The Challenges of Planning and Executing Major Underground Transit Programs in Los Angeles

Bryan Pennington, Senior Executive Officer, Program Management
• Nation’s third largest transportation system
• FY2018 Budget of $6.1 billion
• Over 9,000 employees
• Nation’s largest clean-air fleet (over 2,200 CNG buses)
• 450 miles of Metro Rapid Bus System
• 131.7 miles of Metro Rail (113 stations)
• Average Weekday Boardings (Bus & Rail) – 1.2 million
• 513 miles of freeway HOV lanes
Elements of Measure M

- New rail and bus rapid transit projects
- New highway projects
- Enhanced bus and rail service
- Local street, signal, bike/pedestrian improvements
- Affordable fares for seniors, students and persons with disabilities
- Maintenance/replacement of aging system
- Bike and pedestrian connections to transit facilities
Goals of Measure M

Ease traffic congestion, improve freeway traffic flow, and reduce bottlenecks.

Expand rail and rapid transit system; accelerate rail construction and build new rail lines; enhance local, regional, and express bus service; and improve system connectivity.

Repave local streets, repair potholes, and synchronize signals; improve neighborhood streets and intersections; and enhance bike and pedestrian connections.

Make public transportation more accessible, convenient, and affordable for seniors, students, and the disabled; and provide better mobility options for our aging population.

Earthquake-retrofit bridges, and keep the transit and highway system safe and in good working condition.

Embrace technology and innovation; incorporate modern technology, new advancements, and emerging innovations into the local transportation system.

Create jobs, reduce pollution, and generate local economic benefits; increase personal quality time and overall quality of life.

Provide accountability and transparency; protect and monitor the public’s investments through independent audits and oversight.
Measure M Funding Categories
(by subfund through 2039)

<table>
<thead>
<tr>
<th>Formal Ordinance Subfunds</th>
<th>%</th>
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</thead>
<tbody>
<tr>
<td>Administration/Local Return</td>
<td>1.5%</td>
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<tr>
<td>Transit, First/Last Mile (Capital)</td>
<td>37%</td>
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<tr>
<td>Highway, Active Transportation, Complete Streets (Capital Only)</td>
<td>19%</td>
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<tr>
<td>Local Return* / Regional Rail</td>
<td>17%</td>
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<tr>
<td>Transit Operating &amp; Maintenance</td>
<td>27%</td>
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</table>

* 1% Administration to supplement Local Return, increasing the Local Return Base to 17% of net revenues.
Metro Transit & Highway Projects:
The 40-Year Plan
# Measure M - Major Transit Projects

<table>
<thead>
<tr>
<th>Transit Projects</th>
<th>Project Description</th>
<th>Cost Forecast</th>
<th>Accelerated Schedule</th>
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<tbody>
<tr>
<td>1</td>
<td>Airport Metro Connector/Green Line Extension</td>
<td>$581M</td>
<td>2018</td>
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<tr>
<td>7</td>
<td>East San Fernando Valley Transit Corridor</td>
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<tr>
<td>7 8</td>
<td>BRT Connector Orange/Red Line to Gold Line</td>
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<tr>
<td>5</td>
<td>Gold Line Foothill Extension Phase 2B</td>
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<td>2</td>
<td>Purple Line Extension Transit Project Section 3</td>
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<tr>
<td>10</td>
<td>West Santa Ana Transit Corridor Segment 1</td>
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<tr>
<td>6</td>
<td>Orange Line BRT Improvements (Locations TBD)</td>
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<tr>
<td>25</td>
<td>Gold Line Eastside Extension Phase 2 (one alignment)</td>
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<tr>
<td>19</td>
<td>Green Line Extension to Crenshaw Bl in Torrance</td>
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<td>17</td>
<td>Vermont Transit Corridor</td>
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<td>22 23</td>
<td>Sepulveda Pass Corridor (Rail)</td>
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<tr>
<td>24</td>
<td>West Santa Ana Transit Corridor Segment 2</td>
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<tr>
<td>30 31</td>
<td>Crenshaw Line Northern Extension</td>
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<tr>
<td>41</td>
<td>Orange Line Conversion to Light Rail</td>
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<td>35</td>
<td>Lincoln BI BRT</td>
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<td>38</td>
<td>Green Line to Norwalk Metrolink Station</td>
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<td>40</td>
<td>Sepulveda Pass Corridor Westwood to Airport Metro Connector</td>
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<tr>
<td>44</td>
<td>Gold Line Eastside Extension Phase 2 (second alignment)</td>
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</tbody>
</table>

- Airport Metro Connector | $581M | 2018 |
- Westside (Purple) Phase 3 | $1.98B | 2018 |
- Foothill Extension Phase 2B | $1.1B | 2019 |
- West Santa Ana Branch | $1.03B | 2023 |
- Sepulveda Pass Corridor | $2.84B | 2024 |
- Eastside Phase 2 | $1.5B | 2029 |
- Green Line Ext. South Bay | $891M | 2031 |

- Division 20 Portal/Turnback | $162M | 2017 |
- New LA Rams Stadium | TBD | TBD |

Not shown on map: Crenshaw/LAX Track Enhancement Project, Complete LA River Bike Path and LA River Waterway, System Bike Path, City of San Fernando Bike Master Plan, Historic Downtown Streetcar, North San Fernando Valley BRT Improvements, Arroyo Verdugo Transportation Improvements, Regional Rail and Metrolink Improvements, and South Bay Transportation Improvements.
Transit Construction – 35%

- New rail and Bus Rapid Transit (BRT) capital projects
- Rail yards, rail cars, and start-up buses for new BRT lines
- Includes 2% for system-wide connectivity projects such as airports, countywide BRT, regional rail and Union Station
Directions
Walk to Blue Line and travel to Union Station
Southwest Chief to Los Angeles Union Station
Contents

• Rail transit projects
  • Crenshaw LAX Transit Project
  • Regional Connector Transit Project
  • Westside Purple Line Extension Project
• Critical success factors
• Financial considerations/risk management
• Contract strategy
• Lessons learned
• Future underground construction
• Concluding remarks
• Questions and answers
Metro Rail Transit
Existing and Under Construction
Ground Conditions

- Los Angeles Basin
- Faults
- Hydrocarbons
- Groundwater
- Seismicity
- Methane and Hydrogen Sulfide
Rail Transit Projects

• Crenshaw LAX Transit Project
• Regional Connector Transit Project
• Westside Purple Line Extension Project
  • Section 1
  • Section 2
  • Section 3
- 13.7 km Light Rail
- 8 Stations
- Aerial Grade Separations, Below Grade, At-Grade Construction
- Maintenance Facility Yard
- $1.3 Billion Construction Contract Awarded to Walsh
- $2.058 Billion Project Cost
- 24,400 Project Trips (2035)
Overall project progress is 66% complete.
Underground excavation including tunneling completed July 2017.
Underground guideway and station construction ongoing.
All below, at grade and aerial structures on schedule.
Continued trackwork installation along southern reach of alignment.
REVENUE OPERATION Oct 2019
• 3 km underground light rail line
  – Connects Metro Gold Line, Metro Blue Line, and Expo Line
  – 20 minute reduction in commute
  – 90,000 daily trips
  – 2 ½ minute headway
• 3 underground stations-
  – 2nd/ Hope
  – 2nd/ Broadway
  – 1st/ Central
• One seat ride from Azusa to Long Beach and East LA to Santa Monica
• $1.810 Billion Project Budget
Status Regional Connector Transit Corridor

- Overall Project Progress is 36%.
- Launching shaft, 1st/Central Station, 2nd/ Hope Station and retrieval shaft excavated
- Tie-back installation, station excavation, and utility hanging continue at Broadway Station.
- Preparation for LA County storm drain (Hobas) pipe installation continues at Broadway Station.
- Pile installation, excavation/lagging and utility hanging continue under Flower Street decking.
- Tie Back removal Shaft Completed and obstruction removed.
- TBM completed first run to retrieval shaft July 2017.
- TBM being prepared for second run
- REVENUE OPERATION - 2021
• Overall Project Progress is 24.9%, Construction is 19.8%, Final Design is 94.5% complete.
• Wye re-opened 1st/Alameda intersection.
• Continue TBM shaft excavation; completed installation of top mat of rebar for station invert at 1st/Central. Implemented “Steady State” on September 25, 2016;
• Continue pile and deck beam installation at 2nd/Broadway intersection and water work at 2nd/Spring. Re-opened Broadway on October 15, 2016 as planned.
• Continue excavation at 2nd/Hope Station; installation of struts, walers, drilling and installation of tie-backs at Support Of Excavation (SOE).
• Decking started on Flower Street. Cap beam installation, lagging, waterline relocation
• Tie-Back Removal Pit complete. Restoring street.
• TOTAL COST $1,599M
Westside Purple Line Extension

- 9 mile, 7 Station Extension of Metro Purple Line
- 7 New Stations
- Shop and Yard Expansion
- Twin Bore Tunnels
- CEQA/NEPA; FTA ROD 2012

**Section 1**
- $2.82 Billion
- In Construction
- Revenue Service – OCT 2024 (FFGA)

**Section 2**
- $2.53 Billion
- In Construction
- Revenue Service Date – DEC 2026 (FFGA)

**Section 3**
- $2.66 Billion
- In Procurement
- Revenue Service Date – Operation Shovel Ready

Overall Project Progress is 20% complete.

Excavation for the Wilshire/La Brea Station continues beneath the deck panels. Scheduled completion December 2017.

The Wilshire/Fairfax street decking completed.

The Wilshire/La Cienega Station piling ongoing.

The jet grouting operation along Wilshire Boulevard at the cross passages continues. Scheduled completion October 2017.

TBM delivery at the end of 2017 for tunneling in 2018.
- Design Build Contractor performing final design.
- Construction of the telecom joint trench is proceeding in Century City.
- Water and Power utility relocations at the Century City Constellation Station
- Advanced utility relocations at the Wilshire/Rodeo Station.
• In Procurement
• Two principal DB Contracts
  • Tunnels and Cross Passages
  • Stations, Crossover Structure, Trackwork, Systems, Test and Commissioning
• Subway alignment through oil fields and through oil (tar) sands
• Tunnel and Wilshire/Fairfax to be constructed through tar sands
• Methane and hydrogen sulfide gas
Characteristics of Principal LA Metro Rail Transit Projects

- Construction costs over $1B
- Urban environments
- Connectivity with existing rail transit systems
- Extensive utility diversions
- Entirely or significant sections of tunneled guideway
- Community expectations
- Seismic engineering requirements
- Potential for explosive/toxic gasses in ground
Potential and Perceived Issues

- Construction Problems
- Methane Explosions
- Tunnel Fire
- Tunnel Lining Defects
- Earthquake Resistance
- Excessive Settlement
- Safety (Fatalities)
- Costs
- Tunnel Collapse
- Tunneling Unsafe
- Oil Fields
- Active Faults
Key Issues and Objectives

- Adherence to cost and schedule
- Avoid tunneling mishaps
- Connecting to existing operational rail transit lines
- Significant tunneling and underground stations
- Design aligned with chosen construction methodology
Critical Success Factors

- Dry Tunnels
- Gas Free Tunnels
- Minimize Ground Movements
- No Collapse or Sink Holes
- Earthquake Resistance
- Defect Free Tunnel Lining
- Avoidance of Construction Fires and Explosions
- Consistent Design
- Accident and Incident Avoidance
- Appropriate Contract
Prescriptive Construction Elements

- Station design (foot print/right-of-way limits)
- Station and cut & cover support of excavation (guide Lines/available data)
- Station and cut & cover water / gas proofing (tested/proven)
- Tunnel lining - one pass double gasket (tested)
- Tunneling - pressurized tunneling system (lessons learned)
- Stations and finishes (continuity/maintenance)
- External stakeholder / environmental requirements
- Prescription of key design builder staff (key selection criteria)
- Best management practice by Metro and DB teams
- Metro standards and key requirements
Geotechnical and tunnel instrumentation and monitoring process

Ground Loss Control System

Processing Results

Management Decision

Subsurface Instrumentation

Surface Leveling

Soil Testing

Exploratory Boring

Ground Loss Check

Grouting

TBM Data

TBM Operator

Inspection
3. Control Annulus around lining
Pressurized grout and accelerator automatically injected through tailshield ducts to fill annulus.

2. Support ground around Overcut
Bentonite injection into annulus around shield.

2. Control
Pressure gauges on tailshield body.
[Bentonite line pressure not representative as losses in line and along shield.]

1. Control Face
Pressure on face.

Machine Features
Ground Treatment
- Break-in/out
- Cross Passages
Geotechnical Instrumentation
Monitoring
Financial Considerations

• Funding
  – Complex mix of funds
    • Fare revenue
    • Proposition A and C sales taxes
    • Federal and State grants
    • Interest income/bonds
    • Other local revenue
    • Measure R

• State of Market
Risk Management

• Strict adherence to FTA Guide Lines
• Address risk avoidance and risk management from the start
• Partnering with third party and public agencies
• Best value selection criteria
• Early Industry participation
• One team project approach
Rationale for Metro Design Build Procurement

- Commitments made for an efficient cost effective project delivery
- Metro's past history and experience in project delivery
- Metro is an established and mature agency
- Metro’s operational needs and service requirements are well established
- Benefit from Alternative Technical Concepts
- Ability to Advance Utility Contracts
- Early Contractor Involvement
- Rationale for Metro Design Build Procurement
Metro considers the following factors in determining the delivery method:

- Budget
- Project complexity
- Level of design completed
- Value engineering opportunities
- Integration of design and construction activities
- Risk
- Staff expertise
Strategy Selection

- Contract Packaging Options
- Metro Design Build Procurement Rules
- Selection Process
Lessons Learned

• Advanced Utility Relocations
• Instrumentation and Monitoring
• Pressurized Tunneling Envelope
• Carefully consider procurement method with each project
• Integrated Management Teams
• Standardization
The people of LA County have spoken with a resounding voice of approval of Measure M. Voters passed Metro’s transportation ballot measure with 69.82% support. Thanks to the public for putting their faith in us to build a transportation system for today, tomorrow and beyond. Together, we are making history and are showing the nation – even the world – how to be bold and forward thinking as we continue to transform transportation across our region.
Completed, Current and Future Projects

Legend:
- Environmental Engineering
- Bid
- D/B Construction
- D/B/BI Construction
- Testing
- Opening Date

Map numbers are for reference only. Final project scope will be determined in the environmental process.
Concluding Remarks

• L.A. has huge rail transit expansion program.
• DB - C/LAX, RC and PLE rail transit projects.
• DBB - associated advance utility contracts.
• Early contractor involvement is important tool.
• Market trends must be addressed and mitigated.
• ATC effective on appropriate projects.
• Prescription of some technical items appropriate and necessary.