.
- 1<sup>st</sup> September 2020: Engines (variable) operating in the CAZ/CW Zones, plus those within the GLA defined opportunity areas, are required to meet Emissions Stage IV as a minimum.
- 1<sup>st</sup> September 2020: Engines (variable) operating in Greater London, but outside the CAZ/CW Zones or the opportunity areas, are required to meet Emissions Stage IIIB as a minimum.

*It will not always be possible to procure equipment that is compliant with the NRMM standards for London. If the required machinery is not available, the next best option is to install approved abatement equipment (retrofitting).*

## Appendix D. Calculation of Carbon Saving

Contract	Euro VI Lorry Miles saved	Total Carbon emissions (Tonnes) Assumed 50% Laden and 50% unladen		Number of Tug journeys	Total tug emissions Tonnes	Difference in Carbon emissions between lorries and tugs
Elizabeth Line	1,200,211	2381		1093	1146.80	1234.2
NLE	2,347,856	3329.21 <i>'Information provided by NLE contractor'</i>		1402 <i>'Information provided by NLE contractor'</i>	729.21	2600
TTT to date	3,952,560	4254.56		1420	910.16	3344.4
Total	7,500,626	9964.77		3915	2786.18	7178.6

## Lorry Emissions Calculator

Emissions are typically calculated from UK Gov standard, see link:

<https://www.gov.uk/government/publications/greenhouse-gas-reporting-conversion-factors-2019>

The metric used is CO<sub>2</sub>e see link: <https://www.sustainablebusiness toolkit.com/difference-between-co2-and-co2e/>

Using HGV rigid body (>7.5 tonnes to 17 tonnes). The table is split into the amount of CO<sub>2</sub>e on an unladen and laden vehicle, as more effort is required when laden, which alters the amount of emissions. The relevant extracted numbers are provided in the table below.

		KG CO <sub>2</sub> e
0% laden	Miles	0.88947
100% laden	Miles	1.13982
0% laden	Km	0.55286
100% laden	Km	0.70825

Note: These numbers, taken from the Gov spreadsheet are for Euro VI vehicles.

An example set of calculations for reference is below.

### Unladen

- $1,000,000 * 0.88947 = 889,470 \text{ kg CO}_2\text{e} = 889.47 \text{ tonnes CO}_2\text{e}$

### Laden

- $1,000,000 * 1.13982 = 1,139,820 \text{ kg CO}_2\text{e} = 1139.82 \text{ tonnes CO}_2\text{e}$

## Tug emissions calculator

Tug emissions have been calculated using the following link:

- [https://www.volker-quaschning.de/software/index\\_e.php](https://www.volker-quaschning.de/software/index_e.php)

Utilising the tidal flow allows the tugs to work at 50% maximum engine power when they are unladen. When fully laden, pushing two full barges, they will work at between 70% and 90% maximum power. The tugs on the Thames Tideway Contract are 1200 Horsepower.

# Appendix E. Reported Road Casualties Greater London

## Transport for London

<https://www.tfl.gov.uk/roadsafety>

Table 1. Reported road casualties by severity: 12 months to 30 June 2019, Greater London

	2005-2009 average# A	Jul-17 to Jun-18 B	Jul-18 to Jun-19 (P)* C	Percentage change over 2005-2009 average (C-A)/A %
<b>ALL CASUALTIES</b>				
Killed	211	122	118	-44%
KSI*	6,403	3,906	4,064	-37%
Slightly injured*	25,416	27,568	25,909	2%
All casualties*	31,818	31,474	29,973	-6%

P: provisional estimates and subject to change

KSI: Killed or Seriously Injured

\* Figures for the number of serious and slight injuries from September of 2016 onwards are not directly comparable with previous years as a result of changes in the reporting of injury severity by the police

# Back estimated for the number of serious, slight and all casualties in the 2005-09 baseline.