Nomination for the ITA Executive Council

Sanja Zlatanic, P.E.

Fellow, Chair – National Tunnel Practice
HNTB Corporation

Biography
Sanja Zlatanic, P.E., graduated from the School of Civil Engineering at the University of Belgrade, in former Yugoslavia, in 1988, at the top of her class. Her academic standing led to a job offer prior to graduation at one of the country's most prominent engineering firms, Energoprojekt, which went on to endure the tests of the country's political challenges and economic hardships during the 90's and still thrives today.

Sanja began her career at Energoprojekt working on international projects and continued in this domain following a move to the United States with her husband, in 1991, shortly before the start of the civil war in Yugoslavia. Within a few short years the bloody regional conflict led to the complete dismantling of the country and the creation of new states. With her parents trapped in the region until the end of the war, Zlatanic raised her two sons in New York, and pursued her carrier with great resolve. Her enthusiasm for engineering, especially complex underground structures, overlapped with her appreciation of being a part of the 'American dream', where personal growth is achieved through hard work, persistence, continuous self-improvement, as well as love, empathy and the care of others.

In New York, Sanja joined a well-known tunneling company where she exercised all the 'tools of the trade' in terms of tunnel design, construction and a sophisticated approach to risk-based decision making; she shared these experiences with many prominent national and international experts engaged on the largest tunnel projects in the United States, primarily for transportation.

Over the past 30 years, Sanja has been responsible for managing all phases of major multi-billion-dollar projects, including extensive multi-disciplinary joint venture staff, from feasibility and conceptual engineering through final design and construction. Her superb results in project management and multi-disciplinary coordination and integration of complex underground structures and tunnels has been witnessed and appreciated by clients and major transit agencies nationally and internationally. Her ability to bring forward state-of-the-art innovative solutions through collaboration with top industry experts had brought value to many mega-transit programs.

As an active member of various tunneling and underground societies, she is well recognized in the profession and has published numerous articles, chaired conference sessions and made numerous presentations on the design of construction of tunnels and underground facilities at national and international tunneling conferences. She received a Technical Excellence Award and had been recognized as a Fellow, for extraordinary carrier-long accomplishments, practicing technical excellence and championing innovative approaches to solving underground engineering issues, especially in relation to minimizing the impacts of tunneling beneath densely populated urban environments, communities and businesses. She is an elected Board Member and Secretary General of ACUUS (Associated Research Centers for Urban Underground Space), an international, non-

governmental organization dedicated to partnerships among experts who research, plan, design, construct and decide upon the best use of urban underground space.

Since 2016, Sanja has been Chair of HNTB's National Tunnel Practice and has led and mentored dozens of tunnel consultants bringing value to multi-billion-dollar tunnel projects, including the independent design verification of the Istanbul Strait Road Crossing Tunnel project, in Turkey, overseeing design and construction issues for the SR-99 Alaskan Way Tunnel project, in Seattle, WA, and developing a novel large-diameter single bore tunnel option for transit in the United States, among others. Her projects have won many industry awards.

Sanja firmly believes in the important role women perform in the tunnel industry; the teams who benefit from diverse participation, especially when solving challenges and exploring innovation, are generally more productive. A few decades ago, when Sanja first chose her career, there were just a handful of female professionals in this realm; today, many young women are interested in the field of tunneling and underground engineering and they generally find the industry supportive and rewarding. Having never met a woman who expressed a regret about being in tunneling industry, Sanja trusts it is a 'happy' career choice as well.

Tunneling and underground projects are among the riskiest engineering practice areas. Sanja trusts solid engineering judgement and practical solutions that always have safety as a primary concern. Throughout the years, she has learned the only way to successfully conquer great challenges is to rely on team contribution as well as having the courage to pursue one's own vision and convictions. Often it is not easy; however, in practicing the perseverance, respect and camaraderie that is typical of the tunneling industry, it is possible. Courage is also a big component – one should speak their mind, especially when it comes to ideas or solutions that can move a project forward. The tunneling and mining industry is a very warm and gratifying environment and a very conducive atmosphere for women engineers to thrive. This originates from a long-developed culture of caring – the lives of miners are often in the hands of their teammates. This culture has transferred into the consulting industry as well and a feeling of camaraderie and mutual respect is ever present. "Occasionally, early in my career, I would find myself needing to work harder to 'break the ice' in terms of obtaining a team's trust or having to prove a point – in retrospect, I am very grateful for those instances, as they made me a fast learner, gave me courage to think 'outside the box' and propelled me to develop and put forward innovative solutions," Sanja notes.

SANJA ZLATANIC, PE, SVP
Fellow, Chair – National Tunnel Practice

Sanja brings over 30 years of national and international experience in engineering and design management of multi-billion dollar tunnel and underground projects. primarily for transportation and infrastructure. She has been responsible for managing all phases of major multi-billion-dollar projects, including extensive multi-disciplinary joint venture staff, from feasibility and conceptual engineering through final design and construction. Sanja achieved outstanding results in multi-disciplinary coordination and project integration in domain of complex underground structures and tunnels and has been highly appreciated by clients and major transit agencies nationally and internationally. Her ability to bring forward state of the art innovative solutions through collaboration with top industry experts had brought value to many mega-transit programs. As an active member of various tunneling and underground societies, she is well recognized in the profession and has published numerous articles, chaired conference sessions, and made presentations on the design of construction of tunnels and underground facilities at national and international tunneling conferences. She has received Technical Excellence Award and had been recognized as Fellow, for extraordinary accomplishments practicing technical excellence and introducing innovative approaches to solving complex tunneling issues, especially related to minimizing impacts of tunneling to densely populated urban environments, communities and businesses. She is elected Board Member and Secretary General of ACUUS (Associated Research Centers for Urban Underground Space), an international, non-governmental organization dedicated to partnerships among experts who research, plan, design, construct and decide upon the best use of urban underground space. Her project experience, among others, includes:

LA Metro Sepulveda Transit Corridor - Lead tunnel engineer for planning phase comprising defining most practical and least environmentally impactful route for the potential future longest tunnel in the US providing better transit between the San Fernando Valley, the Westside and LA International Airport (LAX).The natural barrier created by the Santa Monica Mountains makes the I-405 one of the busiest freeways in the nation and tunneling through the mountains might

SANJA ZLATANIC, PE

Firm
HNTB Corporation

Education
Graduate Structural Engineer, 1988, University of Belgrade, Yugoslavia (MS Equivalent)

Executive Education for Women, 2005, Smith College

Professional Registrations
Professional Engineer:
NY, 1997/#074281

Professional Affiliations
American Society of Civil Engineers; International Tunneling Association (ASCE)
Underground Construction Association of Society for Mining, Metallurgy and Exploration (UCA of SME)
American Concrete Institute (ACI)
Associated Research Centers for Urban Underground Space (ACUUS)

Hire Date with HNTB
October 2011

Years of Experience with other Firms (USA and Internationally) 23

Sound Transit -The West Seattle and Ballard Link Extensions (WSBLE) Project - Technical advisor to ST for tunnels and complex underground structures through Alternatives Development Phase to establish and refine specific route, station locations and types, and tunnel alignment and types during planning and advanced conceptual stage of environmental assessment considering public and third-party inputs leading to the Sound Transit Board identifying the project Preferred Alternative. The assessments include twin bore as well as varying large-diameter single bore tunnel configurations evaluated for their operational, passenger circulation and experience, maintenance and safety features, including fire life safety and compliance to NFPA 130 guidelines as well as constructibility and risk aspects.

The WSBLE Project would provide fast, reliable light rail connections to dense residential and job centers throughout the region and add a new downtown Seattle light rail tunnel to provide efficient operating capacity for the entire regional system. The Ballard extension would operate 7.1 miles from downtown Seattle to Ballard's Market Street area and include a new 3.3-mile rail-only tunnel from the International District/Chinatown to South Lake Union and Seattle Center/Uptown. The extension would serve three elevated stations in Ballard, Interbay and near Smith Cove, and six underground stations at Seattle Center, South Lake Union, Denny, Westlake, midtown and International District/Chinatown areas.

Advisory Expert Services Start – End Date: 2018 – ongoing

Construction Completion Date: ongoing

Cost: $11.7B

VTA (Santa Clara Valley Transportation Authority) – Single Bore Tunnel Technical Study and Program Management - Technical lead for Single Bore Tunnel Technical Study, and Engineering Manager for technical criteria and documents development as part of PM team, featuring large diameter tunnel housing 5.1 miles double track tunnel alignment and three underground stations. Excited about the potential of this innovative scheme to minimize construction impacts to residences, businesses and public within dense urban area of the City of San Jose, Sanja has being diligently working with a team of national and international experts to assess feasibility of the concept for application on this BART extension program to Santa Clara Valley. Representing a first-time application of single bore tunnel in the United States, Sanja is determined to lead and provide an objective assessment of benefits and challenges of this innovative scheme to the owner, capitalizing on the fact that tunnel boring machine technology advances had gained momentum and built large portfolio of the successful project histories internationally for this technology to be applied in the United States. This would bring significant overall benefits to the public agencies in terms of minimizing impacts of underground construction within dense urban environments, controlling construction and environmental risks, and improving certainties to construction schedules and capital costs for complex mega transit projects.

Design Services Start – End Date: 2016 – ongoing
Construction Completion Date: ongoing

Cost: $8.3B

Republic of Turkey Ministry of Transport, Istanbul Strait Road Crossing (Eurasia) Tunnel, Istanbul, Turkey

Project Manager and Independent Design Verifier for category 3 structures, systems and facilities for this $1.35B Istanbul Strait Road Tube Crossing project of 14.5 km in length that includes 5.4 km of road tunnels and 3.4km Bosporus Strait Crossing double-deck bored highway tunnel 13.2m (43.3 ft)

in diameter (sixth largest tunnel in the world), and 2km Asian and European side tunnel approaches (roadways, toll plazas, ventilation and system buildings and facilities). The tunnel accommodates a 2-over-2 lane road for passenger vehicles and minibuses including the stopping lane. The tunnel passes through various geological formations including limestone and sandstone and soft channel alluvial deposits consisting of sand and silt. The tunnel is subject to 11 bars of water pressure and located in a high seismic zone in a close proximity to Marmaray fault.

Design Services Start – End Date: 2012 - 2016
Construction Completion Date: 2016

Cost: 1.1B Euro

Washington State DOT – Alaskan Way Viaduct Replacement:
Member of expert review panel and technical oversight lead for $3.1 Billion design build project of 2.1 miles bored tunnel that replaces the Alaskan Way Viaduct along the central Seattle waterfront. The world second largest 58-ft diameter tunnel will be bored beneath city streets; tunnel, staging and settlement mitigation measures design are critical for a successful project execution. Washington State Department of Transportation, Alaskan Way Tunnel, Seattle, WA

Sanja lead technical oversight for tunnel liner, interior structures and settlement mitigation measures design. The 58-foot-diameter double-deck tunnel will replace the existing deteriorated viaduct along the central Seattle waterfront to be built beneath city streets and under 156 buildings, numerous utilities and other infrastructures in downtown Seattle. The project also includes control buildings, fire and life safety, ventilation buildings, and mechanical and electrical components.

Design Services Start – End Date: 2011 - 2018
Construction Completion Date: Feb 2019

Cost: $3.1B

SEPTA (Southeastern Pennsylvania Transportation Authority) and PennDOT – Broad Street Line Extension Feasibility Study for FTA new starts program - Leader for SEPTA feasibility and constructability study of extending the Broad Street Subway Line into the Philadelphia Naval Yard including assessment of major underground risks, construction methods to be implemented, schedule and capital costs.

Design Services Start – End Date: 2015 – 2016
Construction Completion Date: ongoing

Cost: $1.2B

AMTRAK - Baltimore and Potomac (B&P) Tunnel in Baltimore, Maryland –
Peer reviewer, HNTB Program Management team, for preliminary engineering studies and environmental analyses of the B&P Tunnel to improve rail service, reliability and address a longstanding bottleneck along Amtrak's busy Northeast Corridor (NEC). The studies are advanced by The Federal Railroad Administration (FRA), Maryland Department of Transportation (MDOT) and Amtrak to develop and evaluate various alternatives based on the need to improve capacity and travel time through

the corridor, and in consideration of reliability and safety for commuter, freight, and intercity rail service on the NEC

Design Services Start – End Date: 2014 – ongoing
Construction Completion Date: ongoing
Cost: $4.5B

San Francisco MTA – T Third LRT/Central Subway Phase 3 – Leader for SFMTA feasibility and constructability study to optimize existing Muni LRT transit service, assess potential for future rail transit expansion to serve northern San Francisco neighborhoods, including North Beach and Fishermen's Wharf, and analyze constructability issues related to the study alignments and feasibility of potential transit alternatives. The constructability assessment is to be used by SFMTA as an input to a broader analysis of varying expansion concepts to the existing Muni transportation corridor, primarily to the north and north-east of San Francisco, CA.

Design Services Start – End Date: 2014 – 2015
Construction Completion Date: N/A

Cost: $1.15B

New York City Transit – Structural Assessment of Three Underwater Tunnels and Rehabilitation, New York, NY

Technical expert for the structural assessment and rehabilitation of three subway tunnels under the East River in New York which were flooded during Super storm Sandy in October 2012. The tunnels are: Greenpoint, Rutgers, and Cranberry connecting Manhattan, Queens and Brooklyn. The tunnels range in length with the longest approximately 7000 ft long. The tunnels are constructed of cast iron liner with unreinforced cast in pace concrete liner. The intent of the study is to identify visible and potentially latent defects and prepare repair measures. The investigation consisted of using state of the art three-channel scanner providing high resolution photogrammetric, laser and infrared single-pass survey.

Design Services Start – End Date: 2013 – ongoing
Construction Completion Date: on going

Cost: $300M

LA Metro – Crenshaw/LAX LRT Line, Los Angeles, CA

Technical expert/senior technical reviewer for design of underground segment of this $2B design build program for HNTB as a lead designer and engineer of record for DB team. Underground structures/tunnels technical lead during the DB project pursuit leading into a best value DB proposal (best technical and most economical DB proposal). The project includes 3 miles of underground line structures and three underground stations being constructed by the cut and cover method. The underground guideway

includes two 22 ft diameter tunnels constructed with EPB TBM connecting three underground stations.

Design Services Start – End Date: 2013- ongoing
Construction Completion Date: 2022

Cost: $2B

LA Metro – Regional Connector LRT Line, Los Angeles, CA

Engineering lead for Design Build contractor during the tender phase; instrumental in identification of over $80M of potential savings through alternative technical concepts in compliance to LA Metro design criteria. The project includes 1.9-mile underground light-rail system, connecting the Metro Gold Line to the 7th Street/Metro Center Station and providing direct connection between Azusa and Long Beach and between East Los Angeles and Santa Monica; three new stations accommodating ventilation/service facilities-- 1st Street/Central Av, 2nd Street/Broadway, and 2nd Place/Hope; running tunnel, NATM, cut and cover and U-structures.

Tender Services Start – End Date: 2013- 2014
Construction Completion Date: on going

Cost: Life-of-Project Budget -- $1.427 billion

Presidio Parkway Tunnel: The Doyle Drive Replacement Project, San Francisco, CA

Member of expert peer review panel for this high-profile $1 billion public-private partnership (P3) tunnel project to completely reconstruct approximately 2 miles of Doyle Drive, including 10 bridges; three cut-and-cover tunnel sections constructed below the high water level; 11 retaining walls; and an at-grade section. This project also includes reconstructing the Park Presidio and Presidio Access interchanges and improving local street circulation in the area. HNTB is the lead designer and engineer of record responsible for all roadways, structure, electrical, mechanical and landscape components of the project.
Sanja provided oversight and technical reviews of the structural systems and the fire-life safety aspects including the evaluation of the impact of design fire on the primary structural and system elements.

Design Services Start – End Date: 2012- 2016
Construction Completion Date: 2016

Fort Lauderdale Hollywood International A.P. Runway Expansion, Ft. Lauderdale, FL

This is a design-build project providing the airport runway expansion over the top of a highway and railway with a post-tensioned bulb-tee composite structure as the roof of the tunnel. Sanja lead the technical assessment of design especially related to the design fire impact evaluation on the tunnel main structural components including the system elements.

Design Services Start – End Date: 2012 - 2014
Construction Completion Date: 2016

Experience Prior to Joining HNTB

San Francisco Municipal Transportation Agency, Central Subway Project – Underground Stations, San Francisco, CA

Peer review and value engineering team member for underground stations of San Francisco's Central Subway project as part of a tri-venture on this project that consists of 1.8 miles of twin tunnels 20-feet in diameter and three underground stations at a cost of $1.58 billion. Moscone Center Station will be constructed using cut-and-cover method with top-down construction technique. Union Square-Market Street Station is the deepest station at about 100 feet from the surface. It will be constructed using cut-and-cover with top-down approach using inclined secant or tangent piles. Chinatown Station will be constructed using sequential excavation method or NATM in mixed-face ground conditions with a shallow cover and adjacent to sensitive utilities and buildings. Sanja contributed innovative constructability solutions related to slurry wall and secant piles excavation support systems.

Design Services Start – End Date: 2010 - 2011
Construction Completion Date: on going

Cost: $1B

Toronto Transit Commission, Transit Expansion LRT Program, Toronto, Canada

Sanja provided consultancy and technical support for establishing technical and engineering standards for $8.2 Billion Transit Expansion LRT Program for Toronto Transit Commission, including criteria for tunnel precast concrete segmental liner design. She provided independent verification of tunnel liner performance during major fire event in the tunnel for 10.5 km-long Eglington Crosstown Light Rail Transit twin bored tunnels, constructed by EPB TBM with 5.75 m clear inside diameter, and crossing beneath densely populated urban areas where loss of liner would cause loss of ground and large surface settlement impacts.

Design Services Start – End Date: 2010 - 2011
Construction Completion Date: on going

NJ Transit / Port Authority of New York and New Jersey, Trans-Hudson Express (THE), NJ/NY

Chief engineer for underground structures and tunnels responsible for final structural designs and interdisciplinary design integration for all underground structures and facilities (running tunnels, caverns, ancillary and utility tunnels and shafts), including development and implementation of design strategies, criteria and mitigation methods for special loading conditions – fire, blast and structural considerations – to prevent progressive collapse.

She was also contract manager for two largest multi-million dollar THE contracts involving the excavation and final structures of large underground openings forming the final terminal station configuration of the expansion of Penn Station.

The project includes three major tunnel segments to be delivered under design-build contracts: a tunnel in Manhattan running from the Hudson River east to Sixth Avenue; a tunnel under the Palisades to the existing Northeast Corridor in New Jersey; and two single-track tunnels under the

Hudson River. The project also involved construction of a multi-level, 100-foot (30 meter) span terminal cavern station in rock. This cavern, which includes multiple ancillary tunnels and shafts, as well as five ventilation plants, is being build under 34th Street in Manhattan as an expansion of New York's Penn Station. It would provide direct connections to Port Authority Trans-Hudson (PATH) trains and to 14 subway lines operated at 6th, 7th and 8th Avenues by the MTA – New York City Transit.

Design Services Start – End Date: 2006 - 2010
Construction Completion Date: cancelled by NJ Governor

Cost: $11.3B

MTA, No. 7 Subway Line Extension, New York, NY
Design manager for the $2.1 billion extension of the No. 7 line from its current terminus at Times Square to a new station at 34th Street and 11th Avenue. She was responsible for the development of project-specific design criteria in conformance to industry-wide accepted design standards and codes for final structural designs of all mined structures, including multidisciplinary coordination and design integration. Throughout the final design, she led tasks encompassing design optimization through improvement of constructability, development of a construction packaging approach, and mitigation of construction risks.

Design Services Start – End Date: 2004 - 2006
Construction Completion Date: 2012

Cost: $2B

MTA - Long Island Rail Road, East Side Access/ Grand Central Connection, New York, NY
Design manager who led the design development of the Manhattan segment deep station alternative and was responsible for the delivery of the final documents that resulted in the selection of the deep station scheme for this $7.6 billion project. The final documents included the construction methodology approach and comparative analysis of construction risk aspects. When complete in 2020, this project will enable the LIRR to provide direct service to the east side of Manhattan via a new eight-track terminal being constructed at Grand Central Terminal. The contract also involves the closure of the Manhattan construction access shaft in the borough of Queens and the rehabilitation of the existing double-decked, four-quadrant 63rd Street Tunnel. Design Services Start – End Date: 1999- 2005
Construction Completion Date: 2022

Cost: $10.8B

NJ Transit, Hudson-Bergen Light-Rail Transit System, Weehawken Tunnel and Bergen line Avenue Station, Hudson and Bergen Counties, NJ
Project engineer responsible for all aspects of project completion – from condition assessment of the existing tunnel structure to the development of the final design documents and cost estimating for this $200 million project. As part of her responsibilities, she developed and implemented the design methodology used for consideration of design fire impacts to the tunnel and cavern final liners. The project includes the development of the

20.6-mile light-rail transit system served by 32 stations and five regional park-and-ride lots. In addition to providing preliminary engineering and architectural services for all facilities and systems, the project also included final design and contract document preparation of the Weehawken Tunnel and Bergenline Avenue Station. The station is located within the tunnel, which was built in the late 1800s specifically for freight traffic and was used for that purpose until 2002. She was responsible for enlarging the 4,200-foot-long tunnel into a modern double-track light-rail tunnel, including the design of a new underground station cavern, elevation/ventilation shaft, two ventilation plants, and other multimodal service facilities.

Design Services Start – End Date: 1995-1999
Construction Completion Date: 2004

Cost: $400M

National Railroad Tunnel Corporation (Amtrak), East River Tunnels, Rehabilitation of First Avenue and Long Island City Ventilation Shafts, New York, NY

Deputy project manager and project engineer for the rehabilitation of three ventilation shafts at the First Avenue and Long Island City segments of Amtrak's East River Tunnels. The project's objective was to improve railroad operation and passenger safety by providing a safe means of egress from the tunnels to the street and by controlling smoke and heat in the tunnels to provide a clean environment for passengers in the path of egress. In addition to developing design alternatives, establishing the project budget and maintaining schedule control, she was responsible for liaison with Amtrak, project stakeholders, and federal, state and city agencies during the project's approval phase and coordination of project multidisciplinary staff during the final design process.

Design Services Start – End Date: 1994- 1995
Construction Completion Date:2004

MTA Bridges and Tunnels (TBTA), Brooklyn Battery Tunnel Wall and Ceiling Rehabilitation, New York, NY

Project engineer during the project's construction stage, this project for MTA Bridges and Tunnels comprised tunnel ceiling rehabilitation, liner repair for damage caused by water leakage and roadway lighting improvements for the 9,717-foot-long (3,000-meter-long) Brooklyn Battery Tunnel – the second longest underwater crossing in the U.S. – connecting lower Manhattan and Brooklyn. She provided construction support services, reviewed and approved the contractor's alternative designs; developed preferred alternatives; evaluated the contractor's work; and coordinated communication between PB, the MTA and the contractor. The project won the Gold Award in Engineering Excellence from the New York Association of Consulting Engineers (NYACE) in the Transportation Studies and Mega Projects category.

Design Services Start – End Date: 1993- 1995
Construction Completion Date: 1995

MTA New York City Transit Authority (NYCT), 63rd Street Tunnel Connection, New York, NY
Lead designer responsible for several major structures for this complex project, including the 29th Street and 39th Avenue ventilation structures involving extensive underground tunnel connections, the multi-track tunnel structures, slurry wall designs, and modifications to the existing Court Square Station structure. This is a $700 million transit tunnel extension that included a 2,000-foot-long (600-meter-long), two-track connecting tunnel between and under two operating subway lines, two new above-ground ventilation buildings, modifications to six Queens transit stations, and substantial utility relocation. The project provided additional subway service between Manhattan and Queens via the existing 63rd Street Tunnel beneath the East River.

Design Services Start – End Date: 1991- 1994
Construction Completion Date: 1995

MTA New York City Transit (NYCT), Indefinite Quantity Contract CM-995, New York, NY

Project manager responsible for project performance; scope, schedule and budget control; coordination of multi-disciplinary activities on over 30 parallel and diversified project tasks; and coordination with the client, city and state agencies, and local community boards.

Design Services Start – End Date: 1994- 1996
Construction Completion Date: 1996

MTA New York City Transit (NYCT), Intermodal Facilities at Flatbush Avenue, Pelham Bay, and 149 Street Stations, Brooklyn and the Bronx, NY
Project manager whose responsibilities involved providing preferred prototype design through extensive coordination between architectural, structural, electrical, signal, mechanical, and civil disciplines as well as obtaining required design approvals through coordination with city utilities, the New York City Department of Transportation, community boards, and the New York City Arts Commission.

Design Services Start – End Date: 1994- 1996
Construction Completion Date: 1996

Yugoslav Business Center, Belgrade, Yugoslavia:

Project engineer responsible for structural analysis and design of this reinforced 200,000-square-foot (18,600-square-meter) concrete structure, including precast slabs and pile foundations. She performed seismic analysis as per local specifications and recommendations of the European Committee du Beton (ECB), and inspected and supervised construction during foundation work.

Design Services Start – End Date: 1989- 1991
Construction Completion Date: 1992

Government Building, Baghdad, Iraq
Project engineer responsible for design and construction supervision of pile foundations, including strengthening and repair of existing foundations, for

a 300,000-square-foot (27,900-square-meter) building. The design included a seismic evaluation performed in accordance with the American Uniform Building Code (UBC).

Design Services Start – End Date: 1988- 1989
Construction Completion Date: 1990

Publications/Conferences

"Structural Design Methodology for Large-Span Caverns in Rock," NAT Conference, Portland, Oregon, 2010 (session chair).

"Innovative Use of Concrete and Shotcrete," New York City Concrete Industry Board Honor Presentation, 2009.

"Quantitative Assessment of Structural Fire Endurance of Concrete and Shotcrete Tunnel Liners," presented at ITA Conference 2005, Istanbul, Turkey.

"Ground Borne Vibration on the East Side Access Project Manhattan Segment: Issues and "Assessment of Fire-Induced Damage on Concrete and Shotcrete Tunnel Liners," presented at the Transportation Research Board Annual Meeting, Washington D.C., January, 2005

"Structural Fire Performance of Concrete and Shotcrete Tunnel Liners," Journal of Structural Engineering, 2004.

"Connecting a Commuter Railroad to a Historic Terminal in Manhattan", ITA 2003, Prague, Czech Republic.

"Manhattan Segment of East Side Access Project: Design Evolution," Proceedings of the Rapid Excavation and Tunneling Conference, San Diego, California, 2001.

"The Grand Central Connection Project in Manhattan," Proceedings of the 16th Congress of the IABSE, Lucerne, Switzerland, September 2000.

"Minimizing Risk in Underground Construction Using DBOM Approach: A Case History," International Congress on Underground Construction in Modern Infrastructure, Stockholm, Sweden, 1998.

"Modern Use of an Old Tunnel to Meet Public Needs," International Congress on Underground Construction in Modern Infrastructure, Stockholm, Sweden, 1998.

"Design Considerations of a Turnkey Contract for an Underground LRT System," World Tunneling Congress '98 -Tunnels and Metropolises, Sao Paulo, Brazil, 1998.

Awards and Recognition

1. Engineering News-Record (ENR) - Global Best Project, Bridge/Tunnel, Istanbul Strait Road Tube Crossing, 2016
2. International Tunneling Association (ITA) - Tunneling Project of the Year, Istanbul Strait Road Tube Crossing, 2015

3. Gold Award for Engineering Excellence, NY American Council of Engineering Companies, East River Ventilation Shafts Project, 2011
4. Outstanding Underground Project, American Shotcrete Association, Weehawken Tunnel and Bergenline Avenue Station, 2006
5. Grand Conceptor Award, ACEC, 63rd Street Connection Project, 2001
6. Gold Award for Engineering Excellence in Transportation and Mega Projects Category, NY ACEC, Rehabilitation of the Brooklyn Battery Tunnel, 1998

Underground Construction Association
A Division of SME

303-948-4200
Fax: 303-973-3845
E-mail: cs@smenet.org
www.smenet.org/uca
12999 E. Adam Aircraft Circle
Englewood, CO 80112

ITA Working Group 20 – US Interface Sub-Committee (ITAWG20-USISC)

Lead: Sanja Zlatanic szlatanic@hntb.com
Members:

Anthony Bauer, abauer@hntb.com
Gordon Clark, gtclark.pe@gmail.com
Amanda Elioff, amanda.elioff@wsp.com
Rajat Gangrade, rajatgangrade@mymail.mines.edu
Brian Gettinger, Brian.Gettinger@freese.com
Thomas Grassi, tgrassi@hntb.com
Kancheepuram Gunalan, K.N.Gunalan@aecom.com
Brandon Kluzniak, bkluzniak@hntb.com
Priscilla Nelson, pnelson@mines.edu
Raymond Sterling, sterling@Latech.edu
Mike Wongkaew, mwongkaew@hntb.com

ITAWG20-USISC DRAFT Work Plan for 2021-22:

Topic	Description	Suggested Next Steps
White Papers		
Relative costs of tunnels (bored, mined, cut and cover) in comparison to their at-grade and aboveground counterparts, for transportation	Assess relative costs of constructing tunnels and underground structures, primarily for transportation, and compare them with costs of at grade and above-grade solutions. Consider capital costs, design service life, maintenance, and operations, as well as soft costs of environmental, social, tax and real estate impacts; compile research to date and solicit additional research through ITA WG20 Animateur. Distinguish between qualitative (first) and quantitative (second) phases of analysis—where we would need cost estimators' input, for project within the US. **Additional subtopics:** • Examine reasons of high costs of tunneling in the US, especially for transportation projects involving passenger stations and implementation of ventilation and fire life safety standards, in comparison to similar costs elsewhere in the world. • Emergence of new technologies and private equity investments as well as innovative procurement strategies have started challenging the tunneling cost trends. Assess this phenomenon to assist clients and tunnel industry	Action: Gordon Clark/ Brian Gettinger/SZ/(TBD) • Form a task group (reach out to other related ITA USISC WG's) • Provide a proposal outline and present to ITAWG20 Animateur • Schedule May 28, 2021 Next steps: • Provide White Paper • Schedule:TBD

	in positioning and arriving at more sustainable, affordable, and equitable tunnel transportation solutions of the future. • See related links below: https://tunnelingonline.com/why-tunnels-in-the-us-cost-much-more-than-anywhere-else-in-the-world/ https://www.tunneltalk.com/TunnelTECH-Apr2015-Arup-large-diameter-soft-ground-bored-tunnel-review.php https://www.theverge.com/2018/6/14/17464612/boring-company-chicago-elon-musk-cost-estimate https://www.reviewjournal.com/business/business-columns/inside-gaming/boring-co-transparency-needed-for-public-to-buy-in-to-vegas-loop-2152682/	
Underground Space Use for New Mobility Solutions: Initial Guidelines *Include moving goods and services—examine cost benefits of this option; address sustainability and climate change initiatives*	Accelerated development of new mobility solutions including Autonomous Vehicles, Maglev, Hyperloop, and others, necessitates basic understanding of these technologies and their potential uses for efficient inter-city connectivity. It is anticipated these new mobility solutions would grow in the next period due to a need to move people and goods more efficiently. Increased focus on sustainable and renewable energy solutions, coupled with cities desire to preserve surface for more noble uses toward improving people's environment, health, and quality of life, would likely fast-track development of these new technologies. Due to difficulties for establishing dedicated surface right-of-way within developed urban environments, and considering geometric parameters required for super-high-speed mobility technologies, attention to proper planning and utilization of underground space is warranted for their implementation and initial guidelines necessary to explore their challenges and benefits.	Action: Sanja Zlatanic/BK-AB-MW/? • Form a task group (reach out to other interested agencies and organizations • Provide a proposal outline and present to ITAWG20 Animateur • Schedule May 14, 2021 Next steps: TBD
With the emergence of COVID-19, and potential future pandemics, providing safe and healthy transportation mobility, as well as a high level of confidence among riders and employees is of paramount	Professional communities of transportation designers, architects and engineers have a responsibility to ensure that proper design measures are implemented to promote the health and safety of underground transit riders and employees in a post-COVID-19 world. The pandemic has created an opportunity to influence physical components of transit facilities and vehicles to make them less conducive to the spread of pathogens. When riders are confined to spaces such as underground stations, waiting areas, platforms, and vehicles, measures	Action: Thomas Grassi?/ SZ/(?) • Form a task group (reach out to other interested agencies and organizations • Develop relationship with other

concern and requires implementation of appropriate safety measures, procedures and protocols to minimize the spread of the pathogen within underground transportation spaces –-Provide Initial Guidelines.	should be taken to increase riders' confidence and reduce the risk of transmission, including those impacting the architecture and ventilation of the facility. In order to fight against the spread of COVID-19, as well as to preempt and respond to future pathogen spread, for both planned and existing facilities, a systematic approach of combining planning and architectural design measures and interventions with innovative technologies should be considered and compounded in form of Initial Guidelines.	professional organizations and/or schools – American Institute of Architects? TRB? Pratt? NYU? Others? • Provide a proposal outline and present to ITAWG20 Animateur • Schedule May 28, 2021 Next steps: TBD
Collaboration		
What is the killer App that will make people WANT to go to live/work/play in urban underground space	Get major urban regions to sponsor and conduct charettes with the youth and young professionals of that area to create visualizations of underground space and what is needed to make it an exciting place to be.	Action: Priscilla Nelson/TBD
Connect with other professional societies and arrange to host a panel at the intersection between them and us.	Assign each WG20 member at least one society to get connected to – including ASCE, APA, UCA of SME, RMA, RIMS, NASTT, Architects, AGS, AAG, Canadian societies, etc. The WG will build a team of competent and interesting speakers, and will offer panel discussions at the conferences run by different societies. May also develop virtual Zoom panel discussions and offer them to all interested people including major breakthrough underground projects involving innovative underground space use. Build a list of such people; grow connections.	Action: TBD
Develop connections with universities	Develop virtual Zoom lectures and panel discussions and offer them to all interested universities. Build a list of such connections.	Action: TBD
	REQUEST ACUUS & ITACUS ASSISTANCE:	
Land value changes accompanying the choice between	Identify a Real Estate Professor with an interest in studying the changes in land value and land use over time when comparing underground infrastructure solutions	Action: Sanja Z./Raymond Sterling (TBD)

major underground infrastructure projects and surface or elevated options.	with surface or elevated options. Help to find some financing to attract graduate students to study the topic and interact with the studies to help shape the key questions to research.	• Form a task group (reach out to other interested agencies and organizations---ACUUS, AIA, ITACUS, other ITA USISC WG's, etc.) • Provide a proposal outline and present to ITAWG20 Animateur • Identify potential university and/or AIA sponsor(s) • Schedule May 28, 2021 Next steps: TBD
Future Activities		
Systemic Planning of Urban Underground Space: Lessons Learned	Several cities had already implemented systemic planning of urban underground space and advanced it for over a decade while achieving measurable results. Summarizing experiences, lessons learned, benefits and challenges of systemic urban underground space planning would help other urban dwelling initiatives approach their underground space resource planning in an informed way to achieve sustainable and lasting solutions.	Action: TBD • Form a task group (reach out to other interested agencies and organizations • Provide a proposal outline and present to ITAWG20 Animateur
Explore use of technology including digital connectivity to improve potential	Solar power? Autonomous vehicles? Broadband utilidors beneath existing highways? Elevators/escalators?	Action: TBD • Form a task group (reach out to other

future underground space uses	Underground plant life/greenery? Ventilation? Also, see link below for the Lowline, proposed in NYC. The Lowline is a plan to use innovative solar technology to illuminate an historic trolley terminal on the Lower East Side of New York City. Our vision is a stunning underground park, providing a beautiful respite and a cultural attraction in one of the world's most dense, exciting urban environments. The project is currently on hold due to funding issues. http://thelowline.org/about/project/	interested agencies and organizations • Provide a proposal outline and present to ITAWG20 Animateur

Urban Problems

Underground Solutions

Draft May 2009

Lane Cove Tunnel

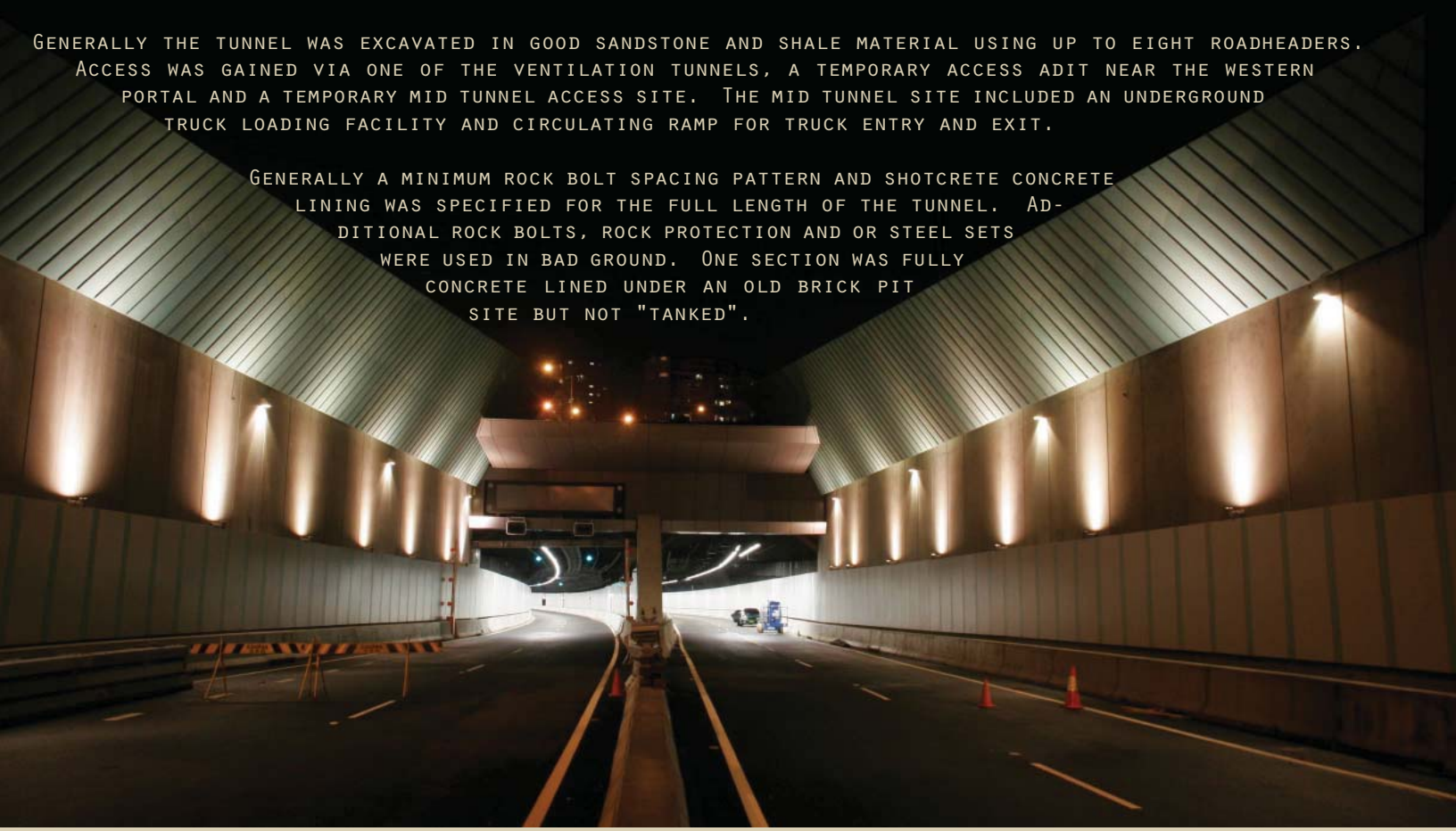
Owner: Connector Motorways Pty Ltd

Designer: Parsons Brinckerhoff
Contractor: Thiess John Holland Joint Venture

Twin two/three lane tunnels 3.4kms in length up to 30 metres below surface. Longitudinal ventilation system with 120 jet fans and two stacks for tunnel exhaust. Tunnel ventilation system was designed for both tunnels to be fully congested.

Generally the tunnel was excavated in good sandstone and shale material using up to eight roadheaders. Access was gained via one of the ventilation tunnels, a temporary access adit near the western portal and a temporary mid tunnel access site. The mid tunnel site included an underground truck loading facility and circulating ramp for truck entry and exit.

Generally a minimum rock bolt spacing pattern and shotcrete concrete lining was specified for the full length of the tunnel. Additional rock bolts, rock protection and or steel sets were used in bad ground. One section was fully concrete lined under an old brick pit site but not "tanked".



Urban Issues

- Architecture
- Service
- Safety
- Public Transit
- **Traffic**
- **Travel Time**
- **Noise Levels**
- **Pollution**
- Natural hazards
- Land Use
- Serviceability
- Construction
- **Multi-Use**
- **Intra-Transit**
- Seismic
- Other

Total Cost: $1.1 Billion (AU)

Planning	Construction
Nov. '00 - Dec. '03	Dec. '03 - Mar '07

A need to improve the efficiency of east-west travel along the corridor for road based transport modes through a reduction in congestion and improved travel times.

A need to improve air quality and reduce traffic noise, particularly along the arterial road network, through a reduction in surface traffic volumes and congestion.

A need to improve connectivity and access for pedestrians and cyclists on Epping Road, improving local access by reducing restrictions on traffic turning movements on Epping road, enhancing the urban fabric of the lower North Shore;

Solution

Energy
Housing
Rail
Road
Pedestrian
Parking
Venue
Shopping
Multi-Use
Storage
Pipeline
Sewer
treatment
Recreation

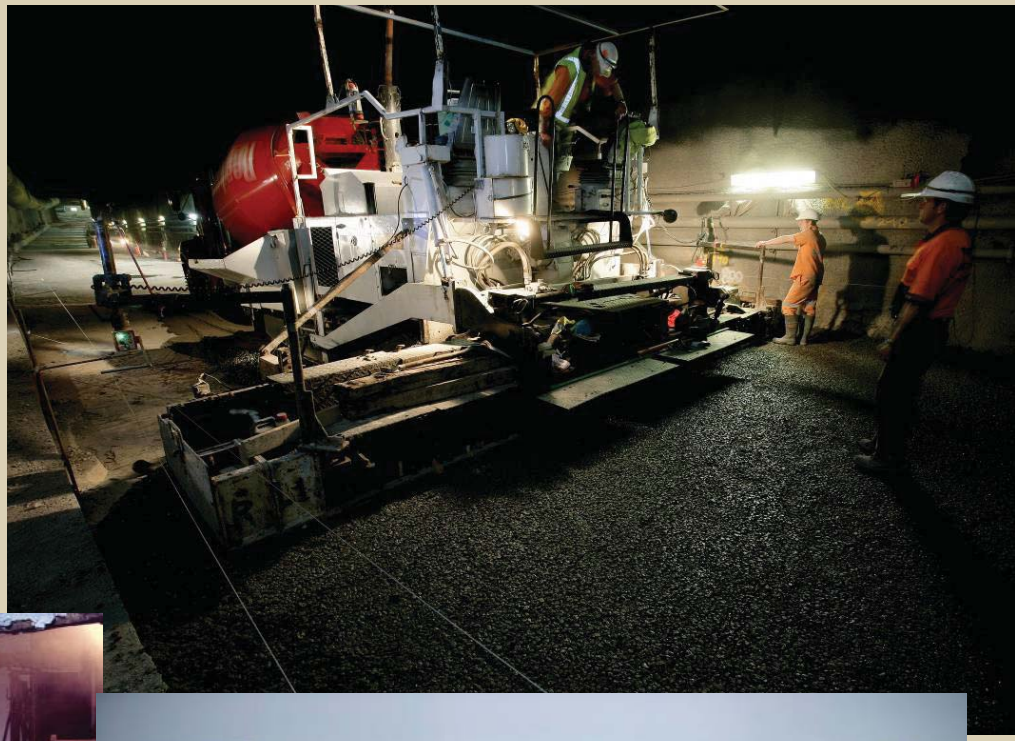
Twin 3.4km tunnels with entry/exit ramps from Pacific Highway.
Widening of 1.5 km of Road west of the tunnel from three lanes to four lanes westbound.
Widening of 3 km of Gore Hill Freeway east of the tunnel to provide a T2 transit lane in each direction.
Reconfiguration of 3 km of Epping Road (surface road above the tunnel) to provide a bus lane in each direction and a shared pedestrian/cycle path.
Reconstruction of the Falcon Street interchange with Warringah Freeway to provide new north facing tolled ramps.

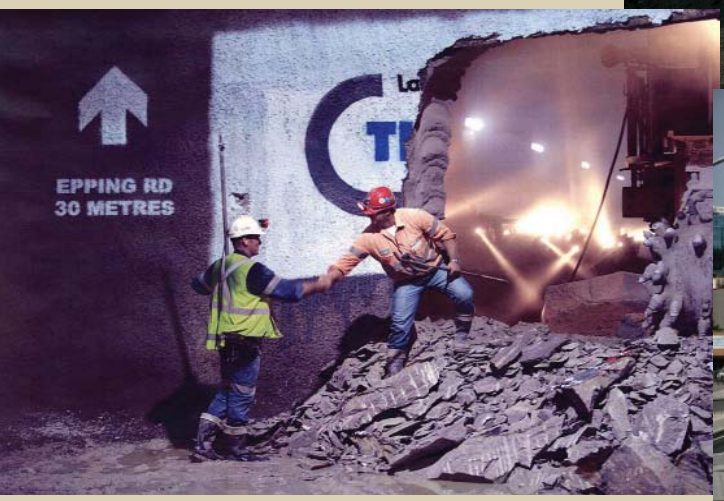
Benefits

Completed the missing link in the 110 km Sydney Orbital road network.
Removed traffic from local roads and arterial roads.
Provided opportunities for public transport improvements.

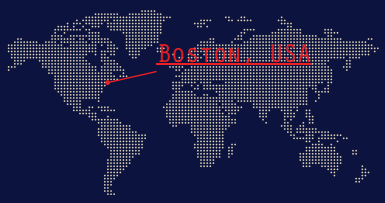
Keys to Success

Early planning and environmental impact assessment for the project.
Well defined scope of the project still allowed innovation in detailed design and construction.
Project delivered at least cost to Government.





Further Information
Roads and Traffic Authority, NSW
Level 4, 260 Elizabeth Street, Surry Hills NSW 2010 Australia
www.rta.nsw.gov.au
Mark Andrew
(02)9218 6225
mark_andrew@rta.nsw.gov.au



Central Artery

Owner: Mass. Turnpike Authority

Designer: Bechtel/Parsons Brinckerhoff
Contractor: TBD

7.8 miles of highway, 161 lane miles in all, about half in tunnels. All told, the CA/T placed 3.8 million cubic yards of concrete - the equivalent of 2,350 acres, one foot thick - and excavated more than 16 million cubic yards of soil. The larger of the two Charles River bridges, a ten-lane cable-stayed hybrid bridge, is the widest ever built and the first to use an asymmetrical design. It has been named the Leonard P. Zakim Bunker Hill Bridge. [English units to be converted!]

The project also includes four major highway interchanges to connect the new roadways with the existing regional highway system. At Logan Airport, a new interchange carries traffic between I-90 and Route 1A as well as onto the airport road system. In South Boston, a mostly underground interchange carries traffic between I-90 and the fast-developing waterfront and convention center area. At the northern limit of the project, a new interchange connects I-93 north of the Charles River to the Tobin Bridge, Storrow Drive, and the new underground highway.

At the southern end of the underground highway, the interchange between I-90 and I-93 is being completely rebuilt on six levels -- two subterranean -- to connect with the underground Central Artery and the Turnpike extension through South Boston. By mid-2005 the interchange carried a total of 28 routes, including High Occupancy Vehicle lanes, and channel traffic to and from Logan Airport to the east. A fifth interchange, at Massachusetts Avenue on I-93, has been rebuilt by the project.

Urban Issues

- Architecture
- Service
- Safety
- Public Transit
- **Traffic**
- **Travel Time**
- **Noise Levels**
- **Pollution**
- Natural hazards
- **Land Use**
- Serviceability
- Construction
- Multi-Use
- Intra-Transit
- Seismic
- Other

Total Cost: $10+ Billion (US)

Planning	Construction
1982 - 1991	1991 - 2007

Original elevated Central Artery Carried 200,000 vehicles per day, traffic congestion 10 hours per day, four times the national accident rate, $500 Million annual costs due to accidents, and traffic jams.

Reconnect North End and Waterfront neighborhoods with downtown, reduce citywide carbon monoxide levels by 12%, create 260 acres of open land.

Solution

- Energy
- Housing
- Rail
- Road
- Pedestrian
- Parking
- Venue
- Shopping
- Multi-Use
- Storage
- Pipeline
- Sewer treatment
- Recreation

26,000 feet of slurry wall (5 miles) were used during construction. These walls were used to support the old elevated freeway during construction as well as serving as ground support for trenching operations directly underneath the old freeway.

Three concrete "jacking pits" were used to excavate beneath nine major railroad tracks, the largest use of tunnel jacking in the world.

Underpinning used to support Red Line Subway during construction at Dewey Square.

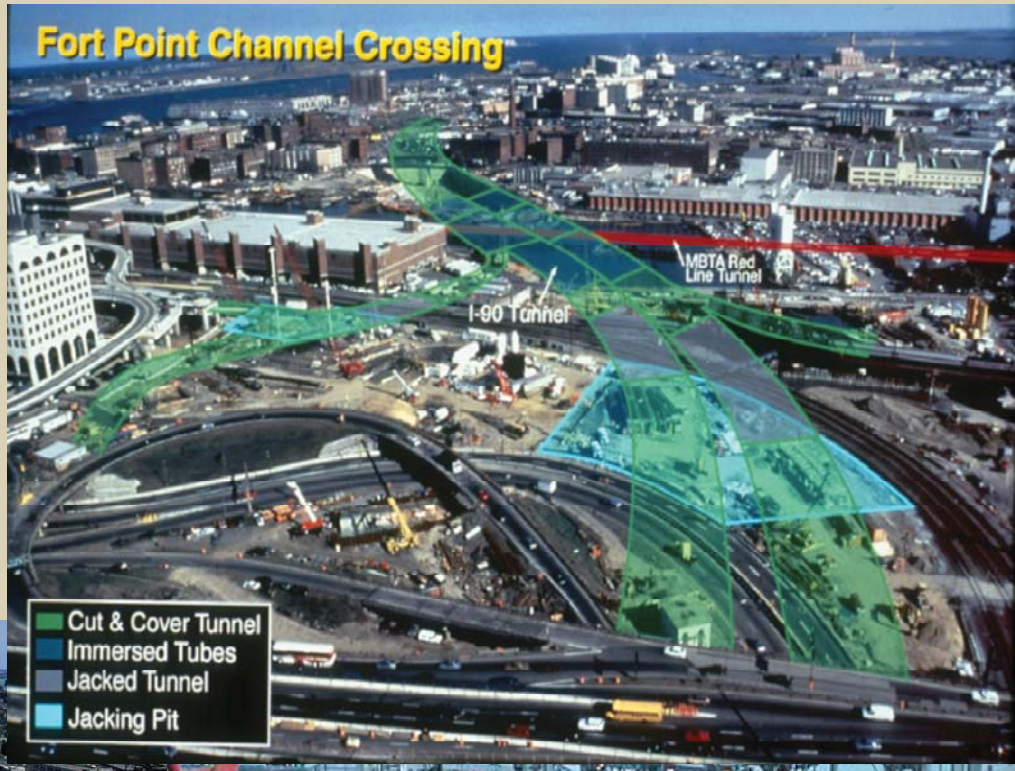
immersed tube tunnels used to cross several bodies of water.

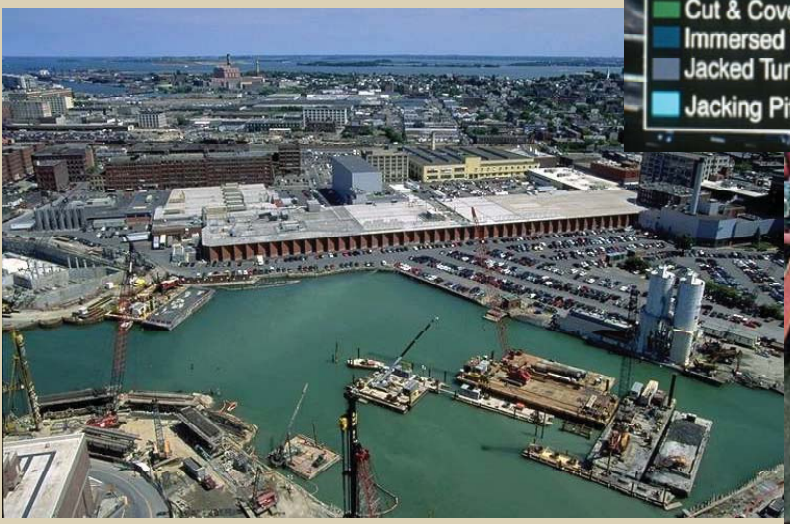
Benefits

Reconnected neighborhoods severed by the old elevated highway. Reduced congestion and pollution by moving traffic more efficiently. Created open space in the city.

Keys to Success

Use of new technologies such as slurry walls and ground freezing. Use of "top down" methods, allowing traffic to be maintained on old system. Continuous community relations and traffic information provided to the public through a command center with live video feed, and construction information.





Further Information

TBD

Canada Plant

Owner: Climespace

Designer: Ingevalor
Contractor: Soletanche Bachy

A 30m deep 21m diameter shaft in the heart of downtown Paris. Constructed for a cooling water plant which distributes cooling water throughout the city. Named "Canada Plant" after the Place Du Canada; the plaza in which it was constructed. The shaft was excavated inside a 35m deep .82m thick diaphragm wall with .3% specified verticality. This required the use of a real-time continuous verticality measurement system as well as correction devices such as mobile flanges.

The refrigeration unit is installed on 5 levels covered with a top concrete slab so that nothing is visible above ground. This was a primary condition imposed by the Paris City Authority in order to maintain the character of the prestigious character of the district. The cost of burying the station was approximately 20-25% higher than a similar station installed in a less central location. These costs were offset by the shorter length and reduced cost in distribution pipes.

Urban Issues

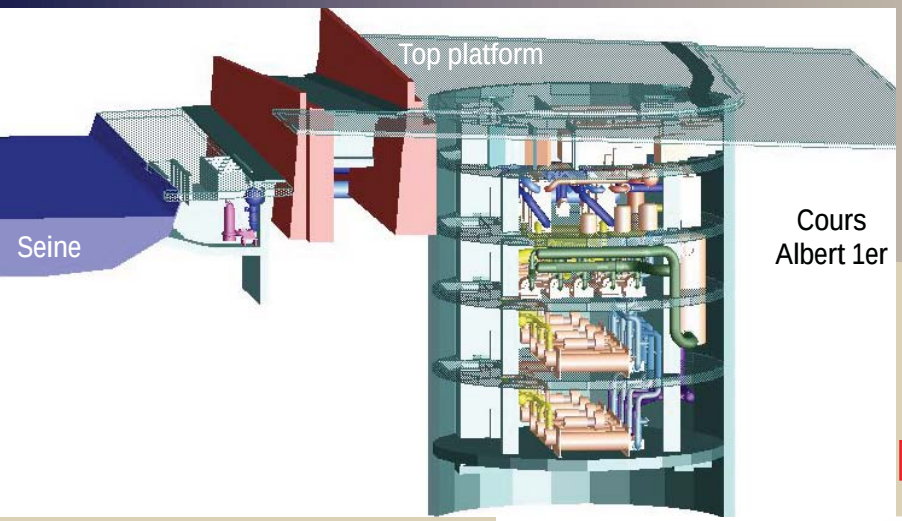
- Architecture
- Service
- Safety
- Public Transit
- Traffic
- Travel Time
- Noise Levels
- Pollution
- Natural hazards
- Land Use
- Serviceability
- Construction
- Multi-Use
- Intra-Transit
- Seismic
- Other

Total Cost: €25 Million

Planning	Construction
Nov. '00 - Dec. '03	Dec. '03 - Mar '07

Near the Grand Palais and opposite the Alexandre III bridge, it was of highest importance to keep the refrigeration unit completely hidden.
Even the gardens have been upgraded once the underground cooling unit was completed. Nothing is visible for the people crossing the gardens under which the unit is installed

During the construction of the diaphragm-wall, a maximum of care was taken to keep the noise level as low as possible (use of silent-proof cranes – no chiselling) and all precautions were taken for keeping the place as clean as possible. (muck away trucks and readymix concrete trucks were kept clean by systematical washing when going out the jobsite).



Solution

Energy
Housing
Rail
Road
Pedestrian
Parking
Venue
Shopping
Multi-Use
Storage
Pipeline
Sewer
Treatment
Recreation

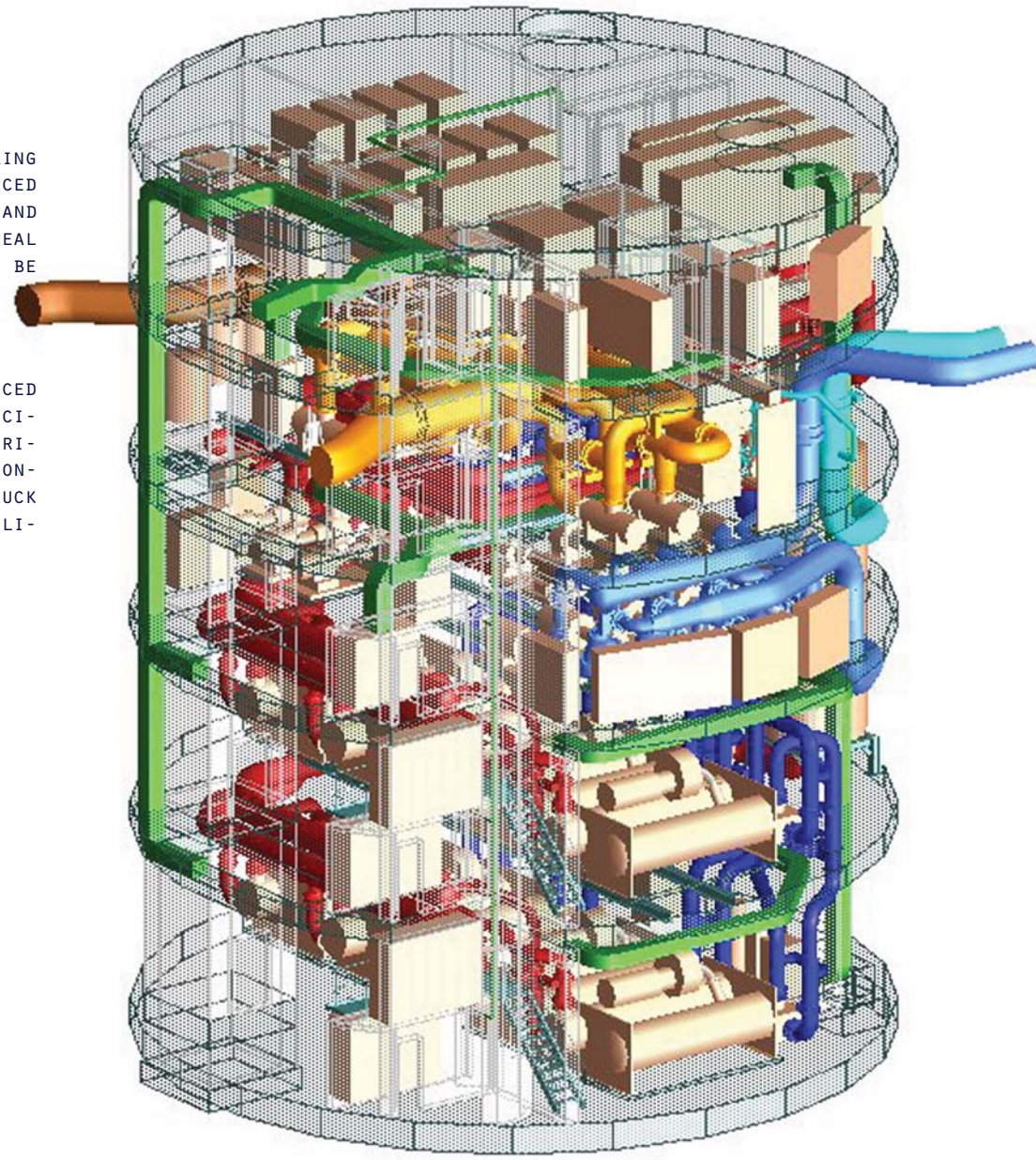
The Canada Plant uses water from the River Seine that is chilled to 5 degrees Celsius and then distributes the water throughout the city to businesses, homes, and public buildings, including the Louvre. By placing the entire plant underground the facility could be located nearer the city center thereby reducing the length of pipe and resultant energy loss.

Benefits

Reduced CFC output by consolidating cooling equipment. Increased efficiency and reduced costs. Area above facility revitalized and park upgraded, increasing aesthetic appeal of area rather than decreasing as would be the case with an above ground facility.

Keys to Success

Use of new technologies such an advanced diaphragm wall design allowing for precision control of excavation on a geometrically constrained site. Mitigation of construction impacts through the use of truck washes, and stringent controls on cleanliness in and around the job site.



Further Information
Maurice Guillaud
111, Rue Bugeaud 69006 Lyon France
mguillaud@sbc.fr

Prague Metro

Owner: Inženýring dopravních staveb

Designer: METROPROJEKT Praha
Contractor: Metrostav/Skanska

The new metro track leads from the existing terminus, Ládví to the new terminus, Letnany by way of two new stations, Strížkov, and Prosek. A temporary park-and-ride yard with 203 parking places is planned for the Strížkov Station. At the new terminus Letnany, which has two vestibules, a bus terminal station is planned with a large parking area and a park-and-ride yard with 683 parking places is also planned. The new metro station Letnany is designed for future connection to the planned Prague exhibition ground. Technical parameters: double track metro line extension, total length of 4,6 km, tunnel section constructed by NRTM method (cross section of double track tunnel is 64 m2) and partly in open air construction pit, depth below surface 11,0 – 17,0 m, ground water pressure about 0,15 MPa, geology - sedimentary stratified rocks with varying level of underground water.

Urban Issues

- Architecture
- Service
- Safety
- Public Transit
- Traffic
- Travel Time
- Noise Levels
- Pollution
- Natural hazards
- Land Use
- Serviceability
- Construction
- Multi-Use
- Intra-Transit
- Seismic
- Other

Total Cost: €517 million

Planning	Construction
May '98 - Dec. '07	May '04 - May '08

The new extension will increase the service area of the Prague metro system, easing traffic to and from the new service area.

Reduction of traffic and congestion reduces overall pollution, use of electric cars creates minimal pollution.

Solution

Energy
Housing
Rail
Road
Pedestrian
Parking
Venue
Shopping
Multi-Use
Storage
Pipeline
Sewer
Treatment
Recreation

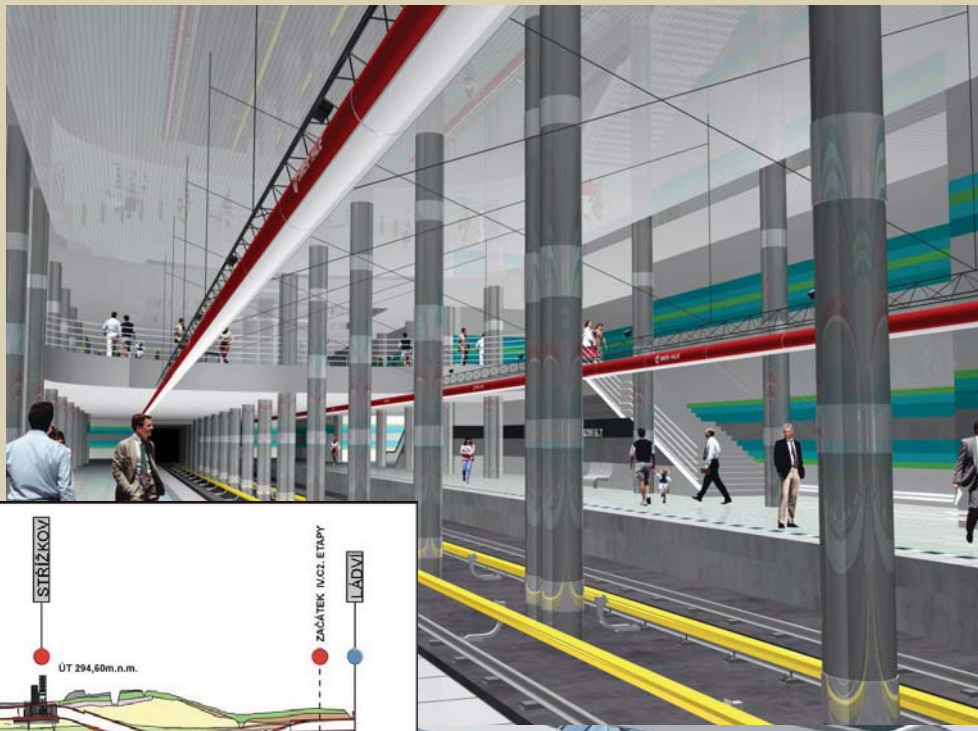
Underground double track metro rail line with an operating length of 4.42 km, and three stations. Average distance between stations is 1413 m, train set 100 m long consists of 5 metro cars. Operating commercial headway - 120 sec, designed headway - 90sec. train set capacity - 845 persons (4 standing persons/m2), operation capacity (pers./km) = 90.1 mil/year. Investment cost € 103 mil/km. electrical energy consumption 15,181 MWh/year (traction), operating expenses €1,25/car.km.

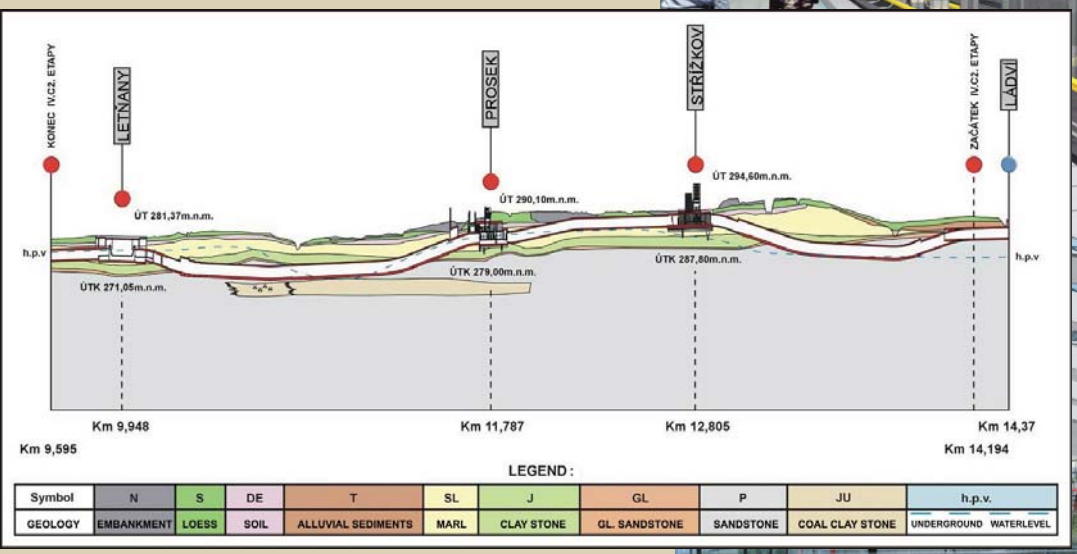
Benefits

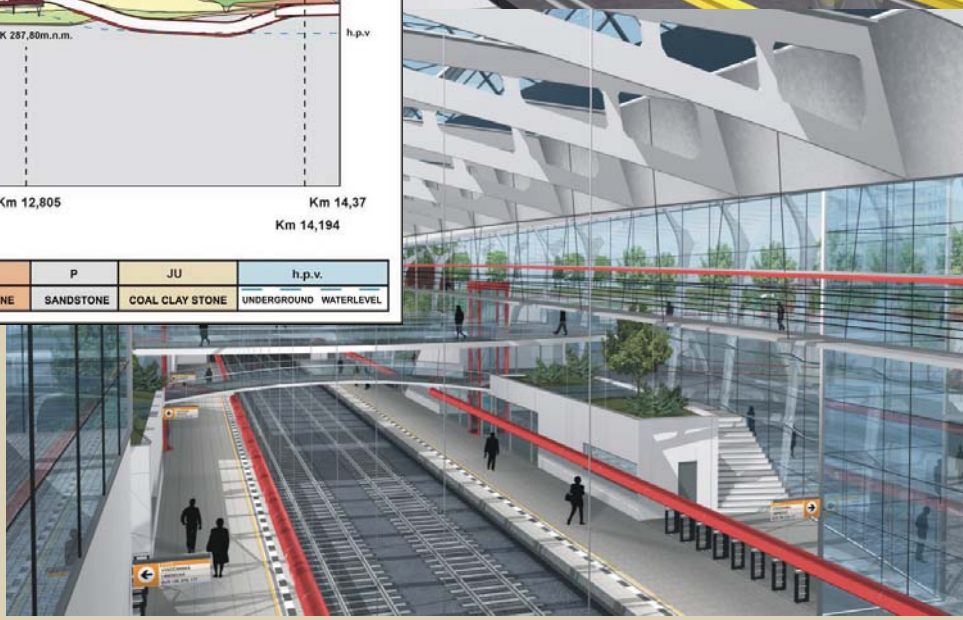
4 bus lines will be eliminated and their routes serviced by the new subway. This will result in significant cost savings as well as decreased congestion, pollution, accidents, and shorter travel times for customers.

Keys to Success

TBD







Further Information
Pavel Sramek
Metrostav, division 8
Prosecka 26, 180 00 Praha 8, Czech Republic
www.metrostav.cz
+420 286 002 220
sramek@metrostav.cz

Northside Storage

Owner: Sydney Water Corporation

Designer: Connell Wagner Pty Ltd
Contractor: John Holland Pty Ltd

Function:
Storage / transfer tunnel for prevention of pollution of Sydney Harbour by intercepting major wet weather overflows from a large urban sewer and conveying to sewage treatment plant for treatment and ocean disposal.

Total tunnel length: 21 kilometers, plus 2 kilometers of access declines and underground caverns

Main tunnel diameter: Varies from 6.6 metres to 3.8 metres

Depth below surface: Up to 187 metres

Depth below sea level: 40 metres to 100 metres

Total Volume: 512,000 m3

Ground Conditions: Medium to high strength sandstone and siltstone. Highly watercharged zones beneath sediment-filled paleochannels forming parts of Sydney Harbour

Construction method: Access declines and caverns – five roadheaders (2 Voest Alpine AM105, 2 Mitsui S300, 1 Mitsui S200). Main tunnel – four open face tunnel boring machines (Wirth 6.6 m dia., Wirth 6.3 m dia., Robbins 6.0 m dia., Wirth 3.8 m dia.)

Spoil handling and disposal: Continuous conveyor system from all 4 TBMs, outloaded to barges at two harbourside loading points (one point via 187 m vertical conveyor and dedicated 1.5 km, 3.8 m dia. conveyor tunnel), transported 18 km across Sydney Harbour by barge to railhead, loaded onto trains and transported 52 km to re-use site.

Total tunnel spoil re-used 1.8 million tonnes.

Urban Issues

- Architecture
- **Service**
- Safety
- Public Transit
- Traffic
- Travel Time
- Noise Levels
- **Pollution**
- Natural hazards
- Land Use
- Serviceability
- Construction
- Multi-Use
- Intra-Transit
- Seismic
- Other

Total Cost: $486 million (AU)

Planning
May '97 - Apr. '98

Construction
May '98 - Nov. '00

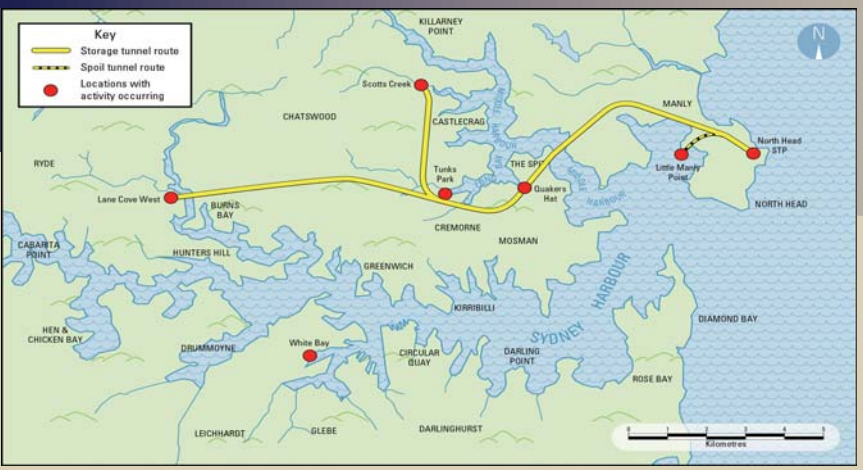
The Northside Storage Tunnel is one component of WaterPlan 21, Sydney Water's long-term strategy for ecologically sustainable wastewater management in its area of operations.

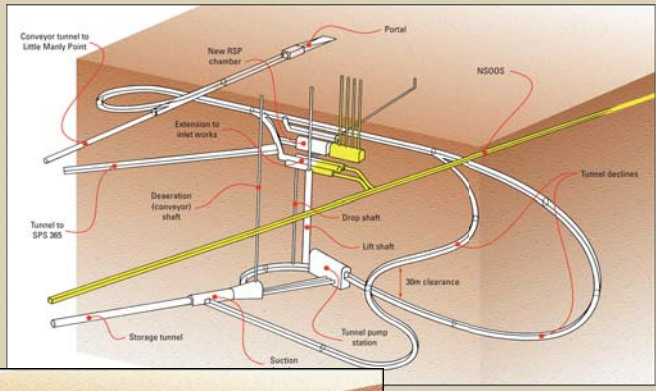
Overflow events occur in wet weather throughout the Sydney metropolitan area but it is those on the north side of Sydney Harbour that have the greatest impact on harbour water quality.

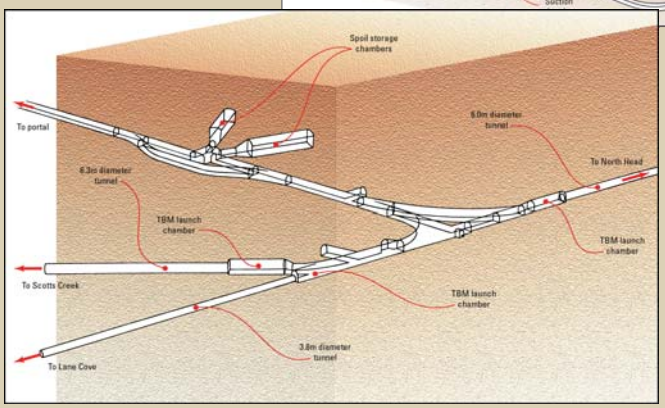
Solution

Energy
Housing
Rail
Road
Pedestrian
Parking
Venue
Shopping
Multi-Use
Storage
Pipeline
Sewer
treatment
Recreation

The locations of the four major wet weather sewerage overflows on Sydney's north side suggested that effective capture and storage could be provided by a tunnel system. The route of the main tunnel commences on the western side of the Lane Cove River and extends some 16 km easterly to North Head Sewage Treatment Plant. Approximately half way along the main tunnel, a branch tunnel extends 3.5 km northerly to Scotts Creek. As part of the project, a 1.5 km spoil conveyor tunnel was constructed between North Head and Little Manly Point on Sydney Harbour.







Benefits

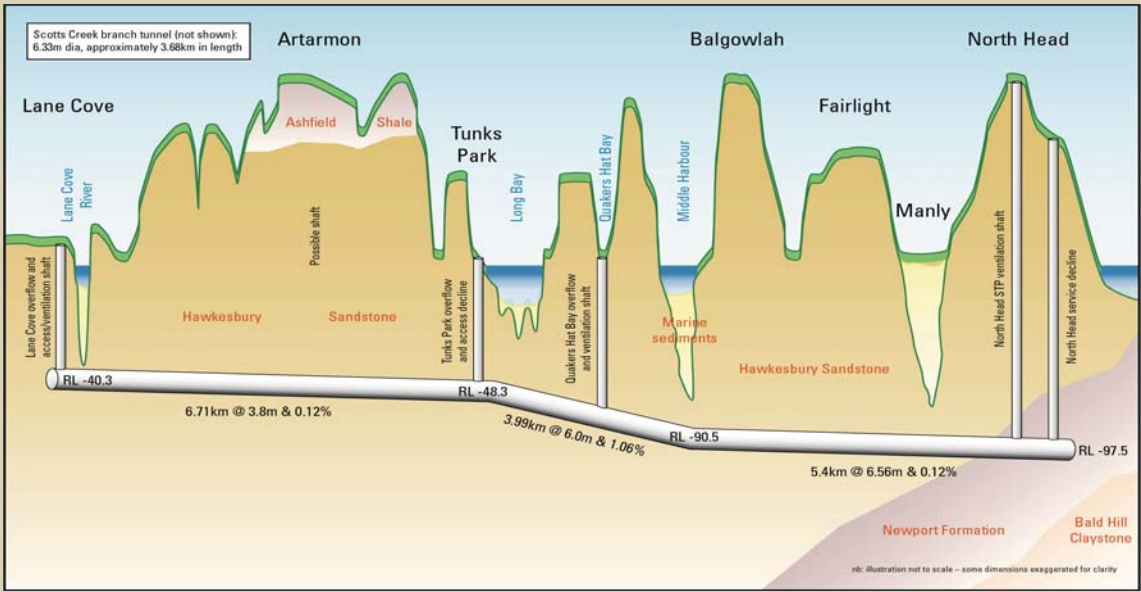
Tunnel solution provided both necessary storage capacity and means of transport of waste water to treatment plant. Flexibility of tunnel alignment allowed location beneath major overflow points. Alternative solution involving localized treatment of overflows unacceptable in highly developed residential areas.

Keys to Success

Project delivered by an alliance formed by public utility (owner), two engineering consultant companies and a construction company. This was the first public sector alliance project in Australia.

Tunnel located sufficiently deep to be totally within rock strata suitable for TBM excavation.

Constructed within highly developed urban residential area, requiring noise, dust, traffic, etc., impacts to be fully addressed. Government policies require waste minimisation to be addressed.



Further Information
Allan Henderson
Sydney Water Corporation
P.O. Box 53, Sydney South NSW 1235, Australia
www.sydneywater.com.au
(612) 9350 6400
allan.henderson@sydneywater.com.au

Marseille City Hall

Owner: Marseilles Municipality

Designer: Franck Hammoutene
Contractor: Beterem

The Mar-
seilles City Hall is a 17th
Century building on the bank of the "Vieux_port" (Old harbor).
It needed a large meeting room, very close to the main building, without any alteration of the settings around.

The underground proposal by Architect Franck Hammoutène was retained,, and won the Silver T-square Prize of architecture

The extension is built under a multi-step esplanade along the 10 m difference of level from Hôtel-Dieu hospital to Vieux Port quay, around the ancient building, the settings of which is fully preserved and greatly valorised

The fan-shaped deliberation hall offering 300 seats has been isolated from noises and vibrations on the public square on its ceiling. A high nave on its side may serve as a meeting place for representatives during assembly time, and otherwise accommodates exhibitions.

Surface 8,300 sq m

Construction in open cut

Urban Issues

- Architecture
- Service
- Safety
- Public Transit
- Traffic
- Travel Time
- Noise Levels
- Pollution
- Natural hazards
- Land Use
- Serviceability
- Construction
- Multi-Use
- Intra-Transit
- Seismic
- Other

Total Cost: TBD

Planning	Construction
TBD - TBD	TBD - TBD

Rather than occupying an open public space, the new underground deliberation hall construction preserved the park while creating an award winning architectural space below. By placing the hall underground, direct access from city hall is possible, increasing safety, and security.

A key requirement of the project was not affecting the architecture and surrounding grounds of the city hall while creating a large hall connecting to it. Therefore the facility was placed underground and the space above restored afterward.

Solution

- Energy
- Housing
- Rail
- Road
- Pedestrian
- Parking
- Venue
- Shopping
- Multi-Use
- Storage
- Pipeline
- Sewer treatment
- Recreation

TBD

Benefits

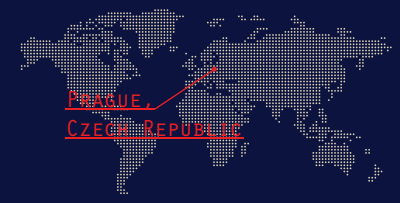
Building underground preserved the architectural qualities of this historic district while allowing for the needs of the community to be met.

Keys to Success

TBD

Further Information

TBD



Prague Ring Road

Owner: The Capital City of Prague

Designer: Satra, spol. s.r.o.
Contractor: Metrostay a.s.

The tunnel complex is located inside the city of Prague, on the western part of the City Circle Road (CCR). The initial design drafts for this section of the CCR project from the 1990s gradually switched from subsurface roads to tunnel structures.
The total length of the tunnel amounts to 1300m for the western tube and 1254m for the eastern tube. The major part of the tunnel was built by mining methods.
The main underground ventilation plant and transformer station, are located in a cavern excavated under Paví Hill, and a ventilation tunnel and shaft connect the cavern with an at-grade exhaust structure. Both main tunnel tubes are interconnected by a total of six cross passages.
Two parallel three-lane mined tunnel tubes (driven by NRTM) run from the northern portal. Both three-lane tubes split in bifurcation chambers into double-lane mined tunnels, which continue along the alignment of the City Circle Road, and single-lane branches, which are connected to Radlická Street. The cut-and-cover tunnels are connected to the mined double-lane tunnels at the portals in Radlická Street.

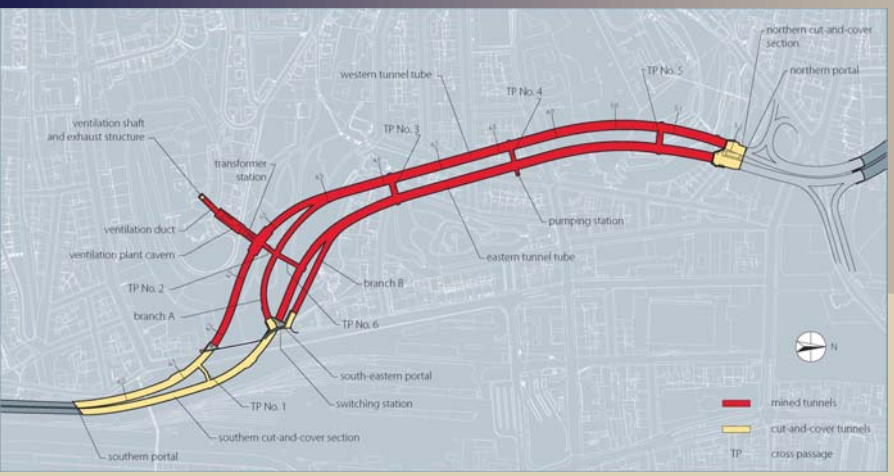
Urban Issues

- Architecture
- Service
- Safety
- Public Transit
- **Traffic**
- **Travel Time**
- **Noise Levels**
- **Pollution**
- Natural hazards
- Land Use
- Serviceability
- Construction
- Multi-Use
- Intra-Transit
- Seismic
- Other

Total Cost: €235 million

Planning	Construction
Jan. '92 - Aug. '04	Dec. '98 - Aug. '04

The basic road system of capital Prague is formed by three rings which are cut across by radial roads. Build-up of the middle ring was started by constructing a bridge across the river Vltava, and the Strahovsky tunnel. Then it was necessary to find an appropriate means of connecting these two projects. Initially a surface road arrangement was proposed. However, further analysis showed serious disadvantages to a surface solution. With an expected 50,000 cars/day, splitting of adjacent urban area by heavy transport and traffic congestion forecasted unacceptable impact to the environment through noise and air pollution. Finally an underground option was accepted by the City Authority. This tunnel connection enables smooth traffic flow that leads to a reduction in emissions, noise and travel time.



Solution

Energy
Housing
Rail
Road
Pedestrian
Parking
Venue
Shopping
Multi-Use
Storage
Pipeline
Sewer
treatment
Recreation

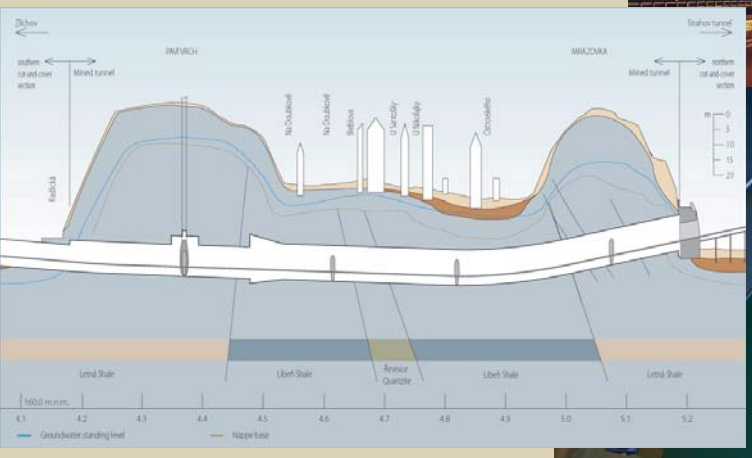
Utilizing a road tunnel complex solves the problem of providing transport in a residential area the city. In spite of its higher initial investment cost the underground solution was approved by town decision makers. Financial assessment of environmental aspects of the project proved the benefits of the proposed solution outweighed the higher costs.

Benefits

Minimized disruption to surrounding residential neighborhood while enabling high speed access throughout the area. Reductions in air and noise pollution. Lowered accident frequency since traffic in the tunnel is unaffected by rain or snow.

Keys to Success

Use of new technologies, such as the NATM. High tech tunnel monitoring and command center, able to remotely deal with emergencies within the tunnel and provide accurate information to emergency crews as to the location of any problems.

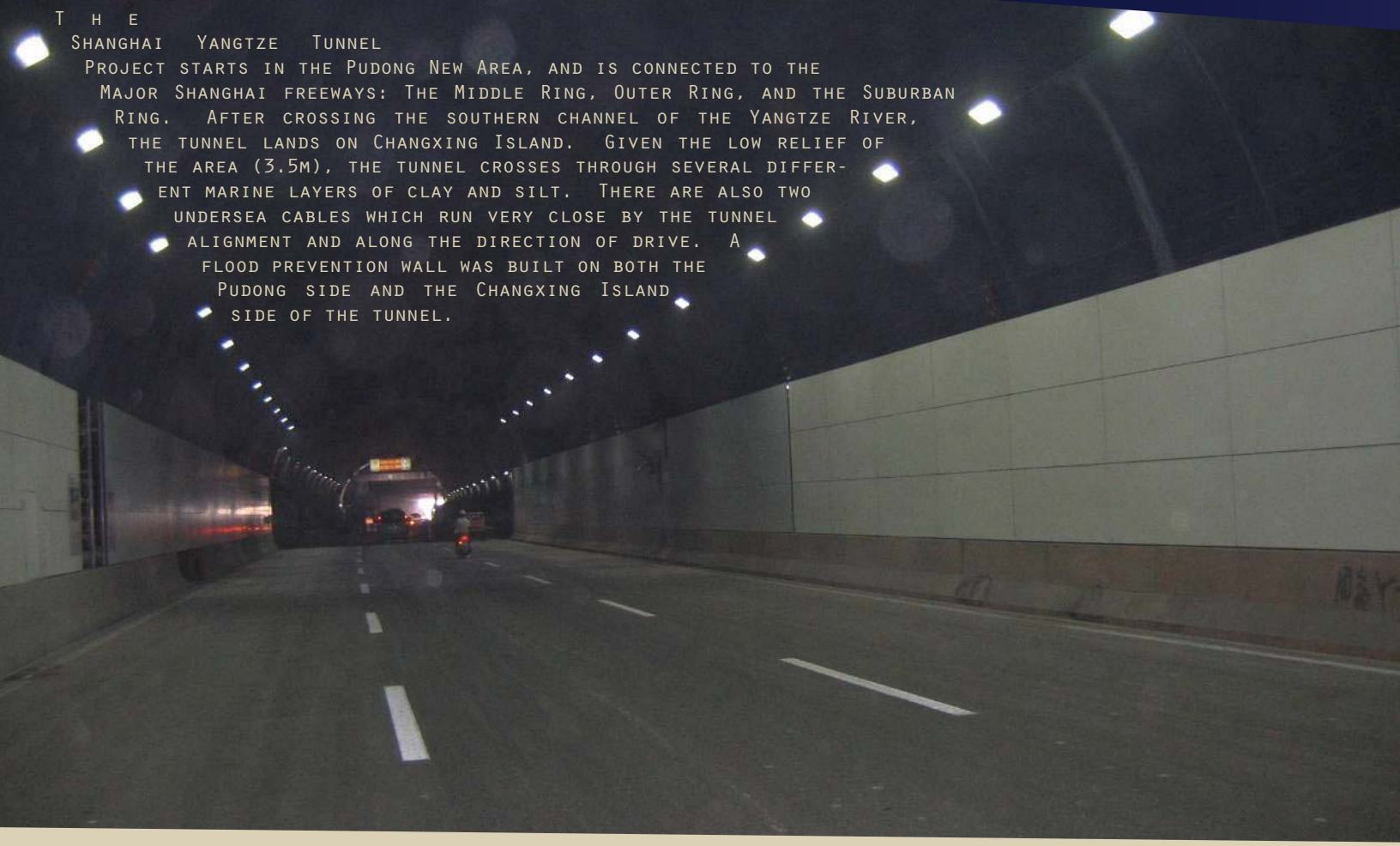


Further Information
Pavel Sourek
Satra, spol. s.r.o.
Sokolska 32, 120 00 Praha 2 - Nove Mesto,
Czech Republic
www.satra.cz
+420 296 337 149

Yangtze River

Owner: Shanghai Changjiang Tunnel & Bridge Development Co.

Designer: STEDI
Contractor: Shanghai Tunnel Engineering Co.



The Shanghai Yangtze Tunnel Project starts in the Pudong New Area, and is connected to the Major Shanghai freeways: The Middle Ring, Outer Ring, and the Suburban Ring. After crossing the southern channel of the Yangtze River, the tunnel lands on Changxing Island. Given the low relief of the area (3.5m), the tunnel crosses through several different marine layers of clay and silt. There are also two undersea cables which run very close by the tunnel alignment and along the direction of drive. A flood prevention wall was built on both the Pudong side and the Changxing Island side of the tunnel.

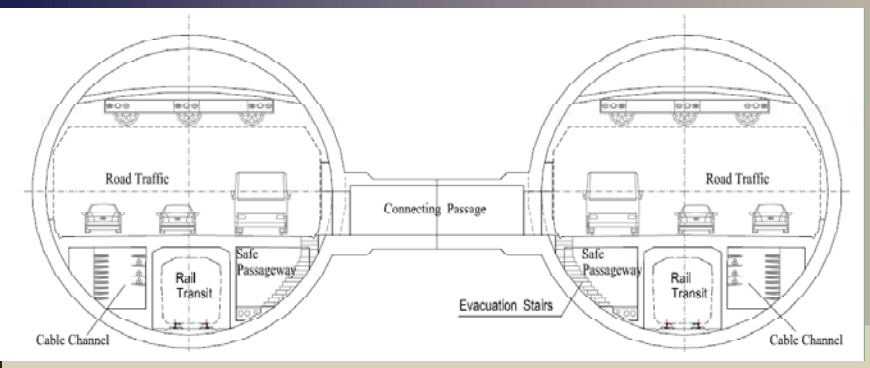
Urban Issues

- Architecture
- **Service**
- Safety
- Public Transit
- Traffic
- **Travel Time**
- **Noise Levels**
- **Pollution**
- Natural hazards
- Land Use
- Serviceability
- Construction
- Multi-Use
- Intra-Transit
- Seismic
- Other

Total Cost: 6.3 Billion RMB

Planning	Construction
1993 - 2004	2004 - 2009

The Shanghai Yangtze River Tunnel is located at the mouth of the Yangtze River in the Northeast of Shanghai. The tunnel is has become a major part of the national expressway system. The tunnel is part of the largest bridge and tunnel combination project in the world. The tunnel will move traffic quickly from the north of the Jiangsu Province, and increase economic development in the Yangtze river delta.



Solution

Energy
Housing
Rail
Road
Pedestrian
Parking
Venue
Shopping
Multi-Use
Storage
Pipeline
Sewer
treatment
Recreation

The internal finished diameter of the tunnel is 13.7m. The tunnel includes three lanes and a deck below them to support future rail traffic. The left and right sides of the tunnel are used for evacuation and cable space respectively. The area above the roadway is used for air exchange ducts.

Benefits

No disruption to waterway traffic. Low environmental impact, and reduced noise, vibration and pollution versus traditional excavation methods.

Keys to Success

Use of two extremely large slurry TBMs with manned entry at up to 5.5 bar. Special wear protection to reduce the need for manned entries. Double pressure seals for the main bearing.

Further Information
Hehua Zhu
Department of Geotechnical Engineering, Tongji University
Shanghai 200092, China
+86 21 65985014
zhuhehua@tongji.edu.cn

Opera house Carpark

Owner: TBD

Designer: Dr Pells, Mr. Colefax, Mr. Barry
Contractor: Thiess Pt Ltd

After the opera house was completed in 1973 there was a need for nearby parking. A 12 story, free standing, underground, double helix structure was built nearby to meet the requirements. The cavern has an outer diameter of 71.2m with a central rock core 36.4m in diameter, with a 7-8m thick crown pillar. The cavern is 34m deep and has four 6m wide tunnels cut through the core pillar to provied cross ceonnections between helixes. the structure itself is free standing within the cavern, which is supported by rock anchors and dowels. The roof is covered with a 150mm layer of shotcrete. The 34m high walls are unlined and there are no formed concrete linings on any of the access and ventilation tunnels or any part of the main cavern.

Urban Issues

- Architecture
- Service
- Safety
- Public Transit
- Traffic
- Travel Time
- Noise Levels
- Pollution
- Natural hazards
- Land Use
- Serviceability
- Construction
- Multi-Use
- Intra-Transit
- Seismic
- Other

Total Cost: $40+ million (AU)

Planning	Construction
1988 - 1990	1992 - 1994

A short access tunnel so as to minimize the perception by patrons that they were driving deep into the earth. A clear span of 17.4m to allow for two rows of parked cars and a central aisle

Excavation technique had to perform to established noise and vibbration constraints established by the Department of Public Works. Pedestrian access from the parking station to the forecourt of the Opera House.

Solution

Energy
Housing
Rail
Road
Pedestrian
Parking
Venue
Shopping
Multi-Use
Storage
Pipeline
Sewer
treatment
Recreation

One of the largest shallow rock caverns in the world with a span of between 17.5 and 19m with a 7-9m thick crown pillar of weathered sandstone supported by tensioned and untensioned anchors as well as a 150mm skin of reinforced shotcrete. The double helix design allows for quick access and egress from events at the Opera House.

Benefits

Allowed easy parking access to a world renowned structure and Sydney landmark.
Did not disrupt surrounding area including harbour, and met all noise and vibration requirements during construction.

Keys to Success

Fully privately financed.
Worlds first double helix underground parking structure.
Large spans supported in sandstone.

Further Information
Roads and Traffic Authority, NSW
Level 4, 260 Elizabeth Street, Surry Hills NSW 2010 Australia
www.rta.nsw.gov.au
Mark Andrew
(02)9218 6225
mark_andrew@rta.nsw.gov.au

Expo Power Station

Owner: Shanghai Municipal Electric Co.

Designer: XD-AD
Contractor: TBD

The Shanghai World Expo 500kV Underground transmission and Substation, situated in the central district of Shanghai is an important project leading up to the 2010 Shanghai World Expo. The project consists of a four level, 130m diameter shaft. The total depth of the shaft is 34m and it was constructed in difficult marine layers varying from soft clay and sand; with a groundwater table approximately 0.3-1.5m below the ground surface. The excavation was made possible through the use of Cylidrical diaphragm walls with a thickness of 1.2m and length of 57.5m. Shaft-grouted piles with a length of 48.6m were used to combat uplift water pressures.

Urban Issues

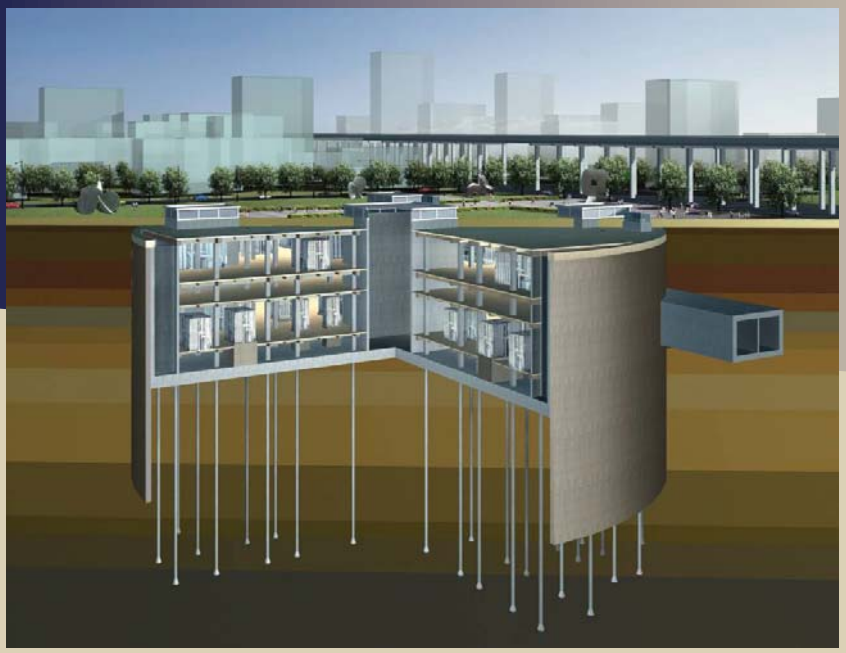
- Architecture
- **Service**
- Safety
- Public Transit
- Traffic
- Travel Time
- Noise Levels
- Pollution
- Natural hazards
- **Land Use**
- Serviceability
- Construction
- Multi-Use
- Intra-Transit
- **Seismic**
- Other

Total Cost: 480 Million RMB

Planning	Construction
Jul. '04 - Dec. '05	Dec. '05 - Jun. '09

The Shanghai World Expo Underground Transmission and Substation (SWEUTS) is located near the heart of Shanghai, therefore land is at a premium. Therefore, the substation will be completely underground while above, a sculpture park is planned. The already strained power gride of Shanghai will be greatly alleviated by the startup of the SWEUTS. The station will also supply reliable power to the 2010 World Expo.

The Shanghai area is seismically active and therefore any major structure must be designed to withstand seismic loads. By placing SWEUTS underground the station is protected and so is the public



Solution

- Energy
- Housing
- Rail
- Road
- Pedestrian
- Parking
- Venue
- Shopping
- Multi-Use
- Storage
- Pipeline
- Sewer
- treatment
- Recreation

The Shanghai World Expo Underground Power Station will supply up to 500kV of electrical power to the downtown Shanghai area and help to guarantee the stability of the already strained power grid during the 2010 Shanghai World Expo.

Benefits

The first 500kV underground power station in China, utilizing most advanced technology and techniques available. The station will guarantee a continuous power supply to the 2010 World Expo.

Keys to Success

Economic use of space in a very dense area, creation of public space while allowing the substation to operate safely and securely.

Further Information
Weidong Wang
East China Architectural Design & Research Institute Co.
Shanghai, China
http://www.xd-ad.com.cn/index.jsp
0086 32 33134530
jiangbin_wu@ecadi.com

Bund Tourist Tunnel

Owner: TBD

Designer: TBD
Contractor: TBD

Bund Tourist Tunnel is located under the Huangpu River in Shanghai downtown.
The Puxi entrance is located in the north side of Chen Yi Square and bordering the Huangpu River. The Pudong entrance is located in south side of the Oriental Pearl TV Tower and in front of the International Conference Center.
Not only is the Bund Tourist Tunnel a tourist attraction but also it is an arterial cross-strait traffic route for Huangpu River. The tunnel is 6.76 meters in diameter, and 646.7 meters long. The tunnel applied a number of new technologies, and broke several records. Excavation was accomplished through the use of an articulated EPB shield machine. The 26.2 meters depth of the excavation pit is the deepest of its type in Shanghai.

Urban Issues

- Architecture
- Service
- Safety
- **Public Transit**
- Traffic
- **Travel Time**
- Noise Levels
- Pollution
- Natural hazards
- Land Use
- Serviceability
- Construction
- Multi-Use
- Intra-Transit
- Seismic
- Other

Total Cost: 500 Million RMB

Planning	Construction
TBD - TBD	Feb. '98 - Apr. '00

The Bund Tourist Tunnel provides a conduit to allow pedestrians to quickly crooss the Huangpu River. The total transit time is between 2.5 and 5 minutes and the tunnel can handle up to five thousand passengers per hour. Easing traffic in downtown Shanghai and decreasing travel time during traffic jams and rush hour.

Solution

Energy
Housing
Rail
Road
Pedestrian
Parking
Venue
Shopping
Multi-Use
Storage
Pipeline
Sewer
treatment
Recreation

The Bund Tourist tunnel employs small automated train cars which use advanced monitoring technologies to ensure optimal service. The tunnel has become an important tourist attraction with over 100,000 riders in the first week of October, 2000.

Benefits

Quickly transports pedestrians across the Huangpu River.
Use of images, music, and lights create an entertaining space while moving passengers efficiently.

Keys to Success

Use of an articulated EPB machine to excevate the tunnel allowed for minimal disturbance during construction.

Further Information
Weidong Wang
East China Architectural Design & Research Institute Co.
Shanghai, China
http://www.xd-ad.com.cn/index.jsp
0086 32 33134530
jiangbin_wu@ecadi.com