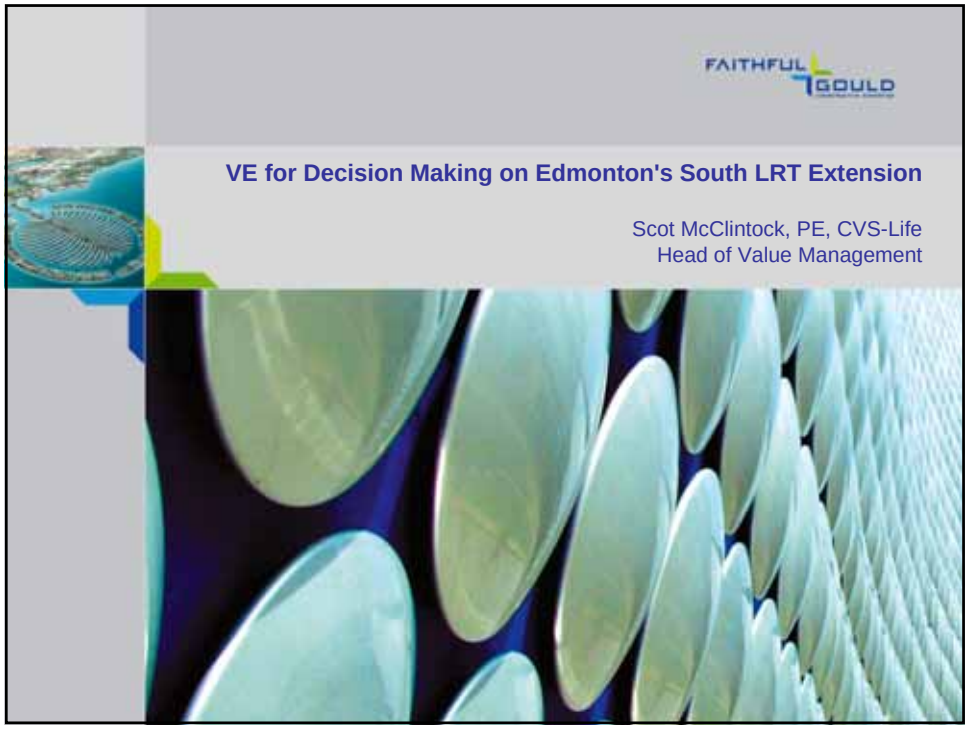
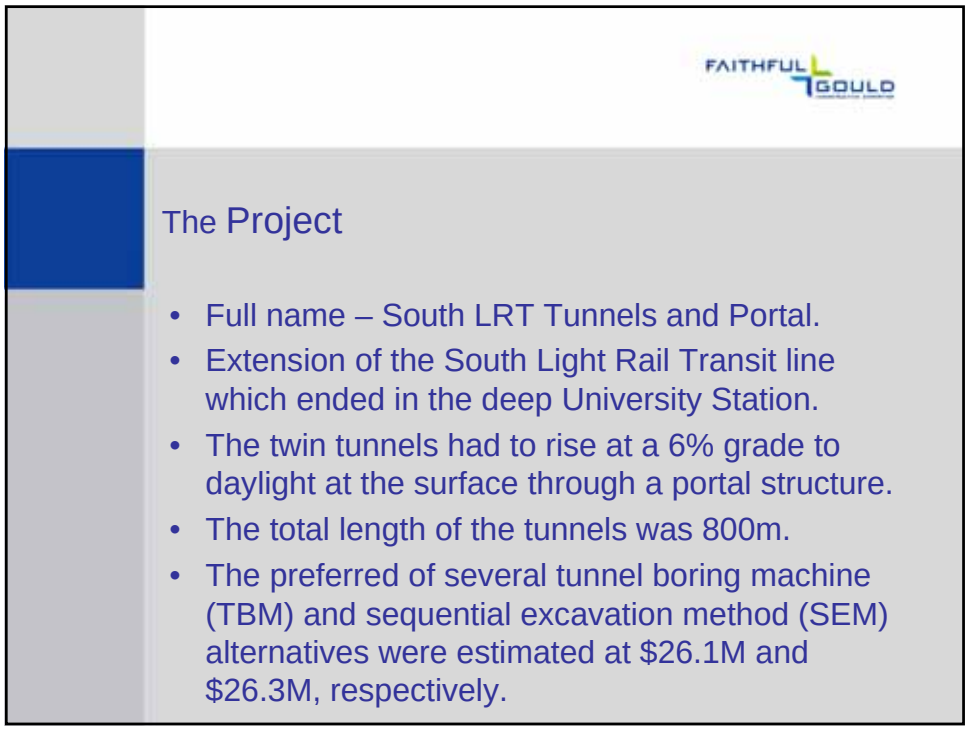
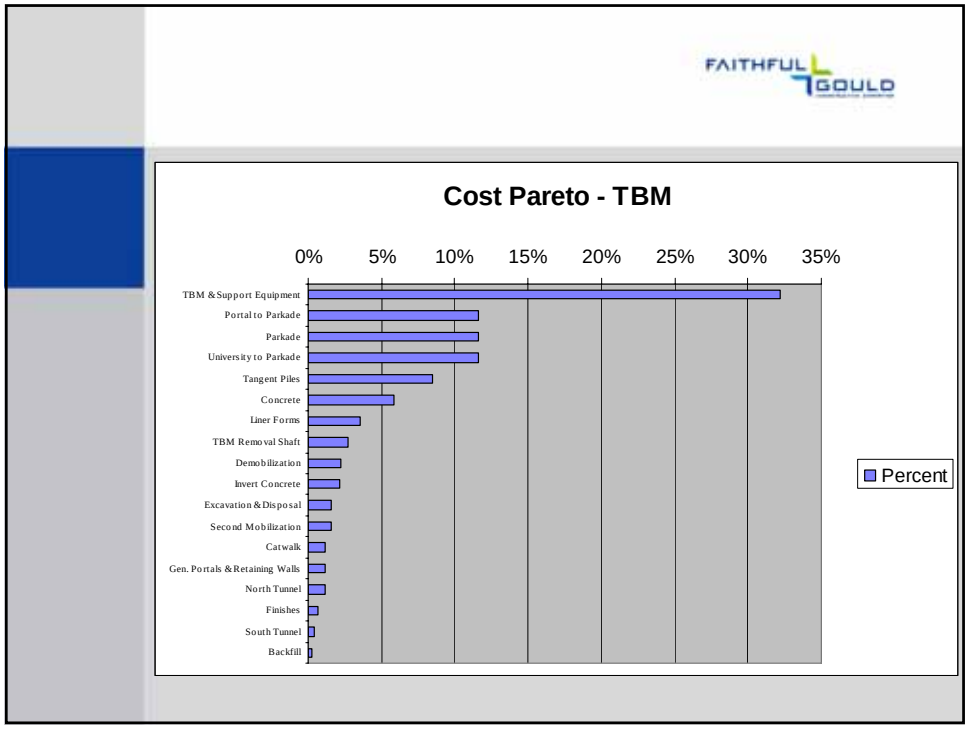
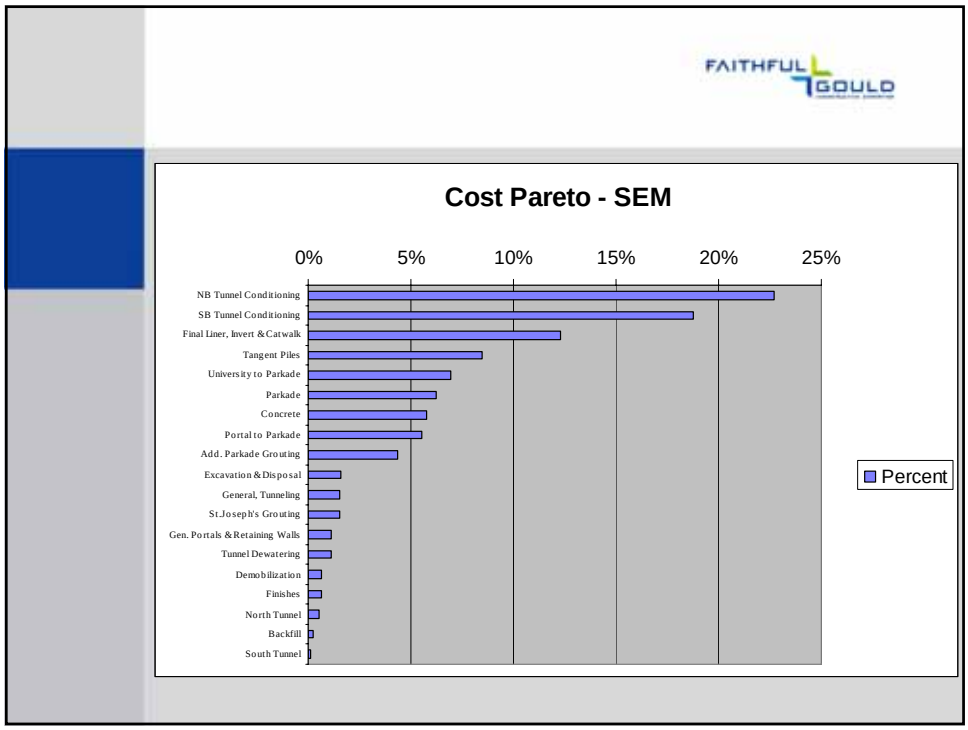

FAITHFUL GOULD
VE for Decision Making on Edmonton's South LRT Extension
Scot McClintock, PE, CVS-Life
Head of Value Management


FAITHFUL GOULD
The Project
• Full name – South LRT Tunnels and Portal.
• Extension of the South Light Rail Transit line which ended in the deep University Station.
• The twin tunnels had to rise at a 6% grade to daylight at the surface through a portal structure.
• The total length of the tunnels was 800m.
• The preferred of several tunnel boring machine (TBM) and sequential excavation method (SEM) alternatives were estimated at $26.1M and $26.3M, respectively.


Cost Pareto - TBM
0%
5%
10%
15%
20%
25%
30%
35%
TBM & Support Equipment
Portal to Parkade
Parkade
University to Parkade
Tangent Piles
Concrete
Liner Forms
TBM Removal Shaft
Demobilization
Invert Concrete
Excavation & Disposal
Second Mobilization
Catwalk
Gen. Portals & Retaining Walls
North Tunnel
Finishes
South Tunnel
Backfill
Percent


Cost Pareto - SEM
0%
5%
10%
15%
20%
25%
NB Tunnel Conditioning
SB Tunnel Conditioning
Final Liner, Invert & Catwalk
Tangent Piles
University to Parkade
Parkade
Concrete
Portal to Parkade
Add. Parkade Grouting
Excavation & Disposal
General, Tunneling
St.Joseph's Grouting
Gen. Portals & Retaining Walls
Tunnel Dewatering
Demobilization
Finishes
North Tunnel
Backfill
South Tunnel
Percent

The Purpose of the VE Study

- Provide senior level design review of present design solutions as documented by design team from critical project decision-makers and a select panel of tunnel experts .
- Confirm viability, performance /operations, and constructability of the present design solutions.
- Identify possible alternatives to reduce project risk, improve constructability, and/or reduce capital costs, within the confines of required functionality and environmental approvals.

VE, the CVS, the Experts, & Hidden Purposes

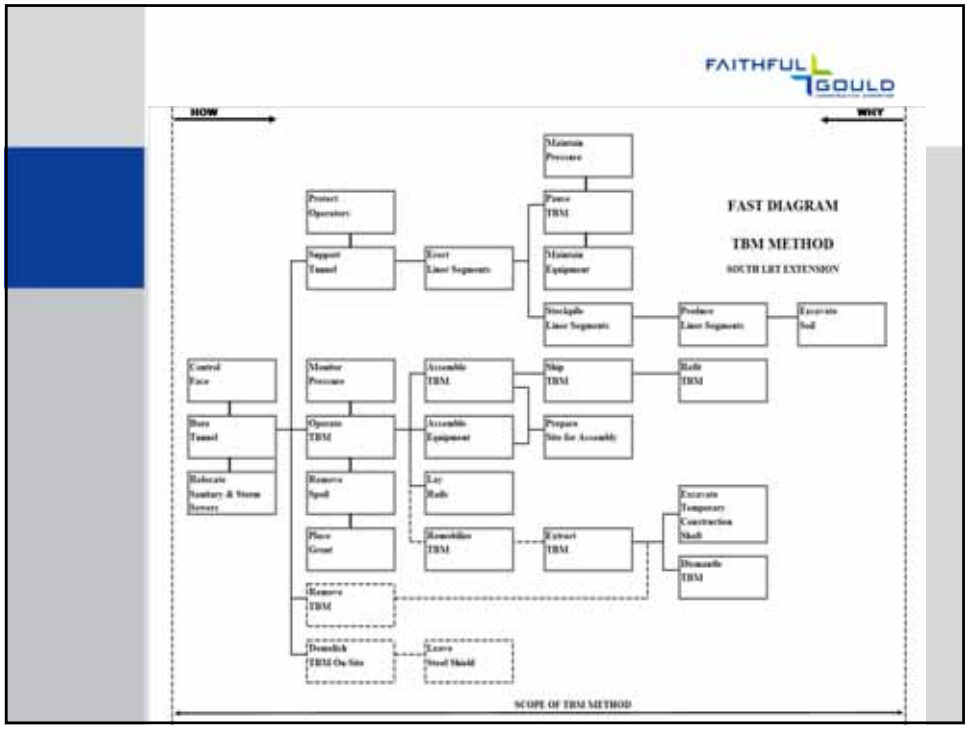
- Three strong personalities had become evident on the multi-headed project team.
- Professional but steadfast disagreements made consensus difficult.
- A three prong plan for consensus was developed, i.e.:
  - Use Value Engineering
  - Select CVS with “Laid Back” Style
  - Include Proven, Respected Experts

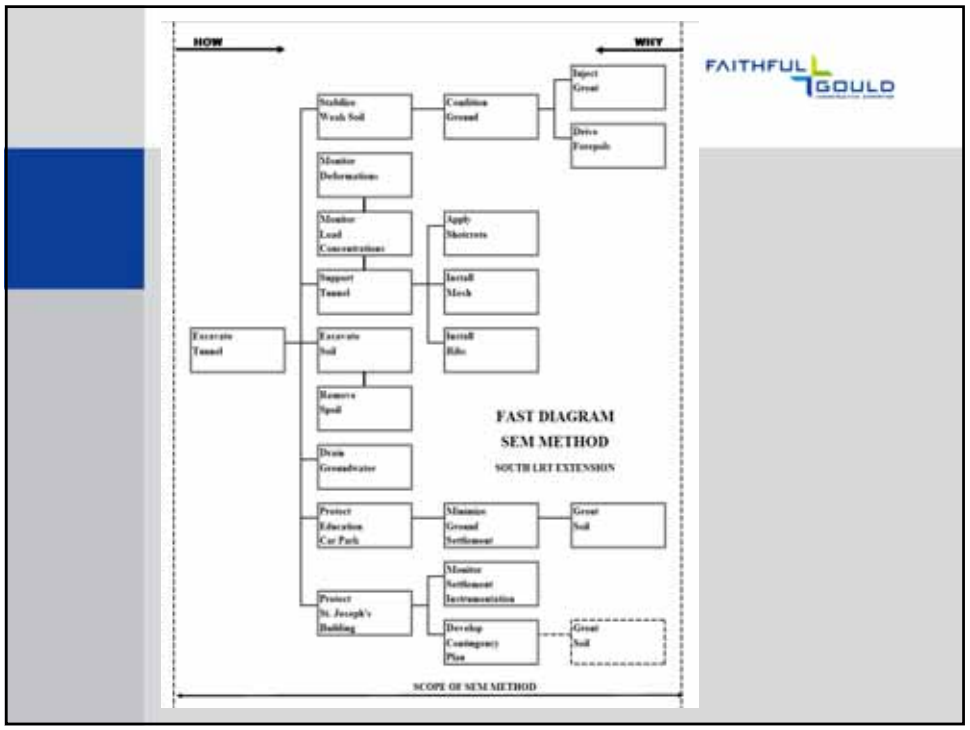
Project Issues

- Availability of proper type and size TBM
- Level and cost of ground conditioning for successful SEM tunnels
- Geotechnical conditions – interpretation and additional investigations
- Safety
- Acceptable level of risk
- Contracting Strategy

More Project Issues

- Methods of bid evaluation
- Equalize the risk between the two methods
- Meeting of established settlement criteria
- Carry both TBM and SEM methods to bidding
- Surface disruption


FAITHFUL GOULD
HOW
WHY
FAST DIAGRAM
TBM METHOD
SOUTH LRT EXTENSION
SCOPE OF TBM METHOD


FAITHFUL GOULD
HOW
WHY
FAST DIAGRAM
SEM METHOD
SOUTH LRT EXTENSION
SCOPE OF SEM METHOD

Value Target Areas

TARGET	Functions
Additional Investigations	Reduce Risk, Refine Design
Ground Conditioning	Stabilize Ground, Facilitate Tunneling
Portal and Retaining Walls	Prepare Vertical Face, Retain Soil
Risk Acceptability Criteria	Reduce Risk, Facilitate Selection
TBM Availability	Procure TBM, Permit Tunneling
Tendering/Prequalification Process	Reduce Risk, Get Quality, Hire Contractor
Waste Handling	Remove Spoil, Dispose of Spoil

Evaluation Criteria	
• Capital Cost	• Risk
• Proven Technology	• Environmental Impact
• Implementability	• Constructability
• Proven Experience	• Impact on Business
• Social Impacts	• Consequences to the City

Creative Phase Results

- 87 creative ideas were captured.
- Evaluation selected 50 ideas for further study.
- 11 of these were combined with other like ideas.
- 25 of these were labeled design suggestions for design team consideration as design proceeded.
- The remaining 14 ideas were developed into VE Proposals for possible implementation.
- In addition, the expert panel addressed many key points of the VE Session in a memo.

Key Workshop Results

- The key issue on which agreement was sought in the VE session was ground conditioning for the SEM, yielding 9 VE Proposals.
- The first of three proposals that deserved special note discussed the need for positive groundwater control using vertical (preferred) or directional drilling.
- Groundwater control was essential since the outwash and inter-till sands contained materials susceptible to flowing ground conditions.

Key Workshop Results

- The second proposal, the preferred SEM option of the expert panel, was to use jet grouting at approximately 600mm on center over the crown throughout the full length of both tunnels.
- The VE Team agreed this design would preclude the need for $980,000 of grout under the car park and generally mitigate settlement risks.
- Actual costs for implementing this option would be determined by the design team as project design continued.

Key Workshop Results

- The third proposal recommended using jet grouting under and near the buildings and forepoling with grout elsewhere. The design team would have to again document the cost implications.
- The reasonable assumption made was a 50-50 split between jet grouting and forepoling with grout.
- The expert panel found this to be a very acceptable option to an all jet grouting option, which would also generally mitigate settlement risks.

In Summary

- The VE Session effectively served as a vehicle to bring critical project decision-makers and a select panel of tunneling experts together for a senior design review.
- The VE process drew out the issues requiring discussion, and helped bring those discussions to conclusions that would help the project move forward successfully.
- Consensus was built in spite of many strong wills and diverse opinions and experiences.

In Summary

- To mitigate the financial risk of the TBM method, the City decided early on to develop an SEM option in parallel, with its different inherent risks.
- The largest benefit of the VE Session was the conclusion that an SEM design could be achieved at an acceptable level of risk.
- The project has since been built using the TBM method with acceptable bids likely kept lower by the competition of the SEM option.

Questions?