TTC Presentation to the Sheppard Transit Expert Advisory Panel

Date: February 24, 2012

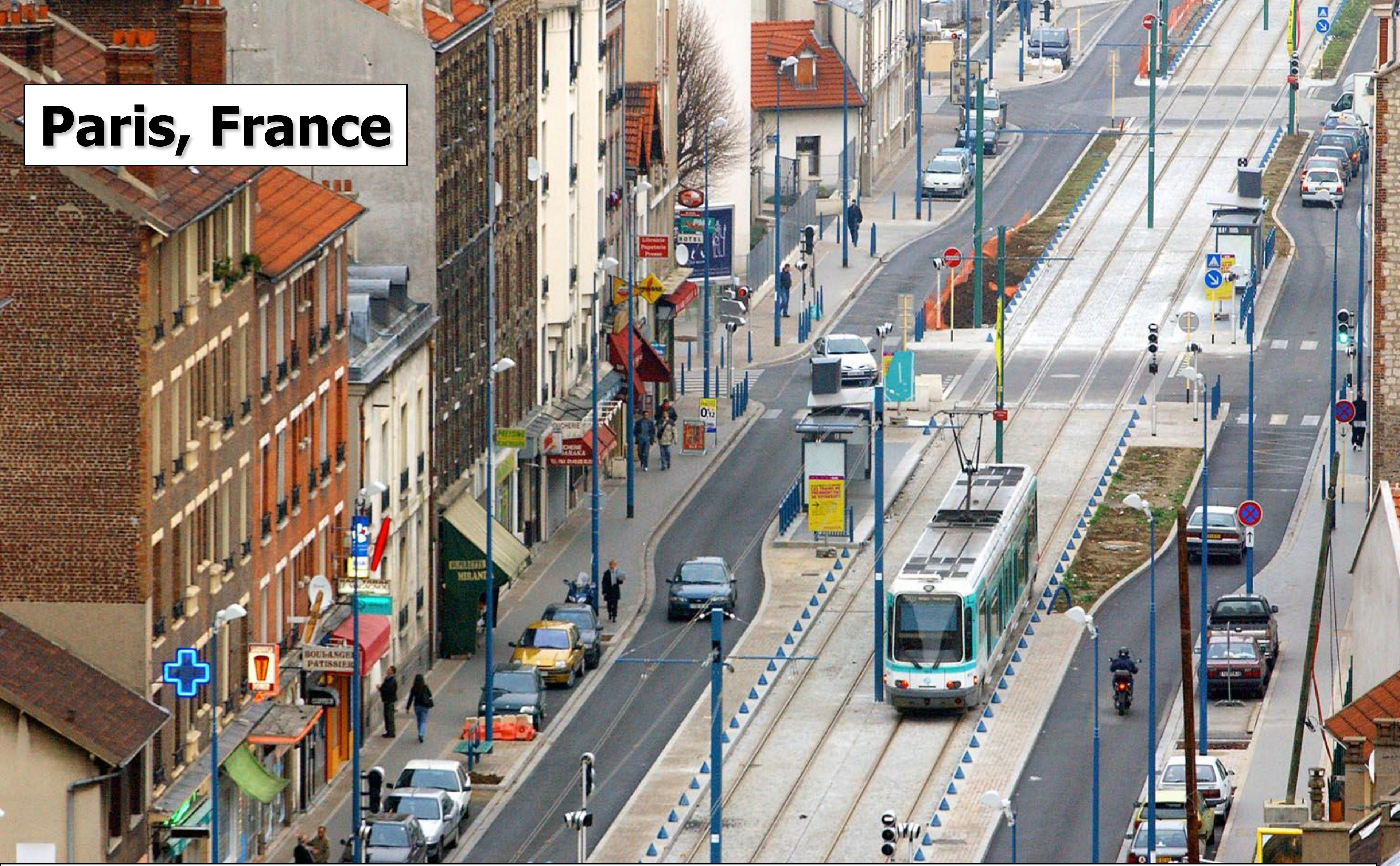
Part 1

LRT in Major Cities


Paris, France
Line T3 – 8 km, 110,000 psgrs/day

Paris, France
30
Line T3 – 8 km, 110,000 psgrs/day

Paris, France



Line T1 – Opened 1992, 30-million riders/year

Grenoble, France

Four lines, 1987-2007

Budapest, Hungary

Grand Boulevard – 54m long trams

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Cologne, Germany

40 km of centre roadway operation

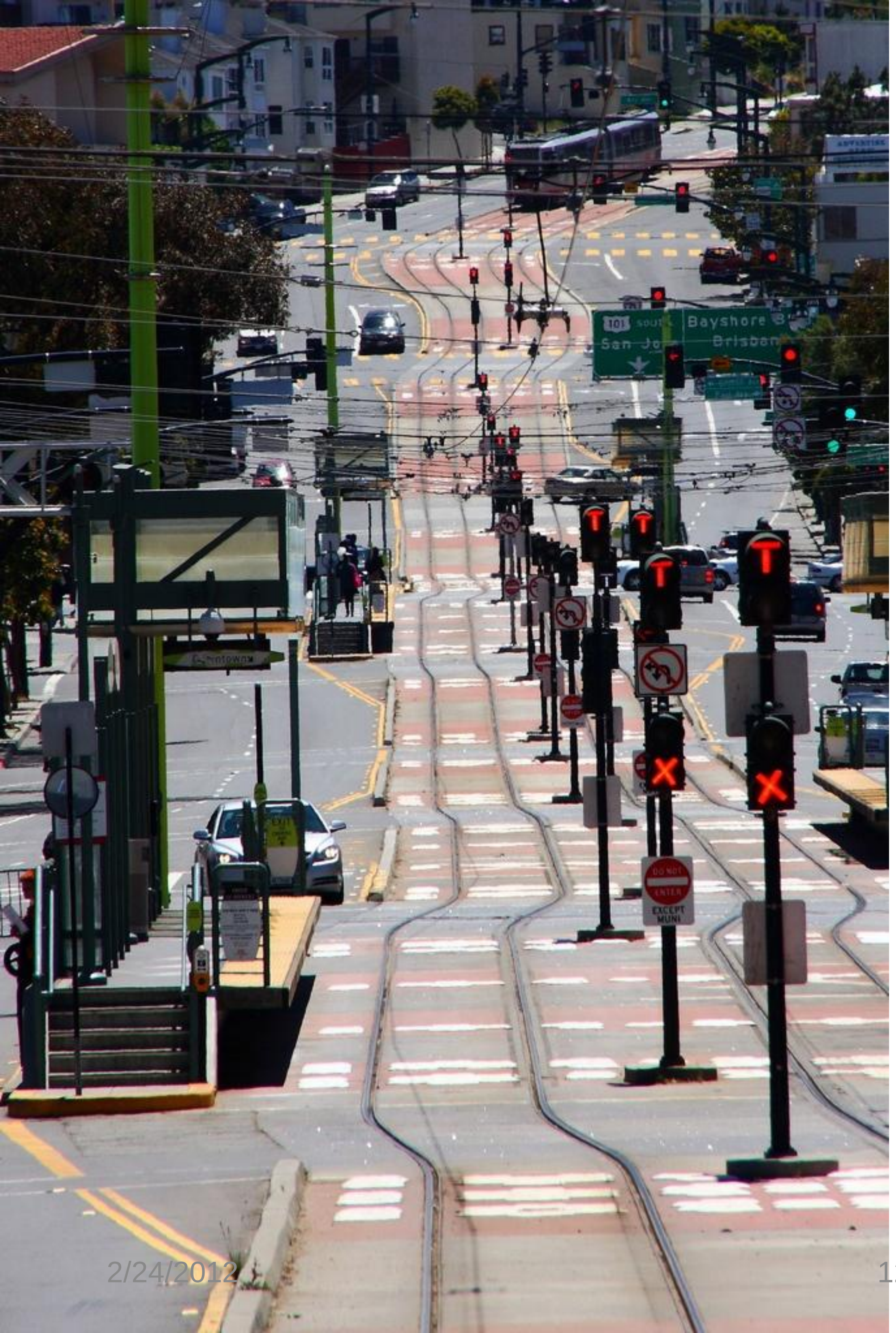
Berlin, Germany

Rebuilt, upgraded post-reunification


Dresden, Germany
Rebuilt, upgraded post-reunification

Barcelona, Spain

Six lines, 20-million psgrs/yr



San Francisco, USA

T-Third – 8 km – opened 2007

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Nice, France

Opened 2007, 90,000 psgrs/day in 2011

St Petersburg, Russia

60 km in centre of road

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Kayseri, Turkey

Opened 2009, 18 km, all in centre of road

Part 2

Underground Construction

International Comparisons

The Madrid Experience

UNDERGROUND CONSTRUCTION INTERNATIONAL COMPARISONS

COMPARING SUBWAY COSTS AND SCHEDULE

- Meaningful cost and schedule comparison of subway projects in different countries constructed at different times is complex
- Requires normalization for political/governmental differences, technical/operational differences and economic/business differences, e.g.:
  - Extent of program and reliability of funding/cash flow
  - Length of line in tunnel vs. surface or elevated
  - Local construction safety regulations
- Study by US Federal Transit Administration used to determined cost per kilometre for design and construction of recent subway projects, worldwide

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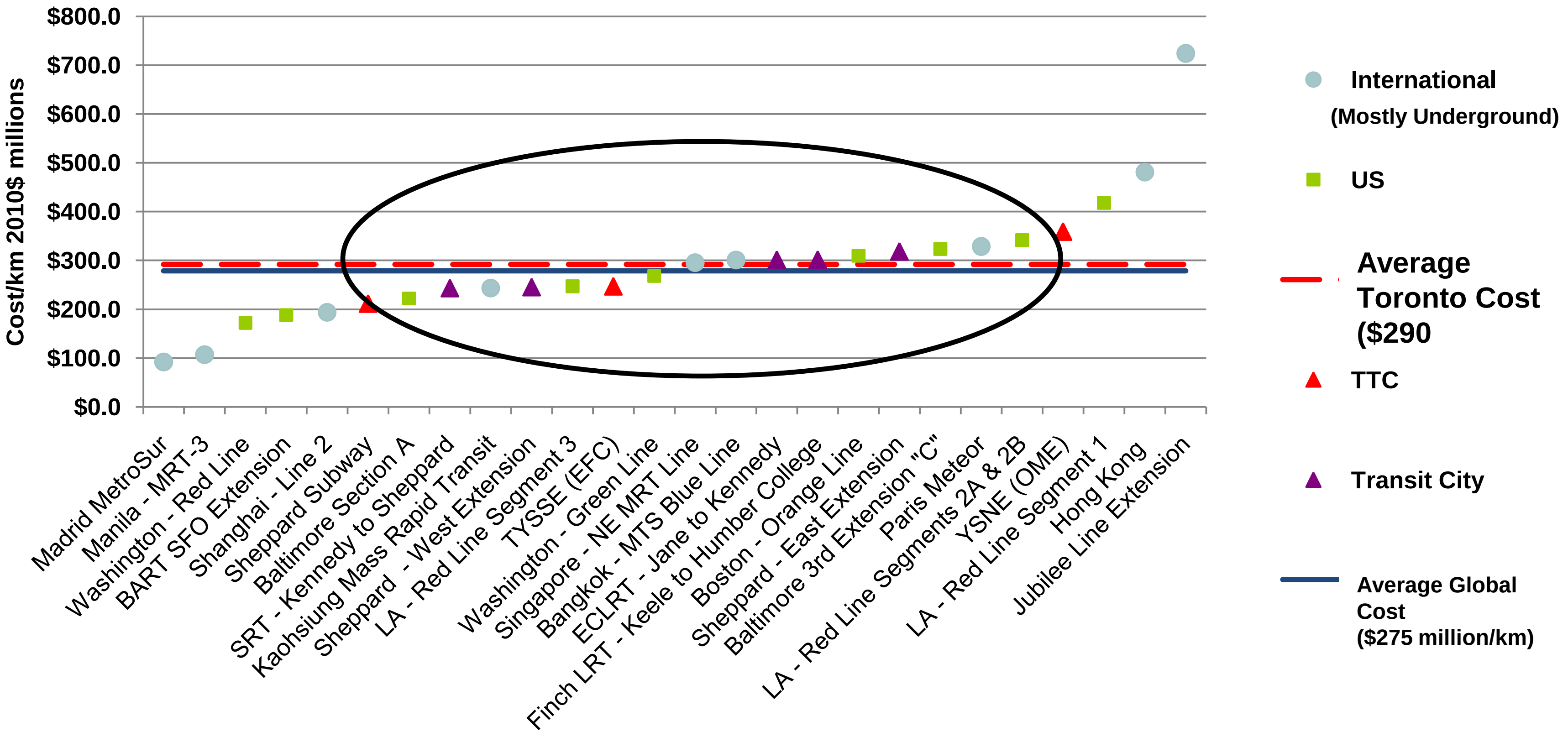
FTA STUDY OF SUBWAY COSTS – WORLDWIDE
- TTC costs slightly higher than average



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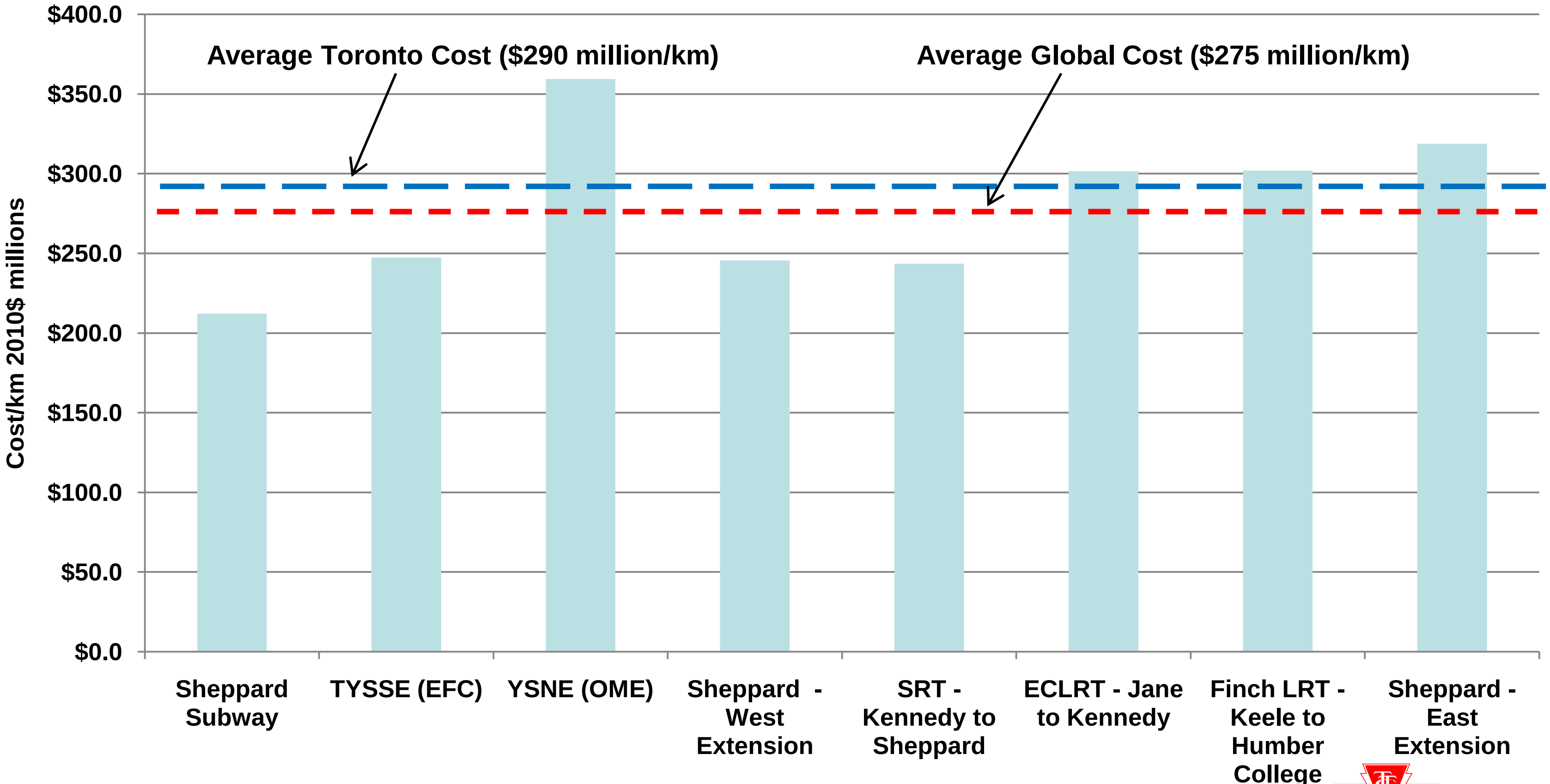
TORONTO PROJECT COST COMPARISON



MAJOR SUBWAY COST VARIATION DRIVERS - 1

- Station length, spacing and type
  - Underground stations are most expensive component of a subway
  - More stations per km = higher overall cost per km
  - Longer stations = higher overall cost per km
  - More terminal/interchange stations = higher overall cost per km
- Proportion of project in tunnel
  - Construction of transit underground is typically 4 times the cost/km of surface and 2 times the cost/km of elevated
  - Higher proportion of project in tunnel = higher overall cost per km
  - Direct comparison of overall project cost/km between projects with significantly different proportions in tunnel is not valid

MAJOR SUBWAY COST VARIATION DRIVERS – 2

- Geotechnical conditions
  - Tunnel advance rate – typical average can vary from .25m/hour to 2m/hour (an 8x factor), depending upon geology and tunnel diameter
  - Mitigation of existing structure settlement, especially with high water table
- Extent of existing underground infrastructure
  - Impacted utilities must be relocated and existing structures may have to be underpinned to prevent settlement
- Market conditions and competition for resources
  - Tunnel construction is highly specialized and the number of experienced contractors/personnel is limited
  - Simultaneous construction of multiple subway projects, worldwide, can raise bid prices

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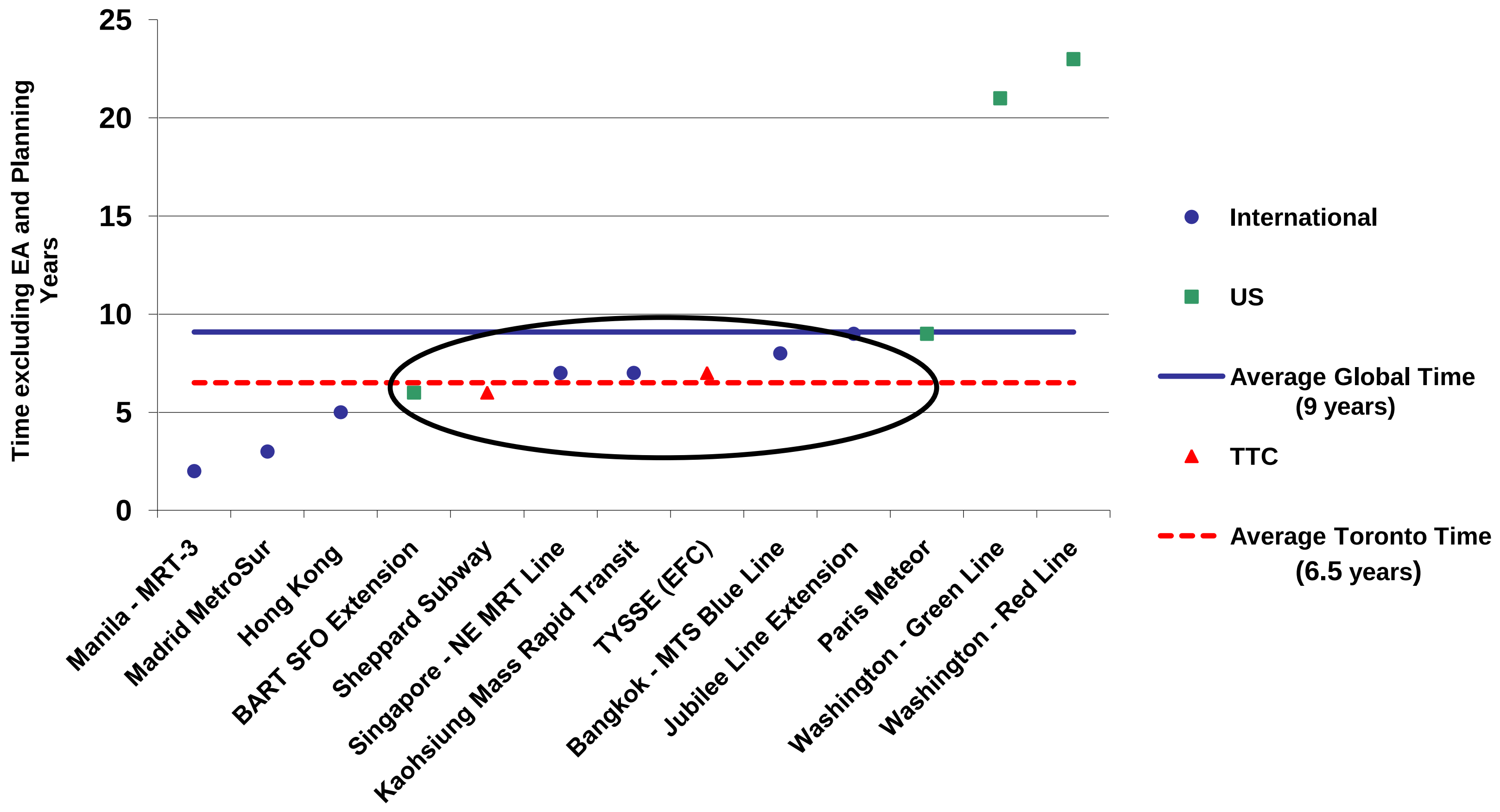
SUBWAY DESIGN AND CONSTRUCTION TIMES

TTC Construction time is faster than International Average



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WHY DO SUBWAYS TAKE SO LONG TO BUILD?

- Planning and Environmental Assessment – typically 2 years
- Design and property acquisition – typically 2 years
- TBM launch area construction – typically 1 year
- Tunnel boring – typically 2 years
- Station construction and fit-out – typically 3 years
- Systems testing and commissioning – typically 1 year
- Actual durations depend upon specific project scope
- Above durations take advantage of typical opportunities for overlapping design and construction activities
- **Typical duration, planning and EA** **2 years**
- **Typical duration, design and construction** **9 years**
- **Typical duration, total** **11 years**

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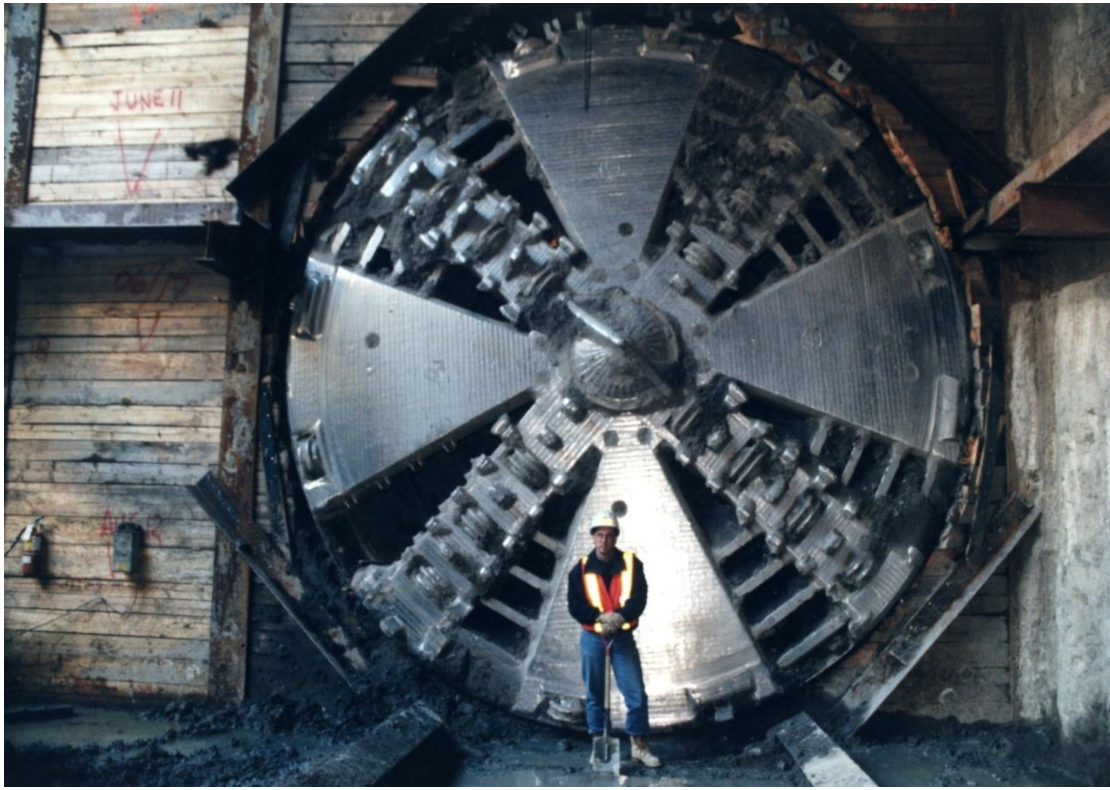
TBM LAUNCH AREA CONSTRUCTION

- Launch Area includes launch shaft and tunnel construction support site
- Construction support facilities include tunnel liner storage and handling, muck handling and drying, concrete making and delivery, TBM power substation etc.

TUNNEL BORING

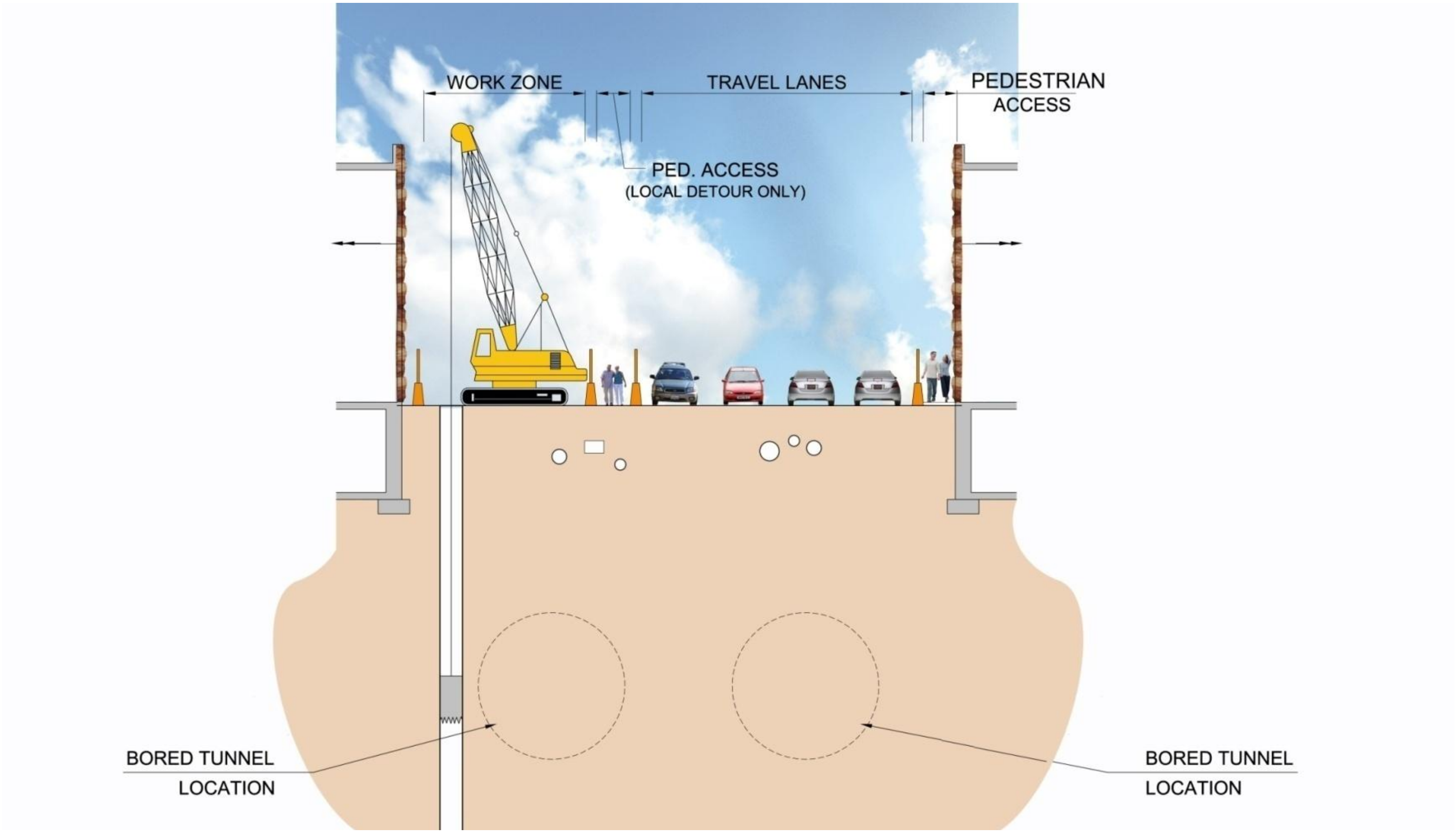
- Duration depends on length of tunnel, average advance rate and number of TBMs
- Number of TBMs increases for longer tunnels and to offset slow advance
- Hence, typical 2-year duration



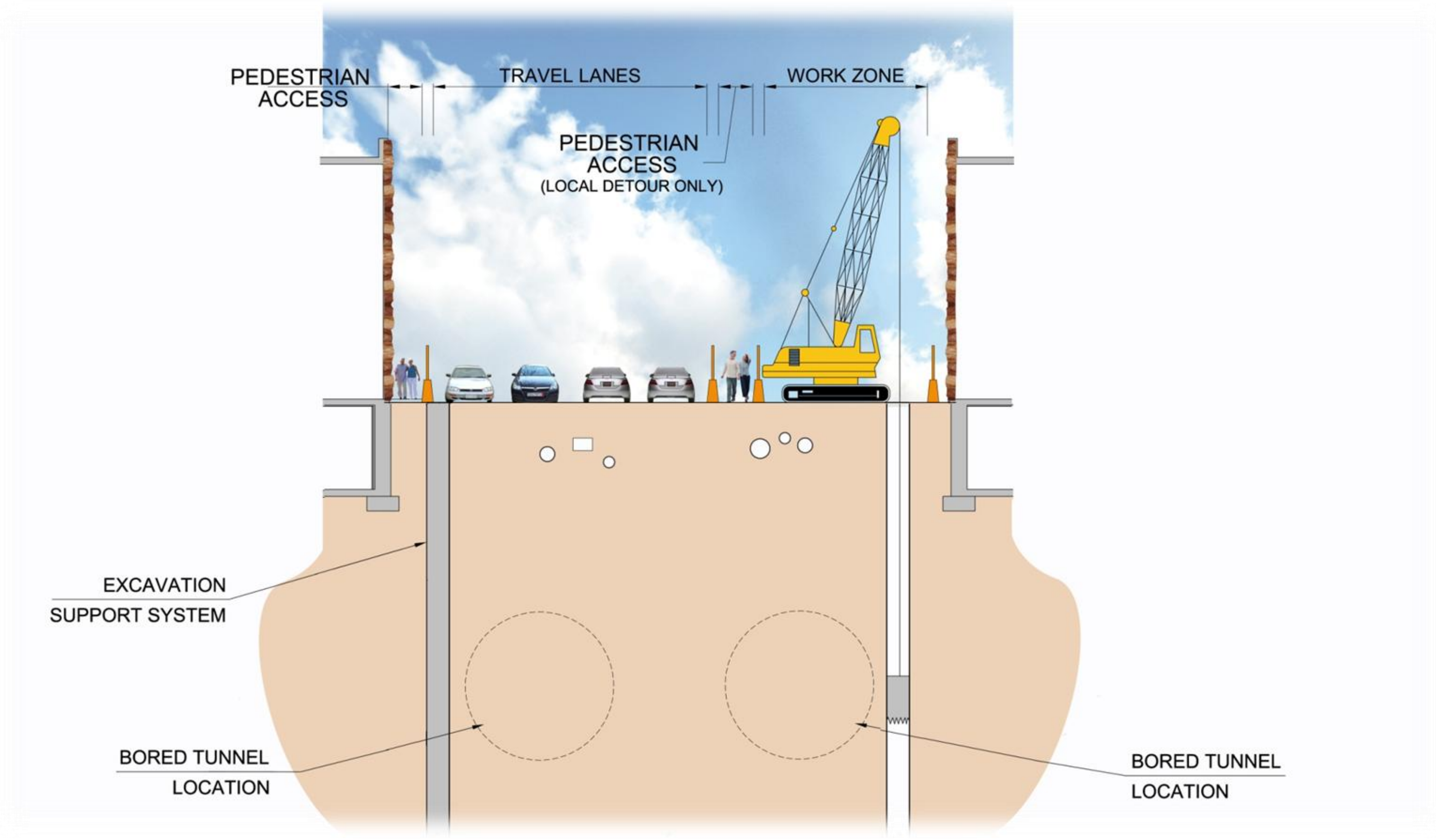
STATION CONSTRUCTION AND FIT-OUT

- Cut-and-cover construction includes:
  - Traffic management
  - Utility relocation
  - Headwalls and sidewalls
  - General excavation and shoring
  - Base, mezzanine and roof slabs
  - Entrances
  - Platforms and stairs
  - Tunnel ventilation facilities
  - Escalators and elevators
  - Plumbing and electrical
  - Architectural finishes

CUT-AND-COVER CONSTRUCTION WITH DECKING - 1



CUT-AND-COVER CONSTRUCTION WITH DECKING - 2



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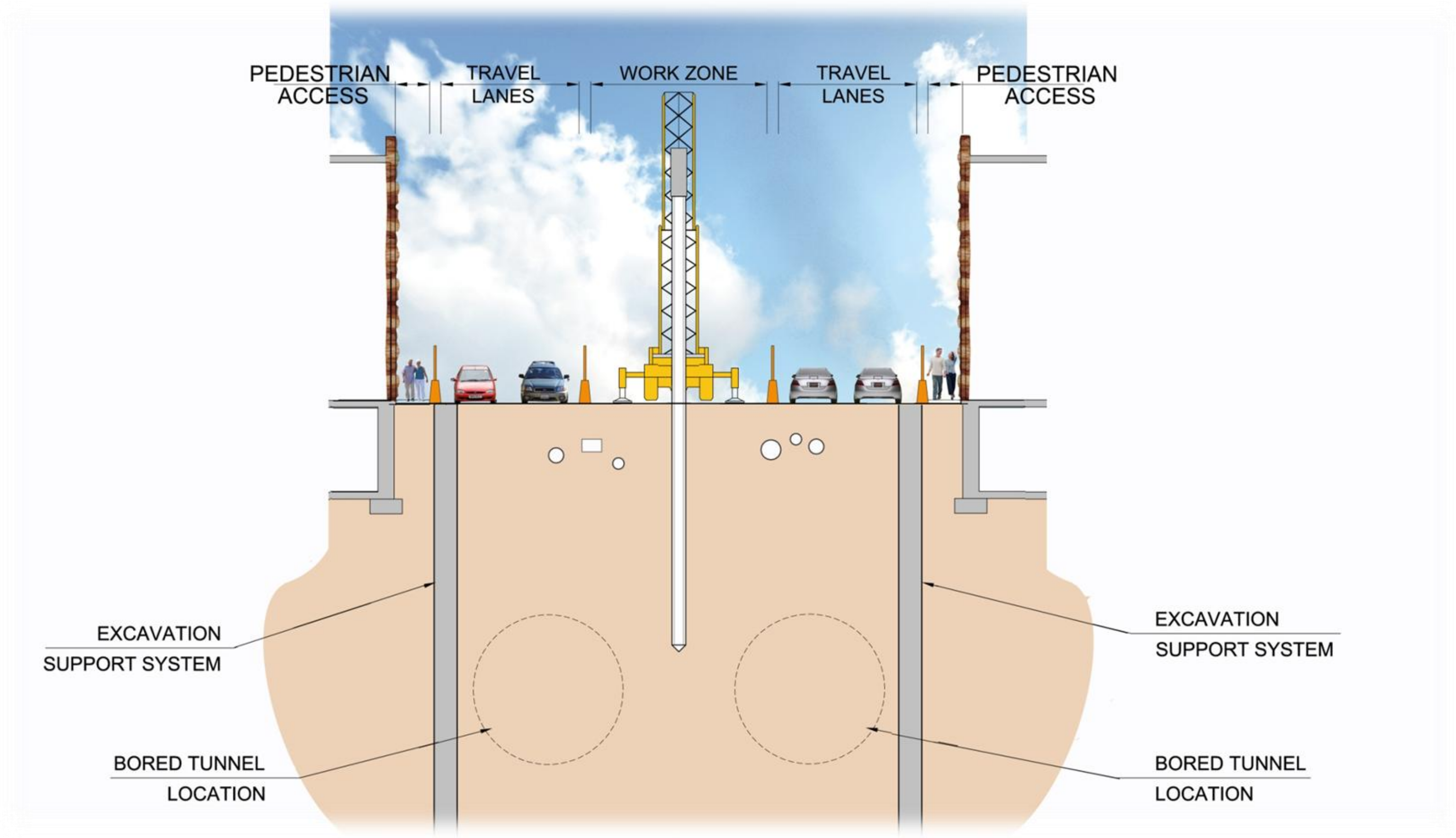
CUT-AND-COVER CONSTRUCTION WITH DECKING - 3



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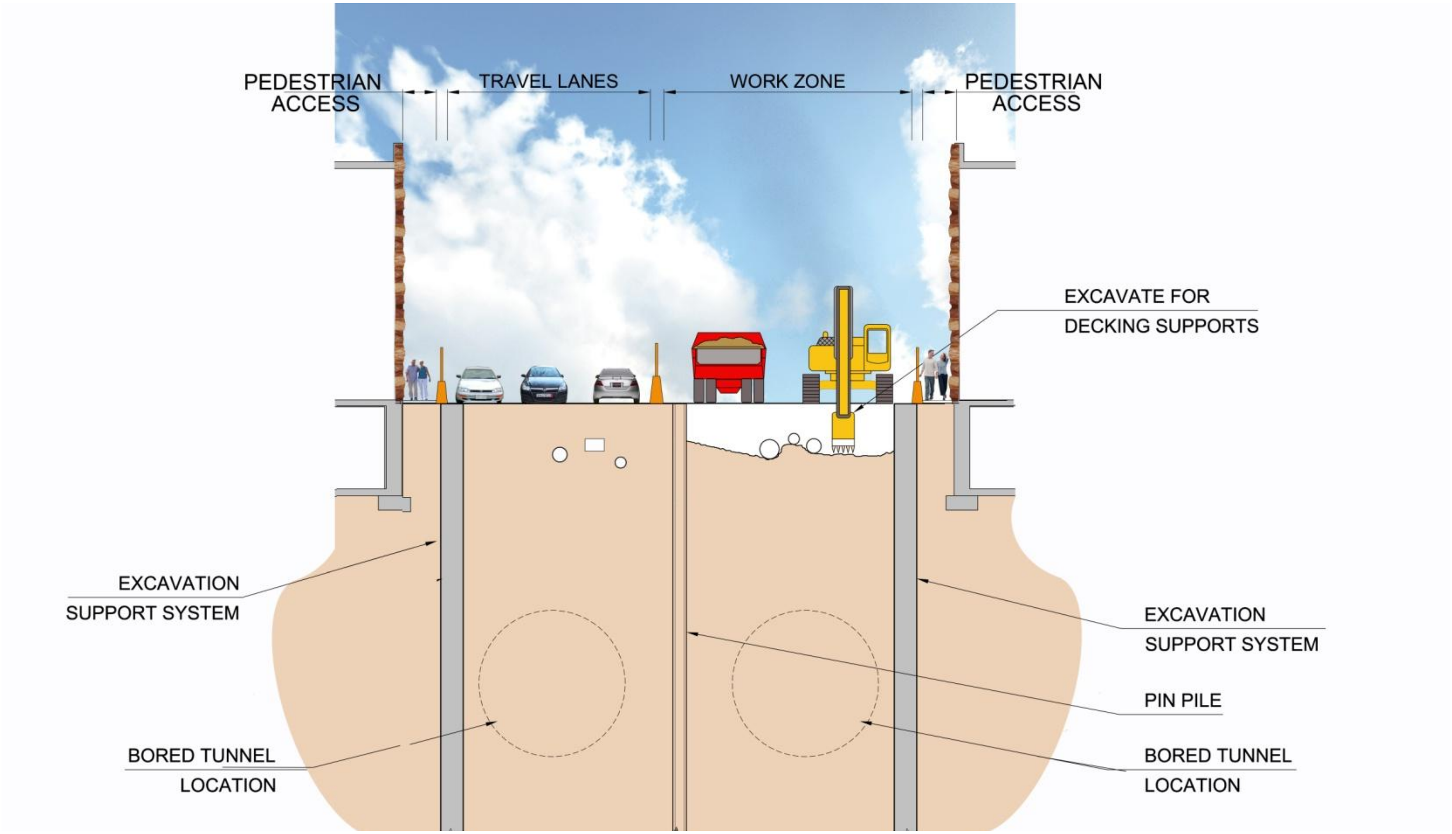
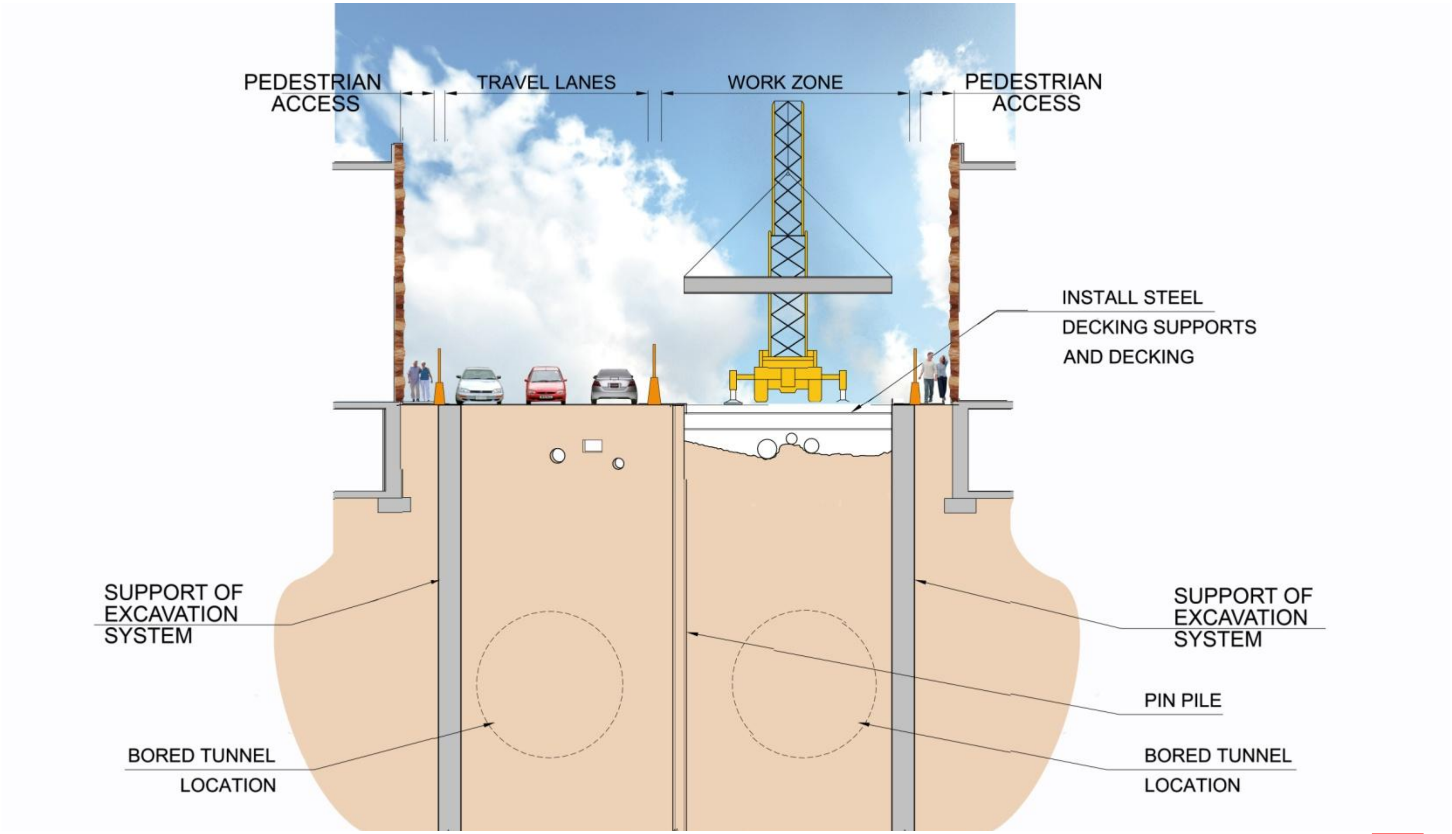
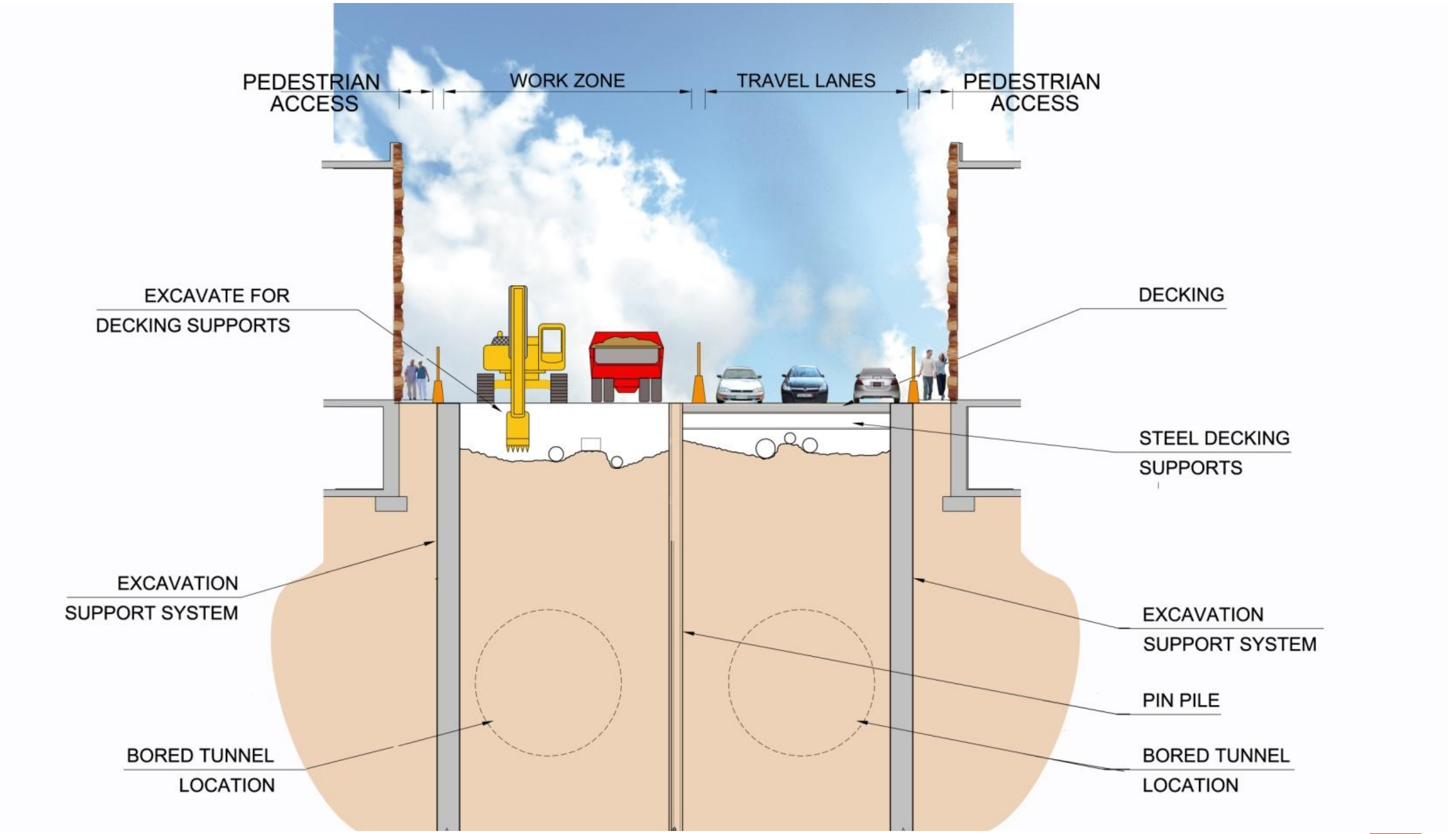
CUT-AND-COVER CONSTRUCTION WITH DECKING - 4



CUT-AND-COVER CONSTRUCTION WITH DECKING - 5



CUT-AND-COVER CONSTRUCTION WITH DECKING - 6



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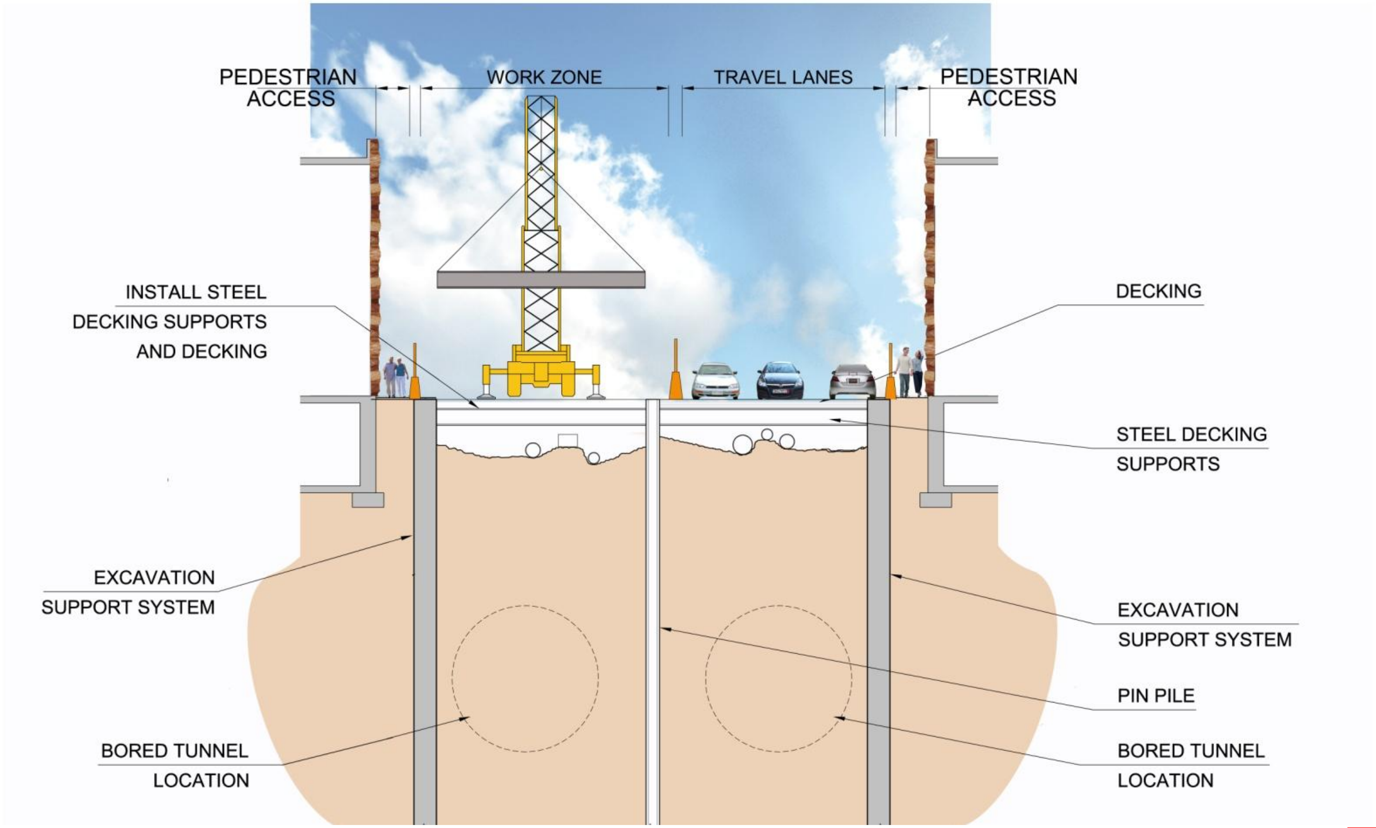
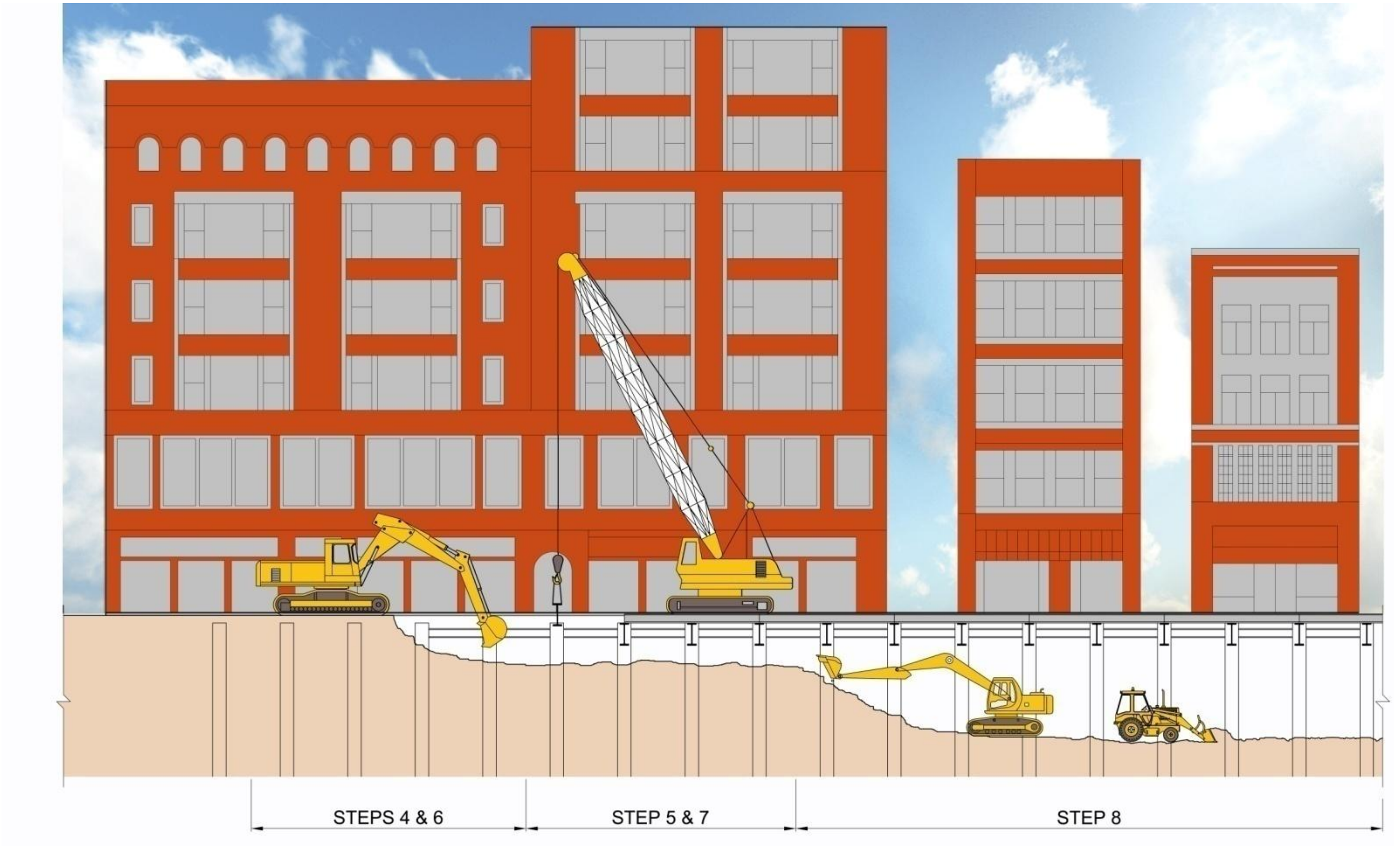
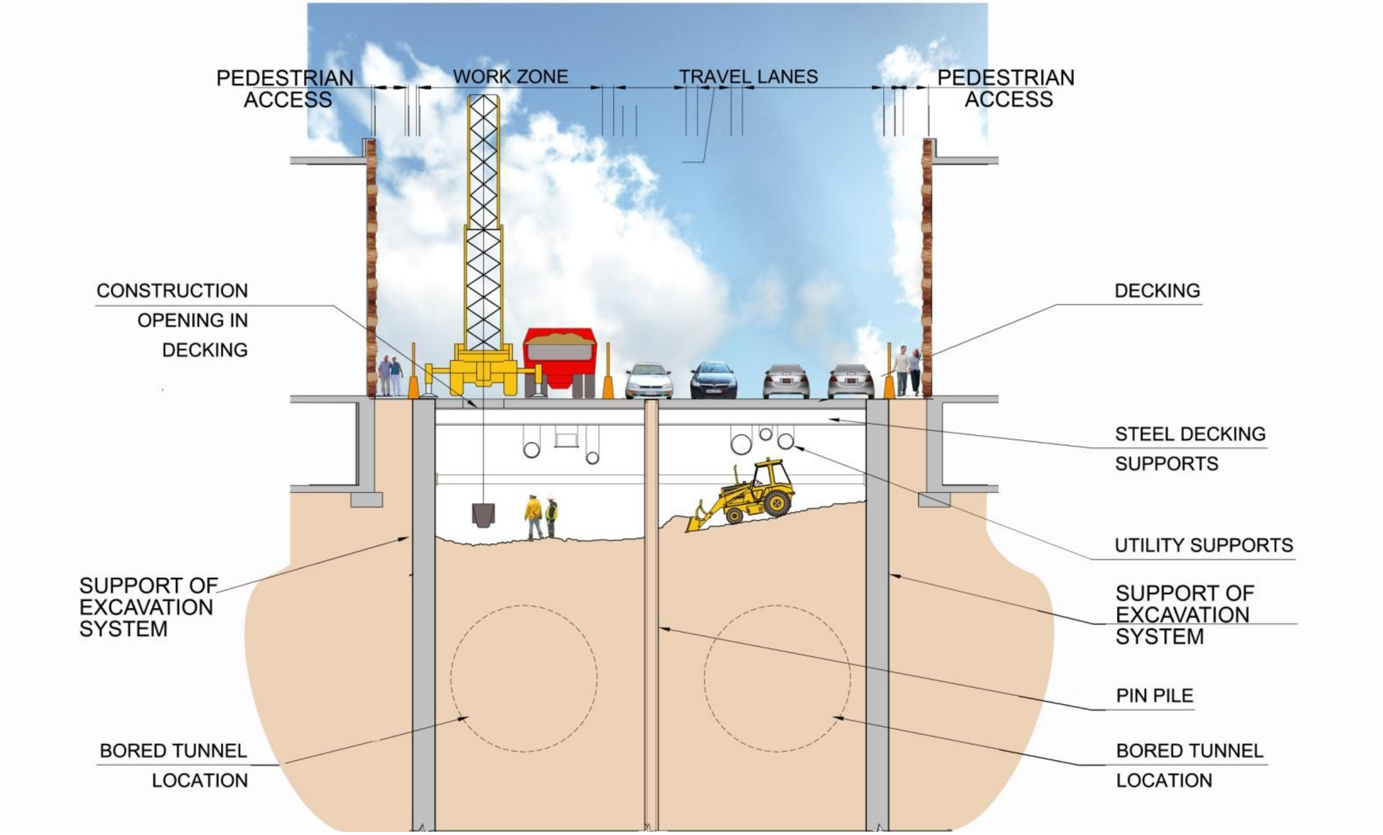
CUT-AND-COVER CONSTRUCTION WITH DECKING - 7



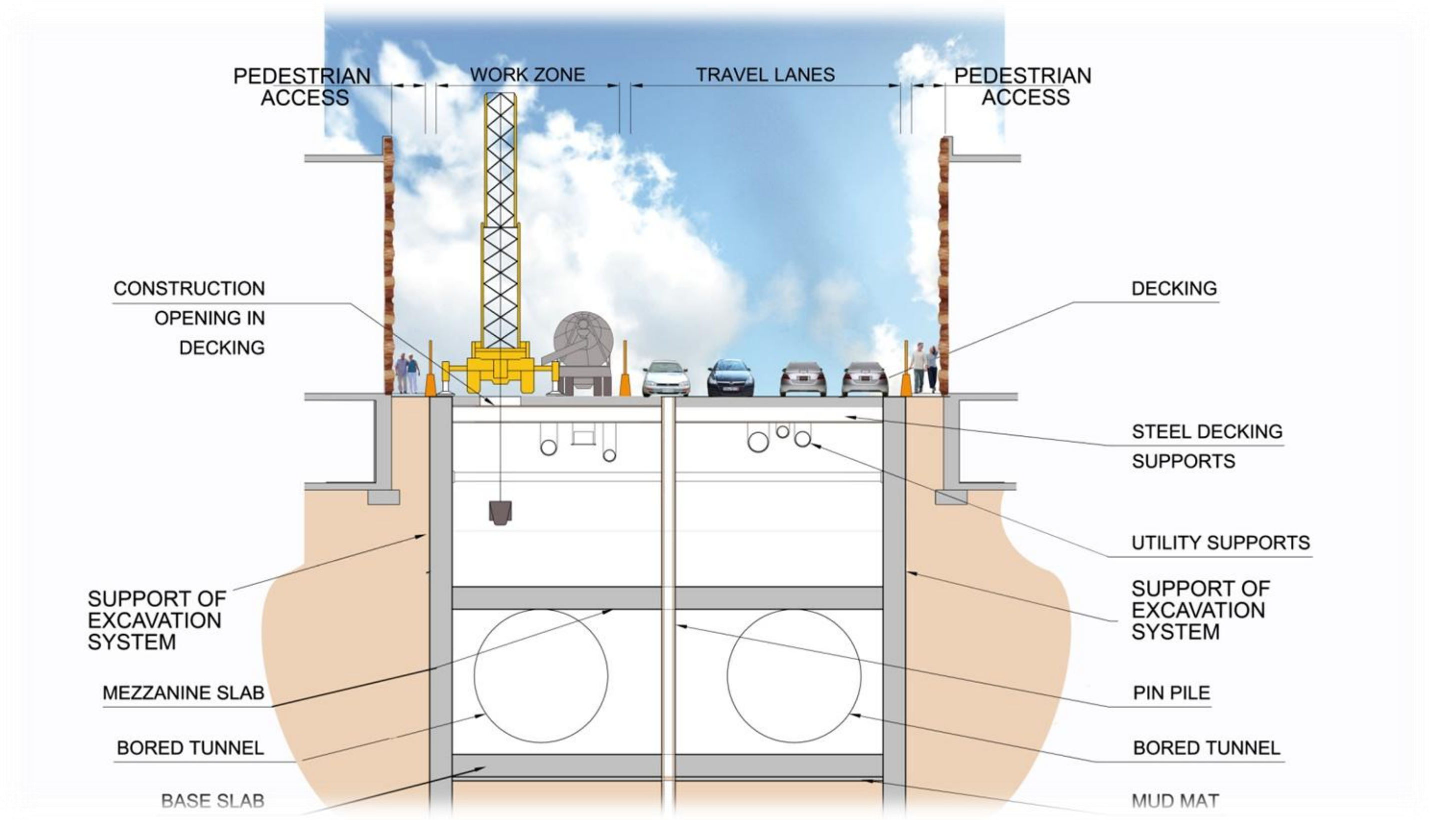
CUT-AND-COVER CONSTRUCTION WITH DECKING - 8



CUT-AND-COVER CONSTRUCTION WITH DECKING - 9



CUT-AND-COVER CONSTRUCTION WITH DECKING - 10



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APTA PEER REVIEW OF TTC PROJECT DELIVERY – 2007

- Estimating of budgets and schedules for capital delivery "in line with customary practice"
- Panel "impressed with the discipline and detail"

APTA PEER REVIEW OF TC SYSTEM CONCEPT – 2010

- Program is “ambitious … yet decidedly well conceived”
- Panel “impressed with the extent of planning and thought given to the alignment, the vehicle choice and the detailed analyses of optional designs and operating strategies”
- “Evidence of a well developed plan was … the sophisticated project office organization and governance structure”
- Scope “paralleled similar advanced projects in Paris, France” as well as similar to North American projects, including Denver, Sacramento, Pittsburgh and Ottawa

CONCLUSION

- "Subway" is not a defined term
- Comparison between cost and schedule of specific projects requires normalization
- Average TTC transit project cost/km of $290 million is within 6% of international average of $275 million
- TTC project times are in-line with international experience

MADRID EXPERIENCE

METROSUR VS. SHEPPARD SUBWAY POLITICAL/GOVERNMENTAL COST DIFFERENTIATORS

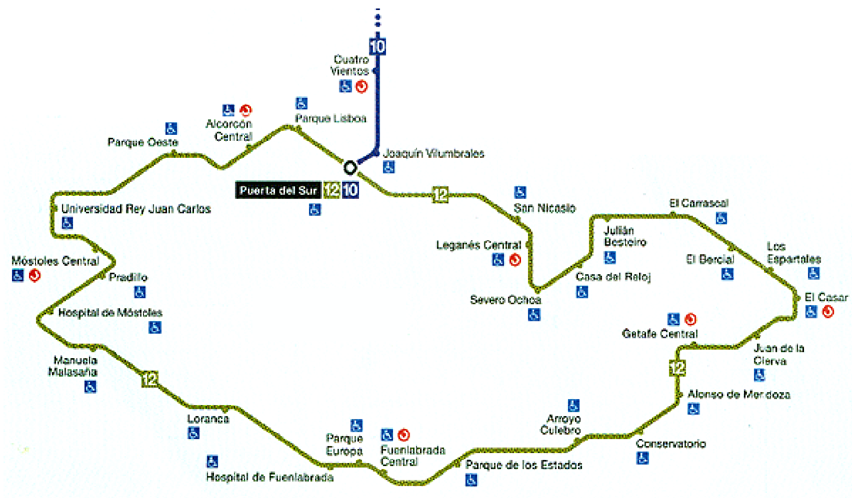
- Madrid MetroSur part of continuous system expansion program
  - Continuity of staff, standards and contractors
- Approvals/Permits
  - No environmental assessment or public participation
  - No permits (Site Plan, Building etc.)
- Property acquisition
  - Compulsory property purchase - City owns property below 10m depth
- Construction change decision making
  - High change approval limits for project staff
  - Major changes approved by Mayor within 24 hours

METROSUR VS. SHEPPARD SUBWAY TECHNICALCOST DIFFERENTIATORS - 1

- Construction conditions
  - 90m wide construction corridor with significant green field component – limited utilities and traffic impacts
  - 30% of line cut-and-cover
  - Work done 24/7/365
- Ground conditions – self-supporting compacted sands
  - Rapid TBM advance rate – 35m/day vs. 15m/day on Sheppard
  - Tolerate high levels of structural settlement to eliminate temporary excavation support systems
- Industry standard fire and life safety code (NFPA 130) not applied
  - Single double-track tunnel – no egress walkway, crossover structures and cross-passages
  - Jet fans in tunnel vs. station fan shafts on Sheppard

METROSUR VS. SHEPPARD SUBWAY TECHNICALCOST DIFFERENTIATORS - 2

- Station requirements
  - Station boxes 130m long vs. 200m on Sheppard
  - Interchange stations 8km apart vs. 5km on Sheppard and no terminal stations (continuous loop)
- Track requirements
  - Conventional direct fixation track vs. noise and vibration isolation on Sheppard



METROSUR VS. SHEPPARD SUBWAY NORMALIZED COST COMPARISON

	Original Cost ($ million per km)	2010 Cost ($ million per km)
Sheppard Subway Cost	**142.5**	**212.3**
Equating Adjustments:		
Accelerated Construction	2.5	3.7
Code Requirements	3.0	4.5
Ground Conditions	4.8	7.1
Cross Over Structures	4.3	6.4
Tail Tracks not required	5.6	8.3
Trackwork Installation	2.5	3.7
Use of Open Cut Construction	5.9	8.7
Proportion of Terminal/Interchange Stations	18.9	28.1
Station Box Size	4.8	7.1
Total Adjustment	**52.1**	**77.6**
Adjusted Sheppard Subway Cost	**90.4**	**134.7**
Madrid MetroSur Cost	**87.1**	**115.0**

CONCLUSION

- Political/governmental cost differentiators are significant, but difficult to evaluate
  - Tend to directly influence schedule more than cost
  - Schedule reduction leads to cost savings
- Major technical differences between MetroSur and Sheppard Subway require normalization for meaningful cost comparison
  - Needs highly detailed analysis
- Preliminary normalized comparison shows Sheppard Subway costing 17% more per kilometre than MetroSur

Part 3

Sheppard Transit

- What Has Changed Since 1986

What Has Changed Since 1986?

1986 Subway Planning

Development Forecasts and OP

- High density development at nodes (subway stations)

Aggressive forecast targets for employment

- NY and Scarborough centres

2011

New OP – focus on Avenues not nodes (subway stations)

- Lower development forecasts
- Protects stable residential areas

Development industry has moved away from high density nodes

Actual Employment is much lower than forecast

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1986 Forecast to 2011 Actual

	1986 Forecast to 2011 [1]	2011 Actual [2]
City Population	2.1 Million in 1986 2.5 Million in 2011 forecasted	2.5 Million - met
City Employment	1.23 Million in 1986 1.7 million in 2011 forecasted	High employment growth around Toronto 1.30 million
Transit Technology	Subway was the predominant form of transit investment	LRT is the predominant form serving areas that do not justify subway investment
Development Trend	Will proceed in nodes	"Avenue" concept v.s. "Nodes" Community opposition to major developments

Sources
1. Sheppard Subway EA Report 1992
2. City Planning
3. TTC

1986 to 2011

	1986 Forecast for 2011 [1]	2011 Actual [2]
North York Centre Employment	29,400 in 1986 93,400 in 2011 forecasted	30,200 jobs in 2011 Mainly residential development
Transit Share - NYC	60% target for 2011	34% actual
Scarborough City Centre Employment	14,400 in 1986 65,000 in 2011 forecasted	13,700 in 2011 Mainly residential development
Transit Share – SCC	55% target for 2011	21% actual
Kennedy and Sheppard	10,000 employment in forecasted for 2011	Limited employment

Sources
1. Sheppard Subway EA Report 1992
2. City Planning
3. TTC

1986 To 2011

	1986 Forecast to 2011	2011
Sheppard Subway Ridership	15,400 person per hour (pph) forecasted for 2011 [1]	4,500 pph actual [3] 7,300 pph east of Don Mills [3] forecast (2031)
Eglinton Subway Ridership	17,600 person per hour [3] forecasted for 2011	6,000 – 10,000 pph [3] forecast (2031)
Let's Move Transit Plan	6 lines totalling 58 km by 2011 - $10.8 B ($2011)	5.4 KM Sheppard Subway 1.3 KM Wilson to Downsview Total by 2011 → $6.7 KM

Sources
1. Sheppard Subway EA Report 1992
2. City Planning
3. TTC

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1986 to 2011

	1986 Forecast to 2011	2011
Life-cycle costs – subway and LRT	Capital and 30-year (3) operating cost used to determine breakeven point: >15,000 pphpd - subway <15,000 pphpd – LRT	Projected demand for 2031 (3) Sheppard Subway east of Don Mills = 7,300
Long-term Subway Maintenance	Subways relatively new (3) - limited TTC experience with long-term ownership costs	Aging subways now cost TTC (3) $270M/year capital and $230M/year operating for maintenance alone

Sources
1. Sheppard Subway EA Report 1992
2. City Planning
3. TTC

What has been learned?

Subways don’t guarantee development

Not all subways have achieved higher development
Many station areas still have large undeveloped property
If you build it – they don’t always come

High capital and operating cost of subways

Need high probability of success
High risk - long delays in approvals and securing funding