MOTT MACDONALD

Transforming rail on Manhattan's East Side

An unprecedented achievement that has overcome a host of challenges, the East Side Access megaproject will provide a major expansion of commuter rail in New York

Project
East Side Access (ESA)

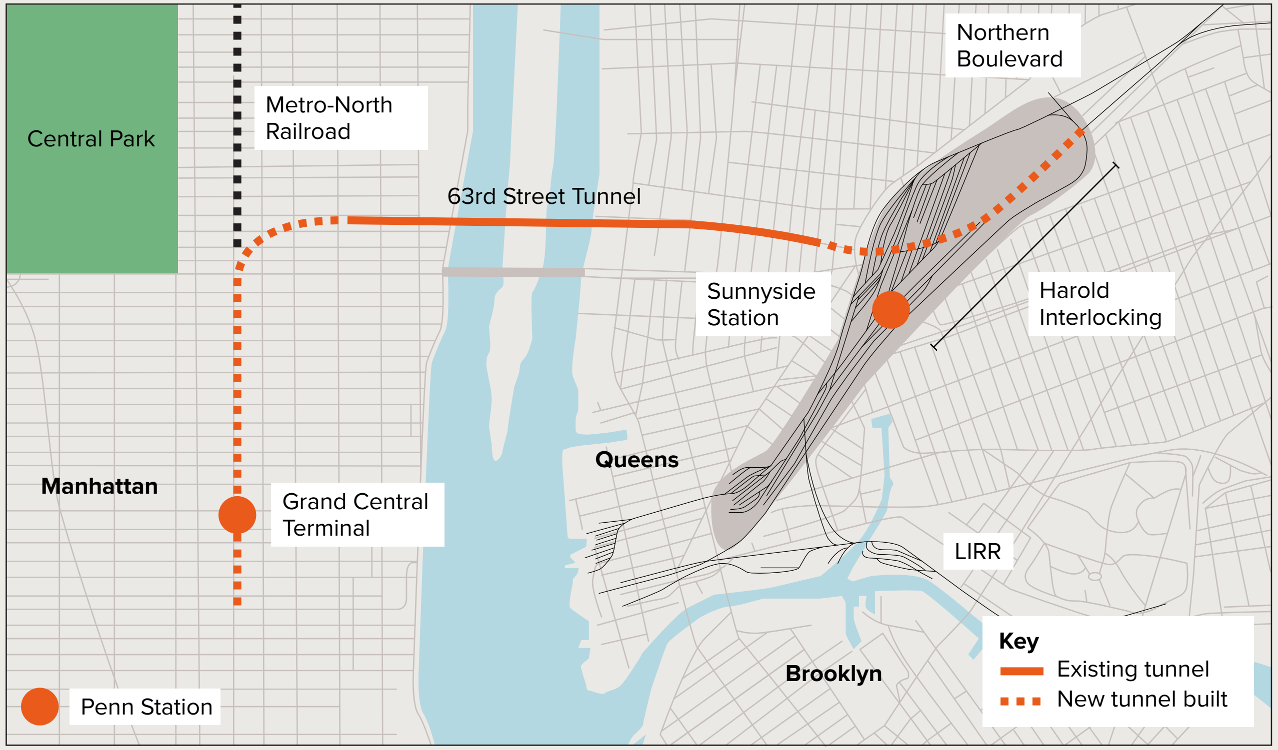
Location
New York, NY, USA

Client
Metropolitan Transportation Authority (MTA)

Project value
US$10.6bn (GBP£7.6bn)

Expertise
Programme management, construction management, procurement, tunnelling

Grand Central Terminal (GCT) in Midtown Manhattan needs no introduction. With its beaux-arts architecture and breathtaking interior, the world-famous landmark is a mainstay in film and television, making it one of the top tourist destinations in the city.



Along with being a retail and dining destination on the east side, GCT serves five different subway lines and Metro-North commuter rail from upstate New York and Connecticut. Prior to the pandemic GCT saw around 750,000 commuters and visitors every day.

This hub of activity and transport is one of only two commuter rail terminals serving all of New York – the other being Penn Station where three different rail providers bring commuters into the city. New Jersey Transit trains arrive from the west using it as a terminus; Long Island Rail Road (LIRR) trains arriving from Queens and Long Island in the east also terminate here and Amtrak's trains use it as a through station on its Boston to Washington, D.C., route.

With record levels of ridership Penn Station is regularly overcrowded, as are the six different subway lines that connect here to take commuters to their offices on the East Side of Manhattan. The solution is the East Side Access (ESA) programme, the first expansion of commuter rail in New York in more than 100 years. This megaproject will provide new commuter rail service from Long Island and Queens to the East Side of Manhattan in a new, eight-track terminal and concourse below GCT, providing relief to Penn Station. It encompasses work in multiple locations in Manhattan, Queens and the Bronx and includes around 15km of tunnelling.

The Metropolitan Transportation Authority (MTA) began planning the project as early as the 1950s, but more recently it has been the MTA Capital Construction agency – formed in 2003 to manage expansion megaprojects for the city's transit network – which has been responsible for making it a reality. Constructing the required infrastructure is a feat in itself, but working in the midst of one of the world's busiest cities presents additional challenges. Funding constraints and delays, and the involvement of third-party stakeholders, have added another layer of complexity to the project.

As part of the Programme Management Consultant (PMC) delivery team Mott MacDonald handled both the engineering challenges and these project constraints by relying heavily on open communication, innovation in the face of adversity, and working collaboratively. Developing this project-wide culture and building trust has been the key to delivering the ESA.

Background and vision

The East Side Access project has been years in the making, with the plans being refined and adapted.

East Side Access will route LIRR commuter services through new track connections in Queens; new tunnels under the Harold Interlocking (the country's busiest rail junction); and through the existing 63rd Street Tunnel under the East River into Manhattan, where new tunnels will curve south under Park Avenue and enter a new LIRR terminal beneath GCT, which comprises two enormous caverns.

In an earlier iteration of the ESA project dating back to the 1960s, the LIRR trains would have ended their journey in the existing lower level of GCT used by Metro-North. However, with major financial problems plaguing the city in the 1970s, the project stalled until the 1990s. In those intervening decades, patterns of commuter ridership changed significantly, and it became clear that the existing lower level terminal at GCT could not handle more passengers. The project therefore evolved towards building a bi-level terminal – essentially, two caverns – beneath the GCT's existing basement.

Other potential solutions were explored in the 1990s – including rail tunnels connecting GCT and Penn station – but were discarded. One constraint was that when the 63rd Street Tunnel was originally dug in the late 1960s using federal funding, it was stipulated that the lower set of tunnels (below the upper set that house the NYCT F train) were to be used for future LIRR service. If they were not used for this purpose then the money spent on constructing them needed to be returned – a requirement which meant alternatives to using the 63rd Street Tunnel were effectively ruled out.

> "This world-class project will be an economic game-changer for New York City and Long Island. There is no other transit infrastructure project in the United States that is as complex as East Side Access or carries as much economic promise for the region it will serve."
>
> **Thomas F. Prendergast**
> Former MTA Chairman and CEO

Scope and expectations

Working within one of the world's busiest cities presented a host of challenges for the project team.

Mott MacDonald's Colin Lawrence joined the project in 2000, as the Manhattan programme manager and chair of the project-wide contract packaging and scheduling working group, and Andy Thompson started on the project in 2006, initially as the package manager for one of the major tunnel construction contracts and later becoming a programme executive appointed by the MTA. In discussing the scope of the project and the various complexities in its planning and construction, both are certain there is really nothing in the world like the ESA.

The underground environment presented a host of obstacles and limitations, including high-rise buildings with deep basements, 100-year-old cut and cover subway lines built by rival private railroads, water tunnels and, in the instance of GCT, a maze of high-pressure steam tunnels.

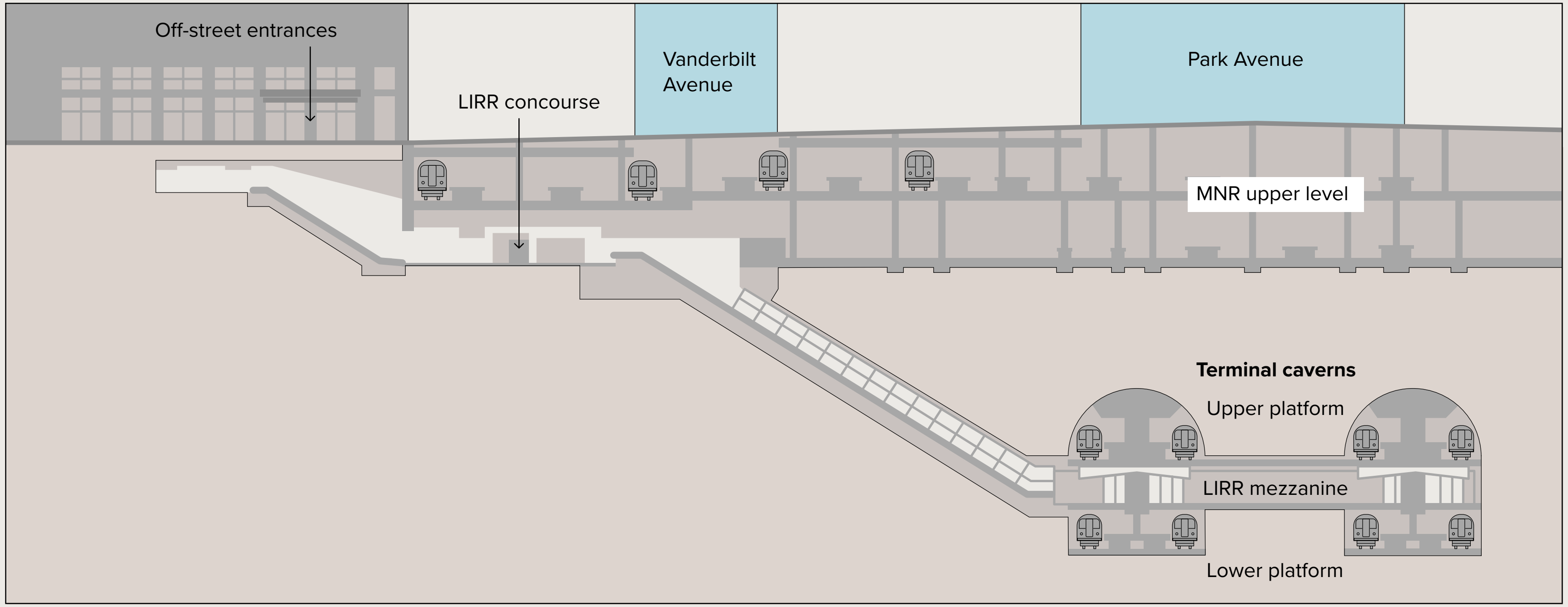
"The planning for this project occurred pre-digital and even before computers. Understanding in three dimensions the underground constraints is a nightmare in Manhattan," Lawrence says. "And East Side Access inherited these legacies. It's easy to be clever now when we've got digital twins where you can see underground in a virtual world. We weren't working with modern solutions."

The construction could not cause any disruption to the already overcrowded transit systems in the vicinity of the project's numerous worksites. No additional truck traffic could be added to Manhattan's streets. Initially, tunnel boring machines (TBMs) had not been considered for the excavation, just drill and blast. This is the backdrop for delivering the largest public works project in the country.

An evolving solution

The new caverns designed for the East Side Access project are worthy of the iconic status of the station.

The two underground caverns for LIRR passengers will be accessible by escalator from street level, while Metro-North trains continue to operate above.



The project's signature component is the new 47,000m² terminal at GCT. Its end-users are not limited to rail providers and their passengers: there is space for retail in the concourse and the project team has been dedicated to ensuring that the caverns become an attractive destination that will acquire iconic status, and blend into the existing historical GCT.

Inevitably for such a massive structure that has been planned over two decades and has so many third parties and potential users to accommodate, the project has continued to evolve over time.

As the team began to realise it was working with the practicality of blasting the entire project in a post-9/11 city, it pushed for the use of other additional excavation methods including TBMs and roadheaders, which would be a boon for the project schedule in years to come.

While the team determined the configuration of construction sequencing for the caverns in Manhattan, on the other end of the project it was doing much the same for the Harold Interlocking portion of the project, which saw between 15 and 20 revisions, of track realignment to accommodate working in, around and under operational track. "Given that all of that planning was going on in only a two-year time frame it's quite impressive that we got to the next stage," Lawrence recalls.

Funding and procurement

Funding for the East Side Access project came from the MTA and the Federal Transportation Authority (FTA).

In 2002 it was agreed that the federal government would contribute US$2.2bn and the MTA would match it for a project budget of US$4.4bn. However, funding issues were to cause uncertainty in the years that followed.

The MTA is a state agency and funded by the New York state legislature on the basis of five-year capital plans. For a project like the ESA with a long-ranging timeline, the budget needs to run across multiple capital plans. In 2008, as the financial crisis loomed, the MTA was in the midst of trying to secure the funding for its 2010-2014 capital plan.

It wasn't until 2011 that the plan finally secured approval. The approved budget, however, was less than requested, meaning the project team had to review the upcoming procurement schedule and identify the components that were needed to keep that critical path going.

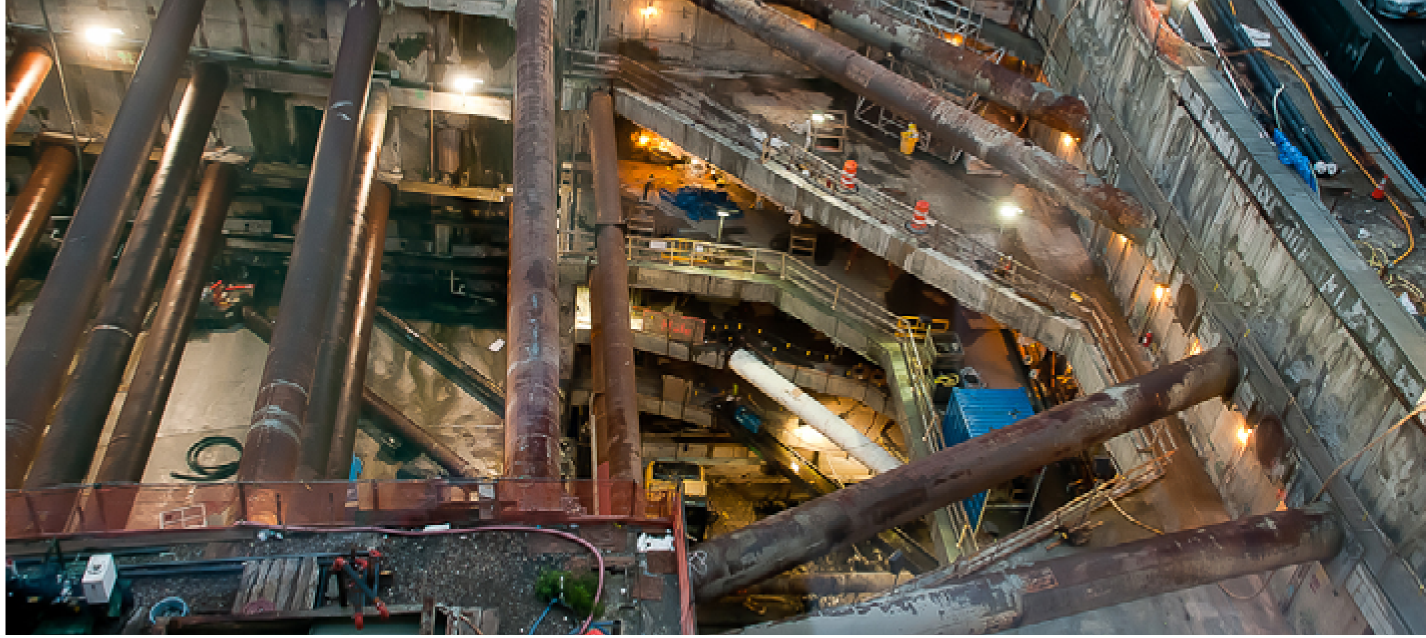
To extract non-critical works and repackage the contract to keep the critical path moving forward, the team decided to look five years out and work backward to help inform these difficult decisions. For example, without ensuring all necessary infrastructure was built to enable the SCADA backbone installation, nothing could be connected, so this was prioritised.

Dividing up the project

Originally the contract packaging envisaged a few large construction contracts.

The contract package to excavate the Manhattan caverns and associated shafts, for example, also contained clearing and demolition, building new access points and creating ventilation shafts, among other preparatory work. But when only one bid was received – which was above budget – the team decided to split this massive contract into seven, and procure each of them in the same time they had planned to procure the single contract.

The complexities of the situation continued to grow. Splitting out work created new predecessor contracts. “Immediately we had introduced seven interfaces that we didn’t have before, and all the difficulties and risk in managing those multiple interfaces,” explains Thompson.



Risk management

All underground construction contracts were procured as requests for proposals, and were able to be negotiated.

This was particularly helpful for the contracts covering soft ground tunnels in Queens, an extremely high-risk job. Through protracted negotiation sessions, risks were identified and risk-sharing mechanisms established within the contract.

"The biggest area of concern was on cutterhead interventions," Thompson recalls. They agreed the first 800 hours of interventions would be covered in the contract price, and any following hours would be based on set parameters.

Working together they established the rates during the negotiations, and the programme development team also established liquidated delay costs to further build trust between the contractor and the client. "That particular job did not have a geotechnical baseline report because they were using slurry TBMs," Thompson says. "Instead we baselined the contractor's schedule and required them to submit very detailed cycle times together with cutterhead usage, tool usage, cutterhead interventions, and so on, as part of their bid. This became contractual as part of the contractor's schedule."

The programme team reached an agreement with the contractor that if they could prove the ground caused delays based on this schedule there would be potential for a claim. And in the end there were none. "In fact, despite all the underground work we did, there was only one minor successful differing site condition claim across the US$2.2bn of underground work on the project," Thompson says.

"That's the attention to detail we had on all the jobs in terms of potential for risks, how we wrote contracts and that changing ground condition clause. We wanted to make it as easy as possible to assess, pay, and resolve."

"This approach worked because on our side of the fence we had people with a lot of experience and an understanding of how that risk could go wrong, and how it could be managed," he explains.

Above ground restrictions

Just beyond the 63rd Street Tunnel in Queens is the Harold Interlocking and Sunnyside railyard, a 2.5km-long rail junction that sees more than 800 trains per day.

The ESA effectively extends the 63rd Street Tunnel by about 1.6km by excavating new tunnels under the existing bilevel facilities. However, before the project could even begin to tackle these engineering challenges below ground, the junction required extensive upgrades.

The way the Interlocking previously operated, Amtrak trains had to cross over the LIRR tracks before entering the East River Tunnels, which are south of 63rd Street.

Should either rail provider have an issue with a train, both timetables would be impacted. As part of the ESA, the MTA built new cut and cover tunnels for the rail providers to bypass and reroute around each other. Other reconstruction work as part of the ESA installed 8km of new tracks, as well as building and updating support structures including access roads, power substations, ventilation facilities, and new systems for communications, signals and power.

As part of this agreement, the MTA also committed to doing all the upgrade work, the rerouting and the tunnelling with no adjustments to the operational timetables of the trains through the junction. From an engineering perspective this is no small task, and the challenge really bloomed when the programme delivery team fully understood the logistic and resource constraints they were facing.

Limited to requesting night-time and weekend outages, as part of the project delivery they established an entire team dedicated to planning and managing all of the railroad outages, including people solely focused on scheduling the work in the junction.

Both LIRR and Amtrak had finite resources available to support work not only on the ESA project but also on their other capital and maintenance projects. Planning for the use of resources was undertaken in the months ahead of planned outages; however, unplanned staff absences, due to crews focusing on snow clearing or service restoration after storm events for example, could cause a planned outage to be cancelled leading to knock-on schedule effects that could prove difficult to recover.

This complex work at the Harold Interlocking, and its extensive stakeholder management, has been a major driver of schedule issues on the project. Any time the project team couldn't take advantage of planned outages, substantial time was lost in the schedule.

While there were no alternatives or solutions for completing this work when third-party resources were limited, the project delivery team found ways to be agile and sought out opportunities to save schedule elsewhere.

800

trains per day going through Harold Interlocking and Sunnyside railyard

Connecting Queens underground

Tunnelling work has been performed by rock and slurry TBMs, sequential excavation method (SEM) through frozen ground, and a combination of blasting, roadheaders and even a TBM in the mammoth caverns.

To connect the mainline tracks in the Harold Interlocking to the existing 63rd Street Tunnel, two separate contracts were awarded to mine through Queens' boulder-ridden glacial till and manmade fill. Two 7m-diameter slurry TBMs excavated four running tunnels for a total of 3,000m, with precast segmental linings. These machine configurations were a first for the local mining workforce.

"Slurry TBMs potentially offered greater control of ground movement than an Earth Pressure Balance Machine (EPBM)," Thompson says. "This was particularly important for passing 10m beneath the 60-mile-per-hour tracks in the Interlocking."

To undertake this highly-complicated stretch of tunnelling, the programme delivery team relied on a collaborative approach with all stakeholders, as well as its innovative baseline method in place of a Geotechnical Baseline Report (GBR).

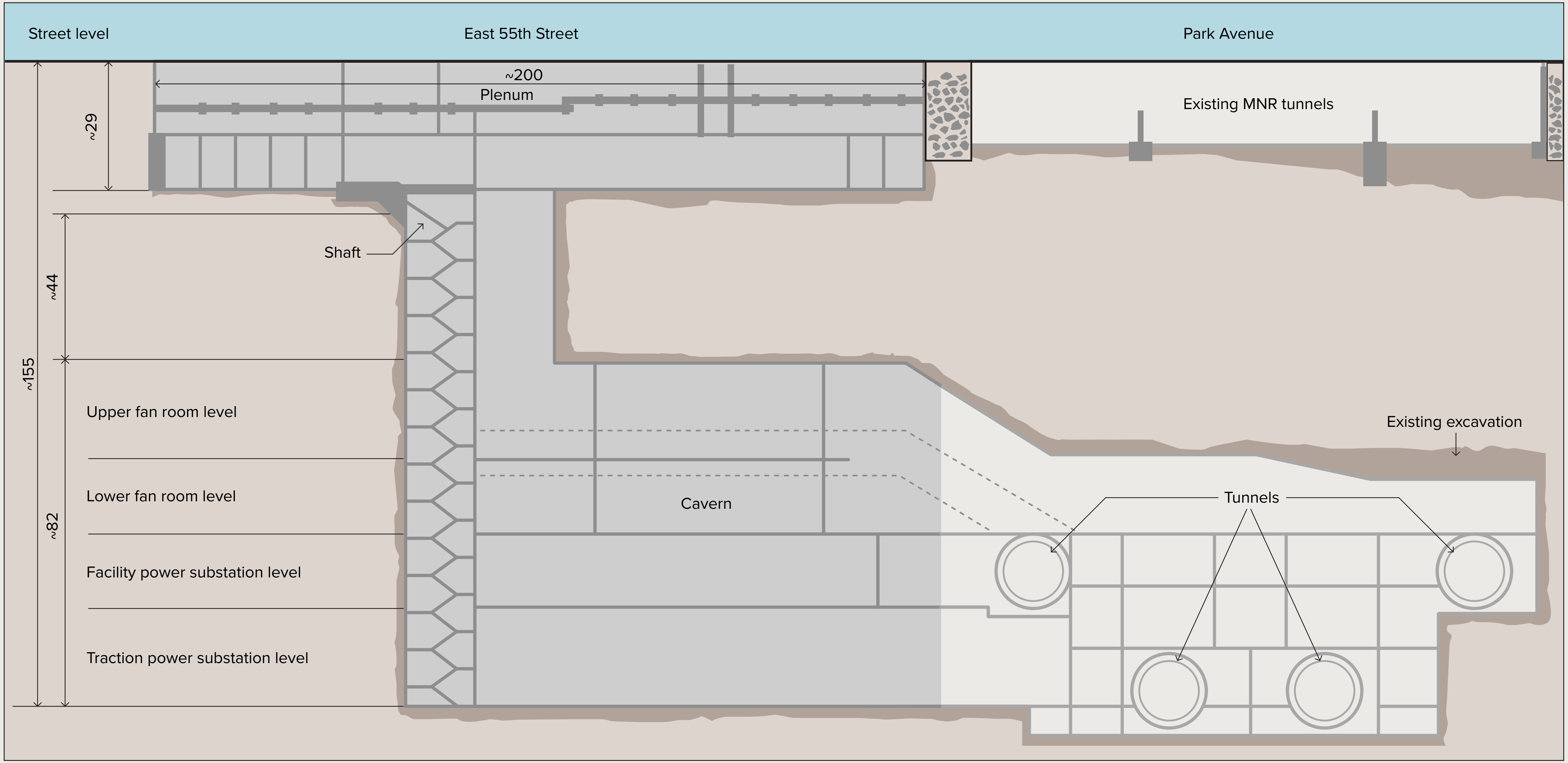
The soft ground tunnels contract was completed on budget and ahead of schedule. However, for these tunnels to connect into the existing 63rd Street Tunnel, the alignment needed to make one more critical crossing under a major highway, Northern Boulevard.

This section is only 37m long, but required a 20m-wide SEM excavation through soft ground with sprayed concrete lining – another first for New York. Above the crossing is a five-track cut-and-cover subway box, the highway and an elevated metro line. The bottom 5ft of the excavation was in solid rock. "The risk and complexity of this is difficult to quantify, but it is very real," Thompson says.

The elevated metro line was supported by the subway box and piles, and the SEM would have to mine through those piles to cross the highway. Collaborating with the contractor, the designer, specialist contractors and numerous third parties, they developed a solution for supporting the infrastructure above ground, using ground freezing to create a freeze arch around the excavation under the subway box. "We also drilled compensation grouting holes so if the freeze heaved the subway box upwards, we could inject hot water," Thompson explains. "At the same time when we later took the freeze off if we had any settlement we were prepared to do grouting to compensate to jack the subway box back up."

Next the contractor had to underpin the elevated subway in preparation for mining through the piles, which it successfully did and completed the SEM mining without any major settlement nor disruption to the transport above it. The crossing took three years and worked out to be almost one million dollars per foot to excavate.

The new Manhattan excavations (left) connected with the existing tunnels and infrastructure at Grand Central Terminal.



Tunnels take Manhattan

On the other side of the East River the geology is drastically different from the soft ground of Queens.

11.5km
of running track mined

13m
production rate, averaged per day

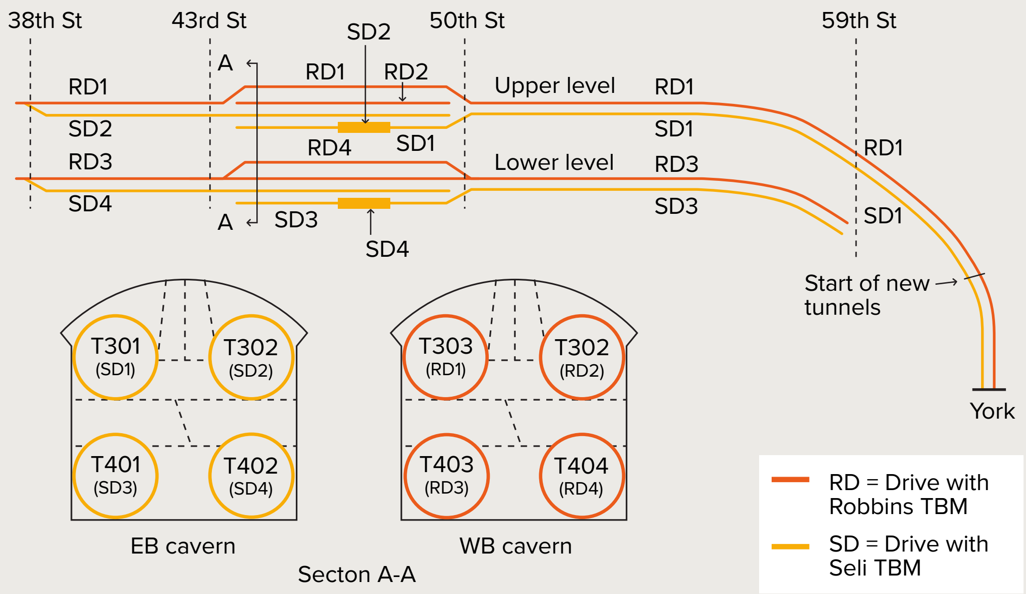
Excavating in the Manhattan Schist, which varies in strength from 68 to 275MPa, the contractor did eight separate TBM drives ranging in length from 2,400m to 500m, working out of a shaft in Queens at the east end of the existing 63rd Street Tunnel. Contractors built all of the underground works in Manhattan by bringing every building material through the tunnels and muck back out through conveyors.

From the 63rd Street Tunnel they have mined approximately 11.5km of running tunnel. The contractor launched the TBMs in a starter chamber made by enlarging part of the existing tunnels and mined toward GCT 5 Wye, a vertical separation point where the running tunnels split into the upper and lower level drives.

From this point four tunnels head south beneath Park Avenue and, shortly before entering the station caverns, there are crossover caverns at both the upper and lower levels. Once through the crossovers, the running tunnels bifurcated and four tunnels pass through the caverns on each level before the eight tunnels reunite to create four tunnels that run to 37th Street.

The contractor selected two hardrock TBMs with a combination of rockbolts, mesh and full-circle steel for the initial support. In reality, less than 5% of the tunnel needed the full-circle ribs, and they were used in areas where the pillar between tunnels was less than 2.5m to provide resistance to gripper loads. TBM operations were undertaken on a five-day, three by eight-hour shift basis and production rates averaged 13m per day.

"A major challenge was relaunching the TBMs as there was no shaft at the southern end, meaning that the TBMs had to reverse through the completed tunnels," Thompson says.



There were eight separate TBM drives using two hard rock TBMs.

The contractor removed segments from the cutterhead creating sufficient clearance to enable one of the TBMs to reverse. However for the other, a shielded TBM, they needed additional clearance. While they would be able to remove the steel ribs installed during mining this would require a staged re-support to be created using rockbolts drilled into rock with mesh and sprayed concrete lining (SCL) prior to dismantling the ribs. For this they used a custom-built gantry to ensure workers stayed under supported ground.

Phasing these TBM back-ups and providing connections between the tunnel drives had to be carefully planned because access ahead of the TBM would be blocked. "At times only one tunnel was available for mucking and material delivery to the active TBM and the relaunch operation," Thompson explains. "Because there were a number of locations where the future running tunnels bifurcated and caverns had been excavated we could create the space that we needed to do these relaunches."

Two methods were used to create the space for TBM relaunches in the wye caverns. The original design of the wyes provided enough space for them to be reused for relaunch with only a short starter tunnel being required to create gripper pads.

After they completed the first relaunch and the TBM had mined through the cavern, the contractor could then use a roadheader to excavate to the finished dimensions. The success of this inspired the contractor, designer and MTA to revise the excavation method for three more TBM relaunch locations and where they mined through the lower level crossover.

This method involved reversing the TBM to a location upstream of the relaunch location, installing a concrete plug in front of the TBM and then driving the TBM into and through the concrete plug. "This gradually engaged the cutterhead into rock along the new alignment with the plug acting as a temporary gripper surface," Thompson says.

Once this method was proven, they redesigned the permanent structures to take advantage of the reduced excavation profiles and some 15,000m^3 of excavation was eliminated at each wye and crossover location. Besides significantly reducing the amount of excavation required at the wye caverns, the use of the plug reduced the time needed for TBM relaunch from four months to six weeks. With these wyes and crossovers located below the main interlocking for GCT the alternative to blasting proved beneficial for numerous stakeholders and third parties.

Cavern sequencing

Another constraint, familiar to any tunnelling project in any city, is that contractors needed to excavate these caverns plus the approach tunnels, five escalator shafts, and construct a concourse, without a laydown area. Thompson describes it as "building a ship in a bottle, with the cork in it."

The MTA's Environmental Impact Statement declared there would be no additional truck traffic to Manhattan. Cavern construction overlapping with TBM tunnelling on the Manhattan side of the project prevented access for cavern contractors to the worksite in Queens. This created an immense problem for delivering supplies to the GCT's cavern worksite.

With the sheer amount of concrete needed on the project it was recognised that it would not be possible to bring concrete through the existing tunnel. The team managed to secure a revision to the EIS to accommodate concrete and explosives deliveries, but trucking muck through city streets remained restricted.

The solution required not only ingenuity on the part of the project delivery team, but also building trust with rail providers. For the concourse built at the lower level of GCT they had direct track access from a previous midday storage yard where they could maintain two tracks through the construction period. "We bought 25 train cars and two locomotives that were purchased for Metro North RailRoad," Thompsons explains. "We actually operated our own railroad."

The railroad connected to a staging area about 15km north of GCT in the Bronx North Yard. All supplies including site offices, reframing steel, glass, marble, and even portable toilets travelled in and out of the city on these railcars.

While innovative, this solution did bring further demand for precise and well-prepared scheduling. The programme delivery team hired a company to run the railroad, and set up a team to coordinate every load with every contractor, 10 days in advance, which is the only way they could guarantee availability on the six railcars it could run at one time. Initially the rail provider offered two train trips per day, which wasn't near the capacity that would be needed. Collaborating with Metro-North and adhering to a strict timetable, they were able to run these deliveries into and out of the city in between the commuter trains.

It was a massive logistical challenge that also required every car and load to be inspected before it was allowed on the system to ensure everything was properly secured and nothing would cause a disruption to the regular service. "That's a contract in and of itself on a lot of other projects, but it became just a normal, everyday thing that we did," Thompson says.

Even with concrete trucks allowed in the city, thanks to the EPA waiver, the team still faced the logistical challenges of the busy city streets surrounding GCT, and the lack of above ground access to underground works. The project delivery team investigated the surrounding streets for any locations where they knew the subsurface provided direct access to the project, and that the road width had ample space for them to take a lane with minimal traffic disruptions.

Working with the Department of Transportation the project delivery team would take possession of a parking lane, screen it off from the public, break out an access hatch in the sidewalk and create concrete drop pipes. These five facilities in the area allowed the trucks to deliver concrete, in some cases for up to three years.

However, this did require proactive third-party management – GCT's neighbours include well-known financial, commercial and other institutions – as well as stakeholder coordination. And at the same time, these drop pipes had to be shared by the project's various contractors. The team maintained ample resources to ensure this ran as smoothly as possible.

"One entire part of our schedule was concrete drop pipe availability," Thompson says, "we had to be efficient." The caverns are 370m long, 20m wide and 20m high, and will house eight platform tracks. In some locations, these have been constructed with as little as 13m of rock between the cavern arch and the operational tracks of Metro-North Rail above them.

Drill and blast excavation in Midtown Manhattan, beneath the city's historic and beloved rail station, with live rail operations, made many people nervous. The project team relied on extensive coordination with third parties, collaboration among stakeholders and a ground-breaking approach to instrumentation to maintain trust and keep the project moving forward. Working with Metro-North, as well as the New York City Fire Department, they established a schedule between trains of 20-minute windows to blast, up to five times a day.

Once the caverns started opening up the project could sink shaft 5, to meet the TBM drives thereby providing a new access to the underground for the workforce, and the project delivery team saw an opportunity to reduce the number of blasts they'd need to do by driving the TBMs through the caverns.

"The TBM bores gave massive relief to the blasting," Lawrence says. "From a peak particle velocity perspective it really helped reduce it."

He explains how this solution also stemmed from needing to correct a scheduling error based on faulty excavation methods. "The original concepts called for burn cuts on the caverns, with long round lengths, which wouldn't have worked, but the original schedule assumed they would," he says.

In the end the contractor performed 2,365 blasts without causing a single train cancellation, delay nor any damage to Metro-North's rail operations. Reusing the TBMs saved schedule. And the project continued to move forward into the next phases.

Collaborative environment

The team attributes their ability for finding alternatives to save schedule or overcome an obstacle imposed by a third-party to the environment they created on the project.

"Looking back at the things we did, so much of it was really challenging, and we just took it in our stride," Thompson says. "We had a very good team who rose to the challenge and we tried to encourage an atmosphere where people were prepared to bring solutions to the table no matter how off the wall."

No more so is this true than in the instance of the cavern walls. Going against the grain of conventional wisdom in both New York and London, the team introduced SCL using hand spraying techniques, over standard rebar against PVC membrane. "We found a way to do it because we had so many complex shapes in the wye caverns, which were constantly changing."

Finding an effective way to use SCL had an array of benefits for the project's schedule. Using SCL they could change the geometry of the wyes and use the TBMs to mine them, eliminating formwork, which would have needed to be up to three storeys tall.

Without the formwork there was more access space in the tunnel because the nozzlemen used scaffolding to spray the shotcrete. "We cut out 20,000 cubic yards of excavation, which is schedule, which is time, which is money," Thompson says. "This is nothing brand new, but it's the way we got everyone to work together to use it in the caverns for the fit out that's so significant."

They developed a hybrid design where all vertical elements were either cast in place or shotcreted while all the horizontal elements – what was needed to create the bi-levels – were precast. This required bringing 6,000 pieces of precast, driven through the tunnels from Queens to Manhattan, on the back of trucks and installed in the caverns. "We did all the concrete in both caverns in nine months," Thompson recalls. "And because we did precast for those pieces it was a much better finish."

Conclusions and outcomes

Mott MacDonald, as part of the programme management consultant team, oversaw 35 separate construction contracts.

This included pre-contract packaging and chairing the contract managing working group for developing 75 contract packages. These range from the US$1.2bn Manhattan tunnels construction package to a US$2M instrumentation installation contract in Queens.

Extensive and detailed planning over the past decade has enabled this complex and stealth tunnelling to take place. While open communication and a spirit of collaboration were both valuable for the project, the team nevertheless encountered constraints with third parties that could not be negotiated.

The solution in these instances was to rely on innovation, which could only be delivered by gaining the client and contractor's trust. "While risk management was applied to the job, there was nothing to draw from, in terms of what are all the risks that could impact the schedule or the budget," Lawrence concludes. "This project is an achievement. It's unprecedented in terms of the scale and complexity, as well as what it will provide for New York City."

From the extensive upgrade work in the Harold Interlocking that will ease conflicts between rail providers to discreetly blasting below active rail operations in Midtown Manhattan, the project delivery team made sure no commuter's daily journey to and from work experienced disruption related to the project.

"It's all about attitude and ability," Thompson says. "The team was capable of thinking three months ahead in the schedule, and they knew each contract better than the contractors because we needed to build a working relationship with our stakeholders. That's the only way we could succeed, by helping our contractors to succeed. And we developed that culture."

This culture extended beyond the client, contractors and third parties. The team improved the safety culture on the project, and created safety measures that MTA Capital Construction later adopted on its other projects.

With Thompson in a project executive role they also established stronger and more proactive resources for public outreach by increasing the full-time staff doing communications, holding more open days and creating a public website for progress photos and updates.

The revised budget for the East Side Access project is US$10.6bn with a current estimate at completion of US$11.1bn. Revenue service is forecasted for December 2022 and ridership is expected to serve as many as 160,000 commuter trips per day. Commuters from Long Island will have a one-seat ride to Grand Central and the upper east side of Manhattan.

When the East Side Access project is completed and providing relief to Penn Station, MTA can move forward with other projects to improve transit in the region, such as the Penn Station Access project, which would add four new rail stations in the East Bronx, significantly cutting travel times to and from Manhattan.

US$11.1bn

estimated cost at completion

> For about sixty years, two generations, the New York transit system was essentially functioning in a status quo, with little action on expansion to meet the needs of a growing region. Today, we are lengthening a subway line, building the first quarter of what will be a new north-south trunk line running the length of Manhattan, and realising a long-held dream of connecting the Long Island Rail Road to Grand Central Terminal. The conclusion of tunnel boring reminds us that New Yorkers remain capable of great achievements.

Joseph J. Lhota
Former MTA Chairman

Opening opportunities with connected thinking.