Independent Evaluation Confederation Line 1 Safe Return to Service Status Update

Technical Briefing

City of Ottawa Transit Commission

By Transportation Resource Associates, Inc.

November 5, 2021

Review of TRA Scope of Work

- TRA charged with independently assessing Confederation Line 1 safe return to service
- New and revamped structure and processes are in place and have been vetted by TRA
- TRA is actively reviewing implementation and stress-testing of the plan

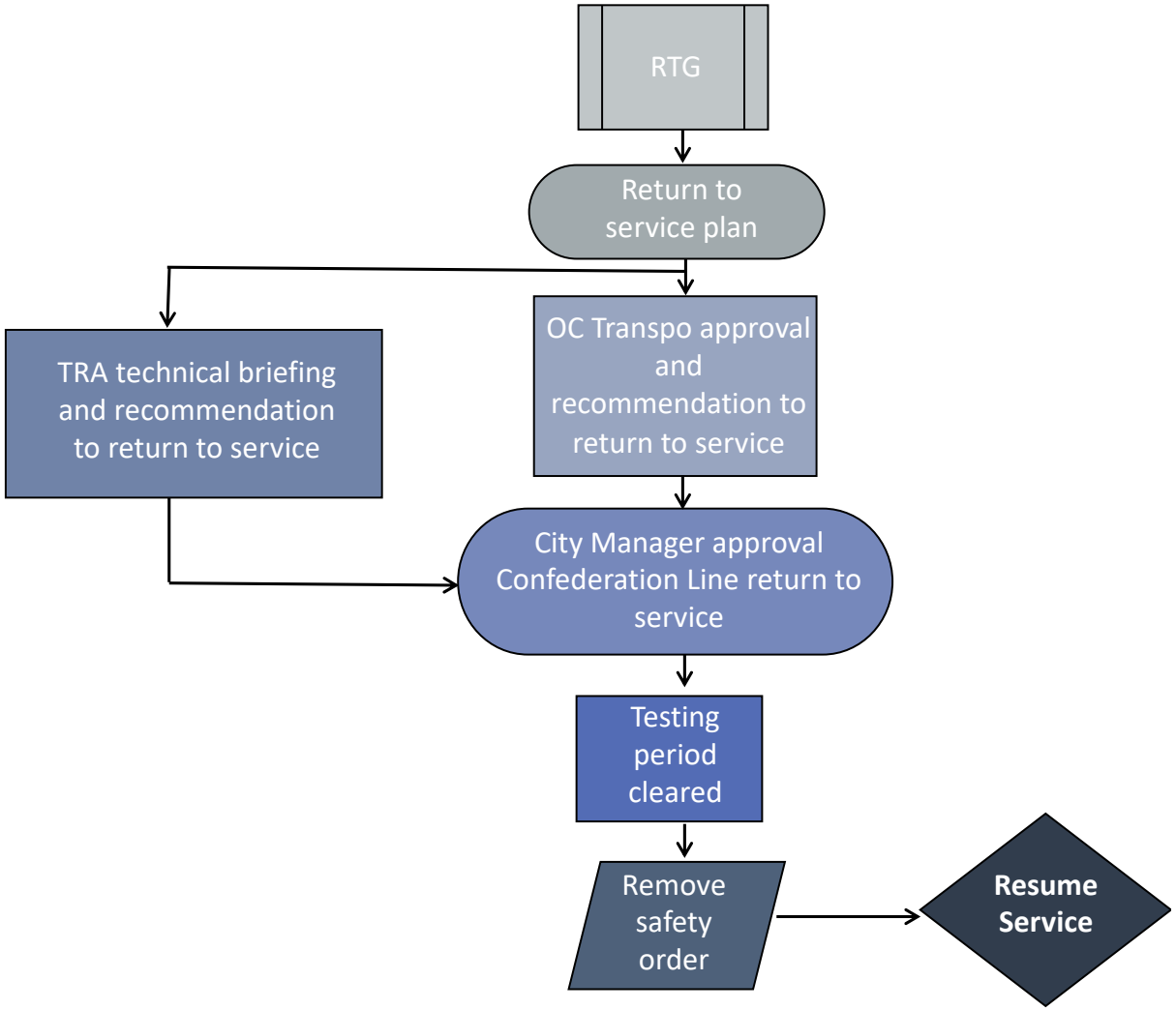
TRA Scope of Work

- Evaluate the appropriateness and adequacy of the investigations and root causes analyses (RCAs) of the August 8th and September 19th incidents
- Determine if primary and contributory causes of incidents were clearly identified and examined
- Assess the validity of the proposed short- and long-term corrective action plans and actions to be instituted to address the RCA
- Ensure there is a close nexus between these proposed action items and the deficiencies they are intended to address
- Examine the comprehensiveness of corrective action documents developed in response to the RCA
- Independently observe and evaluate the implementation of the corrective actions
- Advise the City of Ottawa on completeness and appropriateness of actions undertaken and changes in practice to assure a safe return to service and sustained LRT safety
- Did not investigate issues of Confederation Line 1 project structure, except as specifically related to the two derailments at hand or to overall safety capacity

Stakeholders Involved

- City of Ottawa
- OC Transpo
- RTG/RTM
- RTG/RTM subcontractors
- Parties have been transparent and cooperative throughout TRA's work
- We appreciate their coordination and City Council's questions and input

Return to Service Process

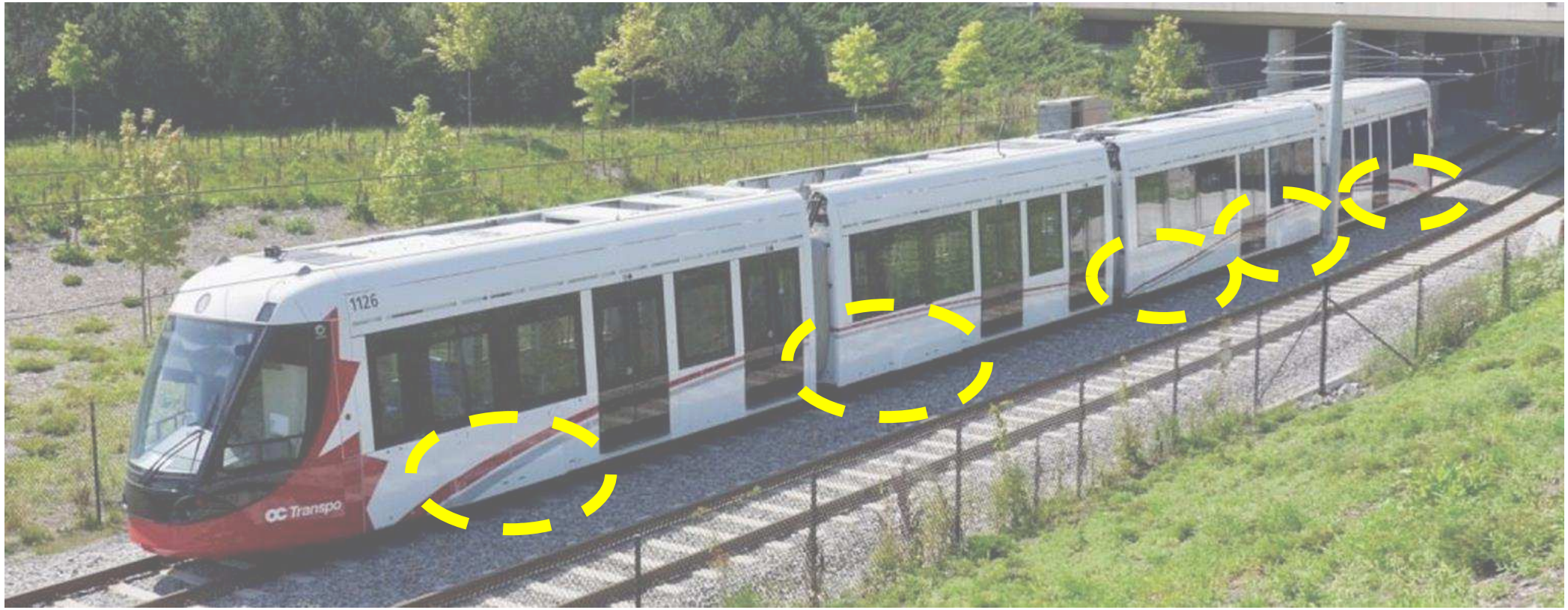


Summary of August 8th Derailment of LRV 19

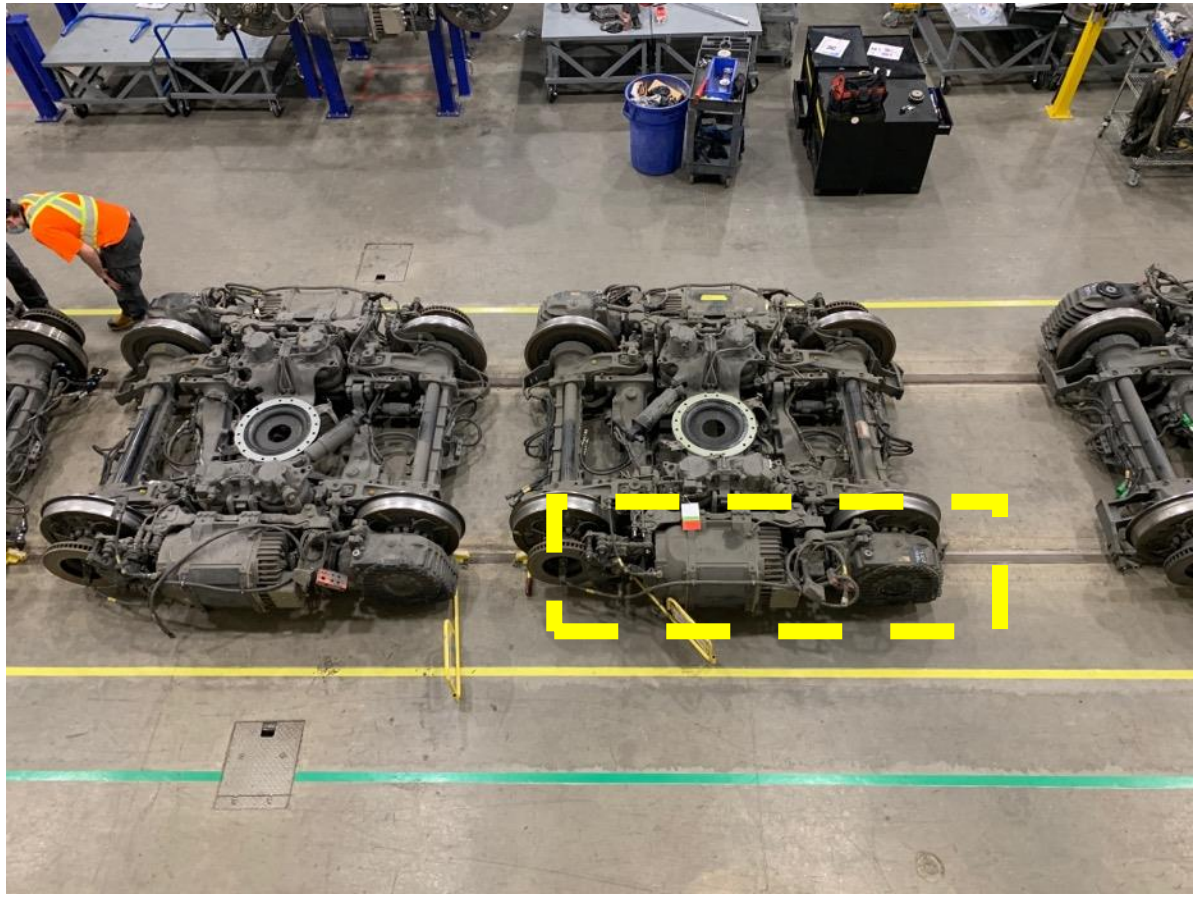
- Analysis and investigation indicate bearing failed, wheel disconnected from axle
- Root cause analysis provides information (and mitigations) to allow service to resume
- Analysis implicates motor bogies with higher kilometrage
- Contractor has short-term mitigation to test bearings, predict potential failures, and repair trains
- Thermal, metallurgical, design analyses are nearly complete, will help prescribe best long-term mitigations

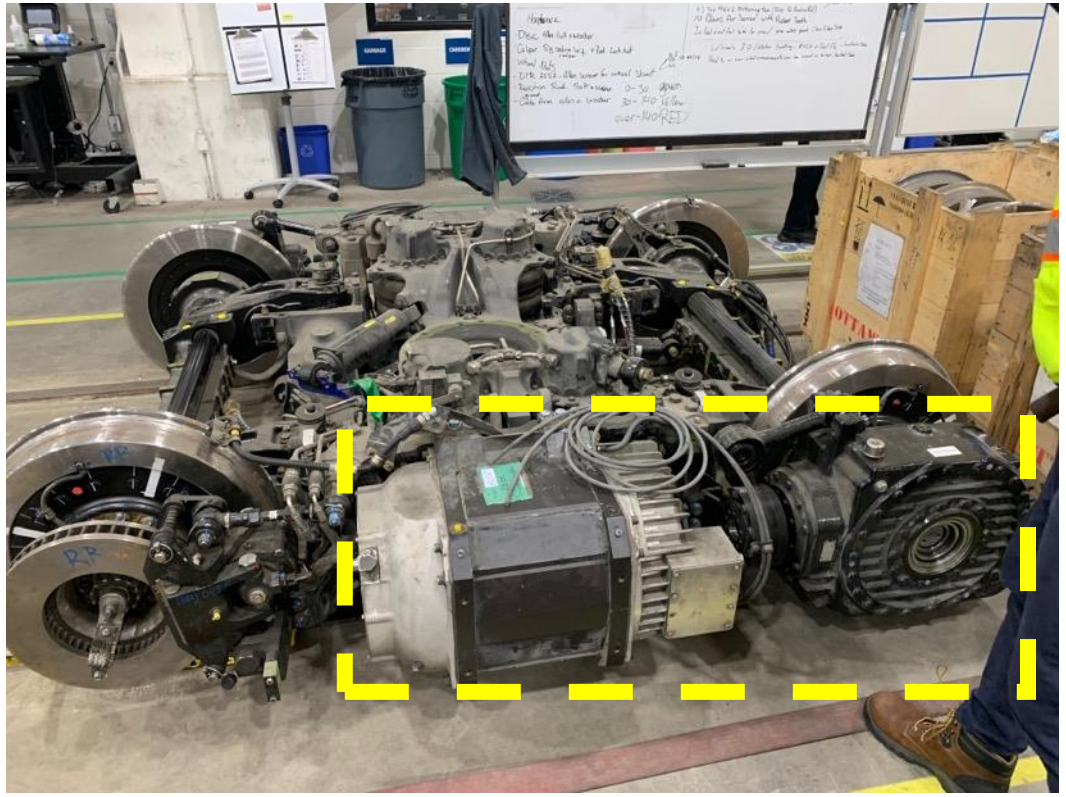
Confederation Line 1 LRV

Bogie Locations



Bogie Assembly





Overhead view of motor bogies (3 per train plus 2 non-motor bogies). Motor and gearbox highlighted.

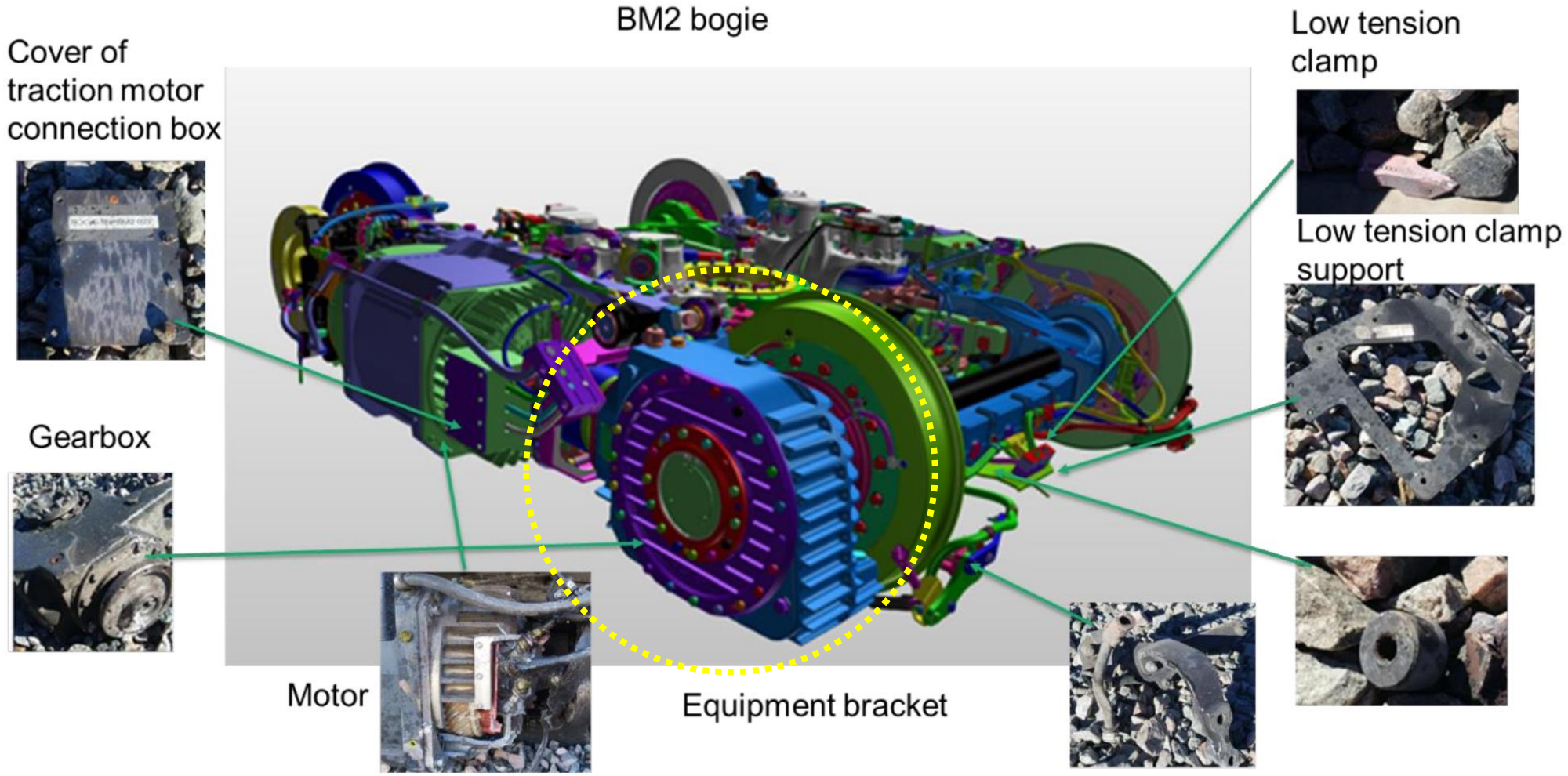
Bogie Assembly

One cartridge bearing assembly (shown below) is the interface between each wheel and the bogie axle

Summary of September 19th Derailment of LRV 21

- Bolts on bogie gearbox were not properly torqued
- Gearbox lost connection with bogie, contacted Tremblay Station platform and track structure, causing derailment
- Process, quality assurance, safety management, and organizational issues contributed to key steps being missed (aligned with TSB findings)
- Revisions to maintenance practices and procedures; addition of supplemental QA/QC; and long-term monitoring enhancements identified as solutions

Gearbox Bolts Torque



Technical Issues and Safety Framework

- Safe return to service has focused on both technical issues (discussed above) and overall safety management and oversight
- There are several layers of safety programs, monitoring, and oversight in place
- Safety framework must be robust enough to address both these two derailments and their technical issues, as well as day-to-day safety decisions

Safety Management System (SMS)Framework

- What is SMS
- Industry standard for public transport, other industries
- Based on four SMS pillars:
  - Safety policy and objectives
  - Risk management
  - Safety assurance
  - Safety awareness
- Functions as a comprehensive, risk-based approach to safety
- Applicable to all levels of safety, including operations, maintenance, risk assessments, and this return to service process
- Robust SMS such as OC Transpo's matches appropriate mitigations to safety issues, from small process improvements to halting service (as happened twice this year)

Confederation Line Oversight Framework

- Based in the SMS framework noted above
- Department- and function-specific safety oversight
- OC Transpo Safety
- City of Ottawa City Manager
- City Regulatory Monitor and Compliance Officer
- The proper and effective implementation of this system of checks and balances should result in a high level of safety assurance.

TRA Monitoring Activities to Date

- Over 80 inspections, interviews, and meetings Oct 4-Nov 5
- Interviews, meetings daily (sometimes 3-4 a day) since October 4
- Site inspections, oversight, and monitoring
- Documentation, records, investigation reports, and analyses assessments (over 200 documents reviewed)
- Assessment of contractor resources and personnel on-site at MSF and as part of return to service plan

TRA Inspections, Interviews to date

10/4/21	Meeting with OC Transpo, contractors, and stakeholders	10/20/21	City Council Transit Commission	10/28/21	Observation of switch locking tests at Tremblay
10/4/21	Meeting with OC Transpo safety	10/20/21	General checkin with Safety	10/28/21	Site visit to MSF2, critical torquing review process
10/5/21	Review of Sharepoint/Safety documents	10/21/21	Daily LRV touchpoint meeting	10/28/21	Observation of bearing play test / inspection at MSF
10/5/21	OC Transpo/RTM safety meeting and review	10/22/21	Daily LRV touchpoint meeting	10/29/21	Review of return to service documentation to date with OC Transpo and RMCO
10/6/21	Meeting with OC Transpo, RMCO	10/22/21	Weekly TRA/City Meeting	10/29/21	Meeting with OC Transpo safety
10/6/21	Meeting with OC Transpo, oversight team	10/25/21	Daily LRV touchpoint meeting	10/29/21	Daily LRV touchpoint meeting
10/6/21	Daily infrastructure repair update	10/26/21	OC Transpo re comments on infrastructure plan	10/29/21	Review of return to service document status and expectations
10/6/21	Daily infrastructure repair update	10/26/21	OC Transpo and RMCO re return to service plan drafts to date	10/30/21	Daily LRV touchpoint meeting and review of return to service documents to date
10/8/21	Daily infrastructure repair update	10/26/21	RTM Safety Briefing	10/31/21	Daily LRV touchpoint meeting
10/12/21	Meeting with RTG, OC Transpo, Ottawa city oversight	10/26/21	Review of RTM SMS and safety approach	10/31/21	Call re LRV open work orders
10/12/21	Meeting with Sam, Brandon, Troy	10/26/21	Daily LRV touchpoint meeting	10/31/21	Call re LRV open work orders
10/12/21	TRA internal debrief	10/26/21	Site visit to MSF	11/1/21	Daily LRV touchpoint meeting
10/12/21	Meeting with OC Transpo, RTG	10/26/21	Review of LRV return to service/inspection records binder	11/1/21	RTS documents briefing/review
10/12/21	Meeting with CMO, OC Transpo	10/26/21	Site inspection of Tremblay incident site	11/1/21	RTS documents status/update
10/13/21	Meeting OC transpo, RTG, Transport Canada	10/26/21	Review of conical bearing assembly specificsq	11/1/21	SMS document update/status
10/13/21	Daily infrastructure repair update	10/27/21	Daily LRV touchpoint meeting	11/1/21	Review of infrastructure repair documentation
10/14/21	Meeting with OC Transpo, Sam/CMO	10/27/21	RTG/RTM incidents and corrective action plans update meeting	11/1/21	Inspection of LRVs 1105 and 1113 in MSF, review of torque/critical connections c
10/14/21	Daily infrastructure repair update	10/27/21	Review of OC Transpo operations training cirricula and practices	11/2/21	Daily LRV touchpoint meeting
10/14/21	OC Transpo meeting re docs to date, city council meeting upcomin	10/27/21	Review of OC Transpo SMS process and framework	11/2/21	Inspection of LRV return to service documentation/binders at MSF
10/15/21	Daily infrastructure repair update	10/27/21	Informal meeting with OC Transpo re safety department	11/2/21	Review of RTS document status
10/15/21	Return to service plan workshop	10/27/21	Investigations and corrective action plans meeting/review with RTM	11/2/21	Review of RTS document status, schedule
10/17/21	meeting re return to service plan documents received Friday	10/27/21	Observation of switch testing, PICO testing, signal testing at and near Tremblay Static	11/2/21	Discussion of slewing ring torque issue, LRV binder observations, overall quality
10/18/21	meeting RE safety critical connections	10/27/21	Review of LRV return to service/inspection records binders for 1115 and 1110	11/3/21	Daily LRV touchpoint meeting
10/19/21	O Line MSF meeting and tour Oct 19	10/28/21	Review of OC Transpo operations training	11/3/21	Review of RTS document status
10/19/21	SMS overview/orientation	10/28/21	Meeting with city manager	11/3/21	Meeting with Renée Amilcar re open items
10/19/21	Training discussion re return to service	10/28/21	Meeting with Renée Amilcar, Troy, Brandon, Dan, Ken, et al	11/4/21	Observation and inspection of mock service/testing
		10/28/21	Daily LRV touchpoint meeting	11/5/21	Review of control center and operations reports and data from mock service

Mitigations and Corrective Actions

- Short-term: Implemented prior to return to service
- Long-term: Implemented over a longer time frame, but committed to by appropriate stakeholders prior to return to service
- Both short- and long-term mitigations vetted, approved, and monitored using SMS approach by the City, OC Transpo, and independently by TRA

Root Causes vs. Corrective Actions

Incident	Root Cause/Issue	Corrective Action	Status
August/LRV19	Bearing failure – excessive play in bearing and lock nut	Physical, hands-on check of bearing play on all wheel assemblies and bearings every 7500 km (approx. 2-3 weeks)	All LRVs checked, inspections to be repeated on an ongoing basis. Documented in LRV-specific binders.

Root Causes vs. Corrective Actions

Incident	Root Cause/Issue	Corrective Action	Status
August/LRV19	Bearing failure – lack of bearing failure detection system	Under review by OC Transpo and contractor	RTG analysis to determine best option for Confederation Line 1 to be submitted to and approved by City

Root Causes vs. Corrective Actions

Incident	Root Cause	Corrective Action	Status
September/LRV21	Process and quality failure in maintenance	Reinspection of all critical connections (from roof down to wheels)	Completed for all LRVs to be used in service, required for additional LRVs prior to their re-entry into service, documented in LRV-specific binders

Root Causes vs. Corrective Actions

Incident	Root Cause	Corrective Action	Status
September/LRV21	Process and quality failure in maintenance	Revamped quality control and quality assurance processes, implemented for all aspects of critical connections check	Completed for all LRVs to be used in service, required for additional LRVs prior to their re-entry into service, documented in LRV-specific binders

Possible Contributory Causes vs. Corrective Actions

Incident	Contrib. Cause	Corrective Action	Status
August and September derailments	Spin/slide indication	Data and train algorithms under review	Ongoing, active analysis to determine if types or thresholds of spin/slide data can be used to alert to a problem

Possible Contributory Causes vs. Corrective Actions

Incident	Contrib. Cause	Corrective Action	Status
August and September derailments	Operator awareness of derailment	Retraining of all operators for situational awareness	Complete, to be monitored ongoing by supervisors and trainers

Return to Service Activities – LRVs

- In addition to mitigations and corrective actions associated with root causes (above)
- All LRV safety-critical open items addressed prior to trains entering testing (including wheels)
- Per-train testing
- All issues identified during any testing phase thoroughly investigated and resolved

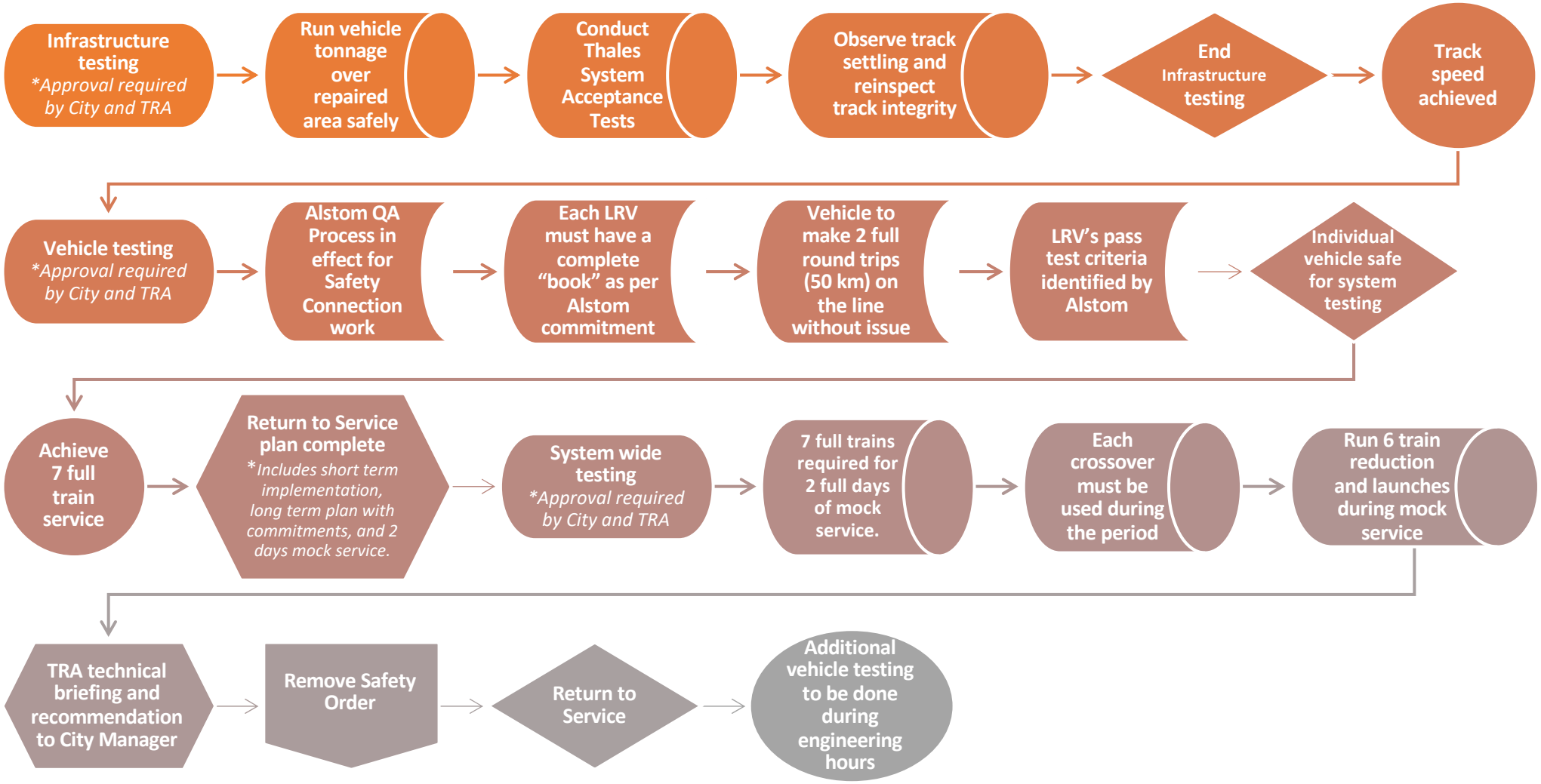
Return to Service Activities - Infrastructure

- Infrastructure repairs, inspection, and testing including station, track, train control system
- Infrastructure testing with trains
- All Confederation Line 1 system elements, including those not involved in derailments (stations, elevators/escalators, overhead catenary system, etc.) current on preventive maintenance inspections

Return to Service Activities

- Operations personnel refreshed/trained on
  - Confederation Line 1 changes and updates
  - Safety reporting systems
  - Alertness for unusual or unsafe issues with train or systems
- Supervisors, instructors, safety personnel on mainline for mock service and return to service
- Overall system testing, mock service
- Detailed TRA review of mock service performance and results (in process)

Testing Process and Monitoring



Ongoing Monitoring and Mitigations

- TRA has observed testing and inspection of vehicles, track, switches, signaling and will continue to monitor maintenance and operations activities
- TRA witnessing and monitoring mock service and first days of return to service
- TRA to regularly assess and verify short-term mitigations status
- TRA to witness and monitor long-term mitigations and status
- Once service resumes, City and OC Transpo (including at TRA's recommendation) can order Confederation Line 1 service suspended again for safety reasons
- Additional trains returned to service will follow the same safety and monitoring processes outlined herein, up to resumption of full service

Testing Status

- Mock service testing based on established criteria
- Mock service started Thursday Nov 4
  - Identified LRV issues
  - Took LRVs out of service immediately per procedure
  - Currently under investigation for any individual and systemic issues
  - Will not re-enter service until resolved
- Mock service will continue until safety and reliability are assured
- TRA will independently verify successful completion of mock service prior to revenue service beginning

Safe Return to Service Determination

- Contingent on safe and reliable completion of mock service – currently in process
- Contingent on final documentation review
- Contingent on demonstrated allocation of additional, qualified resources by RTG and its contractors
- Contingent on RTG commitments to long term solutions
- Contingent on and bolstered by ongoing and increased monitoring, including contractor, OC Transpo, City, and independent TRA monitoring
- TRA will then concur that Confederation Line 1 can safely return to service