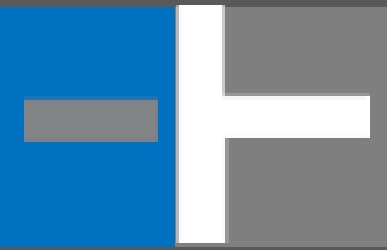


Tunnel Assessment Best Practices



- **Doug Bottorff, PE – Project Manager / Civil Engineer**
- **Matt Mettemeyer, PE – Structural Engineer**

- **Why assessments are important**
- **What is a review and assessment**
- **Examples of assessments**
- **Benefits of a review and assessment**

Why Assessments are Important



- “No one ever goes down there but us.”
- “I’ve been complaining about the condition of these tunnels since I started here and nothing ever changes.”
- “It’s been that way for as long as I can remember.”
- “It would cost too much to repair it now.”

Why Assessments are Important



- If you don't like unexpected / emergency costs resulting from failures, you have some options:

Why Assessments are Important

1. Continue to ignore and hope for the best.
2. Predict the future:



3. Implement a tunnel assessment program.

What is a Review and Assessment

- Observe Distress in the tunnels
Cracks, delaminations, spalls, leaks, corrosion, heaving, etc.
- Document Distress
Record general condition
Each location

Procedure follows ACI 201.1R-08

“Guide for Conducting a Visual Inspection of Concrete in Service”



What is a Review and Assessment



- Assess Condition

Does distress pose an **immediate risk**?

What likely **caused** distress?

Is cause of distress **still present**?

Is anything **changing** in vicinity of distress?

What are consequences of **structural failure**?

What are consequences of **loss of steam**?

What is likely **mode of failure**?



Examples of Assessments

Corrosion due to deicing salts and interior environment

2004



2016



Examples of Assessments

Corrosion due to deicing salts and interior environment

2016



2016



Examples of Assessments

Corrosion due to deicing salts and interior environment

2016



2016



Examples of Assessments

Rate of deterioration

January 2014



January 2015



Examples of Assessments

Rate of deterioration

August 2015



March 2016



Examples of Assessments

Small distress but critical location

January 2014



January 2014



Examples of Assessments

Small distress but critical location

August 2015



February 2017



Examples of Assessments

Cosmetic repairs

November 2013



January 2015



Examples of Assessments

Cosmetic repairs

March 2016



September 2016



Examples of Assessments

Cosmetic repairs

February 2017

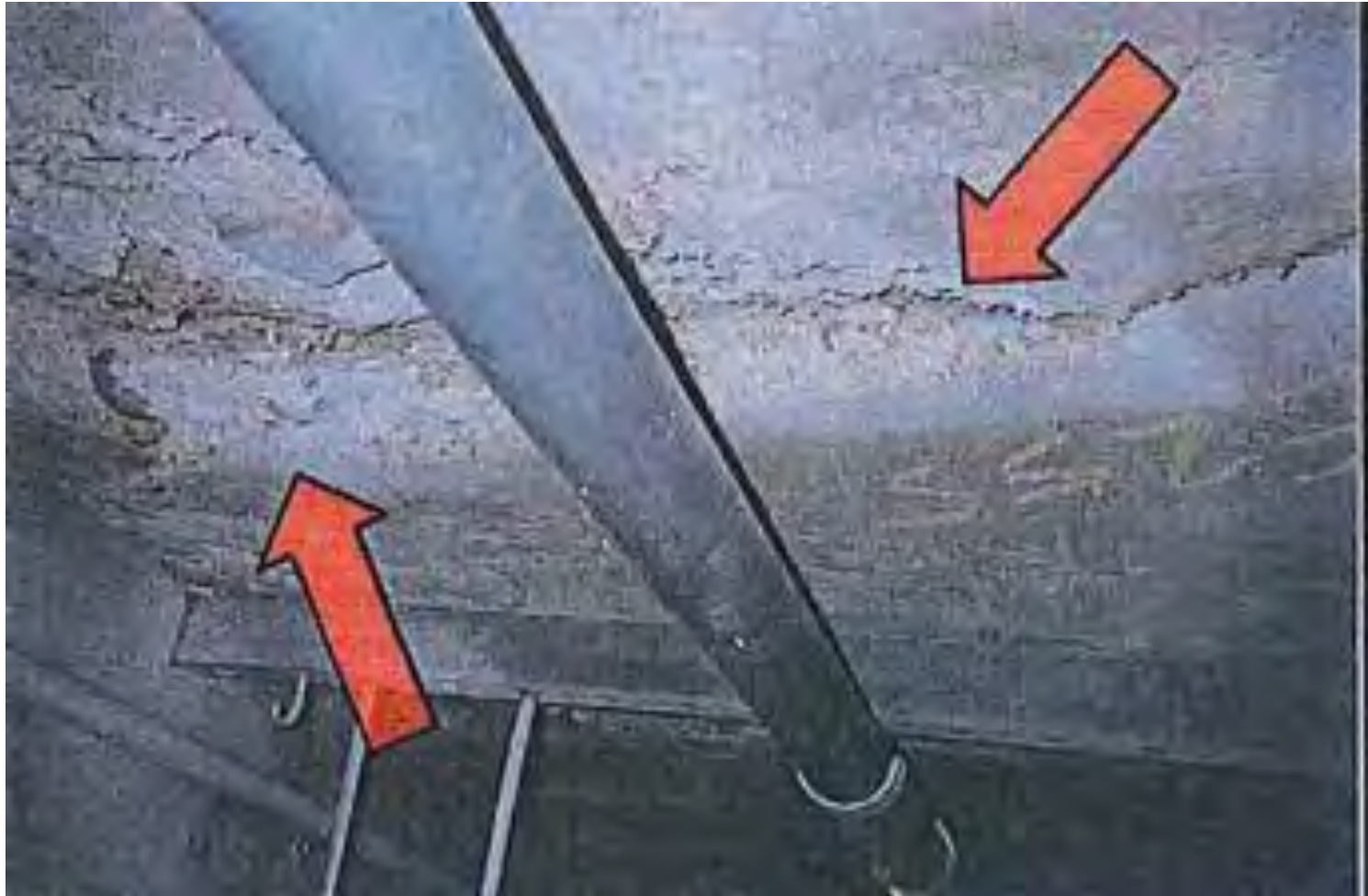


September 2017



Examples of Assessments

1999



2017



Examples of Assessments

1999



2017



Examples of Assessments

1999



2017



Examples of Assessments

2017

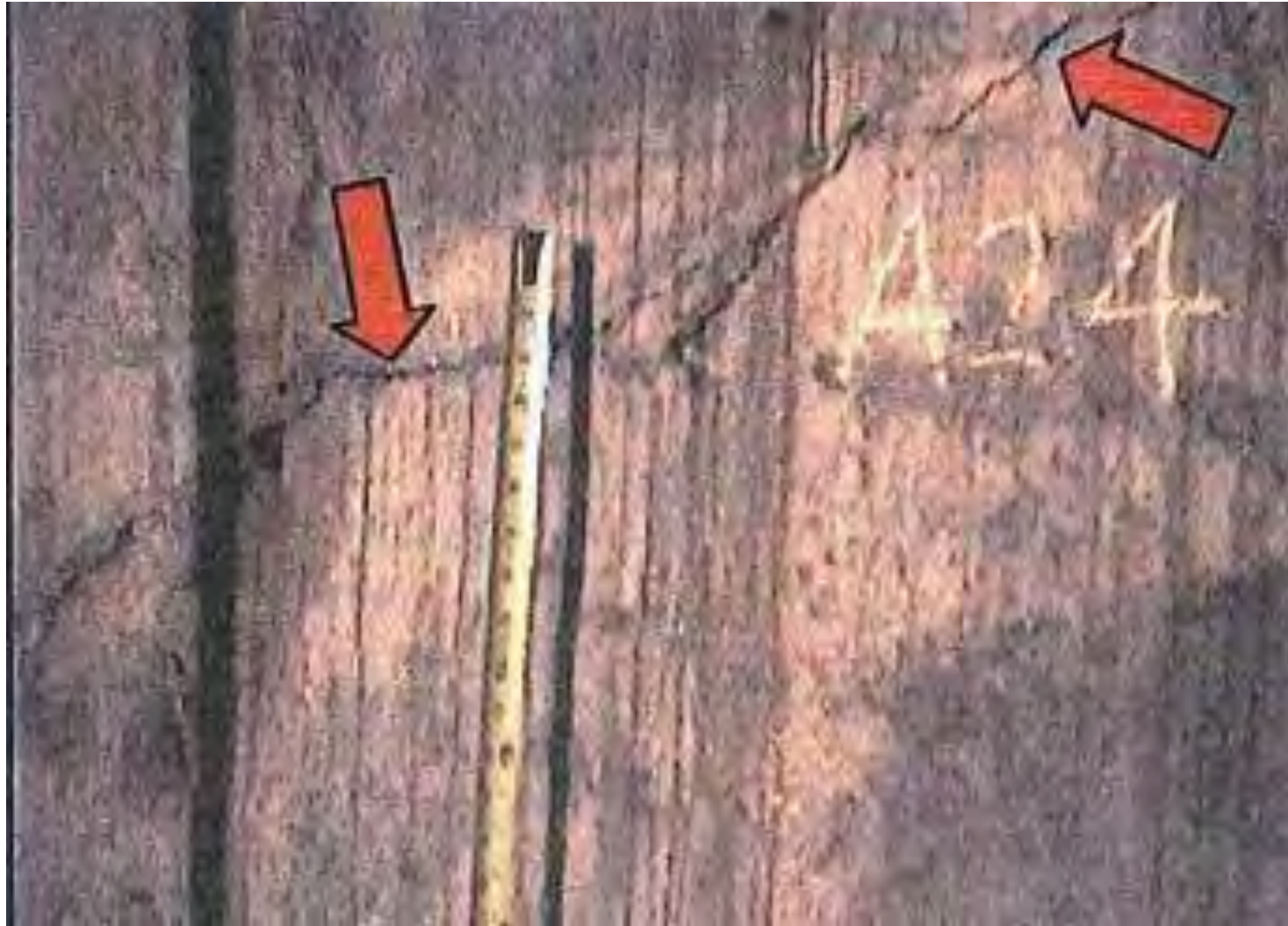


2017



Examples of Assessments

1999



2017



Examples of Assessments

1999



2017



“It has been that way for as long as I can remember.”

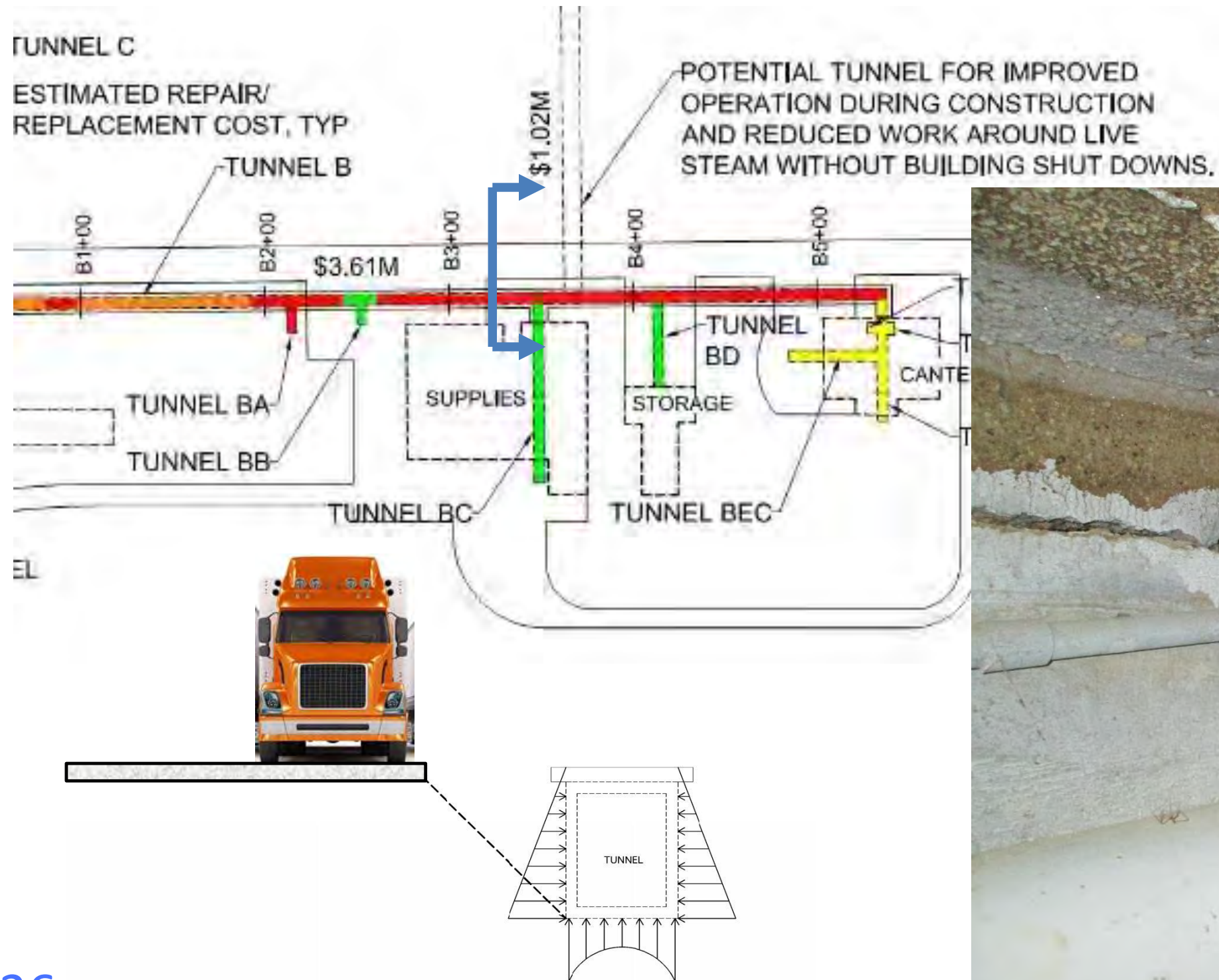
Examples of Assessments

What's wrong with these pictures



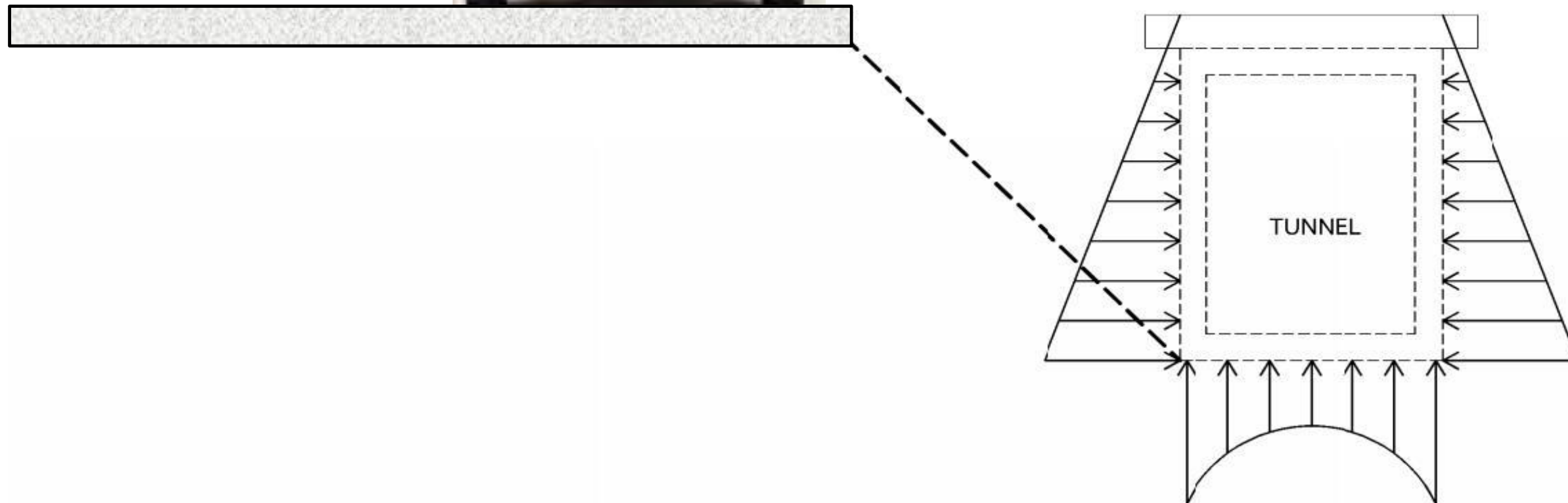
Examples of Assessments

Changing conditions



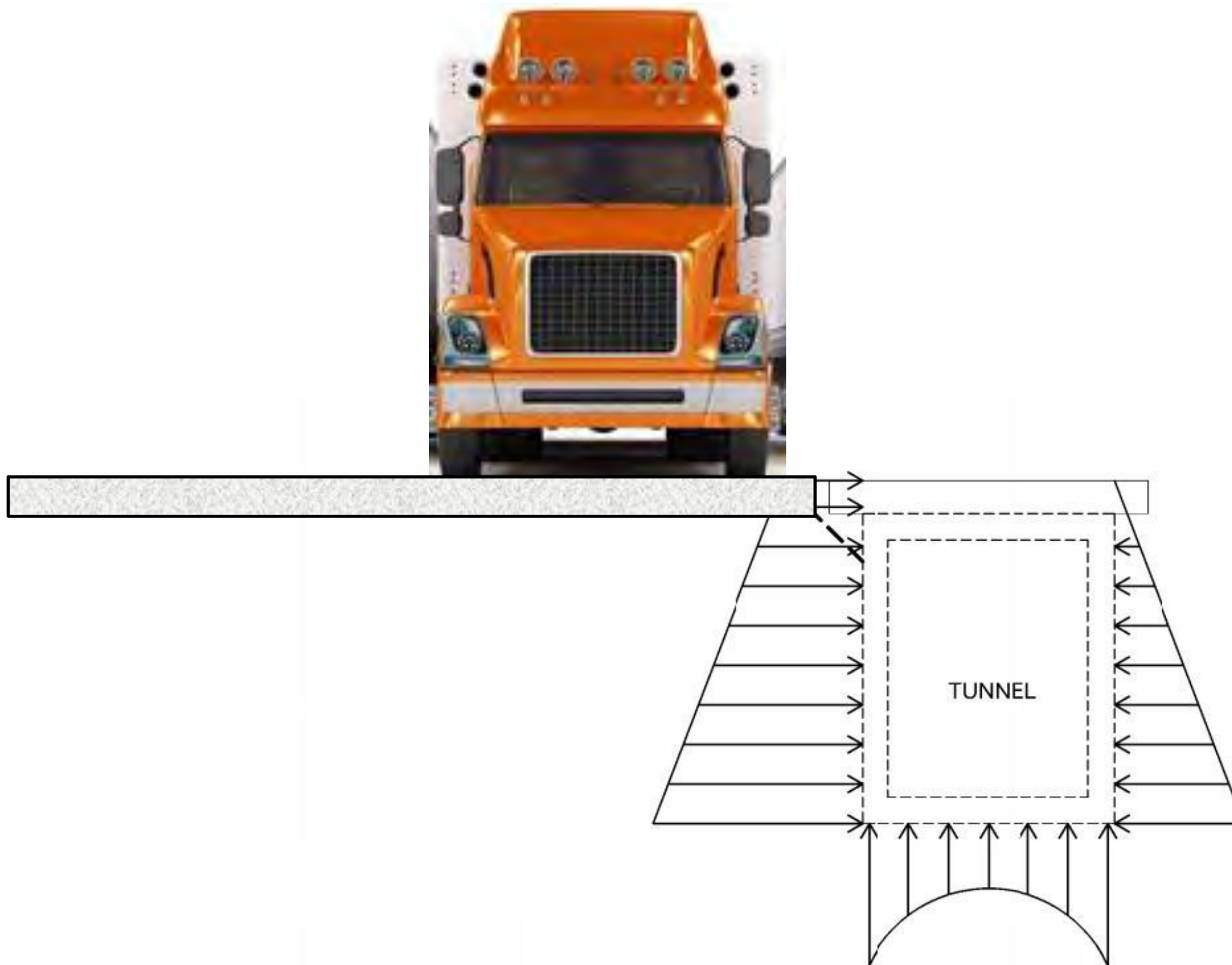
Examples of Assessments

Changing conditions



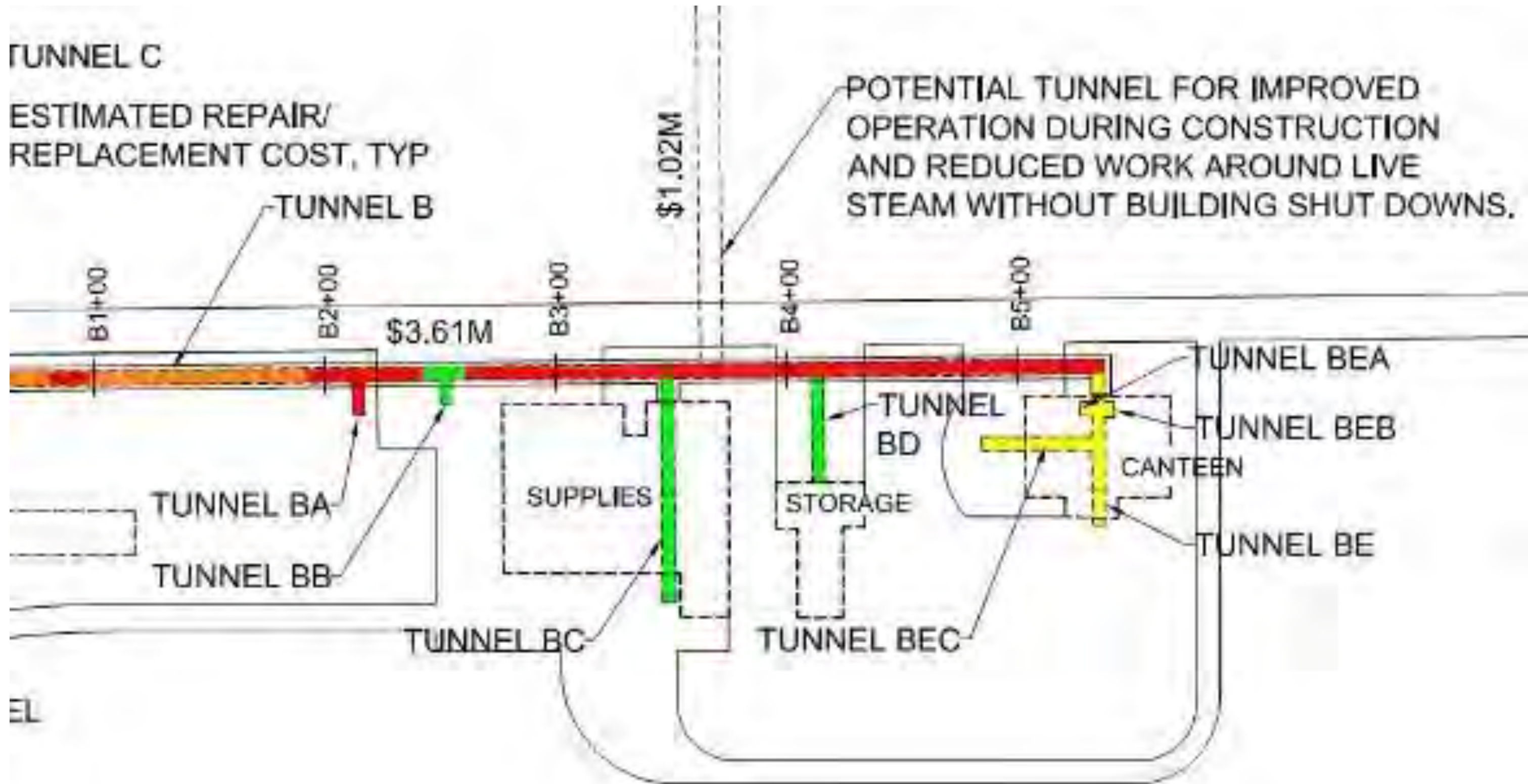
Examples of Assessments

Changing conditions



Examples of Assessments

Changing conditions



Benefits of a Review and Assessment

Identify safety concerns

Identify security concerns



Benefits of a Review and Assessment

- Develop maintenance plans
- Prioritize repairs

Table 1.4 – Summary of Severe Deterioration in Tunnels

Tunnel	Location	Priority	Remarks
Tunnel A	2+00 to 3+00	4	Monitoring heaving floor. Area is in flood zone adjacent to Water Plant.
	10+50 to 11+00	3	Monitoring roof delaminations and spalls. Area is under a pedestrian path adjacent to railroad bridge.
	15+00 to 16+00	1	Monitoring wall delaminations and spalls. Area is under Avenue. Cosmetic repairs completed on west wall in summer of 2016. Performance of these repairs will be monitored. Delaminations found in repairs.
	20+50 to 21+50	4	Monitoring wall delaminations and spalls. Area is under parking lot south of
	25+15 to 25+50	4	Monitoring roof delaminations and spalls. Area is adjacent to footbridge abutment.
	27+90 to 28+10	4	Monitoring roof delaminations and spalls. Area is under sidewalk and adjacent to St.
Tunnel B	8+50 to 14+82	1	Deterioration rate appears to be accelerating.
	21+00 to 21+50	4	Monitoring concrete roof delaminations and spalls in brick arch tunnel. Area is under grass adjacent to a sidewalk northwest of Hall.

Benefits of a Review and Assessment

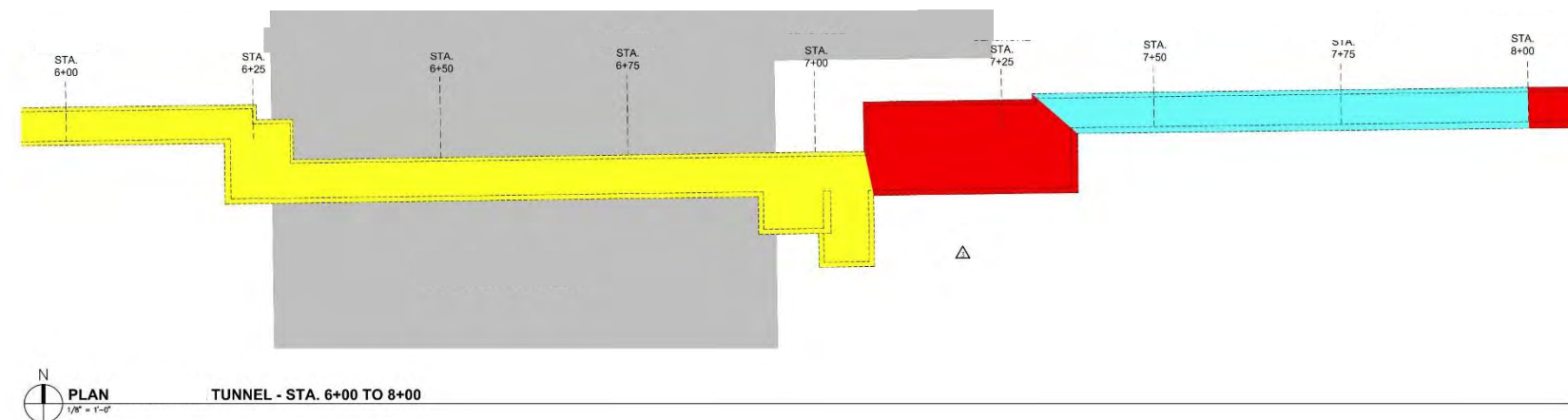
- Planning
 - Incorporate work into other projects
 - Determine the rate of deterioration
 - Develop budgets for repairs
 - Estimate remaining service life
 - Make future design decisions

Table 1.3 – Projects in Vicinity of Steam Tunnel and Vaults (continued)

Current	Project Name	Project #	Tunnel or Vault in Vicinity	Anticipated Work on Tunnel or Vault
	General - Replace Condensate Line Beneath	0720301	H4 and H6	Replace condensate pipe under Replace roof of H6 to facilitate pipe installation. Project will start construction soon.
	Replace Condensate Distribution Lines from Vaults G14 to G5	0728701 WT-001	G14 and G5	Study to replace condensate line under Drive. No work on vaults is currently being considered.
	Leak at expansion joint in Vault D5	0728701 WT-### (not yet defined)	D5	Not yet defined
	Support column concerns in Vault D9	0728701 WT-### (not yet defined)	D9, Service tunnel to south of Tunnel	Not yet defined
	Replace Condensate Distribution Lines Under Street from to Tunnel	0728701 WT-### (not yet defined)	Tunnel	Study to replace condensate line under Street. No work on tunnel is currently being considered.
	Replace Condensate Distribution Lines Under Street from Ramp to Tunnel	0728701 WT-### (not yet defined)	Tunnel	Study to replace condensate line under Street. No work on tunnel is currently being considered.
	Replace Parking Ramp Entrance	0706701	D9, Service tunnel to south of Tunnel	Study to replace pavement on west side of Parking Ramp. No work on vault roof is currently being considered.

Benefits of a Review and Assessment

- Convey information
 - Trained, unbiased, third party opinion to those not typically in tunnels but making decisions regarding their maintenance
 - Simplify complex condition
 - Describe general conditions
 - Quick reference
 - Collect information in one location



① 6+21 - EAST WALL LEAK AT CONSTRUCTION JOINT. GRATING DETACHED FROM OPENING



② 6+42 - CONDUIT LEAKING WATER INTO TUNNEL



③ 7+20 - LARGE DELAMINATION ON ROOF SLAB AROUND PIPE



④ 7+25 - LARGE ROOF SPALL



⑤ 7+30 - SEVERE ROOF SPALL



⑥ 7+36 TO 7+45 - ROOF WITH LARGE OPENING WITH VALVE AND BAR EXPOSED AND SPALLING



⑦ 7+08 - ROOF DELAM

LEGEND	
	NO DETERIORATION
	MILD DETERIORATION
	MODERATE DETERIORATION
	SEVERE DETERIORATION
	HAZARDOUS DETERIORATION

Benefits of a Review and Assessment

- Potential Scope Items
 - Observe and record distress by station
 - Locate and review all steam anchors
 - Locate and review tunnel access hatches
 - Locate and review tunnel ventilation
 - Locate tunnel obstructions
 - Locate missing or damaged insulation
 - Locate insufficient light levels
 - Locate steam or condensate leaks
 - Record temperature data
 - Assess tunnel condition
 - Prioritize repairs, provide costs
 - Summarize findings
 - Document changes in follow up reviews



Thank you

- Observe
- Document
- Assess
- Plan
- Monitor
- Repair

